Preparation for Initial Company Operations

PICO-Student Manual

1st Edition, 5th Printing-April 2014

FEMA

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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), National Fire Data Center (NFDC), and the National Fire Programs (NFP). 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.

Preparation for Initial Company Operations (PICO) is designed to provide a basic foundation for the management of one or more companies operating at a structural fire emergency. The focus of these five units is a review of basic concepts and development of proficiency in critical skills. Key content includes Roles and Responsibilities, Readiness, Communications, Building Construction and Fire Behavior Factors, and Preincident Planning.

Recently, the curriculum for this course has been revised. The revisions were made to apply recent work in naturalistic decisionmaking, and particularly a Recognition-Primed Decisionmaking (RPD) model of how fireground commanders actually make decisions when faced with time pressure and uncertainty.

Calderwood (*Fire Command*, Aug., 1988) has described the research project that showed that fireground commanders rarely generate alternative options and evaluate these options systematically to select the best. There simply is not sufficient time. Moreover, fireground commanders are able to use their experience to identify a reasonable course of action as the first one they consider. Generally, commanders take advantage of their experience to initiate a course of action rapidly, which is how they can make decisions so quickly. If the commanders are concerned about whether the typical course of action will be successful in the actual situation they are facing, the common strategy is to imagine how the course of action will be carried out, looking for ways in which it might lead to complications. If none are found, the course of action is initiated. If minor complications are found, the fireground commander will try to improve the action. If the improvements aren't going to work, the commander will reject the action and consider another typical strategy.

Although the RPD model appears to describe how fireground commanders make decisions, we have not included the model in the student materials. Little is to be gained by explaining to you how you already think. Instead, the course revisions have been based on the RPD model. Since situation awareness, or sizeup, is so central to effective decisionmaking, we have enhanced the materials describing the critical cues for making difficult judgments. Critical cues are those that can cause a shift or an elaboration in the commander's assessment of the situation. This should help you gain a better sense of what you are monitoring. A second modification is to provide guidance to instructors about how best to use debriefings that follow exercises. Too often, these debriefings cover only the wrong actions, and the actions that should have been taken. The value of these debriefings can be increased substantially by having the students consider the way they were interpreting the situation, and how they arrived at that interpretation, including a mental model of what was happening, goals they selected, cues they were watching for, and so forth. We feel that these types of enhancements will help students achieve a higher level of success in using recognitional decisionmaking.

As you proceed through the course, you may have questions that can't be answered in these materials. The USFA has many publications that may be helpful. A list of these can be obtained by calling 1-800-238-3358, extension 1358.

To request one of these publications by title or by publication number, call the automated service number: 1-800-238-3358, extension 1660.

The USFA's Learning Resource Center (LRC) also is available to assist with further research; call 1-800-238-3358, extension 1030.

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COURSE SCHEDULE

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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.

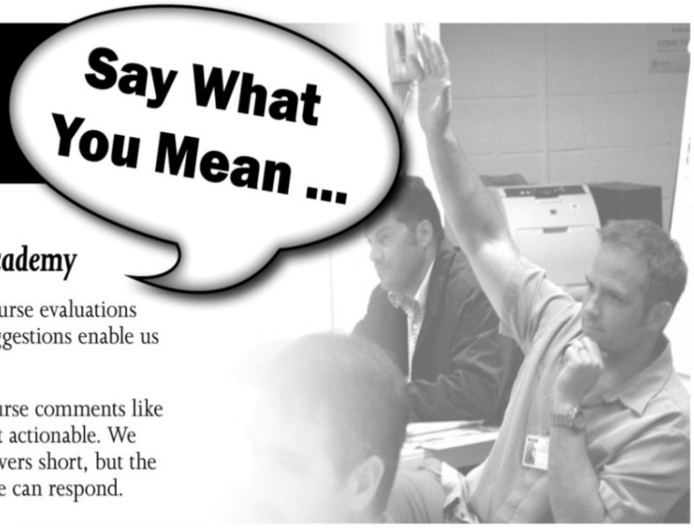
FIREFIGHTER CODE OF ETHICS

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

A Student Guide to End-of-course Evaluations



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:
ROLES AND RESPONSIBILITIES

OBJECTIVES

The students will:

1. *List the eight components of Company Officer (CO) leadership and explain the importance of transition from firefighter to CO.*

2. *Explain the key safety behaviors that affect safe tactical operations.*

3. *Identify the CO's responsibility for an organized approach to emergency incident management.*

4. *Describe the primary sizeup factors and determine their impact on strategies and tactics.*

5. *Analyze the command sequence action planning cycle.*

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INTRODUCTION

In many departments, the promotion from firefighter to officer involves being issued a badge and receiving a handshake from the chief. Often the training needed to handle the new responsibilities is obtained through the trial-and-error process known as "on-the-job" training. *Preparation for Initial Company Operations* (PICO) is designed to provide the new or prospective Company Officer (CO), in a more formal way, with the knowledge and skills necessary to perform effectively at an incident scene.

In smaller departments, the responsibility for company tactical operations may fall to a firefighter if an officer is not assigned to each company. For this reason there is a critical need for the firefighter to understand the roles of the CO.

Many inexperienced CO's assume that all they need to be successful is a basic knowledge of tactics and a good foundation of firefighting methods. In fact, performance at emergency incidents is based on the numerous roles that the CO plays, both on and off the incident scene. This course provides general background information on CO roles and responsibilities, with particular emphasis on those used to prepare for actual incident operations.

TRANSITION TO COMPANY OFFICER

The transition from firefighter to CO involves many changes. The CO supervises a small group of people and is a manager rather than the head firefighter. Once responsible to do the work, the CO now must get work done by others. The CO must gain the respect of the crew through strengthened leadership skills. Leadership traits do not appear suddenly upon promotion. The CO who wants to develop into an effective leader must study leadership and plan a self-improvement program to overcome perceived weaknesses. The CO must issue orders calmly and clearly, make them concise and complete, make sure they are understood, and, if possible, give enough background so their intent is understood. A CO must think, then act. Problems are compounded by hasty, unthinking actions.

In an article in the International Association of Fire Chiefs (IAFC) newsletter a number of years ago, Chief Louis Jaffe proposed a list of qualities and capabilities needed by successful fire service leaders:

- know your job;
- know yourself and seek self-improvement;

- know your people and look out for their welfare;
- keep your people informed;
- set the example;
- ensure that the task is understood, supervised, and accomplished;
- train your people as a crew;
- make sound and timely decisions;
- seek responsibility and develop a sense of responsibility among subordinates;
- employ your command in accordance with its capabilities; and
- take responsibility for your actions.

As a firefighter, the CO was responsible for his/her own safety, but now has the added responsibility for the safety of others. Safety is an attitude, and it is not restricted to the incident scene. The CO's approach to safety will be reflected in the operations of the crew. The CO must ensure that crew members are working together, and that other crews are not placed in danger through lack of coordination.

The new CO has a responsibility for incident management and must learn to manage each incident in a structured way. A system approach includes deciding what is to be done, when it is to be done, and by whom. Resource allocation becomes an important issue.

Even for the best officers, there are times when operations at an emergency scene seem to be a failure. Emanuel Fried, in his book *Fireground Tactics*, provided the following words of advice to the CO when this occurs.

> Command on the fireground is a demanding task for the officer. To improve the ability to handle the situation we have to concede certain basic faults that we find in ourselves. Admit these possibilities:
>
> 1. You are going to get excited.
>
> 2. You will yell.
>
> 3. You will make mistakes.
>
> 4. You will lose buildings.
>
> 5. Back in quarters the next day you will be brilliant in your diagnosis.
>
> 6. You will wonder whether you really know enough to be chief.

> Stop worrying. Every other chief felt the same way at some time. Now look at the fire scene. What is your job? It is this: To manage your personnel and equipment so that the situation is handled in the best possible way.

THE COMPANY OFFICER'S RESPONSIBILITY AS A LEADER

Leadership is a set of skills and attitudes that enable one to get others to accomplish objectives determined by the leader. **Management** is the skill of controlling and directing resources or functions while working toward accomplishment of these objectives. Management is doing things right; leadership is doing the right thing. The CO manages the fireground; the CO leads the fire attack. The leadership role involves both personnel and administrative responsibilities.

Personnel Responsibilities

The CO must foster teamwork and cooperation because most company operations are carried out through team effort and teamwork is especially important during emergency operations. The CO must help develop individuals so that they are prepared for their future leadership role in the department and develop teams through an understanding of group dynamics and sound management principles. Providing a positive role model sends strong messages about expected behaviors, and new members will conform closely to group norms.

Instruction and training support all functions of an organization, and the CO constantly provides this instruction both formally, through drills and practice, and informally, through explanations of policy and job requirements. The CO reviews performance of company members continuously by providing positive reinforcement for good behaviors and by making suggestions for improvement when appropriate. Discipline is instilled by fair and consistent enforcement of departmental rules and regulations.

Verbal and written communications are critical elements of leadership. Good verbal communication skills are needed to accomplish day-to-day work. Listening is an important, and often neglected, part of verbal communication skills. Written communication documents activities and provides formal avenues throughout the organization.

The CO must be self-motivated, and must draw on motivational skills such as providing feedback and creating a positive work environment to motivate individual members and to instill a team spirit and the ability to work together in the company.

Administrative Responsibilities

The CO must support the goals of the organization and direct work effort toward achieving them. The CO plans work assignments and adjusts schedules to meet constantly changing priorities. Reports and records furnish written documentation for all activities and provide protection in our litigation-sensitive society.

The CO assists with the preparation and management of a budget in assigned areas of responsibility. The CO controls costs by conserving energy and other department resources and by fostering proper care and use of apparatus and equipment.

THE COMPANY OFFICER'S RESPONSIBILITY FOR SAFETY

Firefighting is one of the most dangerous occupations in the United States. The fire service averages 100 to 130 deaths and well over 100,000 injuries in the line of duty every year. The CO must take a strong stand for firefighter safety, and inappropriate and unsafe behaviors must be corrected. Leadership at the incident scene must include the officer's ability to predict such occurrences as structural collapse, potential backdraft or flashover, and to evaluate the effectiveness and safety of the operational effort.

Key Safety Behaviors

After 10 years of research, Fire Chief Alan V. Brunacini of the Phoenix Fire Department developed 25 key firefighter safety behaviors:

1. **Think safety at all times.** Often, during accident investigations, firefighters are quoted as saying, "I just did not think." Although a simple step, due to the excitement and confusion of the incident, it's sometimes a forgotten one.

2. **Drive defensively.** The number of vehicles on the road requires extra attention to defensive driving.

3. **Drive slower rather than faster.** Don't let the excitement of the moment get out of control. Speed is a contributing factor in most fire apparatus accidents. The vehicle must always be under control--lights and sirens alone will not prevent accidents.

4. **If you can't see, stop.** Fire apparatus have the greatest number of accidents at intersections. The apparatus should stop at stop signs and red lights.

5. **Don't run for a moving rig.** Very dangerous practice--may slip or fall on apparatus room floor. Members should be properly dressed in personal protective equipment before boarding apparatus.

6. **Always wear your seatbelt.** Before apparatus moves, all members must be seated and belted. CO should give the order for the apparatus to move.

7. **Wear full turnouts and self-contained breathing apparatus (SCBA).** The failure to wear full protective clothing and SCBA has caused the highest number of firefighter fatalities and injuries over the years. An untold number of firefighters contract cancer or other related illnesses due to failure to wear proper protective clothing.

8. **Attack with a sensible level of aggression.** Be mindful of risk versus benefit. The risk/benefit analysis is one of the most critical decisions you will have to make. Take only the risks that have reasonable benefits. Sometimes the best action is no action (e.g., hazardous materials incidents until material is identified).

9. **Always work within the incident's organizational structure--no freelancing.** Each member on the incident scene reports to a single person and operates under that person's control.

10. **Keep crew intact.** You must know where your people are and what they are doing. You must know under what conditions they are working. For example, if you have personnel under extreme heat conditions operating in a confined space, there may be a potential for flashover and they would be in jeopardy. Recognizing the risks associated with introducing people into such an environment and the need to keep crews intact, it is critical to protect them with adequate backup lines, coordinate with ventilation tactics, and ensure communications capability. This will provide the Incident Commander (IC) with the necessary information to monitor safe firefighting practices and crew integrity.

11. **Always have a communications link to the next organizational level.** Report all significant activities to the next organizational level. Report completed or incomplete assignments and request additional resources from the next organizational level.

12. **Don't ever breathe smoke.** Smoke inhalation injuries continue to plague the fire service. SCBA protection must be maintained any time a firefighter is in a toxic atmosphere--this includes overhaul operations.

13. **Always have an escape route (hoseline/lifeline).** Heavy smoke conditions or an interruption of the thermal balance may cause reduced visibility. When the conditions require a rapid retreat, the hoseline or lifeline will help maintain orientation.

14. **Never go beyond your air supply.** Many factors must be considered when wearing SCBA, including training, experience, physical fitness, etc. The nature of some incidents requires extended SCBA air supply (e.g., hazardous materials incidents, subway fires, and highrise fires).

15. **Use a big enough and long enough hoseline.** The selected hoseline needs to be able to deliver adequate water supply to handle the fire. It is much easier to deploy a long enough and large enough hoseline the first time. Formulas and problem-solving exercises for determining fire flow are contained in Unit 5: Preincident Planning.

16. **Evaluate the hazard--know the risk you're taking.** Don't get tunnel vision--look at the big picture. Forecast what the conditions will be in the future. Be proactive.

17. **Follow standard incident procedures.** Know and be part of the plan. Follow the action plan established by the IC. Use sound, standard fireground procedures.

18. **Vent early and vent often.** Proper ventilation will reduce the possibility of backdraft (smoke explosion) and will lower heat and smoke conditions, making the situation safer.

    Ventilation is required when there is a fire in any type of structure. The degree of ventilation required is in direct proportion to the amount of products of combustion being produced. One large hole placed effectively over the area of involvement is far better than many small holes surrounding the area.

In a working fire situation, proper ventilation results in:

- the lifting of the smoke towards the ceiling of the rooms and the ventilation opening;
- greater visibility;

- a reduction in interior temperatures; and
- an increase in the intensity of the fire as it gets additional oxygen, due to the draft caused by the ventilation procedure.

The ventilation procedure must provide sufficient transfer of combustion products to the outside in order to achieve the desired results. Note also the contradiction that exists between points three and four. The fire can be expected to become more intense, yet there will likely be a reduction of interior temperatures due to the release of heat through the ventilated area. During ventilation it is especially important that the IC and the ventilation supervisor stay ahead of the fire, anticipating where it will go so that they can control the flow of the products of combustion--away from occupants or interior firefighters.

19. **Provide lights for the work area.** Lighting the work area reduces the chances of slips and falls. Apparatus should be designed to handle this task.

20. **If it's heavy, get help.** Back strains and sprains remain a leading cause of firefighter injury. Take the time to get extra help if needed.

21. **Always watch your incident position.** Remember that conditions are changing constantly--adjust your plan accordingly. Brush fires, where wind and weather conditions are changing, are a prime example.

22. **Look and listen for signs of collapse.** Newer, lightweight construction makes predicting building collapse difficult or impossible. Constantly monitor the building's condition and pay attention to all signs of collapse.

    Unless you know otherwise, all construction should be considered to be lightweight. This type of construction is the most dangerous to the firefighter from the viewpoint of potential for collapse. Assume lightweight until you are able to confirm some other, more substantial type. In addition, you also must remember that older construction technologies do not ensure safe operations.

In lightweight construction, such as parallel-chord wood truss, plywood I-beams, or pitched truss, collapse has been known to occur in as few as 5 minutes after the fire has involved the assemblies. For steel-bar joist truss, collapse has occurred in as few as 9 minutes.

Collapse indicators may include creaking or cracking sounds, but during a fire you may not hear these. There are other cues to look for:

- Building distortion (twisting, leaning) must be recognized.

- Horizontal cracks in drywall on interior walls may indicate that the floor is sagging and pulling away from the wall assembly.

- Horizontal cracks in exterior brick may indicate wall failure. Remember, many times the walls hold the floors up. Realize that if the walls fail, the floor also will collapse.

- Vertical or diagonal cracks or bowing of brick walls need to be recognized and monitored. Again, wall failure could follow.

- The length of time the fire has involved structure-bearing members must be monitored. Unprotected metal members ordinarily fail rapidly when exposed to high heat or direct flame contact, even for short periods of time.

Note: Realize the potential for sudden collapse without warning, and account for this in your strategic and tactical planning.

23. **Rotate fatigued companies--assist stressed companies.** Fatigued firefighters have a higher injury rate than rested firefighters. Rehabilitate personnel when necessary.

    There is a basic rule of thumb for firefighter rotation. Firefighters should be rotated out after they have consumed two full air bottles on their breathing apparatus. (The firefighter gets a slight breather while the first bottle is being replaced with the second bottle; after the second bottle is consumed, the firefighter should go to rehab to rest and replenish fluids.)

    Other factors affecting the rate at which firefighters get fatigued include the level of effort being expended (e.g., holding a hose versus going up and down stairways) and the humidity (the onset of fatigue occurs more rapidly in very humid climates). Studies have shown that firefighters lose about 70 percent of their energy through dehydration. Departments should have a definitive rehab procedure so that command officers can project total resource needs and have sufficient companies on scene.

24. **Pay attention all the time.** Never lose sight of the environment in which we operate. The environment provides you with cues that help you anticipate rapid shifts in the situation (e.g., hot dark smoke and/or the presence of dark carbonization on the window glass may indicate that backdraft is imminent). Some of the cues that help you predict these shifts are covered in Unit 4: Building Construction and Fire Behavior Factors.

25. **Everybody takes care of everybody else.** Safety is everybody's responsibility. We owe a duty to each other to be safe.

ANALYTICAL SIZEUP FOR INCIDENT MANAGEMENT

The Scientific Method

The Scientific Method involves observing facts, then testing the accuracy of these facts through continued observation. If the facts prove accurate, the scientist seeks some causal relationships between them and other happenings from which logical hypotheses 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 then are called principles.

For decades, the fire service has been observing facts at fires. 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 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 factors." 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.

Strategies and tactics are the activities undertaken to achieve objectives; such activities include forcing entry, ventilating, using hoselines, over-hauling, making decisions, 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, strategies and tactics also can 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 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 already have 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 then will 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 standpipe risers in a city highrise building. It is this universal application of firefighting principles that makes standardized training both possible and practical.

Primary Factors Size-Up Chart

Pertinent factors: It has been established that to systematize the science of firefighting, it is necessary to define variables and limits and to ascertain the relationships among 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 CO's 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 strategies and tactics on the basis of the evaluation made.

The Primary Factors Size-Up Chart (see Appendix) facilitates the study of relationships among primary factors, and indicates the sequence of coverage. Extensive explanations are necessary since all primary and secondary factors that conceivably could 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 hectic conditions. In addition, such lectures or discussions may provide helpful information about only one set of circumstances in one given situation. CO's actually need helpful information about any set of circumstances in any fire situation.

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Activity 1.1

Using the Primary Factors Size-Up Chart

Purpose

To use a Primary Factors Size-Up Chart to analyze a simple incident.

Directions

1. Use the Primary Factors Size-Up Chart in the Appendix to analyze the primary factors of the incident shown on the slide.

2. Indicate the pertinent primary factors in Column #1, on the left side.

Problem Description

Two-story single-family dwelling with an attached garage and no basement. It is 11 a.m. on Wednesday, and the weather is mild. On arrival, fire is visible on the first floor in the A-D corner. An occupant is visible in a second-story window. She appears to be scared but unharmed at this time.

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Evaluating Primary Factors

Life Hazard for Occupants and Firefighters

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.

Safety--Acceptance of warranted risks is essential for good results in carrying out fire activities. A reasonable expectation exists to save lives.

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 a pipe recess or similar channel, the roof should be opened. If this is 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 single-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 the 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 structural channel will spread readily. CO's 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 size hoseline to 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 still will govern the placement of lines.

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

Heat transfer--radiation--Radiation is energy in the form of electromagnetic waves, which are traveling disturbances in space and which include light, heat, radio waves, 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 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.

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 a small fire. In such circumstances, make entry in the manner least damaging to property. Using a key may be a solution. Where the extent obviously is substantial, however, such consideration is not warranted. Speed in getting an efficient operation underway 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 CO's 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). CO's who can check internal extension of fire more frequently 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."

CO's 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 city firefighters are no longer the only ones who have to face fires in highrise buildings or large industrial complexes. 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 also can 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 also can 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 that absorbs heat and delays transmission, but not as effectively as highly 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 lead to 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 escape windows.

Ventilation--Horizontal ventilation is achieved by opening doors and windows. Vertical ventilation is achieved by opening roof bulkheads and making openings 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 or 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 that case, fire escapes usually are used, but aerial ladders or tower-ladder platforms sometimes may 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 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 the fire area before opening lower levels for entry. Fires in cellars or subcellars have limited means of ventilation: deadlights in sidewalks, sidewalk 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 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 made quickly to draw heat and smoke away from the life-hazard area. Occupants may be found conscious but so panic-stricken that rescuing them becomes unusually complicated. Some, unless strongly urged and guided, seek safety blindly, even disastrously.

Some of these building have two interior stairways, located at a distance from each other; others have one stairway and a fire escape. Occupants also can 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 positioning of handlines.

Where no life hazard exists, lines are placed and used according to standard principles. However, more often in these loft buildings, the first line is 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 (sprinkler, perforated pipe systems) must be supplied as conditions dictate. The correct inlet must be supplied, or 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 the relationship among pertinent factors at these fires must be weighed with exceptional care before operations are initiated. All CO's should be keenly alert to signs indicating possible structural collapse so that firefighters can be removed in time, and communication should be established promptly so that all units can be contacted quickly. Some authorities recommend an exterior operation when two or more floors in such buildings are fully involved. This is a sound recommendation, but 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 the exterior wall: 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 fires, and against fire conditions that 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 are 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 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:

- 4 hours for exterior walls, firewalls, party walls, piers, columns, and interior structural members that carry walls; and
- 3 hours for other girders, fire partitions, floors (including their beams and girders), roofs, floor fillings, and required stairway enclosures. Such construction does not include 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 U.S. Air Force bomber crashed squarely into the upper part of the building, spraying approximately 800 gallons of fuel over where it struck. Parts of the 78th and 79th floors caught fire and burned furiously. Gasoline also ran down 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 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 mentioned above, 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 4-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 that can be opened from both sides without a key. They open on a street or yard, or on a vertical open court that 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 security guard 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. Then the fire room can 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 occupants do not need the stairs, 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 standpipe 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 usually are advanced from the windward side of the fire, especially down long 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 structure 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 remove 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, leaving them just a floor or two below the fire can accelerate it, 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 generally have 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 a modern highrise fire shows how modern highrise construction affects other primary factors.

Modern highrises are subdivided into many vertical components so that the possibility of total involvement in fire is almost impossible. In this case study 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 serve the section of floors that include 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 airshaft 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. Operating the return-air fans only, and dumping outside the building can dissipate smoke and heat effectively in the plenum area over an involved occupancy. 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 also may make it unnecessary to break windows to get air.

Even in the best fire-resistive construction, mechanical failure of controls, inadequate control over flammable contents, and structural defects that negate the fire-resistive rating of floors and partitions increase the possibility of both vertical and horizontal spread of heat, and especially of smoke, at a highrise fire. 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 new highrise buildings 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 also were coated with high-flashpoint 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.

- Ducts could be dangerously near other combustible materials, which eventually would be susceptible to ignition.

- Coils containing a toxic or flammable refrigerant gas then could 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 control the spread of smoke and gas satisfactorily. Another common feature is supply inlets in exterior walls that create an exposure hazard from fires in other building.

Other air ducts--Of special significance are air ducts with roof fan housings that are designed to remove gas and heat from large cooking ranges in restaurants, nightclubs, hospitals, and so forth. With improper maintenance, grease can accumulate in ducts and ignite, usually in peak hours in restaurants and nightclubs. 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 belowground or inaccessible from ladders or tower-ladder platforms.

Regulations governing access to exits are violated frequently. 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 left 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 usually can 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 also may be needed to extinguish and prevent extension of fire.

The hazards presented by these fires can be 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 carried out in accordance with the law or with the 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 sheetrock was used between apartments and public halls. The sheetrock was omitted, however, on the inner side of public hall partitions next to furred-out pipe spaces, and these pipe spaces were not adequately firestopped. The required sheetrock also had been omitted on one or both sides of public hall partitions, but the hung ceiling covered this omission. Fiberglass bats used between studs for firestopping and soundproofing proved to be completely ineffective as a firestop under the heavy fire conditions.

As a result, the fire entered an L-shaped 5-by-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 alerted and removed readily. Fortunately also, fire escapes had been provided during the alterations and were helpful in the operation.

The major objectives were 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 alleviated effectively by roof ventilation. Control finally was achieved by a third-alarm assignment and use of 11 handlines, aided by the work of ladder and rescue companies. Thirty-seven injuries were reported as a result of this fire and 44 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, nor the pipe recess abetting vertical spread were visible, and this 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 overhaul 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 security guards, and the hazards in general, already great, are intensified.

Fires in buildings under construction, particularly at high levels, can quickly reach major proportions. There are many reasons for this, including

- wide open construction, providing ample oxygen;
- much fuel supplied by combustible debris, wooden interior scaffolding, chutes, sheds, shanties, and possibly concrete forms;
- paints, oakum, excelsior, tarpaulins, and the like as an additional source of fuel;
- exposed tanks containing flammable gases for use in cutting torches, dangerous gases for heating purposes, and cartridges used for riveting;
- generally strong winds prevailing at high levels;
- abnormal delays in getting water to the fire floor; and
- fire expansion through openings in floors and the absence of windows, doors, and completed walls and partitions.

There is always the danger of timbers falling from topside. 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 then the line may have to be stretched up the outside of the structure and this is a laborious process, requiring numerous personnel.

Danger from the use of explosives for blasting in the very early stages of construction is somewhat alleviated by strict regulations, careful surveillance, and competent security guards. 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 steelwork, and a spark-and-ember hazard that can worsen the exterior exposure hazard. They also can result in greater alarm requirements to operate and a prolonged operation, with 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. 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 in buildings under construction sometimes can 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 12th 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 left side of the fire.

The CO 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 hose 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 the curtain wall construction, thereby reducing the time period of potential hazards that are inherent in buildings under construction.

Building Being Demolished

Much that has been said about buildings under construction applies to those being demolished. For example, the fire department may have trouble getting water to high fires if the standpipe system already has been put out of service but the structure is still 25 stories tall. Some builders, 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 also can have disastrous results, as demonstrated on several occasions. A notable example was the Wanamaker fire, which originated in the building's subcellar 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 on the 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 gauge 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, and there may be such density as to induce panic in the event of fire and smoke. Schools can present somewhat similar problems.

In hospitals and institutions for the care of infants, the elderly, the blind, the deaf, or other physically handicapped, occupants may have to be carried or led out of the building with unusual care. In jails or mental hospitals, rescuers may have to contend with uncooperative, hostile, or generally difficult occupants, as well as cope with heavy locked doors, or cut through bars and windows.

In multiple-residential structures, particularly those of old, ordinary construction occupancies often are overcrowded, at times 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 also is given off and causes injuries to the eyes, lungs, and damp skin areas.

Polyvinyl chloride (PVC) gives off chlorine gas and forms hydrochloric acid with water 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 and are 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 minimize the results of one.

Placement of hoselines--Difficulty in ventilating can reduce the effectiveness of hoselines. Effectiveness also may be affected adversely 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 not 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, will float on the top of it, and thus spread the fire.

Calcium carbide with water gives off acetylene gas and 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 a 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. CO's should carry reference material to help them evaluate the occupancy factor in case of unusual hazardous flammables or chemicals requiring special extinguishing agents. It is dangerous to depend on memory or the availability of competent advice.

Overhauling--The quantity of materials 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 also may 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 by 200 feet 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 objectives. The decision could be to operate from the exterior but not try to ventilate the roof, especially at supermarkets with wide roof spans.

The extent of the fire, rather than merely the area of an occupancy (such as a lumberyard) 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 strategies and tactics, 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 building and the adjoining buildings feature exterior windowless walls with 4-hour fire-resistive ratings, assuming no inlets to air-conditioning systems are 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 consideration always must 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, CO's should carefully consider the type of construction involved in the fire. Non-fireproof or brick-joist construction usually is susceptible to collapse, and has presented some of the most serious problems, especially if they are supported by columns made of cast iron.

In vacant buildings, CO's can anticipate that floor beams have been weakened by vandalism and, quite often, by previous fires. Age of the structure intensifies structural defects. Duration of the fire, how long it has 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 already has 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. Also consider the 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 strategies. The life hazard is maximized. At night fires in unoccupied buildings, the selection of objectives and strategies 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 CO's can evaluate the primary factors more quickly relative to selecting objectives and assigning strategies.

On the other hand, traffic conditions are heavier during the day, hydrants may be blocked, and pressure in the water mains generally is lower because of increased demand.

Weather

Visibility--Impaired visibility makes it more difficult to recognize and evaluate pertinent factors properly, thereby hampering decisionmaking 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 suppression activity.

In addition, supervision becomes a more critical matter because of the increased dangers to personnel.

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 generally are classified as temperatures in the 80's and 90's. High humidity and inversion conditions create 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 roof during a fire may indicate the location of hot spots, and this is where openings should be made.

Wind conditions. Velocity is an important factor. The effect of winds under 15 mph usually can be controlled if defensive measures are taken. With winds of 15 to 30 mph, the rate of fire propagation increases dramatically. Thirty-mph winds are a threat to exposures downwind, and are conducive to conflagrations.

CO's 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 can develop in the absence of ground winds sufficiently strong to support conflagration. Data from wartime experiences indicate that an area less than 1 square mile probably is 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 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 merging of numerous smaller fires into one massive inferno and is more likely to be a wartime than a peacetime phenomenon.

Minimum area and building density are essential, and 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.

Resource Requirements

The term **resource requirements** 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 ordinarily is decreased. If required water supply is not available, the other needs ordinarily are increased. The same "rule" hold true for each of the other primary factors comprising requirements to operate.

Water--To use water most effectively and thereby limit the need for other requirements, CO's 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 proved 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 are. It is important to know how to use each kind of stream to maximum advantage.

CO's who favor one technique for all fires have closed their minds to the possible alternatives. CO's 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 on the occupants as the fog 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 flashpoint 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; 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 wet water 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 differ 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 provide effective protection for exposed surfaces of exposures.

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 (AFFF) 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 obviously are 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 tools, and imaging cameras should be used appropriately. CO's should understand the capabilities and limitations.

Protective clothing--Enforcing department policies on appropriate use of protective equipment such as approved bunker gear, helmets, hoods, gloves, and breathing apparatus is critical to the safety of personnel.

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

- water to sprinklers shut off;
- only partial sprinkler protection;
- inadequate water supplies;
- faulty building construction;
- an 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 brought to the Incident Command Post (ICP) immediately for consultation with the IC.

Topography

Hilly communities--When operating at a fire on steeply graded streets, it may 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 terrain must be enforced.

Explosions

Backdraft or smoke explosions--Smoke explosions or backdrafts at fires are 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 also can 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, do not enter such areas until they are 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. Fire 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 immediatly. Fire personnel can assist in the evacuation but should not participate in searching for the bomb, since they have neither the protective equipment nor the special training required for such a task.

Exposure Hazards

Covering interior exposures--The interior exposure hazard, depending on the degree of severity, can have either a favorable or unfavorable effect on 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 also can be affected by the proximity factor.

Duration of Operations

For one reason or another, fire operations of long duration generally are 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

Streets that are one-way, 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 handicap efforts to use portable, aerial, or tower ladders. The width of the streets naturally has a bearing on 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 department.

Some communities convert a main thoroughfare into a mall with sidewalk cafeterias and extensive garden trimmings. This creates considerable problems for fire and rescue efforts.

THE COMMAND SEQUENCE ACTION CYCLE

Critical factors of incident operations often are overlooked or not given enough emphasis. This problem can result in poor use of resources, inappropriate strategies and tactics, safety problems, high incident costs, and lower effectiveness.

A simple (but thorough) process for planning can be used for small, short-term and long, more complex incidents and events. This process is referred to as the Command Sequence Action Cycle and consists of six sequential steps.

The first three of these six steps can be done by the CO or at a formal planning meeting. The last three steps ensure that the plan does its intended job. These six steps consist of:

1. Understanding the situation.
2. Establishing incident objectives.
3. Developing incident strategy.
4. Tactical direction and resource assignments.
5. Implementing the plan.
6. Evaluating the plan.

Understanding the Situation

In general, the essential information needed to understand the situation begins with the sizeup and consists of:

- what has occurred;
- whether or not the incident will get bigger (or smaller); and
- present (and future) resource and organizational needs.

Problem Identification

The analysis and comparison of incident primary factors and cues are the basis for problem identification.

Establish Incident Objectives; Develop Strategy; Select Tactics

Example:

Occupied house fire: Two-story occupied dwelling, 20 by 40 feet, ordinary construction, fire located in the living room area, first floor, Side D, report of occupants trapped in second-floor bedroom, Side B. No external exposures.

Objectives:

- Safe removal of occupants.
- Contain and control fire to the room/building of origin.

Strategies:

Example of strategies for objective: Safe removal of occupants.

- Strategy #1: Rescue occupants.
- Strategy #2: Confinement/Extinguish.
- Strategy #3: Ventilation.

Tactics:

For the rescue strategies the tactics might be

- Tactic #1: Deploy search/rescue group to upper floors.
- Tactic #2: Deploy a hoseline to first floor for stairwell/occupant protection.
- Tactic #3: Ventilate stairwell (if possible) and Side B to support occupant removal.

Strategies:

Example of strategies for objective: Contain and control fire to room/building of origin.

- Strategy #1: Confinement/Extinguish.
- Strategy #2: Ventilation.
- Strategy #3: Salvage.

Tactics:

For the confine/extinguish strategies the tactics might be

- Tactic #1: Deploy a hoseline to first floor Side D for confinement/ extinguish.

- Tactic #2: Deploy a hoseline to second floor Side D for interior exposure protection.
- Tactic #3: Vertical ventilation of roof apertures and horizontal ventilation first and second floor.
- Tactic #4: Use of salvage covers and control of water run-off.

Action Plan

Tactical direction includes determining the tactics and operations necessary for the selected strategy and determining and assigning appropriate resources. The tactical direction is developed around a specific operational period and must have measurable results.

For large incidents that may last for some time, there is a limit to what may be achieved (in terms of accomplishing an incident objective in a **single** operational period). Therefore, tactical directions should be stated in terms of accomplishments that can be achieved realistically within the timeframe of an operational period.

Resource assignments will be made for each of the specific work tasks. These assignments will consist of the kind and number of resources needed to achieve the tactical operations for each operational period.

If resources are not available for a specific tactical operation, then the IC may need to prioritize tactical assignments or reassess the tactics (and perhaps the overall strategy).

Implementing the Plan

The CO should communicate the appropriate tactical assignments to incident resources via radio or face to face. The CO should ensure that the tactical assignments are understood clearly by the resources assigned, and that they are facilitating the strategy developed to meet the overall incident objectives.

Evaluating the Plan

The CO should evaluate the effectiveness of the Incident Action Plan (IAP) continually to meet the overall incident objectives. This evaluation should occur every 10 minutes while operating under emergency conditions at an incident. Fireground conditions can change very rapidly during emergency operations and fireground commanders must evaluate the effectiveness of the plan continually.

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Activity 1.2

Primary Factors Size-Up Chart Applications

Purpose

To develop skills in the use of the Primary Factors Size-Up Chart.

Directions

1. Read the problem description for this specific activity.

2. The instructor will provide you with additional information.

3. In your small group, discuss the problem presented. Use the Primary Factors Size-Up Chart to determine your strategies and Incident Command System (ICS) organization and to determine resources needed.

4. For an incident requiring resources beyond those initially dispatched, complete an ICS structure for the total resources required.

5. Prepare the ICS structure on easel pad paper.

6. The instructor will allow 5 to 10 minutes for completion.

7. The reporter appointed by the instructor explains the group's ICS structure and rationale for its development to the remainder of the class. Limit your group report to **no more** than 5 minutes.

8. Fire flow calculations were determined with the following formula:

   Length x width ÷ 3 for first floor of building. This provides the basic fire flow for involvement of a single floor. The flow required for protection of internal exposures (25 percent for each floor above the fire, up to a maximum of 5 floors) and external exposures (25 percent for each external exposure) is added to the base fire flow.

Problem Description

On arrival you find a two-story light commercial building with fire showing on the first floor in the A-B corner. There is a one-story exposure building on the B side of the fire building. Calculate the total fire flow required, using the NFA formula described in the Activity instructions.

Example: A two-story structure 40' x 60' with a single exterior exposure and a fire on the first floor.

40' length x 60' width	2,400	ft^2 floor area
2,400 ft^2 ÷ 3	800	gpm basic fire flow
1 interior exposure (25 percent of base)	200	gpm
1 exterior exposure (25 percent of base)	200	gpm
Total required fire flow	1,200	gpm *

* The total required fire flow should be rounded to the nearest 100 gpm to permit quick estimation of the flow required for the present and projected level of involvement (25, 50, 75 percent, etc.).

The fire flow is based on involvement of the lowest floor with maximum exposures; this provides the maximum flow required for a single floor of involvement (100 percent). If multiple floors are involved, this flow must be increased based on the number of floors involved.

SUMMARY

In this unit the components of CO leadership and the importance of transition to CO were explained. The 25 key safety behaviors that affect safe tactical operations were discussed. The CO's responsibility for an analytical approach to emergency incident management using the Primary Factors Size-Up Chart and the Command Sequence Action Cycle was analyzed.

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APPENDIX

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Primary Factors Size-Up Chart

Column #1 Primary Factors Size-Up Chart		P	Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
Pertinent Factors (P) Check Appropriate boxes		P	Examples of Incident Objectives • Removal of all occupants within 10 minutes • Contain & control fire to building of origin in 30 minutes • Contain, control, limit fire in exposure within 1 hour • Remove all smoke within 20 minutes List Incident Objectives	(R) Rescue • Interior/Exterior			
Life Hazard	Occupants Firefighters			(E) Exposure Protection • Exposure Examination			
Location/Fire	Fire Bldg/Exposures on Arrival After Arrival - Burn Time			(C/E) Confinement/Extinguishment • Hoseline Placement			
Construction	Fire Building Exposures			(O) Overhaul • Expose Hidden Fire			
Occupancy (Contents)	Fire Building Exposures			(V) Ventilation • Removal of all Occupants • Fire Control			
Height	Fire Bldg (Front/Rear) Exposures (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.	(S) Salvage • Water run-off • Apply salvage covers			
Area	Fire Bldg/Configuration Proximity of Exposures/Config.		#2				
Structural Collapse	Fire Building Exposures Apparatus Placement		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor. • ______ • ______ • ______ • ______ • ______ • ______	
Weather	Visibility Temperature/Humidity Wind – Direction/Velocity		#4	#1 #2			
Resources	Apparatus/Personnel/Equip/RIC Water Supply/Suppression Agent		#5	#3			
Auxiliary Appliances	Fire Building Supplied Exposures Supplied		#6	#4			
Topography	Street Conditions		#7	#5			
Explosion Backdraft	Flashover Conditions		#8	#6 #7			
Time	Duration of Incident Time of Day Time of Alarm		#9				

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Twenty-Five Key Firefighter Safety Behaviors

Think safety all the time.	Always wear your seatbelt.	Always have a communications link to the next organizational level.	Evaluate the hazard--know the risk you are taking.	Always watch your incident position.
Drive defensively. Twenty-five percent of fatalities occur going to or returning from fire.	Wear full turnouts and SCBA.	Don't ever breathe smoke.	Follow standard incident procedures.	Look and listen for signs of collapse.
Drive slower rather than faster.	Attack with a sensible level of aggression.	Always have an escape route (hoseline/handline).	Vent early and vent often.	Rotate fatigued companies--assist stressed companies.
If you can't see, stop.	Always work within the incident's organizational structure--no freelancing.	Never go beyond your air supply.	Provide lights for the work area.	Pay attention all the time.
Don't run for a moving rig.	Keep crew intact.	Use a big enough and long enough hoseline.	If it's heavy, get help.	Everybody takes care of everybody else.

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NOTE-TAKING GUIDE

NOTE-TAKING GUIDE

Slide 1-1

PREPARATION FOR INITIAL COMPANY OPERATIONS

Slide 1-1

Slide 1-2

UNIT 1: ROLES AND RESPONSIBILITIES

Slide 1-2

Slide 1-3

INTRODUCTION: INITIAL COMPANY OPERATIONS

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Slide 1-4

FIVE UNITS

Unit 1: Roles and Responsibilities
Unit 2: Readiness
Unit 3: Communications
Unit 4: Building Construction and Fire Behavior Factors
Unit 5: Preincident Planning

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Slide 1-5

OBJECTIVES AND OVERVIEW

The students will:

- **List the eight components of Company Officer (CO) leadership and explain the importance of transition from firefighter to CO.**
  - **Transition to Company Officer**
  - **The Company Officer's Responsibility as a Leader**

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Slide 1-6

OBJECTIVES AND OVERVIEW (cont'd)

- **Explain the key safety behaviors that affect safe tactical operations.**
  - **The Company Officer's Responsibility for Safety**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Identify the CO's responsibility for an organized approach to emergency incident management.**
  - **Analytical Sizeup for Incident Management**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Describe the primary sizeup factors and determine their impact on strategies and tactics.**
  - **Primary Factors Size-Up Chart**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Analyze the command sequence action planning cycle.**
  - **Command Sequence Action Cycle**

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TRANSITION TO COMPANY OFFICER

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DEFINITION OF A COMPANY OFFICER

- **Supervises a single resource of the fire department**
- **Member of a company who acts in the capacity of a CO**

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DEFINITION OF A COMPANY OFFICER (cont'd)

- **The CO's position is one of the most important in the organization.**
- **Promotion to CO is worthy of acknowledgment.**

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DIFFICULT POSITION: A CHANGE IN ROLE

- Once responsible to perform work
- Now must get work performed through others

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PERSONNEL RESPONSIBILITIES

- To foster teamwork and cooperation
- To assist with individual and team development
- To provide a positive role model
- To instruct/train

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PERSONNEL RESPONSIBILITIES (cont'd)

- To review performance
- To instill discipline
- To communicate
- To motivate

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ADMINISTRATIVE RESPONSIBILITIES

- **To support the goals of the organization**
- **To plan work assignments**
- **To compile reports and records**
- **To prepare/implement budget**
- **To control costs**

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Slide 1-17

Firefighting is one of the most dangerous occupations in the United States.

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Slide 1-18

FIREFIGHTER DEATHS PER 100,000 FIRES

- **Residential fires--**
  45 percent
- **Stores and commercial--**
  15 percent
- **Under construction or renovation--**
  30 percent

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Slide 1-19

KEY SAFETY BEHAVIORS

After 10 years of research, Fire Chief Alan V. Brunacini of the Phoenix Fire Department developed 25 key firefighter safety behaviors.

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25 KEY FIREFIGHTER SAFETY BEHAVIORS

Think safety all the time.	Always wear your seatbelt.	Always have a communications link to the next organizational level.	Evaluate the hazard--know the risk you are taking.	Always watch your incident position.
Drive defensively. 25% of fatalities occur going to or returning from fire.	Wear full turnouts and SCBA.	Don't ever breathe smoke.	Follow standard incident procedures.	Look and listen for signs of collapse.
Drive slower rather than faster.	Attack with a sensible level of aggression.	Always have an escape route (hoseline/handline).	Vent early and vent often.	Rotate fatigued companies--assist stressed companies.
If you can't see, stop.	Always work within the incident's organizational structure--no freelancing.	Never go beyond your air supply.	Provide lights for the work area.	Pay attention all the time.
Don't run for a moving rig.	Keep crew intact.	Use a big enough and long enough hoseline.	If it's too heavy, get help.	Everybody takes care of everybody else.

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ANALYTICAL SIZEUP FOR INCIDENT MANAGEMENT

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USE THE SCIENTIFIC METHOD

- **Observe the facts (sizeup).**
- **Test the accuracy of the facts through observation.**
- **If the facts are accurate, logical hypotheses can be deduced.**
- **If hypothesis is proved true, outcomes may be predicted in similar situations.**
- **These hypotheses are called principles.**

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PRIMARY FACTORS SIZE-UP CHART

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Slide 1-24

Column #1 Primary Factors Size-Up Chart
Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed
Column #3 Activities (Strategies)
Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE INEFFECTIVE

Pertinent Factors (P) Check Appropriate boxes P
Life Hazard: Occupants; Firefighters
Location/Fire: Fire Bldg/Exposures on Arrival; After Arrival - Burn Time
Construction: Fire Building; Exposures
Occupancy (Contents): Fire Building; Exposures
Height: Fire Bldg (Front/Rear); Exposures (Front/Rear)
Area: Fire Bldg/Configuration; Proximity of Exposures/Config.
Structural Collapse: Fire Building; Exposures; Apparatus Placement
Weather: Visibility; Temperature/Humidity; Wind – Direction/Velocity
Resources: Apparatus/Personnel/Equip/RIC; Water Supply/Suppression Agent
Auxiliary Appliances: Fire Building Supplied; Exposures Supplied
Topography: Street Conditions
Explosion Backdraft: Flashover Conditions
Time: Duration of Incident; Time of Day; Time of Alarm

Examples of Incident Objectives
- Removal of all occupants within 10 minutes
- Contain & control fire to building of origin in 30 minutes
- Contain, control, limit fire in exposure within 1 hour
- Remove all smoke within 20 minutes

List Incident Objectives
#1 Provide for the safety of all Responders for the duration of the incident.
#2
#3
#4
#5
#6
#7
#8
#9

(R) Rescue
- Interior/Exterior

(E) Exposure Protection
- Exposure Examination

(C/E) Confinement/Extinguishment
- Hoseline Placement

(O) Overhaul
- Expose Hidden Fire

(V) Ventilation
- Removal of all Occupants
- Fire Control

(S) Salvage
- Water run-off
- Apply salvage covers

List Incident Strategies | Assigned to
#1
#2
#3
#4
#5
#6
#7

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

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PERTINENT FACTORS (SIZEUP)

Column #1:

The conditions and elements that should be recognized and evaluated on arrival and during operations

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INCIDENT OBJECTIVES

Column #2:

- **Safe Removal of All Occupants:**
  - **When life hazard for occupants is the limiting or strategic factor.**
- **Contain and Control Fire to Room/Building of Origin:**
  - **No life hazard for occupants, and fire is considered to be controllable by a direct or indirect attack.**
- **Contain, Control, and Limit Fire in Exposures:**
  - **No life hazard for occupants, and the situation is temporarily uncontrollable.**

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ACTIVITIES (STRATEGIES)

Column #3:

- **Rescue**
- **Exposure Protection**
- **Confine/Extinguish**
- **Overhaul**
- **Ventilation**
- **Salvage**

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Column #1 Primary Factors Size-Up Chart		P
Pertinent Factors (P) Check Appropriate boxes		P
Life Hazard	Occupants	
	Firefighters	
Location/Fire	Fire Bldg/Exposures on Arrival	
	After Arrival - Burn Time	
Construction	Fire Building	
	Exposures	
Occupancy (Contents)	Fire Building	
	Exposures	
Height	Fire Bldg (Front/Rear)	
	Exposures (Front/Rear)	
Area	Fire Bldg/Configuration	
	Proximity of Exposures/Config.	
Structural Collapse	Fire Building	
	Exposures	
	Apparatus Placement	
Weather	Visibility	
	Temperature/Humidity	
	Wind – Direction/Velocity	
Resources	Apparatus/Personnel/Equip/MC	
	Water Supply/Suppression Agent	
Auxiliary Appliances	Fire Building Supplied	
	Exposures Supplied	
Topography	Street Conditions	
Explosion Backdraft	Flashover Conditions	
Time	Duration of Incident	
	Time of Day	
	Time of Alarm	

Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed
Examples of Incident Objectives • Removal of all occupants within 10 minutes • Contain & control fire to building of origin in 30 minutes • Contain, control, limit fire in exposure within 1 hour • Remove all smoke within 20 minutes List Incident Objectives
#1 Provide for the safety of all Responders for the duration of the incident.
#2
#3
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#6
#7
#8
#9

Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
(R) Rescue • Interior/Exterior			
(E) Exposure Protection • Exposure Examination			
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(V) Ventilation • Removal of all Occupants • Fire Control			
(S) Salvage • Water run-off • Apply salvage covers			
List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor. • • • • • •	
#1			
#2			
#3			
#4			
#5			
#6			
#7			

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MAKING DECISIONS

- **Strategies affect the importance of primary factors.**
- **Primary factors have an effect on strategies.**

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LIMITS

- **Life hazard:**
  - **Risks to firefighters ranging from merely unusual to extreme may be warranted.**
- **No life hazard:**
  - **Firefighters are never to be jeopardized.**

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Activity 1.1
Using the Primary Factors Size-Up Chart

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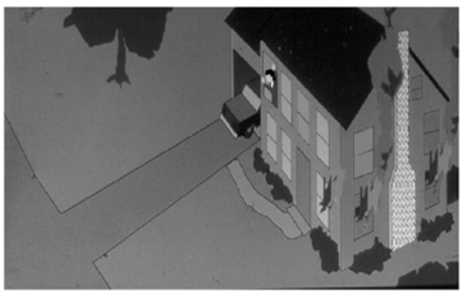
Slide 1-32



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LIFE HAZARD FOR OCCUPANTS

What effect would status of occupants have on your strategy?

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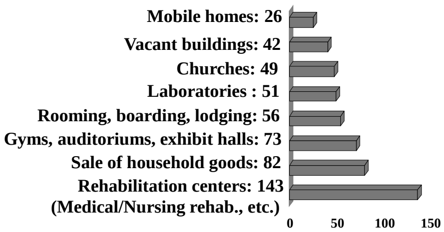
LIFE HAZARD FOR FIREFIGHTERS



Firefighter injuries per 1,000 fires

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LOCATION OF FIRE ON ARRIVAL

What effect would location of fire on arrival have on the strategy?

- **Fire building**
- **Exposures**

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EXTENT OF FIRE AFTER ARRIVAL

What impact would extent of fire after arrival have on your strategy?

- **Fire building**
- **Exposures**

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CONSTRUCTION

What is the effect of construction on strategy?

- **Residential**
- **Commercial**

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OCCUPANCY

What effect would occupancy have on your strategy?

- **Type of occupancy**
- **Contents of structure (fire load)**
- **Exposures**

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HEIGHT

What effect would height of building have on your strategy?

- **Fire building**
- **Exposures**

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AREA

What effect would area of building have on your strategy?

- **Fire building**
- **Exposures**

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STRUCTURAL COLLAPSE

What effect would structural collapse have on your strategy?

- **Fire building**
- **Exposures**
- **Collapse zone**
- **Apparatus placement**

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WEATHER

What effect would weather have on your strategy?

- **Low temperatures**
- **High temperatures**
- **Rain**
- **Wind**

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RESOURCE REQUIREMENTS

What effect would resource requirements have on your strategy?

- **Water**
- **Apparatus**
- **Equipment**
- **Personnel**
- **Special extinguishing agents**

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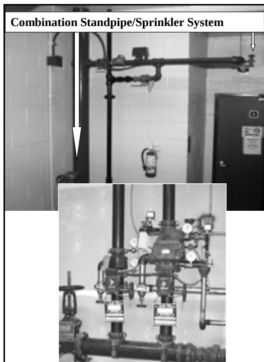

AUXILIARY APPLIANCES

What effect would auxiliary appliances have on your strategy?

- **Sprinkler systems**
- **Pressurization of stairways or other building areas**

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TOPOGRAPHY

What effect would topography have on your strategy?

- **Steeply graded streets/roads**
- **Leveling portable ladders on grades**
- **Congested streets/roads**
- **Snow-/Ice-covered streets/roads**

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EXPLOSIONS

What effect would explosions have on your strategy?

- **Smoke explosions**
- **Bomb explosions**

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DURATION OF OPERATIONS

What effect would duration of operations have on your strategy?

- **Long-duration incidents are difficult to deal with.**
- **May indicate heavy involvement and structural collapse.**
- **Maximizes the exposure hazard.**
- **Consider relief for personnel.**

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COMMAND SEQUENCE ACTION CYCLE

- **Critical factors of incident operations are often overlooked (or not given enough emphasis).**
- **This can result in:**
  - **Poor use of resources.**
  - **Inappropriate strategies.**
  - **Safety problems.**
  - **High incident costs.**
  - **Lower effectiveness.**

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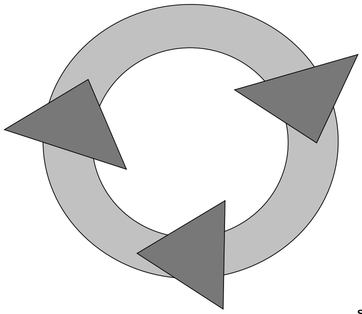
COMMAND SEQUENCE



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COMMAND SEQUENCE ACTION CYCLE (cont'd)

Consists of six sequential steps:

1. **Understanding the situation**
2. **Establishing incident objectives**
3. **Developing strategy**
4. **Directing tactical and resource assignments**
5. **Implementing the plan**
6. **Evaluating the plan**

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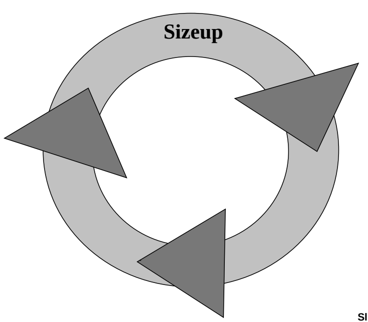
COMMAND SEQUENCE (cont'd)



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UNDERSTANDING THE SITUATION

Involves knowing:

- **What has occurred**
- **If the incident will expand (or get smaller)**
- **Present (and future) resource and organizational needs**

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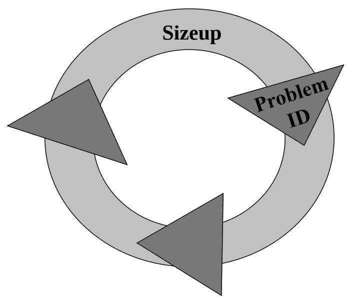
COMMAND SEQUENCE (cont'd)



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PROBLEM IDENTIFICATION

The analysis and comparison of incident primary factors and cues are the basis for problem identification.

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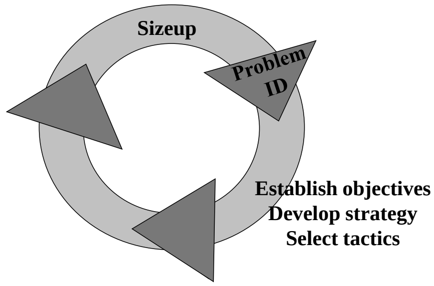
COMMAND SEQUENCE (cont'd)



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What is an objective?

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ESTABLISHING INCIDENT OBJECTIVES

Objectives must be

- **Attainable**
- **Measurable**
- **Flexible and broad**

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IDENTIFYING INCIDENT STRATEGY

- **Answers the question: What needs to be done?**
- **Describes the method (activities) that should be employed to accomplish the objective.**
- **For small incidents: This is the sole responsibility of the Incident Commander (IC)/CO.**

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IDENTIFYING INCIDENT STRATEGY (cont'd)

- **For large incidents: Members of the General Staff will contribute incident strategies:**
  - **Rescue.**
  - **Exposure protection.**
  - **Confine/Extinguish.**
  - **Overhaul.**
  - **Ventilation.**
  - **Salvage.**

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TACTICAL DIRECTION AND RESOURCE ASSIGNMENTS

- **What is a tactic?**
- **A tactic answers the question: How are we going to accomplish the strategy?**

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TACTICAL DIRECTION

- **Tactical direction includes determining tactics necessary for selected strategy and assigning appropriate resources.**
- **Developed around specific operational periods.**
- **Large incidents may last for some time.**
- **Tactical directions should be realistic.**
- **Resource assignments will be made for each of the specific tasks.**

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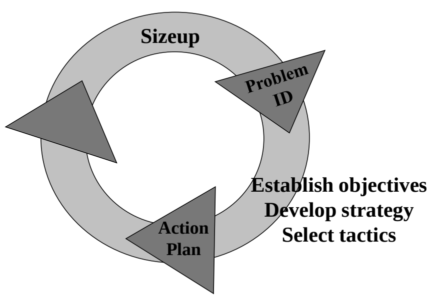
COMMAND SEQUENCE (cont'd)



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ESTABLISHING AN ACTION PLAN

Walkaround

Hypothetical house fire

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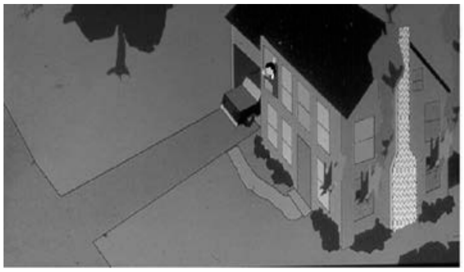

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EXAMPLE OF OBJECTIVES

- Occupied house fire:
  – Two-story occupied dwelling, 20' x 40', ordinary construction, fire located in the living room area, first floor, Side D, report of occupants trapped in second-floor bedroom, Side B. No external exposures.
- Incident objectives:
  – Safe removal of occupants.
  – Contain and control fire to room/building of origin.

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EXAMPLE OF STRATEGIES

- Example of strategies for Objective #1: Safe removal of occupants:
  – Strategy #1--Rescue
  – Strategy #2--Confine/Extinguish
  – Strategy #3--Ventilation

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EXAMPLE OF TACTICS

For Objective #1 the strategy and tactics may be

- **Rescue**
  - **–Tactic #1--Deploy search/rescue group to upper floors**
  - **–Tactic #2--Deploy a hoseline to first floor for stairwell/occupant protection**
- **Ventilation**
  - **–Tactic #3--Ventilate stairwell (if possible) and Side B to support occupant removal**

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EXAMPLE OF STRATEGIES (cont'd)

- **Example of strategies for Objective #2: Contain and control fire to room/building of origin:**
  - **– Strategy #1--Confine/Extinguish**
  - **– Strategy #2--Ventilation**
  - **– Strategy #3--Salvage**

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EXAMPLE OF TACTICS (cont'd)

For Objective #2 the strategy and tactics may be

- **Confine/Extinguish**
  - **– Tactic #1--Deploy a hoseline to first floor Side D for confinement/extinguishment**
  - **– Tactic #2--Deploy a hoseline to second floor Side D for interior exposure protection**
- **Ventilation**
  - **– Tactic #3--Vertical ventilation of roof apertures and horizontal ventilation first and second floor**
- **Salvage**
  - **– Tactic #4--Positive ventilation with proper use of fans**
  - **– Tactic #5--Use of salvage covers and control of water runoff**

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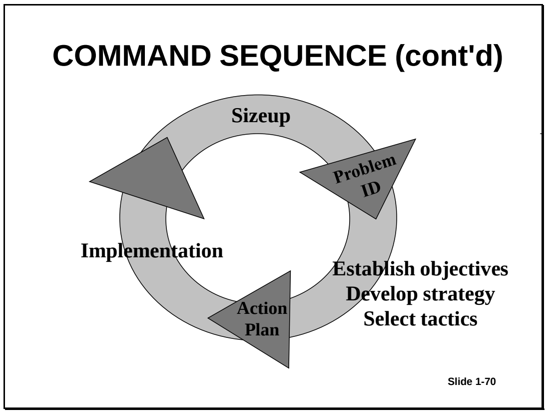

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IMPLEMENTATION

- Communicate assignments clearly
- Ensure assignments are understood
- Obtain timely feedback

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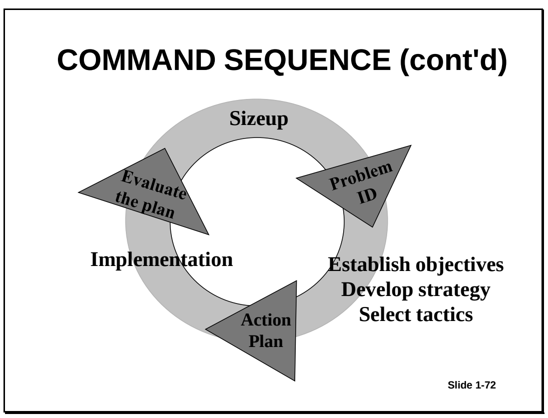

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EVALUATING THE PLAN

- **Is the strategy attaining the overall objectives?**
- **Are the appropriate tactics facilitating the strategy?**
- **Does the plan need to be modified or adjusted?**
- **Continue the sizeup and evaluate the effectiveness of the Incident Action Plan (IAP) (evaluate every 10 minutes).**

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Activity 1.2
Primary Factors Size-Up Chart Application

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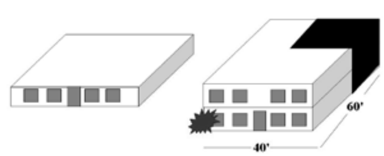
PICTURE OF PROBLEM



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SUMMARY

In this unit we have

- **Identified the components of CO leadership and explained the importance of transition to CO.**
- **Discussed the 25 key safety behaviors that affect safe tactical operations.**
- **Identified the CO's responsibility for an analytical approach to emergency incident management using the Primary Factors Size-Up Chart and the Command Sequence Action Cycle.**

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UNIT 2: READINESS

OBJECTIVES

The students will:

1. *Prioritize personal values and describe their relationship to incident management and firefighter safety.*

2. *Describe the five elements of company readiness and explain the importance of each element.*

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READINESS--AN INTRODUCTION

Fire departments exist to save lives and property. Professional Company Officers (CO's) respond to each incident knowing that they are ready to manage their part in meeting this goal efficiently and effectively. They must prepare themselves and their companies; and develop a thorough knowledge of departmental operations and procedures, a knowledge of their districts and communities, and a knowledge of the resources available to them.

COMPANY OFFICER'S PERSONAL READINESS

The CO must recognize that his/her major role is to direct the efforts of others. To do this, a body of knowledge that provides for effective, safe company operations must be developed. The personal characteristics that affect this ability to direct and perform are based on the CO's training and experience, knowledge of all aspects of operations, leadership and management ability, desire and motivation, and physical condition.

Values

Personal values are another component of the critical risk/benefit decision. The CO must be aware of the relationship between a person's personal values and the impact that those values have on critical decisions that must be made quickly at incident scenes. The primary responsibility of the CO is his/her own safety and the safety of the firefighters of his/her company. The risks taken by personnel should be consistent with the potential results to be achieved.

Knowledge

Every CO should have background knowledge appropriate to the requirements of his/her own situation. Areas of general background knowledge include safety considerations, as applied to strategic, tactical, and operational modes; building construction; and the ability to make fire behavior predictions. Communications skills, knowledge of strategy and tactics, the ability to analyze the company's performance at incidents, and an understanding of liability issues and the importance of accurate records and reports also are important.

A personal plan for improving those areas of identified weaknesses should be developed. Seeking continual improvement has long-term career development benefits.

COMPANY READINESS

The fire company is a team and may be called upon to work independently or with other companies as part of a response assignment. If the achievement of the Incident Commander's (IC's) goal is dependent upon the readiness of the company, it follows that the CO has a big job preparing for it.

Before the Alarm

Readiness of both personnel and resources is critical to overall success. The CO must know the attitude toward safety, the motivational level, the physical condition, and the knowledge and skill level of company members. The collective capabilities of the group are important to allow adequate lead time when making incident assignments. It is the performance level of the group as a whole, rather than that of individuals, that should be measured in a nonthreatening way. Apparatus, personal protective equipment, and firefighting equipment should be maintained properly and be available in adequate types and amounts.

During the Alarm

The company must be prepared to work as a tactical unit toward achieving the objectives assigned by the IC. The possibilities include functioning as a single unit at minor incidents, and functioning with other companies where the CO serves as the IC until relieved, or where the CO commands several companies.

Response to Nonfire Incidents

The company also must be prepared to deal with nonfire emergencies. Many departments provide Emergency Medical Services (EMS), and almost all departments could become involved in various types of rescue situations. The public relations benefit of supplying nonemergency service, within policy constraints of the department, should not be overlooked and the company should prepare to provide those services.

Returning to Service

Returning the company to service is probably the least liked of company activities but is extremely important to the well-being of personnel at subsequent alarms. Personnel should be accounted for and rested.

Apparatus and equipment should be serviced and repaired. The CO should prepare the necessary reports and conduct a postincident information analysis--compliment personnel and note areas that require improvement.

KNOWLEDGE OF DEPARTMENTAL OPERATIONS

The CO must understand the organizational structure, relationship between line and staff personnel, and chain of command. Standard Operating Procedures (SOP's) provide guidelines for operations and should be simple and flexible, but should not remove the CO's decisionmaking responsibility. The CO should be thoroughly familiar with the department's command and control procedures and be ready to assume the various CO roles within the departmental Incident Command System (ICS).

KNOWLEDGE OF DISTRICT AND COMMUNITY

Many fire officers have a general feeling for the nature of their fire problem, but have not thought in detail about how they would deal with all of the specific incident types facing them. Assessing the potential types of incidents that you will have to face in your community can help you begin to attack a fire even before you reach it (through preincident planning and training). An understanding of the specific fire problems facing the CO is critical to company readiness. Determining the specific hazards that exist in the CO's district enables the CO to establish preincident planning and company training priorities.

Community Risk Assessment

Community risk assessment involves three elements: life risk, property risk, and consideration of community consequences. The risk-benefit decision that we have discussed must be made primarily through the consideration of these three elements. Life risk is affected by the number of people at risk, the degree of risk, and the ability of the occupants to provide for their own safety. Property risk is affected by construction factors, the condition of structures, exposures, occupancy, and the available water supply. Community consequences are determined by the potential impact of a specific incident on a specific community. Considerations include direct life loss and property damage potential, indirect losses such as wages and taxes, loss of pride and community spirit (e.g., a landmark destroyed), and environmental impact.

General Knowledge

General knowledge of your fire district is essential for quality company performance:

- **Characteristics of district**: size, population, valuation, response distances, and topography.

- **Access within district**: The roads and streets and their conditions (normal day and night, unusual, or restricted) can affect response.

- **Occupancy of the district**: businesses, industrial, schools, rest homes, theaters, airports, petroleum producers, residential, hotels.

- **Structural conditions in district**: old or new, widely spaced or congested, fire-resistive.

- **Contents and processes in district**: predominant industries, specialized processes.

- **Water supply in district**: A CO should be familiar with water sources; adequacy and reliability; storage; distribution; and auxiliary supplies such as private wells, lakes, streams, and swimming pools.

- **Fire incidence in district**: What is the history of the types of fires and special problems encountered?

KNOWLEDGE OF AVAILABLE RESOURCES

Because the CO may function as the IC for some period at an incident, he/she must know about the availability of specific resources.

Resource Inventory

The CO should have available a resource inventory that provides a listing of special apparatus, information about personnel staffing and capability, and other local governmental and outside agencies that are available to assist with department operations. If a departmental resource inventory is not available, the CO can prepare an informal list of resources available in his/her own district.

Balancing Incident Needs with Resources

Part of being ready is planning for the organization and management of resources. Anticipating needs in time so that adequate resources are available is a tough decision that is made even more difficult if sufficient planning has not been done prior to incident operations. Stay ahead of the fire. As identified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, a rapid intervention crew (RIC) should be on scene to allow for timely reaction to unforeseen occurrences.

Effect of Environment on Resources

The CO should be aware of the effect of weather conditions on personnel, apparatus, and equipment. Rehabilitation areas should be established, because fatigue tends to undermine safety. The CO should plan for backup resources so they are available when needed. In extreme environmental conditions, the CO should consider risks and benefits.

QUICK ACCESS PREFIRE PLANNING

Preincident preparation involves preparing a preplan for a given building or hazard. This preplan should be comprehensive, but presented in a format that can be used by a CO while en route to an emergency. The Quick Access Prefire Plan (QAP) was developed to meet these needs.

Elements include, but are not limited to, the following:

- building description;
- occupancy;
- hazard to personnel;
- water supply;
- estimated fire flow;
- fire behavior predictions;
- predicted strategies;
- problems anticipated; and
- fixed protection/detection systems.

The reverse side of the QAP should include a floor plan and a plot plan.

Building Description

The general description of the structure should include the construction classifications such as wood-frame, balloon, ordinary, or noncombustible. The construction method and materials of the roof will be critical if your company is assigned to "ventilation" and the materials used to construct the floors could be vital to the safety of your personnel. This section of the QAP should paint a broad picture for you about the structure.

Occupancy

The occupancy of the structure may help prepare the responding CO for problems that may be anticipated. As an example, should the occupancy indicate that the structure houses a chemical warehouse, a hazardous materials incident could be anticipated.

Hazards to Personnel

The safety of your personnel is your first and foremost responsibility. It is necessary to evaluate special hazards about the structure that may not be readily apparent upon arrival. This should assist you in evaluating risk versus benefit for your anticipated operations.

Water Supply

The availability of water to sustain a fire suppression operation is critical. It is imperative that the location and available flow be recorded for easy access. If a static water source such as a pond is to be used in conjunction with a water shuttle, it is important to identify the source of the water, how many tankers/tenders will be needed, and whether or not a supply engine is to be dispatched to the water source. Since the available flow from hydrants may change during certain times of the day, an average available flow should be calculated.

Estimated Fire Flow

Using the National Fire Academy (NFA) fire flow formula (covered in Unit 5: Preincident Planning) the anticipated flow needed for the structure and exposures can be calculated. All the first-arriving CO needs to do is to estimate what percentage of the structure is involved. This also can be used to determine what hoselines should be used and how many personnel may be required. Should the fire flow requirements exceed your discharge capability, a defensive operation may be required until additional resources arrive.

Fire Behavior Prediction

Certain predictions about a fire may be possible upon examination of a structure. As an example, if an open stairway is found, it can be expected that fire could extend quickly to the floor above. If the building has a high life hazard, such as a nursing home, and doors normally are blocked open, it can be expected that there will be rapid smoke travel throughout the structure.

Projected Strategies

If certain strategic goals can be identified during the onsite visit, they should be noted. As an example, it may be appropriate to identify a "defensive" operational mode for a vacant factory or barn due to its deterioration. It may be appropriate to identify an "offensive" operation to support primary search if the structure is less than 25-percent involved.

Problems Anticipated

This provides an opportunity to record special problems that may restrict or limit your operations. The presence of a concrete slab roof may present a difficult ventilation problem, or the parking of trucks/trailers around a warehouse may limit access.

FIXED PROTECTION/DETECTION SYSTEMS

Standpipe

It is important to record the classification of the standpipe (I, II, or III) and the location of the connection.

Fire Pump

The presence of a fire pump will be critical for the development of the required fire flow for both standpipes and sprinklers. Since the operation of the pump may be critical to your ability to develop required fire flows and to ensure that sprinklers operate properly, you should be familiar with the building's water supply system. In addition, the pump may activate on the standpipe system as you are operating, and cause a sudden surge of pressure.

Sprinklers

It is important to note whether a structure is protected by an automatic sprinkler system. The presence of sprinklers may be considered during the sizeup and strategic decisionmaking process. Decisions such as supplying the system by one of the first-arriving engine companies may be critical. The notation of sprinkler placement on the preplan will remind the CO's driver/operator of the need to observe any difficulty encountered in supplying the system. If a pump is supplying a sprinkler system and is having a difficult time maintaining an operational pressure, it may be an indication that there are a large number of heads operating. Alternatively, the system may be broken/disconnected and the water is not reaching the fire. This information is vital for the pump operator to identify and inform the CO.

Fire Detection

The presence of a fire detection system is vital in identifying the location of the fire. The location of the annunciator panel should be indicated on the preplan along with the type of detection system (smoke, heat, automatic sprinkler, water flow, or other).

SUMMARY

The ability of a fire department to perform is dependent upon the personal readiness of the CO, the personnel, apparatus, tools, and equipment assigned, and the knowledge that the department and the CO have of departmental operations, the district and community, and resources available. The department can meet the challenges presented at the incident scene only by always being "ready."

APPENDIX

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Quick Access Prefire Plan

Building Address:

Building Description:

Roof Construction:

Floor Construction:

Occupancy Type:	**Initial Resources Required:**

Hazards to Personnel:

Location of Water Supply:	**Available Flow:**

	Estimated Fire Flow			
Level of Involvement	*25%*	*50%*	*75%*	*100%*
Estimated Fire Flow				

Fire Behavior Prediction:

Predicted Strategies:

Problems Anticipated:

❑ **Standpipe:**	❑ **Sprinklers:**	❑ **Fire Detection:**

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NOTE-TAKING GUIDE

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NOTE-TAKING GUIDE

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UNIT 2:
READINESS

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OBJECTIVES AND OVERVIEW

The students will:

- **Prioritize personal values and describe their relationship to incident management and firefighter safety.**
  - **Readiness--An Introduction**
  - **Company Officer's Personal Readiness**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Describe the five elements of company readiness and explain the importance of each element.**
  - **Company Officer's Personal Readiness**
  - **Company Readiness**
  - **Knowledge of Department Operations**
  - **Knowledge of District and Community**
  - **Knowledge of Available resources**
  - **Quick Access Prefire Planning**

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DEFINITION

The fire company is ready when its members have the necessary knowledge, skills, and resources to carry out the tactical operations required to meet the goals and objectives of the Incident Commander (IC).

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ELEMENTS OF COMPANY READINESS

- **The Company Officer (CO) personally**
- **The company**
- **Knowledge of departmental operations**
- **Knowledge of district and community**
- **Knowledge of resources available to company and department**

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COMPANY OFFICER'S PERSONAL READINESS

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COMPANY OFFICER'S PERSONAL READINESS (cont'd)

- Develop a body of knowledge that will provide for effective, safe company operations
- Recognize that your major role is to direct the efforts of others

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COMPANY OFFICER'S PERSONAL READINESS (cont'd)

The personal characteristics that affect the ability to direct and perform are based on:

- Training and experience
- Knowledge of operations
- Leadership and management ability
- Desire and motivation
- Physical condition
- The influence of personal values

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GENERAL BACKGROUND KNOWLEDGE

- Safety considerations
- Building construction
- Fire behavior
- Communication skills
- Strategy, tactics, and tasks
- Analysis of company's performance
- Understanding of liability issues

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COMPANY READINESS

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COMPANY READINESS (cont'd)

Before the alarm
- **Readiness of personnel**
- **Collective capabilities**
- **Readiness of assigned resources**

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COMPANY READINESS (cont'd)

During alarm the company must
- **Work as a tactical unit**
- **Function as a single company at minor incidents**
- **Function with other companies**

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COMPANY READINESS (cont'd)

Response to nonfire emergencies

- **Emergency Medical Services (EMS) first responder**
- **Other emergency responses**

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COMPANY READINESS (cont'd)

Returning to service

- **Personnel**
- **Apparatus**
- **Equipment--personal and firefighting**
- **Prepare required reports**
- **Conduct informal postincident analysis**

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KNOWLEDGE OF DEPARTMENTAL OPERATIONS

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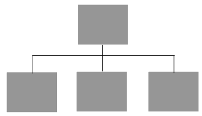
ORGANIZATIONAL STRUCTURE

- Specific department organizational structure
- Relationship between line and staff personnel
- Who the CO reports to
- Who reports to the CO



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STANDARD OPERATING PROCEDURES

- Provide guidelines for operations
- Provide anticipated strategies
- Formal and department-wide
- Consistent with Incident Command System (ICS)

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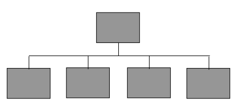
COMMAND AND CONTROL



- Be thoroughly familiar with the structure of the departmental ICS
- Understand the various roles within the ICS

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KNOWLEDGE OF DISTRICT AND COMMUNITY

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COMMUNITY RISK ASSESSMENT

- **Risk potential**
- **Risk vulnerability**
- **Community consequences**

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COMMUNITY RISK ASSESSMENT (cont'd)

Life risk affected by:

- **Number of people at risk**
- **Degree of risk**
- **Ability of occupants to provide for their own safety**

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COMMUNITY RISK ASSESSMENT (cont'd)

Property risk affected by:
- **Construction factors**
- **Condition of structure**
- **Exposures**
- **Occupancy**
- **Water supply**


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COMMUNITY RISK ASSESSMENT (cont'd)

Community consequences potential impact:
- **Direct life loss and property damage**
- **Indirect losses**
- **Loss of pride**
- **Environmental impact**


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CHARACTERISTICS OF DISTRICT

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ACCESS WITHIN DISTRICT

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OCCUPANCY OF THE DISTRICT

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STRUCTURAL CONDITIONS IN DISTRICT

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CONTENTS AND PROCESSES IN DISTRICT

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WATER SUPPLY IN DISTRICT

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KNOWLEDGE OF AVAILABLE RESOURCES

Resource inventory:

- **Special apparatus**
- **Personnel**
- **Other local governmental agencies**
- **Outside agencies**

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KNOWLEDGE OF AVAILABLE RESOURCES (cont'd)

Balancing incident needs with resources:

- **Adequate resources**
- **Additional resources**
- **Regional basis**

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KNOWLEDGE OF AVAILABLE RESOURCES (cont'd)

Part of the readiness process for the CO is to plan for the organization and management of resources.

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KNOWLEDGE OF AVAILABLE RESOURCES (cont'd)

Effect of environment on resources:

- **Effect on personnel**
- **Effect on apparatus and equipment**

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Quick Access Prefire Plan

Building Address:
1233 Main Street

Building Description:
2-Story "Ordinary" Construction with Basement

Roof Construction:
Built up (tar and paper) over 2' boards

Floor Construction:
1" boards over 2" x 10" joist

Occupancy Type:
Mercantile "Men's Clothing"

Initial Resources Required:
1 Rescue, 2 Engines, 1 Ladder

Hazards to Personnel:
Large amount of rental clothing stored in basement

Location of Water Supply:
Main St. & 29th Ave.

Available Flow:
1,500 gpm

	Estimated Fire Flow			
Level of Involvement	25%	50%	75%	100%
Estimated Fire Flow	800	1,600	2,400	3,200

Fire Behavior Prediction:
Rapid fire growth due to racks of clothing and open stairs to second floor.

Predicted Strategies:
Primary search with offensive fire attack operations--up to 25% involvement

Problems Anticipated:
Rapid fire growth, only one access/egress to basement and second floor

☐ **Standpipe:** ☐ **Sprinklers:** ☐ **Fire Detection:**

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WHO DOES PREFIRE PLANNING?

- **Fire departments that want to be proactive**
- **CO's who understand that prefire planning is essential for effective operation**

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PURPOSE OF A QUICK ACCESS PREFIRE PLAN

- **For first-in officers**
- **A form from which you can read important data**
- **Does not take the place of a more detailed prefire plan for complex facilities**
- **Training reference for target hazards**

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BUILDINGS REQUIRING A PREFIRE PLAN

- **Target hazards**
- **Other important structures/facilities**
- **Consider small structures**

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SUMMARY

Five elements of company readiness:
- **The CO personally**
- **The company**
- **Departmental operations**
- **District and community**
- **Resources available**

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UNIT 3: COMMUNICATIONS

OBJECTIVES

The students will:

1. *List four benefits of effective incident communications and explain the importance of each.*

2. *List the six steps identified in the communications model and explain the importance of each step.*

3. *Apply the communications model to practical fireground communications when given a scenario.*

4. *Given a simulated incident where communication is a critical issue, develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.*

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UNDERSTANDING INCIDENT COMMUNICATIONS

Effective communication is the basis of good incident management, and faulty communication is the cause of many incident problems.

Types of Communication

- mobile radio;
- face to face;
- cell phone; and
- written Incident Accident Plan (IAP).

Communication at the incident is more than just the officer yelling orders. For communication to be effective, several important steps need to take place. Communication is defined as the giving and receiving of information. Effective incident communication demands that a third step be included in the definition. Information may be given and received but those involved must be assured the information is understood because decisions made will be based on information received and understood.

THE NEED FOR EFFECTIVE INCIDENT COMMUNICATIONS

Personnel Safety

Paramount on the list of the Incident Commander's (IC's) responsibilities is the safety of personnel. Effective communication allows the IC to know where personnel are at all times. It allows for coordinated tactical operations so that no one crew is operating beyond the scope of the overall plan and the support of other crews. Personnel can be advised quickly of any safety hazards that may exist at the scene. Swift reaction and attention to any medical emergency can result from effective lines and methods of communication.

In the back of every IC's mind is the fear that one of the personnel will be killed or injured. By using proper communications throughout the emergency scene, the fear can be reduced and the safety of personnel protected.

Effective Use of Resources

For a Company Officer (CO) to manage an incident capably, the action plan needs to be conveyed in a manner that is clearly understandable to subordinates, with an emphasis on brevity. The CO's ability to communicate orders succinctly and clearly eliminates confusion and gives subordinates defined boundaries in which to operate. This drastically reduces the chance or need for firefighters to function independently or to freelance. A well-communicated action plan keeps emergency personnel functioning as part of the team, and maximizes the capabilities of the tactical resources with which the CO has to work.

The emergency scene is dynamic in nature, not static: It is constantly changing. If the CO is to have an accurate picture of what is going on, information needs to flow back from subordinates. Procedures need to be established outlining when and how this information is to be transmitted back to the CO. Without periodic updates on how crews are progressing, the CO can be left in the dark, unable to react properly to the changing conditions. Once again, this information should be transmitted in a clear, concise manner.

In looking at problems with emergency communications and the need for procedures, skills, and discipline, one classic example of why poor practices lead to poor scene management can be found in compulsive talkers. They can be identified by the following characteristics:

- Key microphone prior to knowing what they are going to say. (Dead air often filled with "uh---uh---.")

- Broadcast messages whose meanings are either vague, of little importance, repetitive, or rambling. Most likely, all of the above.

- Ask numerous questions, the answers to which serve mostly to delay operations. This ties up the radio channel so that others are unable to get in any messages.

If you know a compulsive talker, you can probably add to the list of characteristics. It should be noted that good communications skills, procedures, and training can correct this.

Improved Interagency Cooperation

Good communication practices make your department look good. Radio communication may be the only contact you have with other agencies. How well you communicate may be the basis on which they judge your department. Effective communications make it easier for other agencies to understand your needs, thus improving their value to you. Effective communications help eliminate duplication of efforts among agencies operating at the same incident.

Legal Implications

Many radio communications are taped. Should a legal action occur, tapes may be entered as part of the evidence. You and the jury may get to hear just how well you and your department communicate. It can be embarrassing when it's your own voice making you look bad. If you don't sound professional, don't expect members of the jury to be sympathetic. All departments must follow Federal Communications Commission (FCC) licensing requirements. Many departments don't have enough frequencies now. Not knowing and following FCC regulations can jeopardize the frequencies you do have.

THE NEED FOR A COMMUNICATIONS MODEL

Establish Procedures

The first step in the establishment of a program to upgrade a department's communications should be a set of Standard Operating Procedures (SOP's). These written procedures should include lines of communication, what frequencies to use, and when to use them. Equipment designations, a standard set of words and phrases, a method of alerting personnel of hazardous conditions at an emergency scene, preventive maintenance for radio equipment, and proper use of the radios should be included.

For procedures to be most effective they should be compatible with other emergency service agencies with which a department is likely to work. This will require cooperation and compromise on the part of all agencies involved. Looking at when agencies need to be included, keep in mind that the "real world" is capable of outdoing most "worst case scenarios" used in planning. Every effort should be made to include as broad a region as possible in your cooperative group.

Once procedures are established, training should begin immediately. The training not only will help the personnel on the department understand the system but also will give a good indication of any weakness or changes that need to be made in the procedures. Periodic training with the other emergency agencies also should be done to assure compatibility.

When the procedures are in place and the training has been conducted, the department will have the opportunity to hold personnel accountable for conforming to established standards. It is much easier to play the game right if someone lays out the rules. By instituting procedures and providing training, the department gives personnel a set of rules to follow. What should be remembered is that "perfect practice makes perfect." When personnel understand the procedures and have been trained in their use, the procedures will come automatically during an emergency.

THE COMMUNICATIONS MODEL

The Model Is a Six-Step Process

Training in the use of the model makes communication a matter of habit and it also develops confidence in your ability to communicate effectively.

Step One: The Sender Formulates an Idea to Convey to Another Person

Before attempting to send the message, the sender must have clearly in mind what message is to be conveyed. It is very difficult to make a message clear to others until it is clear in your own mind.

Messages must be concise. Eliminate information that is not essential to the message you are trying to impart. The more information that is included, the greater the chance that important parts will be lost. If it is necessary to send a long message, send it in manageable parts. If the demands of the incident are interfering with your ability to formulate your messages, you must delegate to get back within the span of control. Formulation of ideas takes place in the brain.

Step Two: Sender Sends the Message

The first part of sending the message is getting the attention of the intended receiver. The second part of sending the message is actually conveying the message.

Differences in word meaning are a major source of communication failure. An example is the word "charge." You charge someone a fee for doing a service; you charge a purchase when you want to pay later; you charge a battery when you want it to provide electricity; you charge a horse into battle against the enemy; you get a charge out of something funny; you put a powder charge in a cannon; and you charge a criminal with crimes.

Discourage use of 10-Codes and pet names for apparatus, equipment, or buildings. Use clear text and standard resource designators. Clear text is a standard set of words and phrases used as part of your Incident Command System (ICS). Standard resource designators consist of standardized terminology used to identify apparatus and equipment.

In the case of written communication, sending occurs when words are written.

In oral communication, spoken words are sent.

Step Three: Transfer the Message Through the Medium

Types of verbal media include face-to-face exchanges and the radio. If you are using written media, can the other person read it? Written media are often used at major incidents covering a long period of time.

Visual media include hand signals, signs or symbols (nonverbal), body language, and expressions and gestures.

Training should include proper use of equipment. Outside interference in the form of noise or confusion should be minimized. Equipment maintenance and purchase must have a high budget priority because of the importance of communications to safety and effectiveness. Examples of media by which written communication is transferred include memos, letters, and fax. Oral communication can be transferred by direct conversation, radio, telephone, etc.

Step Four: The Receiver Receives the Message

The first part of receiving the message involves letting the sender know you are ready to receive the message. The second part of receiving the message is actually receiving the intended information. Training and positive reinforcement of good skills should be provided. The receiver should try to minimize background interference. Written communication is received by the eyes and verbal communication by the ears.

Step Five: The Receiver Interprets the Message

Training must be provided if the level of understanding of the receiver is not adequate enough to grasp the sender's meaning. Clear text and standard resource designators provide common terminology. It is possible that the sender may have sent the message incorrectly or the receiver might have heard it incorrectly. Interpretation takes place in the brain.

Step Six: The Receiver Confirms that the Message Has Been Received and Understood by Providing Feedback

If the message is important enough to send, it is even more important to know that it was received and understood. If there is any confusion or misunderstanding, the sender has the opportunity to correct it. The sender should ask for feedback if it is not provided. Radio traffic is reduced because the communications model allows for confirmation of receipt and understanding immediately through feedback.

Example of communications model in action:

Formulation of idea:

Sender:	"I want Engine 1 to take a 1-3/4-inch line to second floor." **(Thought)**
Sender:	"Engine 1, Command." **(Getting attention of receiver)**

Transfer through medium: **(Radio transfers message from sender to receiver)**

Receiver:	"Command, Engine 1." **(I'm paying attention)**
Sender:	"Take a 1-3/4-inch line to second floor." **(Conveying information)**
Receiver:	"I'm going to have my crew take a 1-3/4-inch line to second floor." **(Thought)**
Receiver:	"Taking a 1-3/4-inch line to second floor." **(Feedback that Engine 1 understands assignment)**
Sender:	"Affirmative, Engine 1."

Common Communications Problems

There are a number of roadblocks to effective communications. These should be understood and avoided as much as possible. Some roadblocks can only be resolved on a long-term basis, others may be out of the control of the CO. It remains the responsibility of the CO to identify each communication roadblock he/she is unable to resolve and to bring these problems to the attention of his/her superiors through the appropriate channels of authority.

When firefighters get together to tell war stories and talk about the problems they face, one of the major stumbling blocks to their operating at maximum effectiveness will inevitably be the lack of good communications. Communication is acknowledged by CO's to be their number one problem. When we look at the causes and try to determine what needs to be done to improve our emergency scene communications, there are some basic concerns that need to be examined.

Lack of Adequate Communications Equipment

Either through budget restraints or lack of proper planning, many departments are forced to function with equipment that is ineffective or outdated. Radios that will transmit but will not receive, old tube-type radios that require an hour of service for each half-hour of use, lack of enough portable radios, departments forced to use CB radios for emergency operations, not enough base stations, pagers, repeater sites, and a multitude of other hardware limitations prevent emergency personnel from communicating effectively. Whatever other problems departments may have in communicating, there will continue to be problems until they identify the shortcomings of their current hardware, and address a means of acquiring sufficient functional equipment.

Lack of Adequate Emergency Frequencies

Another limiting factor a great many departments face today is the lack of an adequate number of emergency frequencies. Many departments share a frequency with other agencies or groups of agencies. It is not uncommon to find fire, police, street department, water, sewer, and any other agency with a radio, all sharing the same radio channel. In the event of an emergency it is not always possible to convince those agencies not involved to forego the use of the radio frequency they share. Personnel at an emergency may find themselves competing for air time with the sewer department's effort to find out why the sewers in town are backing up. Both feel they have the priority need.

For those departments that have their own frequency, there still can be significant problems if no tactical frequencies are provided. If administration radio traffic, simultaneous alarms in progress, and alarm paging are all done on the same frequency, it will create confusion. Separate tactical frequencies need to be obtained so that emergency scene communications can be made without the interruptions and confusion caused by other radio transmissions. As a department grows, more tactical frequencies should be added so the possibility of multiple calls running at the same time on the same frequency is not a regular occurrence.

Mix and Match Frequencies

Unless you happen to own the only piece of emergency equipment on a distant Pacific island, there is a need to communicate with other agencies. What we typically find when there are multiple agencies operating at the same emergency scene is each agency with its own frequency. For example, police are unable to talk to fire, fire has no means of talking to the ambulance, and the ambulance is incapable of talking to the mutual-aid fire department that just arrived. One agency is high band, another low band, another VHF, and the one agency with the big budget is trying to talk to everyone else in the 800 MHz range. What is lacking, in addition to planning and coordination, is a common frequency or plan that would allow emergency responders to communicate among themselves.

Incompatible Radio Codes

Any department has its choice of a multitude of radio codes. Several national organizations, State agencies, and local jurisdictions publish their own codes. More than one department uses the code that came with its CB radios. What may be an "accident with injuries" using one code can be "a dead animal in street" using another. Many departments use codes particular to their own agency. The department may design these to cover its own seemingly unique activities, or activities it does not want made known to all area scanner owners. The end result is a wide variety of radio codes in use at a multiagency response. Not only can this be confusing, but dangerous as well. The use of codes should be kept to an absolute minimum. A standard set of words and phrases should be used to eliminate confusion and assure messages are understood and acted upon.

Need for Common Terminology

The fire service has a language of its own, but different departments and different parts of the country may speak a dialect not completely understandable to someone from another department or area. A truck carrying lots of water may be a water tender in one department, a tanker in another, or a water wagon in yet another. It's a booster line in Colorado but you had better call it a red line in Texas. That tanker may be a truck with lots of water in some parts, but in others it's an airplane loaded with retardant. When departments work together, there must be a mutual understanding of terms. There is no reason or excuse to ask an adjoining department for a tanker and be surprised when an airplane shows up. The understanding needs to occur prior to the emergency, in meetings between the agencies. An emergency scene is a poor location at which to do planning or training.

BENEFITS OF USING THE COMMUNICATIONS MODEL

The fire service enjoys the reputation of having dedicated public servants. One way to improve and enlarge that reputation is by projecting a professional image in the way communications are handled. Other emergency service and governmental agencies will use communications as one of the measures by which to judge your department. When a representative from another emergency agency views your department as being highly capable, cooperation is easier to receive. In addition, you have recruited a supporter who enjoys public credibility.

It is important to any department's growth to have the support of the community. With so many scanners now in use in cars, homes, and carried as portables, few, if any, radio transmissions go unnoticed. What the public hears may likely be the only contact you have with the majority of them, and communications will be the sole criterion upon which they evaluate your department.

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Activity 3.1

Communications

Purpose

To examine the relative effectiveness of one-way and two-way communications in giving directions.

Directions

Part 1: One-Way Communications

1. One member of the class will be provided with a drawing. That individual will provide clear and concise instructions to the group on how to construct a copy of the drawing.

2. The task is to draw a picture of a group of geometric shapes in a particular pattern.

3. Only one-way verbal communication will be used. Gestures and illustrations cannot be used to facilitate the process of giving instructions.

4. In the space below, construct the drawing according to your fellow student's instructions.

Part 2: Two-Way Communications

1. The same task will be performed again.

2. This time two-way verbal communications may be used. Ask questions and provide feedback to ensure that you understand the directions. Gestures and illustrations cannot be used to facilitate the process of giving instructions.

3. The individual with the drawing should provide clear and concise instructions to the group on how to construct a copy of the drawing.

4. In the space below, construct the drawing according to your fellow student's instructions.

TACTICAL COMMUNICATIONS RESPONSIBILITIES

When communications break down on the incident so do coordination, control, and the ability to provide for firefighter safety.

All personnel have the responsibility to communicate effectively. This starts with a good brief initial report by the first-in officer, and continues throughout the incident.

There are different types of tactical communications, including initial conditions reports, implementation orders of the action plan, progress reports from CO's who are responsible for carrying out the IAP, reports of safety hazards or evacuation orders, and tactical benchmarks.

Review the Sizeup Reports

- The initial report is to be given immediately upon arrival on location.
- It should include the exact location and conditions as observed:

  - Nothing showing.

  - Size of structure--stories and dimensions.

  - Type of construction--occupied or vacant.

  - Smoke/Fire--location and density.

  - Status of occupants--if known.

  - Exposures--Sides A, B, C, D, or other.

  - Engine ___ is establishing ____ Street Command.

Subsequent Report/Tactical Benchmarks

A subsequent report can include information not immediately reported and/or information developed upon investigation--to be given ASAP or within 5 minutes.

It is important to communicate the completion of tactical operations addressing specific incident priorities. These are

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

Completion of primary search (life safety priority) allows a shift of emphasis in tactical operations to incident stabilization. For example, transmit: "**Primary search of first floor completed**."

- Resources confining the fire to permit search operations now can be applied to extinguishment.

Stopping the forward progress of the fire allows the CO to shift resources to property conservation. "**Under control**."

- Some resources assigned to fire attack and ventilation may be reassigned to overhaul and property conservation.

When further property loss is stopped, the CO can begin the process of demobilization. "**Loss stopped**."

- Resources can be made available and returned to service.

Progress Reports

To be given by the CO every 10 minutes until fire is under control. **"Report on conditions."**

The tactical operations to which they were assigned are having a positive impact (**good news**).

Assigned tactical operations are not having a positive impact and why (**bad news**).

Let your immediate supervisor know the nature of the problem. Try to offer a solution to the problem, along with the bad news, since you are usually in the best position to make that determination.

Additional resources that may be needed include additional crews to assist with the tactical operation and any additional or specialized equipment.

Advance warning to the supervisor is needed when relief crews will be required, and if and when resources might be available for release or reassignment. Periodic reports on the status of the incident and assigned resources also need to be made to the supervisor.

Reports of safety hazards or evacuation orders. "**Emergency traffic**."

All personnel have the responsibility to communicate when safety hazards are identified that may have an adverse effect on firefighter safety or the tactical operation.

A method to convey emergency information quickly should be established through SOP's. Written procedures should include a method to convey this information quickly to everyone on the incident. These should be included as an important part of your department's communications training. Written procedures also should include methods, in addition to radio communications, to notify personnel of imminent danger and of the need to evacuate to safety. These can include blasts on the air horns, sirens, public address (PA) systems, and anything loud and easily understood by all personnel.

Departmental procedures should include a method that accounts for all personnel when the structure has been evacuated: designated reporting locations, radio check-off system, and confirmation by supervisors that all personnel are accounted for.

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Activity 3.2

Communications Exercise

Purpose

To demonstrate how teams share information in order to accomplish the team objective. Team members should become aware that each team member has information that is needed by the others in order to accomplish their functional responsibility, and that sharing the information will improve the effectiveness and efficiency of the team's performance.

Directions

1. Determine whether your engines can use the most expedient access route to a fire by safely crossing the bridge over Anderson Creek within a mile of the fire, or if they have to use an alternate route that will delay response by 2 hours. There are no aircraft available, and the stream is too wide and swift to cross without using the bridge.

2. Use the information you are given to make a determination of which route is safe to use. You are allowed to remove items from the engine if you feel it will be enough to allow a safe crossing.

3. Each team member will get slips of paper that contain information for the accomplishment of this task.

4. Team members can share information with each other only **verbally**.

5. Report out results.

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Activity 3.3

Command Sequence #1: Fields Hill

Purpose

To develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.

Directions

1. You will be working in teams of three for this simulation exercise.
2. A Command Sequence Tactical Chart for each team position is included here.
3. The instructor will designate two students per team jointly to assume the role as the first-due engine CO.
4. The instructor will designate one student per team as a team recorder; this position will rotate among team members when doing the large simulations.
5. Team recorder will record all actions taken by the first-due CO onto the Command Sequence Tactical Chart.
6. The instructor will review the Command Sequence Tactical Chart preparation process with the class.
7. A Quick Access Prefire Plan (QAP) and plot plan also are provided.

Part 1

1. View the slides to assess the primary sizeup factors and visible cues.
2. Complete the Primary Factors Size-Up Chart and develop the sizeup report.
    a. Primary factors.
    b. Initial objectives.
    c. Initial strategy.

Part 2

1. View the slides of the Fields Hill fire and read the simulation messages.

2. Complete the Command Sequence Tactical Chart.

3. Be prepared to present your sizeup report and charts to the class.

Activity 3.3 (cont'd)

Command Sequence Tactical Chart

To be completed during simulation:

Tactical Assignment	Assigned to	Progress Report

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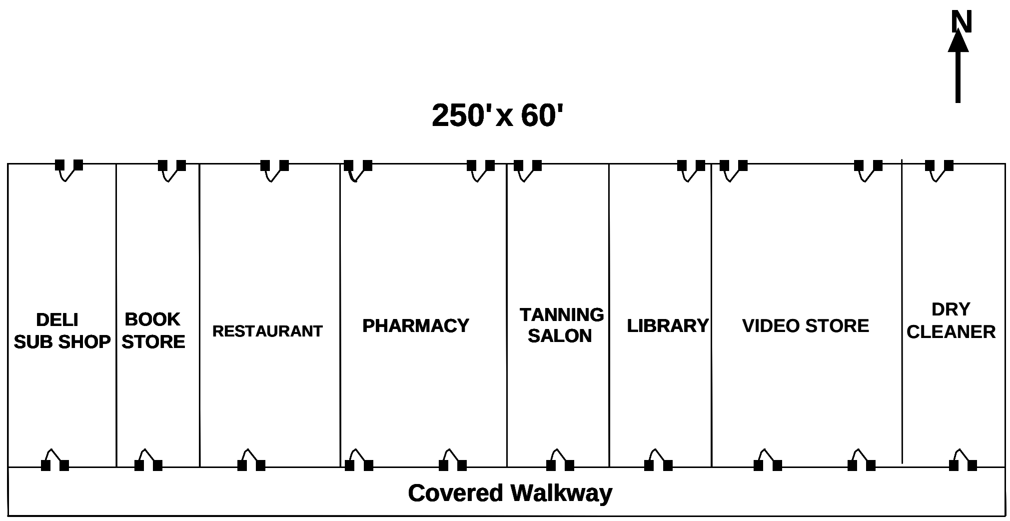
Activity 3.3 (cont'd)

Transfer of Command Chart

To be completed upon transferring command:

Location and Extent of Fire:	
Control Efforts:	
Deployment of Resources:	
Need for Additional Resources:	

Fields Hill
Plot Plan



Quick Access Prefire Plan

Building Address:
101-119 Fields Hill Drive

Building Description:
One-story/frame construction, 60' x 250', each occupancy is 25' x 60'; two occupancies are double occupancies.

Roof Construction:
Ridgepole and rafter, 1" x 6" sheathing, wood roof gable with dormers and common attic/loft

Floor Construction:
Poured concrete with tile floors

Occupancy Type:
Strip mall

Initial Resources Required:
3 engines, 1 ladder, 1 squad

Hazards to Personnel:
Moderate to heavy fire loading in several occupancies; occupancies using commercial cooking equipment

Location of Water Supply:
Hydrant, 8-inch municipal system 400' apart

Available Flow:
1,200 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	*25%*	*50%*	*75%*	*100%*
Estimated Fire Flow	1,250	2,500	3,750	5,000

Fire Behavior Prediction:
Rapid spread of fire if extension into common attic/loft area; potential gas-fed fire

Predicted Strategies:
Rescue, confinement/extinguishment, ventilation, salvage, and overhaul

Problems Anticipated:
Potential commercial natural gas leak; potential roof collapse

☐ **Standpipe:**
None

☒ **Sprinklers:**
Commercial dry chemical system installed in cooking area of restaurants--no other sprinkler systems are installed.

☒ **Fire Detection:**
Smoke detectors

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Activity 3.3 (cont'd)

Column #1 Primary Factors Size-Up Chart			Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
Pertinent Factors (P) Check Appropriate boxes		P	Examples of Incident Objectives • Removal of all occupants within 10 minutes • Contain & control fire to building of origin in 30 minutes • Contain, control, limit fire in exposure within 1 hour • Remove all smoke within 20 minutes	(R) Rescue • Interior/Exterior			
Life Hazard	Occupants			(E) Exposure Protection • Exposure Examination			
	Firefighters						
Location/Fire	Fire Bldg/Exposures on Arrival			(C/E) Confinement/Extinguishment • Hoseline Placement			
	After Arrival - Burn Time						
Construction	Fire Building			(O) Overhaul • Expose Hidden Fire			
	Exposures						
Occupancy (Contents)	Fire Building			(V) Ventilation • Removal of all Occupants • Fire Control			
	Exposures		List Incident Objectives				
Height	Fire Bldg (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.	(S) Salvage • Water run-off • Apply salvage covers			
	Exposures (Front/Rear)						
Area	Fire Bldg/Configuration		#2				
	Proximity of Exposures/Config.						
Structural Collapse	Fire Building		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor. • ______ • ______ • ______ • ______ • ______ • ______	
	Exposures						
	Apparatus Placement						
Weather	Visibility		#4	#1			
	Temperature/Humidity			#2			
	Wind – Direction/Velocity						
Resources	Apparatus/Personnel/Equip/RIC		#5	#3			
	Water Supply/Suppression Agent						
Auxiliary Appliances	Fire Building Supplied		#6	#4			
	Exposures Supplied						
Topography	Street Conditions		#7	#5			
Explosion Backdraft	Flashover Conditions		#8	#6			
				#7			
Time	Duration of Incident		#9				
	Time of Day						
	Time of Alarm						

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NOTE-TAKING GUIDE

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NOTE-TAKING GUIDE

Slide 3-1

UNIT 3: COMMUNICATIONS

Slide 3-1

Slide 3-2

OBJECTIVES AND OVERVIEW

The students will:

- **List four benefits of effective incident communications and explain the importance of each.**
  - **Understanding Incident Communications**
  - **The Need for Effective Fireground Communications**

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Slide 3-3

OBJECTIVES AND OVERVIEW (cont'd)

- **List the six steps identified in the communications model and explain the importance of each step.**
  - **The Need for a Communications Model**
  - **The Communications Model**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Apply the communications model to practical fireground communications when given a scenario.**
  - **Benefits of Using the Communications Model**
  - **Tactical Communications Responsibilities**

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OBJECTIVES AND OVERVIEW (cont'd)

- **Given a simulated incident where communication is a critical issue, develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.**

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UNDERSTANDING INCIDENT COMMUNICATIONS

- **Mobile radio**
- **Face to face**
- **Cell phone**
- **Written Incident Action Plan (IAP)**

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FIREGROUND COMMUNICATIONS

- **More than just yelling orders**
- **Involves several steps**
- **Giving and receiving information**
- **Information understood**

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THE NEED FOR EFFECTIVE INCIDENT COMMUNICATIONS

- **Ability to communicate essential information quickly**
- **Knowing where personnel are at all times**

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EFFECTIVE USE OF RESOURCES

- **Manage action plan effectively**
- **Gather clear and concise information**
- **Flow of important information only**

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IMPROVED INTERAGENCY COOPERATION

- **Makes department look good**
- **Makes it easier for others to understand your needs**
- **Eliminates duplication of efforts**

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LEGAL IMPLICATIONS

- **Many radio communications are taped.**
- **Tapes may be entered as part of the evidence.**
- **All departments must follow FCC licensing requirements.**

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THE NEED FOR A COMMUNICATIONS MODEL

- **Communications are a major factor in how well emergencies are managed.**
- **Departments need to train on improving fireground communication procedures.**

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THE NEED FOR A COMMUNICATIONS MODEL (cont'd)

Departments should have written communication procedures.

- **Basis for training.**
- **Compatible with other agencies.**
- **Members know what the communication rules are.**
- **Used during postincident analysis.**

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THE NEED FOR A COMMUNICATIONS MODEL (cont'd)

Written procedures provide a model.

- **Assurance that all the important factors in effective communication are included.**
- **Followed at all incidents.**
- **"Perfect practice makes perfect."**

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THE COMMUNICATIONS MODEL

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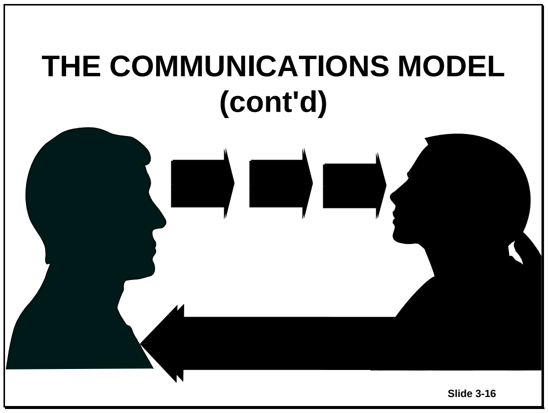

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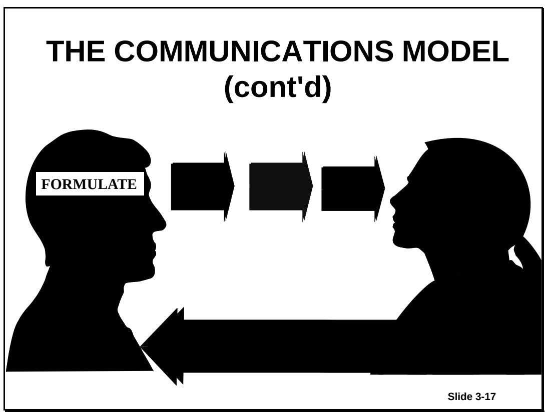

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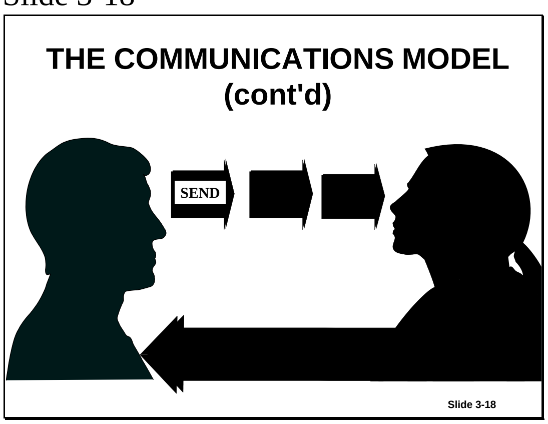

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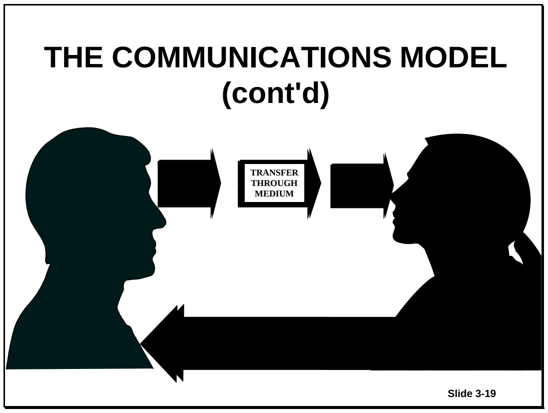

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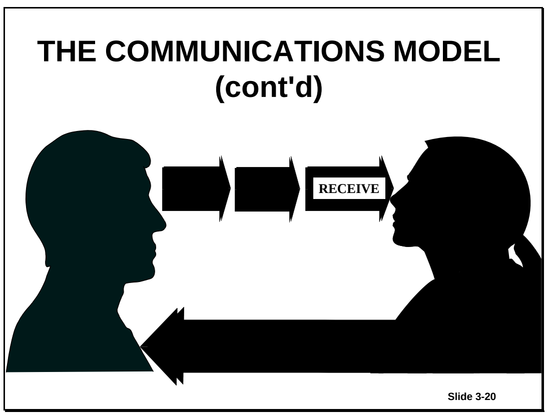

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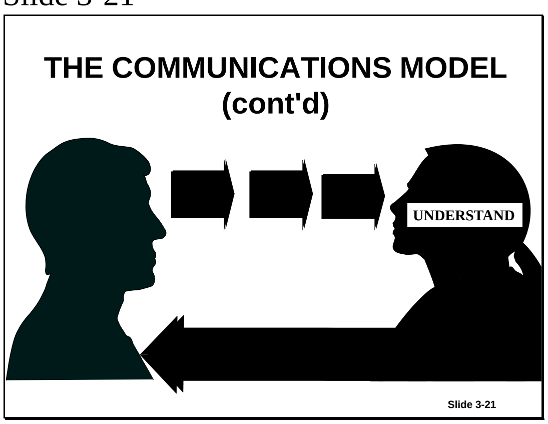

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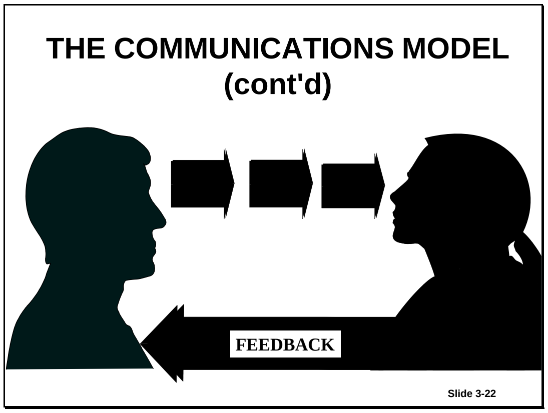

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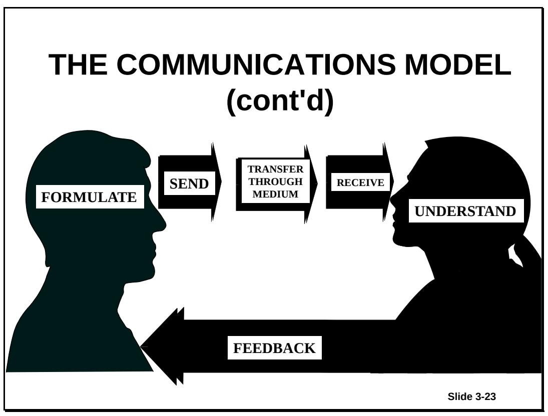

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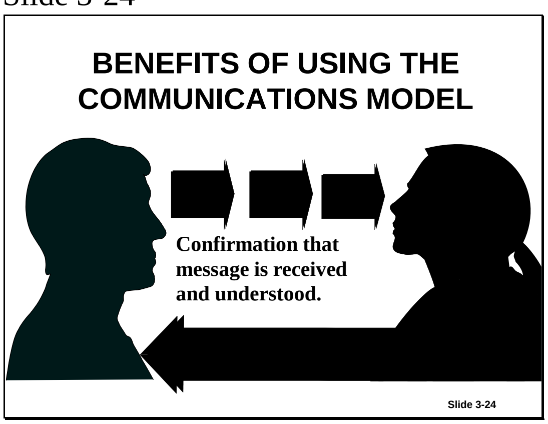

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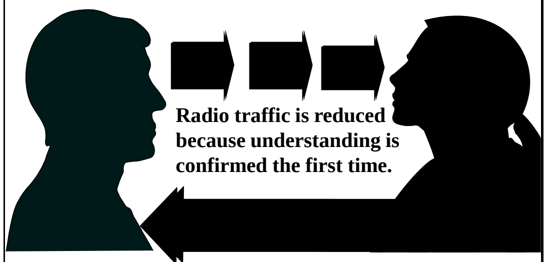
BENEFITS OF USING THE COMMUNICATIONS MODEL (cont'd)



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Activity 3.1 Communications

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TACTICAL COMMUNICATIONS RESPONSIBILITIES

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TACTICAL COMMUNICATIONS RESPONSIBILITIES (cont'd)

When communication breaks down on the fireground the following also break down:

- **Coordination.**
- **Control.**
- **The ability to provide for firefighter safety.**

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TACTICAL COMMUNICATIONS RESPONSIBILITIES (cont'd)

All personnel have the responsibility to communicate effectively.

- **Starts with a good brief initial report by first-in officer.**
- **Continues throughout the incident.**

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TYPES OF TACTICAL COMMUNICATIONS

- **Initial conditions reports**
- **Implementation orders**
- **Progress reports**
- **Reports of safety hazards**

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TACTICAL BENCHMARKS

- Completion of tactical operations
- Completion of primary search
- Stopping the forward progress of the fire
- When further property loss is stopped

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TACTICAL COMMUNICATIONS RESPONSIBILITIES (cont'd)

Progress reports from CO's "Report on conditions":

- Advanced warning to the supervisor as to when relief crews will be needed
- If/When resources might be available for release or reassignment
- Periodic reports concerning status

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REPORTS OF SAFETY HAZARDS

- All personnel have the responsibility.
- A method to quickly convey emergency information should be established.
- Accounts for all personnel when the structure has been evacuated.

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SIZEUP REPORT OF FIREGROUND CONDITIONS

- Initial report to be given immediately upon arrival on location.
- Exact location and conditions as observed.
  - Nothing showing.
  - Size of structure--stories and dimensions.
  - Type of construction--occupied or vacant.
  - Smoke/Fire--location and density.
  - Status of occupants--if known.
  - Exposures--Sides A, B, C, D, or other.
  - Engine______is establishing ___________ Street Command.

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SIZEUP REPORT OF FIREGROUND CONDITIONS (cont'd)

- Subsequent report includes information not immediately reported and/or information developed upon investigation--to be given ASAP or within 5 minutes.
- Progress report is to be given by the Incident Commander (IC) every 10 minutes until fire is under control.

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Activity 3.2 Communications Exercise

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Activity 3.3
Command Sequence #1:
Fields Hill

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COMMAND SEQUENCE #1:
FIELDS HILL
WALKAROUND

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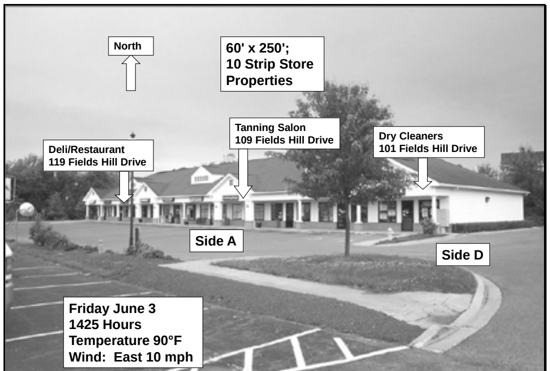

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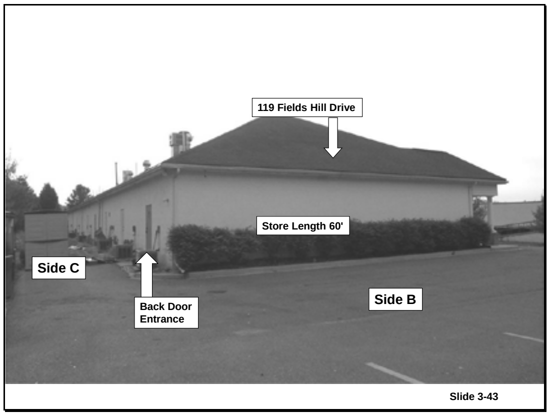

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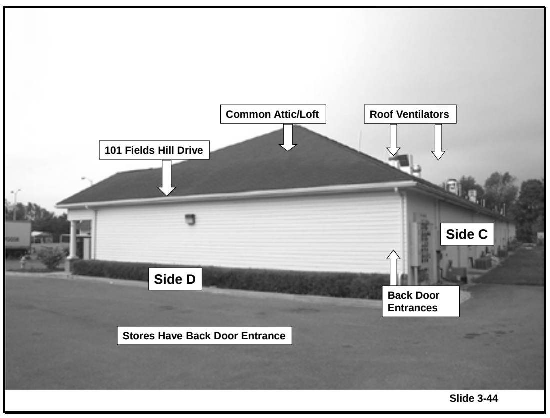

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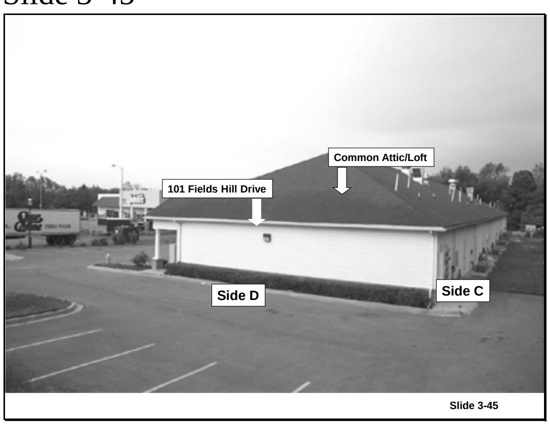

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COMMAND SEQUENCE #1
FIRST-ALARM RESOURCES

- **Engine 1**
- **Engine 2**
- **Engine 3**
- **Truck 1**
- **Squad 1**
- **Battalion Chief 1**
- **All companies staffed with four firefighters**
- **Battalion Chief 1: 30-minute response**

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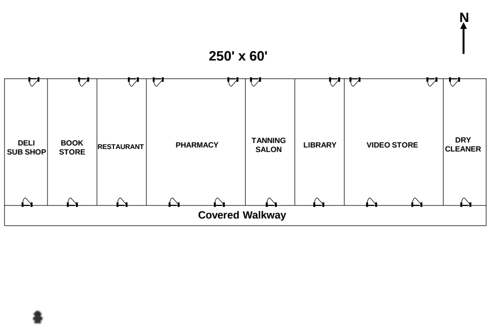

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Column #1 Primary Factors Size-Up Chart
Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed
Column #3 Activities (Strategies)
Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE INEFFECTIVE

Pertinent Factors (P)
Check Appropriate boxes P
Life Hazard: Occupants; Firefighters
Location/Fire: Fire Bldg/Exposures on Arrival; After Arrival - Burn Time
Construction: Fire Building; Exposures
Occupancy (Contents): Fire Building; Exposures
Height: Fire Bldg (Front/Rear); Exposures (Front/Rear)
Area: Fire Bldg/Configuration; Proximity of Exposures/Config.
Structural Collapse: Fire Building; Exposures; Apparatus Placement
Weather: Visibility; Temperature/Humidity; Wind – Direction/Velocity
Resources: Apparatus/Personnel/Equip/RIC; Water Supply/Suppression Agent
Auxiliary Appliances: Fire Building Supplied; Exposures Supplied
Topography: Street Conditions
Explosion Backdraft: Flashover Conditions
Time: Duration of Incident; Time of Day; Time of Alarm

Examples of Incident Objectives
- Removal of all occupants within 10 minutes
- Contain & control fire to building of origin in 30 minutes
- Contain, control, limit fire in exposure within 1 hour
- Remove all smoke within 20 minutes

List Incident Objectives
#1 Provide for the safety of all Responders for the duration of the incident.
#2
#3
#4
#5
#6
#7
#8
#9

(R) Rescue
- Interior/Exterior

(E) Exposure Protection
- Exposure Examination

(C/E) Confinement/Extinguishment
- Hoseline Placement

(O) Overhaul
- Expose Hidden Fire

(V) Ventilation
- Removal of all Occupants
- Fire Control

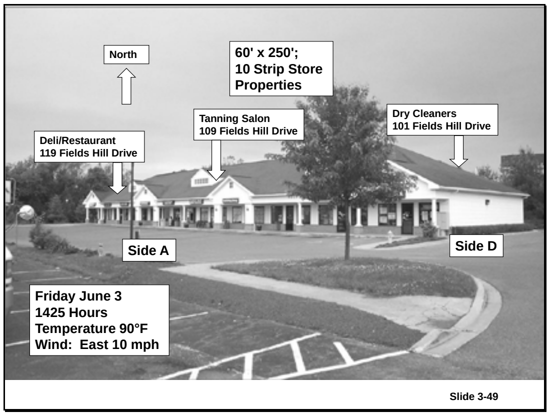
(S) Salvage
- Water run-off
- Apply salvage covers

List Incident Strategies | Assigned to
#1
#2
#3
#4
#5
#6
#7

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

Slide 3-48

Slide 3-49



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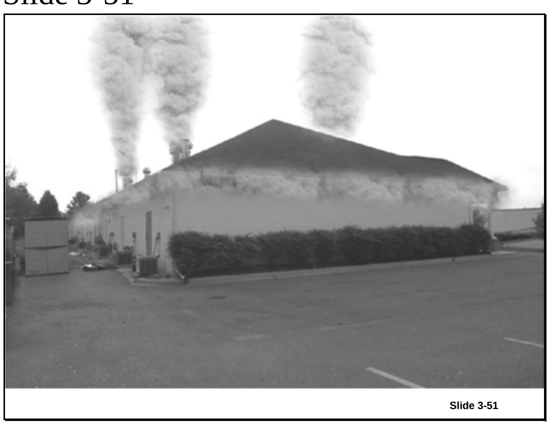

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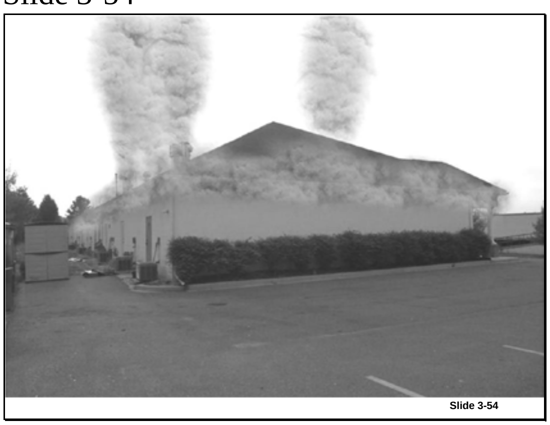

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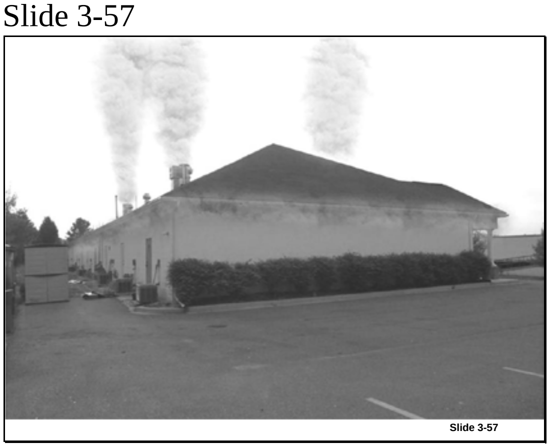

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SUMMARY

- When incident communication is effective, information has been given in a clear and concise manner and has been received and understood.
- Effective incident communication is needed to improve firefighter safety, make effective use of resources, improve interagency cooperation, reduce liability, and increase accountability.

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SUMMARY (cont'd)

- The steps of the communications model are formulating, transmitting through a medium, receiving, interpreting, and providing feedback.
- Types of tactical communications that occur on the incident include initial sizeup reports, implementation orders for the action plan, progress reports, reports on safety hazards, evacuation orders, and tactical benchmarks.

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SUMMARY (cont'd)

The major benefit of using the communications model is the assurance that messages have been received and understood.

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UNIT 4: BUILDING CONSTRUCTION AND FIRE BEHAVIOR FACTORS

OBJECTIVES

The students will:

1. *List the five classifications of buildings and explain the characteristics of each classification.*

2. *Identify the strengths and concerns for each building construction classification.*

3. *List and explain the critical fire behavior factors that relate to tactical operations for an assigned fire scenario.*

4. *Given a simulated incident where building construction is a critical issue, develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.*

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BUILDING CONSTRUCTION CLASSIFICATIONS

Basic knowledge of how buildings are constructed and how they will react when subjected to fire is of vital importance to every Company Officer (CO). A building that is on fire is physically being destroyed. The mission of the CO is to determine if it is possible to enter the structure, how long the structure can last under fire conditions, and what strengths the building can offer or what weaknesses may exist. Each type of building will react differently under fire conditions, and certain predictions can be made. As an example, a wood-frame building with a lightweight roof structure of truss rafters can be expected to lose its structural strength faster than a building with a roof structure of standard rafter and ridge board design.

Construction Classifications

Generally, it is not possible to distinguish construction classifications from the exterior of a building. Most often, even the experienced observer must look at the bearing members (wall, floor, and roof assemblies) in order to tell the construction classification. At the end of each section describing different construction classifications we will provide a brief summary describing cues and rules of thumb that correspond with that classification.

Fire Resistive

Fire resistive is a method of construction where all key structural elements that hold the building up will withstand normal fire conditions for a minimum of 3 hours. The structural elements generally will be reinforced concrete or steel with a fire protection covering applied. In addition, the floors will be fire resistive and designed to limit fire spread. This type of structure has demonstrated fire after fire that it can withstand complete devastation of the contents and still remain structurally sound. While the structural components are a very positive feature, there may be some concerns that a CO should be aware of. As an example, fire in many buildings may spread from floor to floor at the area where the outer wall of the building attaches to the floor segments. Many designs provide for a space between the floor and the wall. This area may be closed off with insulation or may be totally open. In addition, the windows are very often the vehicle for fire spread with fire leaping from floor to floor. To manage this problem some architects have staggered the windows or placed eyebrows over the tops of the windows.

Fire-resistive cues: Bearing members are either reinforced, poured, or prestressed concrete assemblies or skeletal steel with the steel protected by sufficient layers of drywall or a sprayed-on, fire-resistive coating. Special fire suppression problems for CO's would include open floor plans, which have large open areas without separations or compartmentation; limited opportunities for ventilating; and high heat levels inside the structure.

Noncombustible

Noncombustible is a method of construction where the structural components will not burn, but may be susceptible to early collapse under fire conditions. The walls may be constructed of steel or masonry with steel floor and roof structure. This steel will be unprotected from the products of combustion and may be vulnerable to early failure. This method of construction is very popular in commercial or industrial structures. While the structural elements will not contribute to the fuel load, unprotected steel will expand as it warms and eventually will not be able to support itself. As it expands, it has the capacity to push walls or to twist and collapse, and may drop the structural members that it was supporting.

The strength of this construction is in the load-carrying capacity and the long areas that it can span without support posts. It is an easily constructed type of building with large steel beams or trusses put in place with cranes. Steel is attached easily to other components by bolting, riveting, or welding, and a frame can be assembled quickly. The weakness of this construction is in the reaction to fire conditions, where the steel expands and weakens with the potential for collapse. This building generally is considered a candidate for early deterioration under fire conditions. A CO must pay close attention to this classification in order to ensure the safety of firefighters.

Noncombustible cues: Bearing members are made of noncombustible materials such as metal, concrete, stone, etc. Most often these buildings are skeletal steel assemblies where the steel is exposed and unprotected from the effects of fire.

Heavy Timber

Heavy timber (mill) is a method of construction using substantial wood structural elements for floor and roof supports and with masonry exterior walls. This method was used heavily in the northeastern United States to construct mills. The mills often would be built near natural sources of waterpower, and would be constructed up to six stories in height. As the exterior walls were masonry, they would be wider at the bottom than at the top. As the walls rise, they diminish in size, since they will be carrying less load. In many of these structures the walls at the ground floor could be up to 36-inches thick. The structural timber would be a minimum of 8 inches by 8 inches, and they were spaced based upon the load they would be supporting. Under fire conditions, the floors and support timbers burn slowly and remain strong for a considerable time. In many of these structures the floors were several inches thick to support heavy machinery and goods. To minimize water damage to floors below, the floors would be equipped with scuppers.

The strength of this type of building is in the size of the wooden structural members that held the floor and roof in place, in addition to the masonry walls. While these buildings often had firewalls with fire doors, they also posed massive fire problems due to large open areas with heavy fire loads, oil-soaked floors, and large quantities of combustible stock. In general, this classification is considered a strong building to work in during fire conditions, but one in which fire can quickly surpass a fire department's ability to suppress.

Heavy-timber (mill) cues: These buildings have masonry walls. The floors and roof assemblies are wood. The wooden members are much larger than nominal lumber sizes. Look for a minimum of 4-inch by 6-inch wood joists, 6-inch by 8-inch wood columns, and thick floor decking.

Ordinary

Ordinary construction has been termed "Main Street, USA." This type of building also gained the name "taxpayer" because often the owner would operate a store on the first floor and live on the second floor. The business would pay the taxes on the property and the utilities, while the owner lived in the building virtually free. This building has masonry exterior walls, and the floors and roof are wood joist. The structural members for floor joists and roof rafters were often 3 inches by 10 inches and typically would span 12 feet to 14 feet, supported by a post-and-beam arrangement for interior walls. Since many of the streets on which these buildings were constructed were narrow, an effort had to be made to limit collapse of the masonry wall. A technique called "fire cut" would be used, where the end of the floor joist or rafter going into a bearing wall would be cut on an angle so that the bottom of the rafter or joist would be longer than the top. The idea was that when the wood member burned off on the inner portion of the structure it would pull out of the wall and fall into the structure, rather than lifting the wall directly above it and pushing the masonry wall into the street. Through the years these buildings typically were renovated several times with ceilings dropped, new voids created for new plumbing fixtures, and walls removed between occupancies in order to expand floor space.

The strength of these structures is in the masonry walls and the full-dimension lumber used to construct the floor and roof components. In addition, the floor and roof elements were installed with a fire cut so that they could drop out of the walls without bringing the walls into the street. The number of renovations that the building has had often will cause unexpected fire travel and multiple-floor involvement.

Ordinary (masonry/wood joist) cues: These buildings have masonry walls. The floor and roof assemblies are wooden. The floor joists often sit in the masonry walls in sockets that hold the joist ends. To determine whether or not the joists have been fire cut, normally one must go to the basement level and examine the first-floor joists where they sit in the wall sockets.

Wood Frame

Wood frame is a method of construction where the structural components are framed out of wood. The use of a combustible structural element poses a special concern as it will lose its load-carrying capacity as it burns; eventually gravity will take over and pull whatever it was supporting to the ground.

Post-and-beam is a method of wood-frame construction and typically is used in barn construction. A modern method is called "pole barn" construction, where large pressure-treated poles are set into the ground and the framework of the building is hung from these poles. The poles themselves will last considerably longer under fire conditions than the materials used for the roof or walls.

Balloon is a method of wood-frame construction that was popular when long structural materials were available. The common characteristic of this type of building is that the wall studs extend from the foundation of the structure to the roof. When it was time to attach the second floor, the floor joists were simply nailed to the wall studs. This created an open area the entire length of the wall's studs, and across the floors to the opposite side of the building as well. If a fire got into the walls, ceiling, or floor space it was free to go wherever it pleased. Firefighters often tell of being inside the basements of these buildings and shining a light at the foundation with a fellow firefighter in the attic reporting that he/she saw the light shining through. Generally, the interior walls were constructed of wood lath over wood studs with plaster attached; the lath was said to resemble kindling, and was arranged in a very desirable manner for rapid fire extension up through a stud channel. This structure typically used full-dimension lumber and had close spacing of structural elements. If a CO were not correctly reading the building, he could become fooled quickly as the fire worked the building in all directions. Extension must be checked aggressively in this type of structure.

Platform is an open method of construction that has been popular since the late 1940's. The structure is built one floor or story at a time. Each floor has a floor deck, sill plate, wall studs, and a plate at the top of the wall. For a fire to travel from one floor to another through the walls, it has a great deal of material in its path to burn through. More often a fire will find another route of extension. Fire may extend via ventilation shafts for dryer, bathroom, and kitchen vents. Areas around plumbing pipes or heating ducts also will be vulnerable to fire extension. Generally the interior wall construction will use drywall material, which is inherently fire resistive and provides for compartmentation of a fire. The weak components most often will be the floor or roof.

Lightweight methods of construction have become popular, with truss construction or a sandwich-beam method of floor or roof support. Generally wooden trusses will be made of smaller dimension lumber, and are held together with metal gusset plate fasteners. Under fire conditions the plates may loosen and the structural integrity of the entire component may be lost. Another technique in use today is the process of ripping a 3/8-inch or 1/2-inch groove into a 2 by 4 and inserting a piece of 3/8-inch or 1/2-inch plywood. The size of the plywood is dependent upon the area to be spanned. These are commonly found in floor joists or as rafters on a flat or limited pitch roof, and are even becoming popular in some strip-mall construction. The strength of this method of construction is the floor-by-floor method of building. A weakness may very well be the lightweight floor or roof design.

Wood-frame cues: Wood-frame buildings normally have a masonry foundation with all floor, wall, and roof assemblies composed of nominal-sized lumber. The great percentage of private, detached dwellings are wood-frame construction.

FIRE BEHAVIOR FACTORS

An important part of your job will be the ability to make an accurate fire behavior prediction. Understanding fire behavior factors will assist you greatly in determining what is happening and what is likely to happen. They will have an impact on safety, strategy, and the use of resources. Those factors are

- heat release;
- thermal stratification;
- rollover;
- flashover; and
- backdraft.

Heat Release

Heat is described in several ways, all of which bear a definite relationship to each other. In order to better understand the concept of heat, the following definitions are necessary:

- British thermal unit (Btu): One Btu is the amount of heat required to raise the temperature of 1 pound of water 1°F (-17.2°C) (when the measurement is performed at 60°F (15.6°C)).

- Heat of combustion: the amount of heat that will be released by a substance when it is completely consumed by fire.

A number of variables influence the output of heat from burning materials:

- the amount of area of solid combustibles exposed to heat and oxygen (the state of subdivision);
- the area of free surface of the liquid (in case of flammable substances, to give off vapor pressure); and
- the conductivity of solids (wood, etc.), which can influence the amount of heat given off when materials burn.

Knowledge of the types of materials present in a given fire situation and their heat values is important, and can assist you in determining the amount of water to apply, as well as the behavior of other materials within the environment.

Even though the heat values (in Btu's) of various materials are not precise, they provide us with necessary information for developing the concepts of "fireloading" and the heat absorption qualities of water. Some examples of the heat of combustion values of various materials are shown in the following table.

Materials	Btu/lb.
Asphalt	17,150
Cotton batting	7,000
Gasoline	19,250
Paper	7,900
Polystyrene	18,000
Polyvinyl chloride	7,500 to 9,500
Wood	7,500 to 9,050

Thermal Stratification

Thermal stratification is the layering of heat in a given enclosed area. The ceiling or upper area will be a higher temperature. Floor covering materials are potentially less hazardous than ceiling or wall surfaces.

In the prefire inspection, you should not ignore the degree of combustibility of materials used throughout the occupancy. In the MGM Grand Hotel fire, the use of plastic materials in ceiling areas dramatically affected the fire behavior.

The introduction of water through a nozzle will change the thermal stratification of the enclosed area rapidly. In most cases, a thermal balance will occur following the introduction of water. The temperature in the room will equalize.

If the thermal balance is disturbed, temperatures can be raised beyond the point where any victims trapped inside would have a chance of surviving. Wide fogs applied into a room can turn into superheated steam, endangering both potential victims and firefighters. Full protective clothing and self-contained breathing apparatus (SCBA) are a must for firefighters.

Rollover

The term rollover is used to describe the fire or flame front that often is observed rolling along in front of the materials that are actually burning. As a combustible gas is produced and liberated from combustible materials it must mix with air (oxygen) in order to burn. Since the material that is burning consumes tremendous amounts of air (oxygen) there may be a limited amount of air (oxygen) in the upper levels of the room to support combustion of all the fuel being produced. This fuel-rich atmosphere will be pushed in front of the fire by the thermal column of heat from the fire and may not come within its flammable limits until several feet away from the main body of the fire. This is especially true in confined areas such as hallways. Often fire seems to be rolling along at ceiling level at a distance up to 10 to 20 feet ahead of the main fire. What actually is being witnessed is a fuel-rich mixture being pushed well ahead of the fire; when it comes into its flammable limits (mixture of air and fuel gas) it burns. This is often described as the fire rolling over.

Flashover

A very basic definition of flashover is the ignition of combustibles in an area heated by convection or radiation, or a combination of the two. The combustible substances in a room are heated to their ignition points and almost simultaneous combustion of the material occurs. In other words, the entire area is preheated to its ignition temperature and can become fully involved in fire in a matter of seconds.

Some of the warning signs of imminent flashover are intense heat, free-burning fire, unburned articles starting to smoke, and fog streams turning to steam a short distance from the nozzle.

To reduce the chance of flashover, temperatures need to be lowered quickly by ventilation and water application.

Backdraft

As a fire develops, the combustion process creates an atmosphere that is deficient in oxygen and can lead to the possibility of backdraft occurring. This also is referred to as a smoke explosion. The difference between flashover and backdraft is the amount of oxygen present. In flashover there is adequate oxygen available for combustion, and the fire is free-burning prior to flashover. In backdraft, there is insufficient oxygen for active burning, and the fire is smoldering. It is an oxygen-deficient atmosphere.

Normally, sufficient oxygen is present during most fires so that the conditions leading to backdraft are minimized. However, when oxygen is depleted and the fire begins to smolder, an oxygen-deficient atmosphere is created in the fire area. When conditions like this develop, gases such as carbon monoxide and carbonaceous-particle smoke or suspensions are produced. These are capable of reacting with oxygen.

This poses an explosion threat if oxygen is allowed to enter the structure improperly. The accumulated gases will ignite readily, spreading fire or causing a violent explosion. Due to temperatures in the room, the fuel is evolving into ignitable vapors at or above their ignition temperatures. All that is needed is oxygen to complete the fire triangle.

When backdraft conditions are present and oxygen is introduced before the inside pressure is relieved, the resultant explosion can eliminate firefighters and their hoses. The potential for backdraft exists in buildings, rooms, attics, or any other confined space. An indication of backdraft is when a fire has depleted the oxygen content in an area, yet has preheated that space above the ignition temperatures of the combustibles in it. Another indicator is hot, heavy smoke issuing from the building (smoke is sometimes described as lazy, or sick-looking). This may be accompanied by dark carbonization on the window glass. In this situation, the building may seem to be breathing (drawing smoke back in the opening followed by expelling smoke from the opening). Backdrafts may occur during the incipient phase as well as the smoldering phase.

Ventilation is the first priority and must precede fire attack under backdraft conditions.

FIRE TRAVEL PREDICTIONS

Heat and Smoke Travel

Checking fire extension requires a knowledge of how fire spreads, along with a knowledge of building construction features and the effects of concealed vertical and horizontal spaces. Whenever and wherever openings are made, hoselines should be ready. While every effort should be made to minimize damage to the building and its contents, openings have to be large enough for inspection, hose manipulation, and ventilation.

Until determined otherwise, it is a safe assumption that when a working fire exists inside a building, fire has entered concealed vertical channels.

Personnel should be looking for indicators such as blisters and discolorations on walls, smoke patterns at molding, walls hot to the touch, or smoke (or fire) showing around roof features, such as vent pipes, etc. If these are present, checking vertical extension is a must.

The tendency for most fire to travel vertically does not preclude horizontal travel. Fire will follow any path available: void spaces between ceilings and floors, over false or hanging ceilings, around utility conduits, etc. Extension occurs not only within the structure, but also from building to building. Here again, hoselines must be in place prior to opening up these areas. Most of the time, the indicators of fire in these areas are difficult to read, but look for some of the indicators present in vertical spread. These areas should not be overlooked and have been responsible for fatalities, as well as for fires getting out of control.

Tactical operations in large and complex occupancies will have to be coordinated carefully in order to accomplish a reduction or change in heat and smoke travel. Ventilation is a key tactical operation that will affect how, when, and where heat and smoke spread through a structure.

In your prefire inspections and plans, always look at all the possibilities of heat and smoke travel in a specific occupancy. The time of the fire is not the time to study heat and smoke probabilities.

Based on the fire behavior factors and resource capabilities, you must make a fire behavior prediction that answers the following questions:

- Where is the fire at this time?
- In what direction is it likely to spread?
- Is there a probability that flashover is imminent?
- Is there a probability that backdraft is imminent?
- Is collapse likely to occur within the time required for offensive operations?

Once you have the answers to these questions, you have identified the problems, and can have a much clearer idea of what the resource needs are.

How Fires Extend

The travel of fire in structures can be predicted based on a good understanding of building construction and fire behavior factors. Fire, smoke, and heat travel are dependent on many factors, such as void areas within the structure, the effect of the wind, and the positioning of hoselines.

The building layout and design can be an advantage or a disadvantage to your fire confinement and suppression efforts. Generally, fires in large open areas will be more difficult to confine than fires in a compartmented area. Fire load and built-in fire protection features will affect your efforts. Items such as firewalls, fire doors, and automatic sprinkler systems can play a major role in the amount of resources you will need and the efforts it will take.

Fires generally spread from room to room via open doorways or through lightweight doors that do not last more than a few minutes under fire conditions. Fires generally spread from floor to floor via open stairways, or open shafts and voids.

Predict Fire Travel

Fire travel predictions can be made by asking a few basic questions:

- Where is the fire now?
- Where is the smoke showing?
- What is in place to stop the spread of the fire and smoke to other areas of the structure, such as firewalls or other fire-resistant materials?
- What signs do I see, such as discoloration of paint, bubbling tar, or other building reactions, that will provide me with clues as to the fire travel?

The ability to predict fire travel will provide a CO accurate predictions that can lead to successful operations, realistic and proactive decisions, and adjustments as needed.

A good CO is an informed CO. An informed CO will be a well-trained CO. A well-trained CO will be a safe CO. Be careful out there!

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Activity 4.1

Predicting Fire Travel

Purpose

To review construction features, fire and smoke development, and to predict fire travel patterns.

Directions

1. You will be working in small groups.

2. The instructor will assign each group one construction type. You will be asked to review the features of the building/construction type your group has been assigned. Your group also will be asked to make predictions of how fire will travel within this structure.

3. Your group will record your predictions on an easel pad or paper.

4. Your group will select a spokesperson to explain to the class how fire would travel in this building.

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Activity 4.2

Command Sequence #2: McDonald's

Purpose

To develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.

Directions

1. You will be working in teams of three for this simulation exercise.
2. A Command Sequence Tactical Chart for each team position is included here.
3. The instructor will designate two students per team jointly to assume the role as the first-due engine CO.
4. The instructor will designate one student per team as a team recorder; this position will rotate among team members when doing the large simulations.
5. Team recorder will record all actions taken by the first-due CO onto the Command Sequence Tactical Chart and the Primary Factors Size-Up Chart.
6. The instructor will review the Command Sequence Tactical Chart preparation process with the class.

Part 1

1. View the slides to assess primary sizeup factors and visible cues.
2. Complete the Primary Factors Size-Up Chart and develop the sizeup report.
    a. Primary factors.
    b. Initial objectives.
    c. Initial strategy.

Part 2

1. View the McDonald's fire slides and read the simulation messages.
2. Complete the Command Sequence Tactical Chart.
3. Be prepared to present your sizeup report and charts to the rest of the class.

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Activity 4.2 (cont'd)

Command Sequence Tactical Chart

To be completed during simulation:

Tactical Assignment	Assigned To	Progress Report

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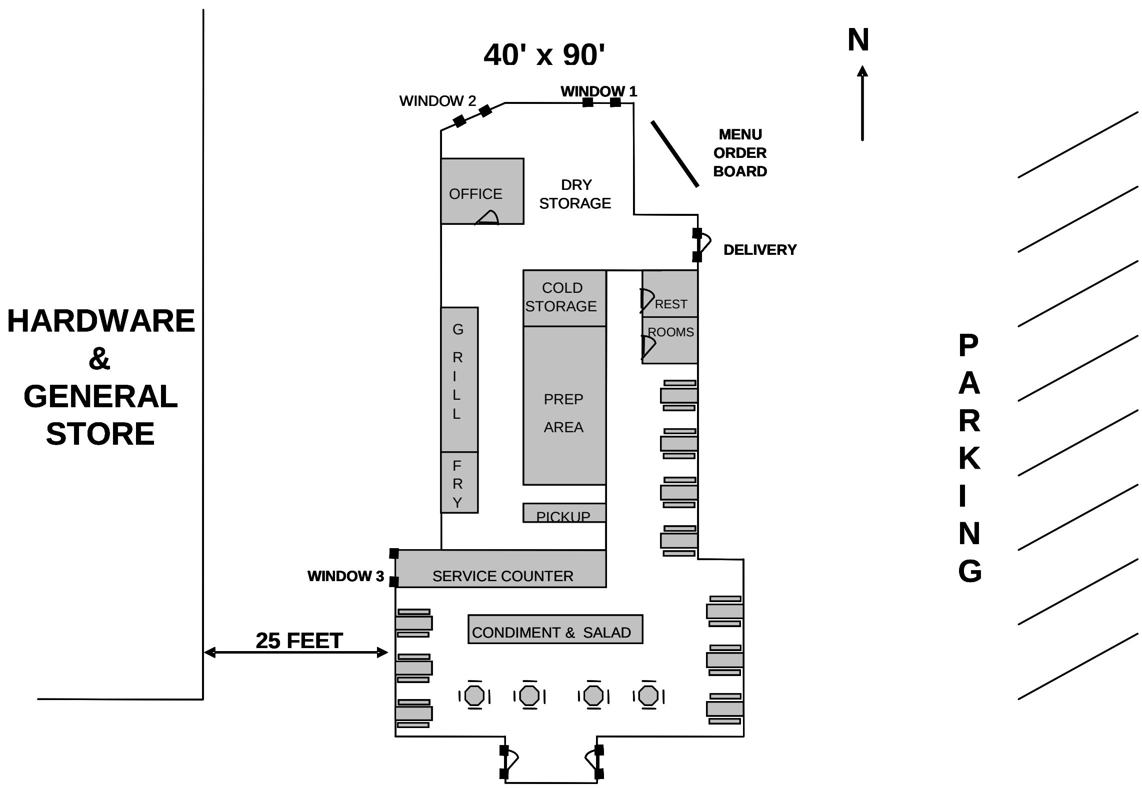
Activity 4.2 (cont'd)

Transfer of Command Chart

To be completed upon transferring command:

Location and Extent of Fire:	
Control Efforts:	
Deployment of Resources:	
Need for Additional Resources:	

McDonald's
Plot Plan



Quick Access Prefire Plan

Building Address:
22 Hill Drive

Building Description:
One-story/frame construction; 40' x 90'

Roof Construction:
Truss roof

Floor Construction:
Poured concrete with tile floors

Occupancy Type:
Fast-food restaurant

Initial Resources Required:
3 engines, 1 truck, 1 squad

Hazards to Personnel:
Moderate to heavy fire loading in storage areas; occupancy using commercial cooking equipment

Location of Water Supply:
Hydrant, 8-inch municipal system 400' apart

Available Flow:
1,200 gpm per hydrant

	Estimated Fire Flow			
Level of Involvement	*25%*	*50%*	*75%*	*100%*
Estimated Fire Flow	330	660	990	1,320

Fire Behavior Prediction:
Rapid spread of fire if extension into attic/loft area; potential gas-fed fire

Predicted Strategies:
Rescue/confinement/extinguishment, ventilation, salvage, and overhaul

Problems Anticipated:
Potential natural gas leak; high fire loading in storage areas; potential rapid truss roof collapse

- [ ] **Standpipe:** *N/A*
- [ ] **Sprinklers:** *N/A*
- [X] **Fire Detection:** *Smoke detectors*

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Activity 4.2 (cont'd)

Column #1 Primary Factors Size-Up Chart			Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
Pertinent Factors (P) Check Appropriate boxes		P	Examples of Incident Objectives	(R) Rescue • Interior/Exterior			
Life Hazard	Occupants		• Removal of all occupants within 10 minutes	(E) Exposure Protection • Exposure Examination			
	Firefighters						
Location/Fire	Fire Bldg/Exposures on Arrival		• Contain & control fire to building of origin in 30 minutes	(C/E) Confinement/Extinguishment • Hoseline Placement			
	After Arrival - Burn Time						
Construction	Fire Building		• Contain, control, limit fire in exposure within 1 hour	(O) Overhaul • Expose Hidden Fire			
	Exposures						
Occupancy (Contents)	Fire Building		• Remove all smoke within 20 minutes List Incident Objectives	(V) Ventilation • Removal of all Occupants • Fire Control			
	Exposures						
Height	Fire Bldg (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.	(S) Salvage • Water run-off • Apply salvage covers			
	Exposures (Front/Rear)						
Area	Fire Bldg/Configuration		#2				
	Proximity of Exposures/Config.						
Structural Collapse	Fire Building		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor. • __________ • __________ • __________ • __________ • __________ • __________	
	Exposures						
	Apparatus Placement						
Weather	Visibility		#4	#1			
	Temperature/Humidity			#2			
	Wind – Direction/Velocity						
Resources	Apparatus/Personnel/Equip/RIC		#5	#3			
	Water Supply/Suppression Agent						
Auxiliary Appliances	Fire Building Supplied		#6	#4			
	Exposures Supplied						
Topography	Street Conditions		#7	#5			
Explosion Backdraft	Flashover Conditions		#8	#6			
				#7			
Time	Duration of Incident		#9				
	Time of Day						
	Time of Alarm						

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NOTE-TAKING GUIDE

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NOTE-TAKING GUIDE

Slide 4-1

Slide 4-2

Slide 4-3

Slide 4-4

OBJECTIVES AND OVERVIEW (cont'd)

- **Given a simulated incident where building construction is a critical issue, develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.**

Slide 4-4

Slide 4-5

BUILDING CONSTRUCTION CLASSIFICATIONS

- **Understanding the strengths, concerns, and specific characteristics of construction types is critical.**
- **As structural elements become weakened, gravity will take over and pull the building down.**

Slide 4-5

Slide 4-6

BUILDING CONSTRUCTION CLASSIFICATIONS (cont'd)

- **Fire resistive**
- **Noncombustible**
- **Heavy timber**
- **Ordinary**
- **Wood frame**

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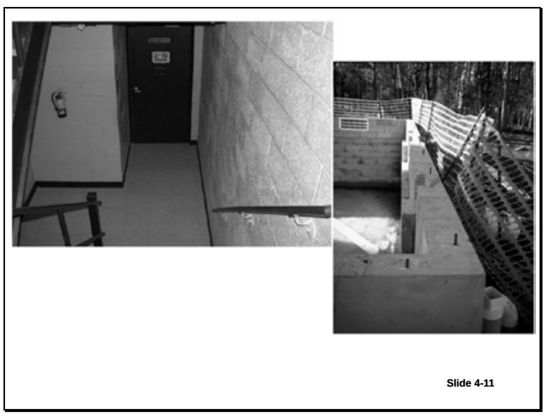
Slide 4-7

Slide 4-8

Slide 4-9

Slide 4-10

Slide 4-11



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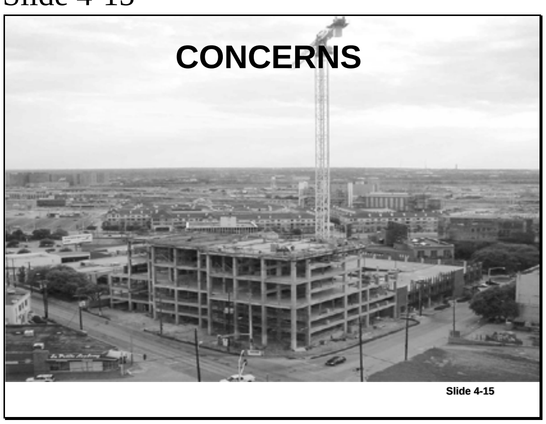

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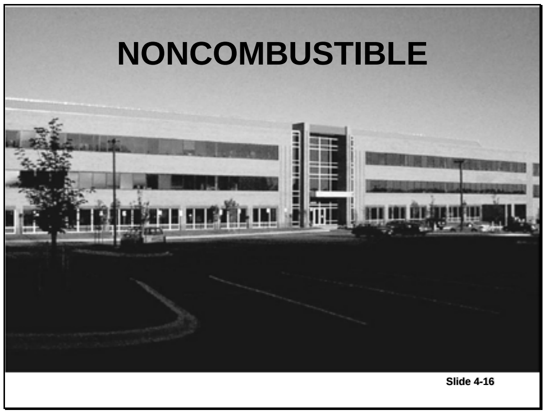

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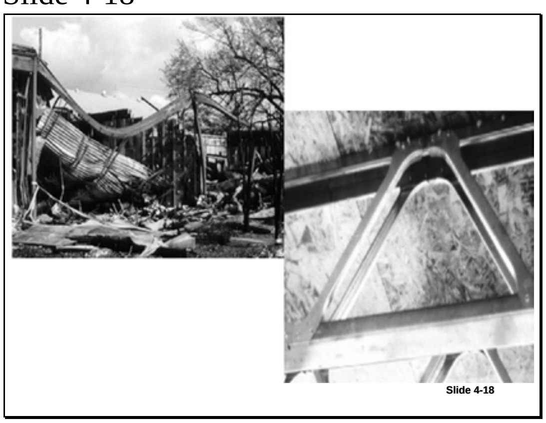

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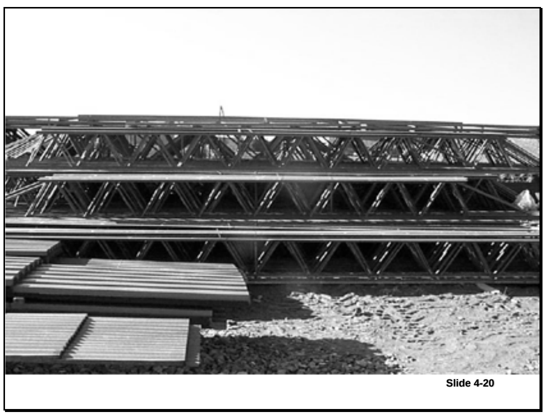

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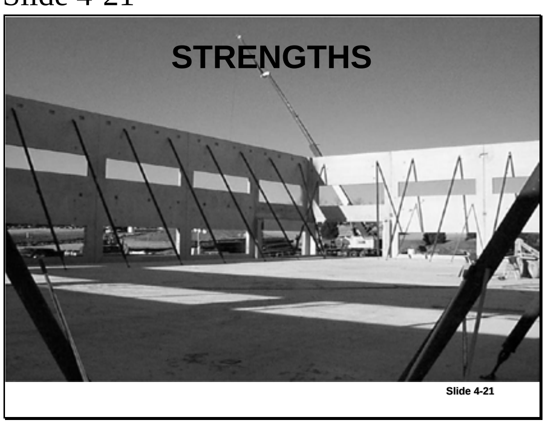

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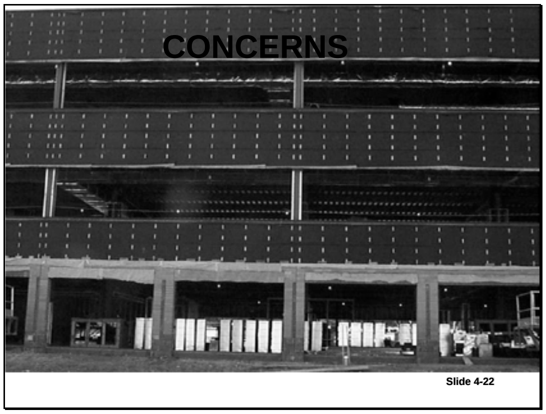

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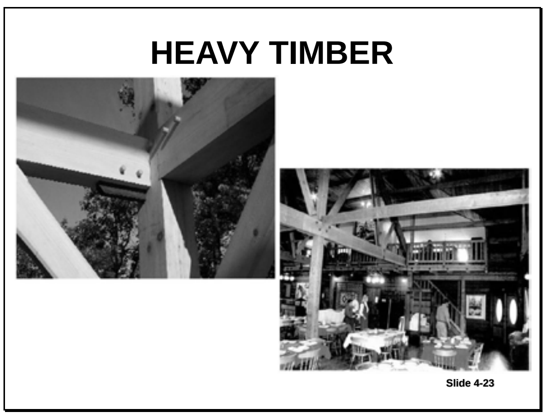

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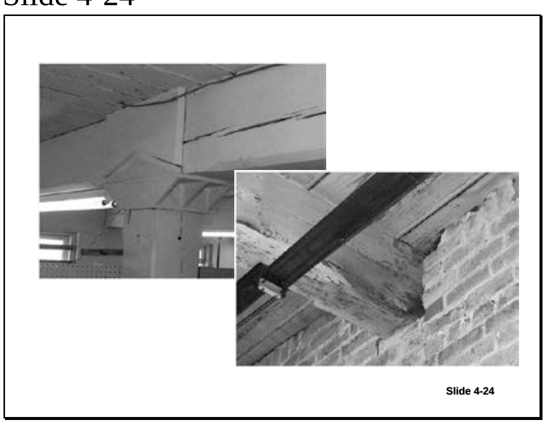

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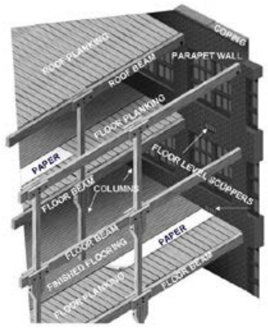
HEAVY-TIMBER/MILL CONSTRUCTION



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STRENGTHS

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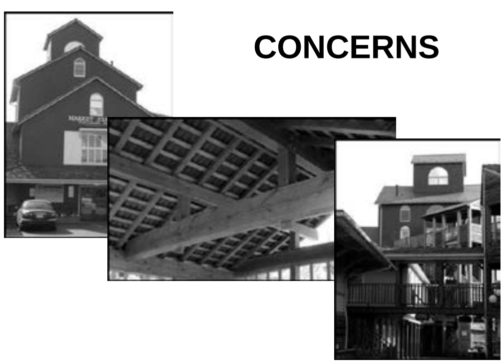
CONCERNS



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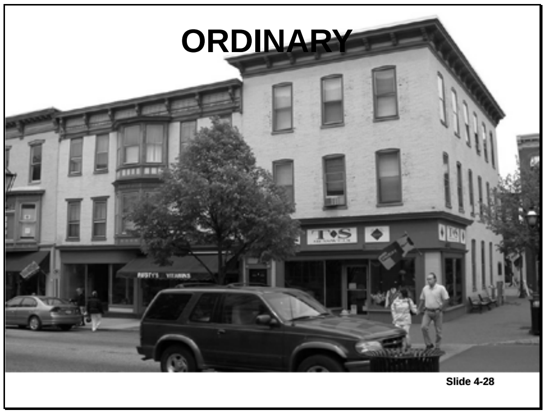

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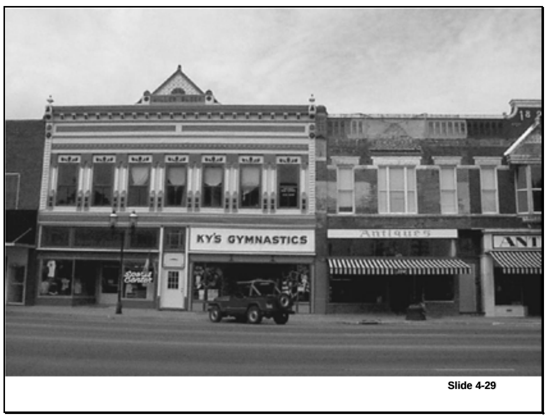

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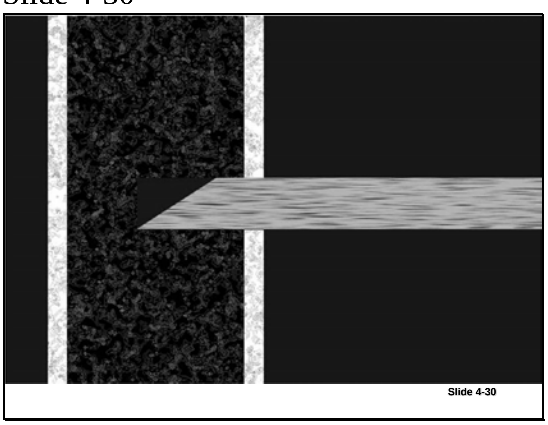

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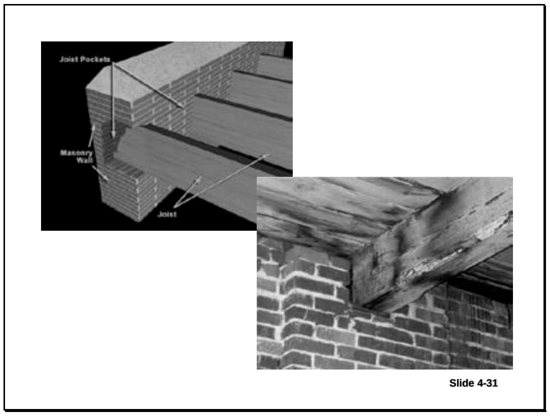

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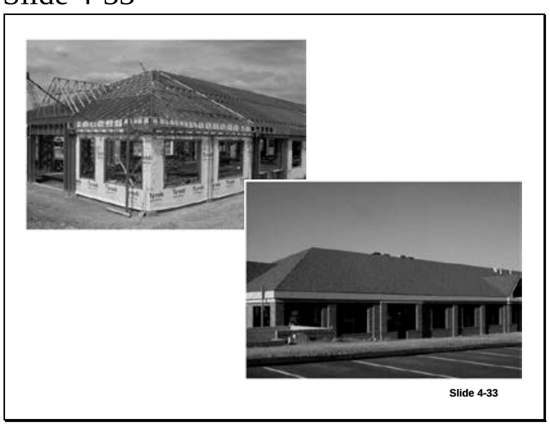

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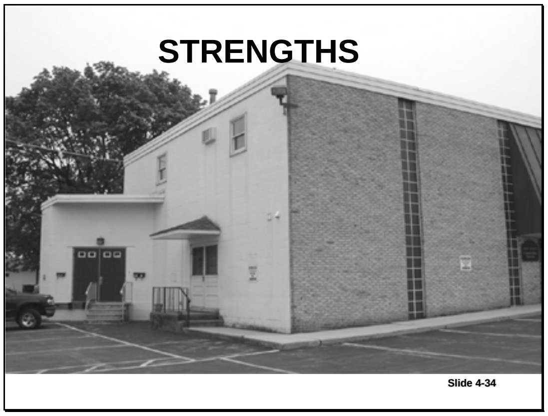

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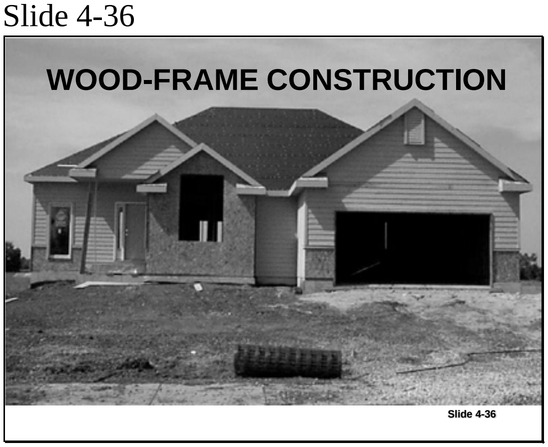

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BALLOON-FRAME CONSTRUCTION

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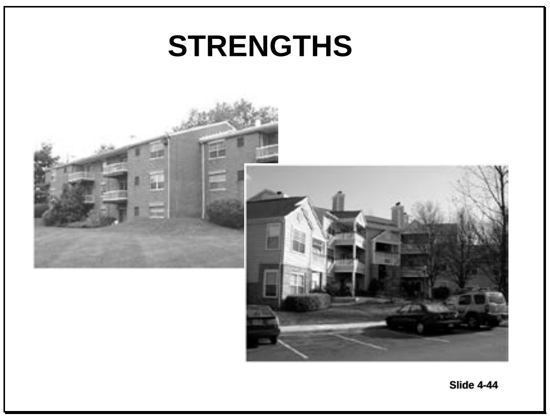

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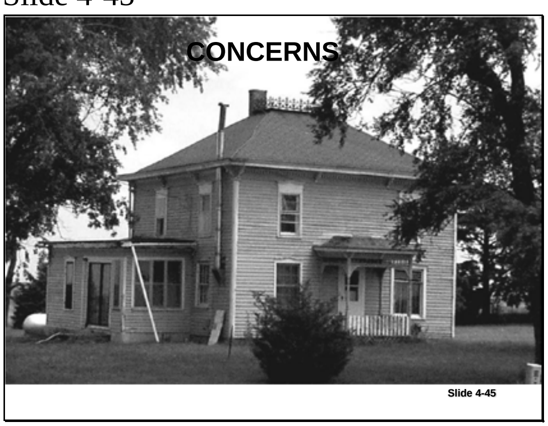

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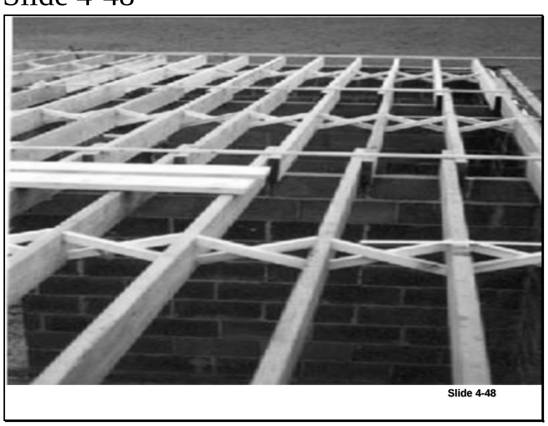

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Slide 4-50

FIRE BEHAVIOR FACTORS

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Column #1 Primary Factors Size-Up Chart			Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
Pertinent Factors (P) Check Appropriate boxes		P	Examples of Incident Objectives: • Removal of all occupants within 10 minutes • Contain & control fire to building of origin in 30 minutes • Contain, control, limit fire in exposure within 1 hour • Remove all smoke within 20 minutes	(R) Rescue • Interior/Exterior			
Life Hazard	Occupants			(E) Exposure Protection • Exposure Examination			
	Firefighters						
Location/Fire	Fire Bldg/Exposures on Arrival			(C/E) Confinement/Extinguishment • Hoseline Placement			
	After Arrival - Burn Time						
Construction	Fire Building			(O) Overhaul • Expose Hidden Fire			
	Exposures						
Occupancy (Contents)	Fire Building			(V) Ventilation • Removal of all Occupants • Fire Control			
	Exposures		List Incident Objectives				
Height	Fire Bldg (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.	(S) Salvage • Water run-off • Apply salvage covers			
	Exposures (Front/Rear)						
Area	Fire Bldg/Configuration		#2				
	Proximity of Exposures/Config.						
Structural Collapse	Fire Building		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor.	
	Exposures						
	Apparatus Placement						
Weather	Visibility		#4	#1		•	
	Temperature/Humidity			#2		•	
	Wind – Direction/Velocity					•	
Resources	Apparatus/Personnel/Equip/RIC		#5	#3		•	
	Water Supply/Suppression Agent					•	
Auxiliary Appliances	Fire Building Supplied		#6	#4		•	
	Exposures Supplied						
Topography	Street Conditions		#7	#5			
Explosion Backdraft	Flashover Conditions		#8	#6			
				#7			
Time	Duration of Incident		#9				
	Time of Day						
	Time of Alarm						

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HEAT RELEASE

Contingent upon:
- **Type of fuel**
- **Physical arrangement of fuel**
- **Rate of conversion to a gas**

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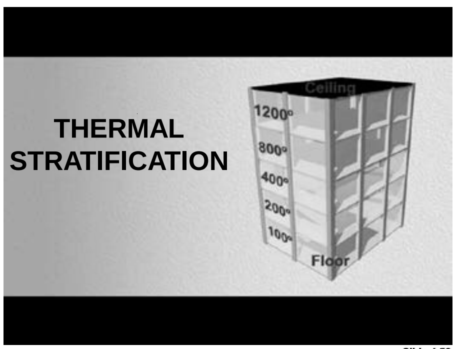

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FLASHOVER PREVENTION

- **Ventilation**
- **Water application**

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BACKDRAFT PREVENTION

Ventilation high in structure

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FIRE TRAVEL PREDICTIONS

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FIRE, SMOKE, AND HEAT TRAVEL

Determined by:
- **Building construction**
- **Building layout**
- **Fuel load**
- **Built-in fire protection**
- **Air-handling system**
- **Fire department ventilation efforts**

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NEED TO PREDICT FIRE TRAVEL

- **Accurate predictions lead to successful operations.**
- **Enables officer to make realistic decisions.**
- **Continual prediction enables Incident Commander (IC) to make adjustments.**

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FIRE TRAVEL ASSESSMENT

- **Where is the fire?**
- **Where is smoke showing?**
- **What is there to stop the fire?**
- **Where are signs of increasing heat or unusual signs of building reaction to fire?**

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Activity 4.1
Predicting Fire Travel

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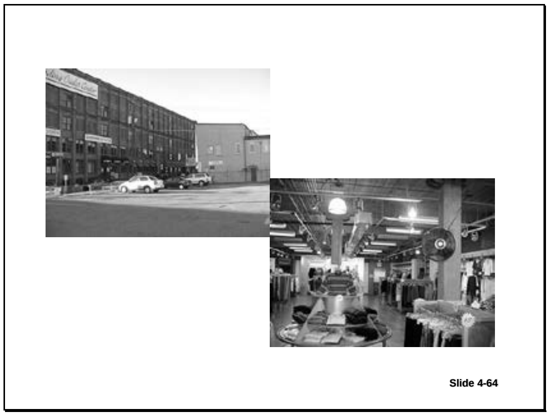

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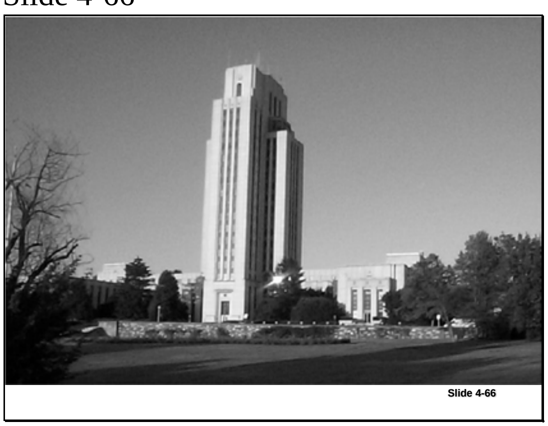

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Activity 4.2
Command Sequence #2:
McDonald's

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COMMAND SEQUENCE #2: MCDONALD'S WALKAROUND

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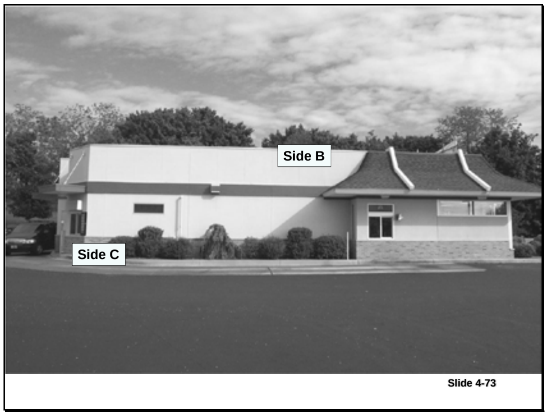

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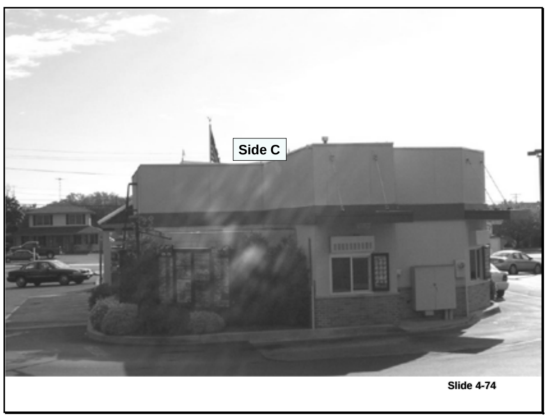

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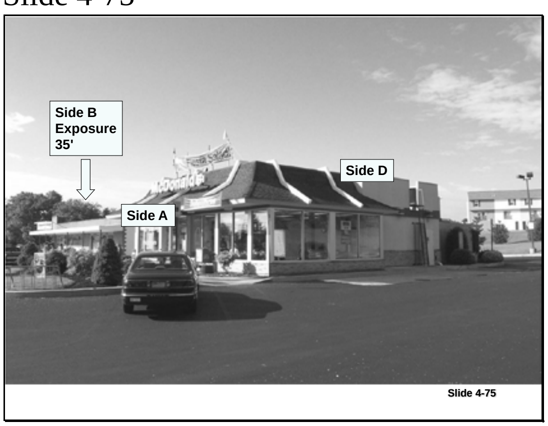

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COMMAND SEQUENCE #2
FIRST-ALARM RESOURCES

- Engine 1
- Engine 2
- Engine 3
- Truck 1
- Squad 1
- Battalion Chief 1
- All companies staffed with four firefighters
- Battalion Chief 1: 30-minute response

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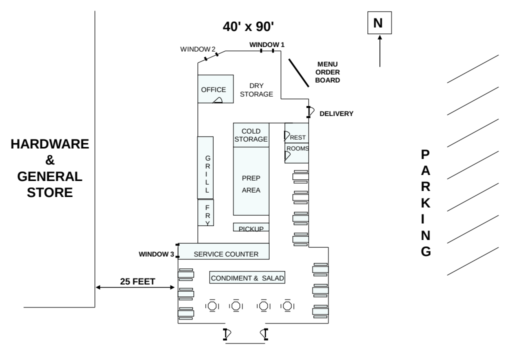

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Fire Scenario for McDonald's

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Slide 4-85

Column #1 Primary Factors Size-Up Chart			Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
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	Firefighters		• Contain & control fire to building of origin in 30 minutes	(C/E) Confinement/Extinguishment • Hoseline Placement			
Location/Fire	Fire Bldg/Exposures on Arrival		• Contain, control, limit fire in exposure within 1 hour	(O) Overhaul • Expose Hidden Fire			
	After Arrival - Burn Time		• Remove all smoke within 20 minutes	(V) Ventilation • Removal of all Occupants • Fire Control			
Construction	Fire Building		List Incident Objectives	(S) Salvage • Water run-off • Apply salvage covers			
	Exposures						
Occupancy (Contents)	Fire Building						
	Exposures						
Height	Fire Bldg (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.				
	Exposures (Front/Rear)						
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	Proximity of Exposures/Config.						
Structural Collapse	Fire Building		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor.	
	Exposures						
	Apparatus Placement						
Weather	Visibility		#4	#1		•	
	Temperature/Humidity			#2		•	
	Wind – Direction/Velocity						
Resources	Apparatus/Personnel/Equip/RIC		#5	#3		•	
	Water Supply/Suppression Agent						
Auxiliary Appliances	Fire Building Supplied		#6	#4		•	
	Exposures Supplied						
Topography	Street Conditions		#7	#5		•	
Explosion Backdraft	Flashover Conditions		#8	#6		•	
				#7			
Time	Duration of Incident		#9				
	Time of Day						
	Time of Alarm						

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SUMMARY

- **Building construction classifications**
- **Accurate prediction of fire behavior**

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UNIT 5: PREINCIDENT PLANNING

OBJECTIVES

The students will:

1. *Properly calculate required fire flow for structures using the National Fire Academy (NFA) fire flow formula.*

2. *Given a simulated incident where resources are a critical issue, develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.*

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PREINCIDENT PLANNING

Preincident preparation involves the process of preparing a preplan for a given building or hazard. This preplan should be comprehensive, but presented in a format that can be used by a Company Officer (CO) while en route to an emergency. The Quick Access Prefire Plan (QAP) was developed to meet these needs.

Before the QAP can be prepared, the CO must determine required fire flow and resource requirements for a given structure or hazard.

FIRE FLOW REQUIREMENTS

A sometimes difficult question that must be answered by the first CO to arrive at the scene of a fire incident is, How much water is needed for effective fire control? The answer to that question must be readily available and will have an impact throughout the incident in terms of determining resource requirements and use, and the tactical operations that are employed.

Determining the amount of water required for fire control in a specific occupancy is best done during preplanning. During preplanning a calm and deliberate assessment can be made of the occupancy, with proper emphasis being placed on particular features or conditions that should be considered when establishing the required fire flow. When preplanned fire flow information is available to the CO upon arrival at the incident scene, decisions can be made more readily and with greater accuracy based on this information.

FIRE FLOW FORMULA

On occasion, fire incidents are encountered where preplanned fire flow information has not been developed or is not readily available. Under these circumstances CO's often are able to make this determination using the National Fire Academy (NFA) fire flow formula. The NFA has developed a "quick-calculation" formula that can be used as a tactical tool to determine fire flow requirements at the scene of the incident. This formula can provide a starting point for deciding the amount of water required, apparatus needed to deliver the water, and the number of companies that should be used to apply it.

The NFA quick-calculation formula was derived through a study of fire flows that were successful in controlling a large number of working fires along with interviews with numerous experienced CO's from throughout the country regarding the fire flows they have found to be effective in various fire situations.

The information developed through these efforts indicate that the relationship between the area that is involved in fire and the approximate amount of water required to extinguish the fire effectively can be established by dividing the square footage of one floor of the structure by a factor of three. This quick-calculation formula is expressed as:

$\frac{L \times W}{3}$ = fire flow in gallons per minute (gpm) for one floor at 100-percent involvement.

This formula is applied easily to the square footage of the entire structure by multiplying the fire flow for one floor by the total number of floors above the fire (up to four floors). After exposure charges are added (if any) it then is reduced accordingly for various percentages of fire involvement.

The example shown below illustrates how the formula can be used for a typical one-story, single-family wood-frame dwelling with approximate dimensions of 50 feet by 30 feet.

$\frac{50' \times 30'}{3}$ = gpm or $\frac{1{,}500}{3}$ = 500 gpm for one-story structure for 100-percent involvement

- 100-percent involved = 500 gpm;
- 75-percent involved = 375 gpm;
- 50-percent involved = 250 gpm; and
- 25-percent involved = 125 gpm.

The quick-calculation formula indicates that if this structure were fully involved, it would require approximately 500 gpm to control the fire effectively. If only half of the building were burning, 250 gpm should suffice, and 125 gpm should be sufficient if one-fourth of the building were involved.

Multiple Stories

In multistory buildings, if more than one floor in the building is involved or threatened with fire, the fire flow should be determined based on the area represented by the number of floors that are actually burning. For example, the fire flow for a two-story building of similar dimensions as that used in the previous example would be.

$$\frac{50' \times 30'}{3} \times 2 \text{ (floors)} = \text{gpm} \qquad \text{or} \qquad \frac{1{,}500}{3} \times 2 = 1{,}000 \text{ gpm}$$

Total fire flow for two floors at 100-percent involvement is 1,000 gpm.

- 100-percent involved = 1,000 gpm;
- 75-percent involved = 750 gpm;
- 50-percent involved = 500 gpm; and
- 25-percent involved = 250 gpm.

In "fire-resistive" buildings, if other floors are not yet involved but are threatened by the possible extension of the fire (up to four floors above the fire floor), they should be considered as exposures, and 25 percent of the required fire flow for the fire floor should be added for exposure protection. In all other building construction classifications the floors above the fire should be included as part of the fire problem (up to four floors).

If adjacent structures are being exposed to fire from the original fire building, a 25-percent exposure charge of the required fire flow of the building should be added for each side of the fire building with exposures. Should the exposure actually become involved with fire, the exposure(s) then should be treated as a separate fire.

Rules of Thumb for Exposures

- Property that is less than 40 feet away is **most likely** an exposure.

- Property that is between 40 and 100 feet away is **probably** an exposure.

- Property that is over 100 feet away is **most likely not** an exposure.

However, one must evaluate the exposures with respect to the actual situation. This could mean a property 20 feet away would not be an exposure if there were a hill or other earthen barrier between it and the fire situation. Or a building 150 feet away could be an exposure during heavy wind conditions, or if the fire building were an explosives manufacturer.

The example shown on the following page illustrates how the quick-calculation formula is applied to a one-story structure that is fully involved and exposing two adjacent structures:

$$\frac{50' \times 30'}{3} \times 1 \text{ (floor)} = 500 \text{ gpm}$$

Exposure: 500 gpm x (25 percent x 2) = 250 gpm

Total fire flow required = 750 gpm

In using the quick-calculation method to determine required fire flows it is important to remember that the answers provided by this formula are approximations of the amount of water needed to control the fire. You are estimating the area of the building and the amount of fire involvement within the building. Since firefighting is an inexact science to begin with, the use of the quick-calculation formula cannot be expected to determine the exact number of gpm that will be required for full fire control.

While the formula will provide the CO with a starting point to determine how much water may be needed for an effective fire attack in normal situations, common sense and good judgment also are required to evaluate the effect of the water once it is being applied. Once the needed fire flow is developed and is being placed on the fire, the fire should darken down in a minute or two. However, other factors may not be evident to the CO. These include positioning of interior walls and partitions, piling of stock, flammable and combustible liquids or oxidizers, and significant failure of the roof (or other vertical assemblies) that lets steam escape. If an immediate knockdown takes place, the amount of water being applied should be reduced to minimize water damage to the structure or its contents.

RESOURCE CAPABILITY AND DISTRIBUTION DATA

Once the required fire flow has been determined, the capability of available resources will determine the strategy and tactics required to control the incident. If the fire flow capability of available resources exceeds the required fire flow, an attack on the fire usually can be made. However, before this decision is implemented the CO should consider the following:

- Is it safe for offensive operations, based on existing conditions?
- Is the fire area accessible?
- How many hoselines are needed at what gpm?
- How many people are needed for fire attack?
- What are the best vantage points for applying the water?

- What support activities are required?

- What safety concerns do I have?

If, on the other hand, the fire flow requirement exceeds the fire flow capability of available resources, a defensive mode of operation is usually required. Depending on the particular situation, larger hose streams, more apparatus, more equipment, and more personnel may have to be requested. It also is important to remember that situations are encountered where little can be done to save the involved building with the resources available. Then exposure protection, by necessity, becomes the primary objective.

QUICK ACCESS PREFIRE PLANNING

Preincident planning information can be defined as the need-to-know information that is gathered and recorded in a usable format and maintained so that it is available to fire companies when responding to the specific occupancy.

The value of good preincident planning information can be illustrated simply by recalling the last time the company responded to a working fire in an occupancy that had been preplanned, and contrasting that experience with a similar response that had not been preplanned.

The preincident plan permits the CO to make early "informed" decisions as he/she arrives at the incident or incidents. Information is critical to sizeup and the setting of incident priorities. The lack of good planning information forces the CO to guess in order to fill critical information voids as he/she sets goals.

Preincident information benefits all members of the chain of command and contributes to effective incident management. The fire scene or incident can be considered a problem that requires a solution. Since the most difficult portion of the problem-solving process is the development of facts, it can be seen that the analysis and eventual answers to the Incident Commander's (IC's) problems can be found in the facts developed in the prefire plan process.

Quality information, therefore, enhances analysis and permits prioritization of initial actions. Accurate analysis also allows the CO to predict outcomes as he/she begins to apply resources to the incident. A good preincident plan should yield a good estimate of the resources that ultimately will be required for incident management.

Finally, good preincident planning is essential to a safe fire scene. The plan provides knowledge of layout, structural conditions, fire load, and other factors, which will determine how aggressive the CO intends to be as he/she considers risk versus benefit. Safety benefits should be considered an integral part of the prefire plan.

Use of the Plan

The continuing value of the preincident plan requires that it be recorded, shared, and maintained for use in the fire scene. The use of a common or standardized preplan form such as the NFA's QAP is encouraged to provide consistent recording and ease of use on the incident.

Many departments use onboard computers to store preincident planning information. This method has been particularly useful in materials identification in hazardous materials incidents.

The microfiche system of storage provides for storage of large volumes of information in a small area and can provide hard copy (a piece of paper in your hand) capability.

The lock box is being used more frequently. The lock box is placed in a convenient, accessible location at the occupancy site and can contain the preincident plan, materials location, and other useful information such as current inventories. The fire department keeps the key.

Regardless of the method of recording and maintaining the preincident plan, it must be updated as needed and shared with other fire companies.

Training must be conducted in the use of the plan. The training sessions must include all first-responding companies and, in some cases the occupancy management. The training should not be specific as to assignment of companies.

Preincident planning, like safety, often is overlooked. Quality preincident planning is essential if the CO intends to establish and maintain a proactive management environment.

Activity 5.1

Quick Access Prefire Plan

Purpose

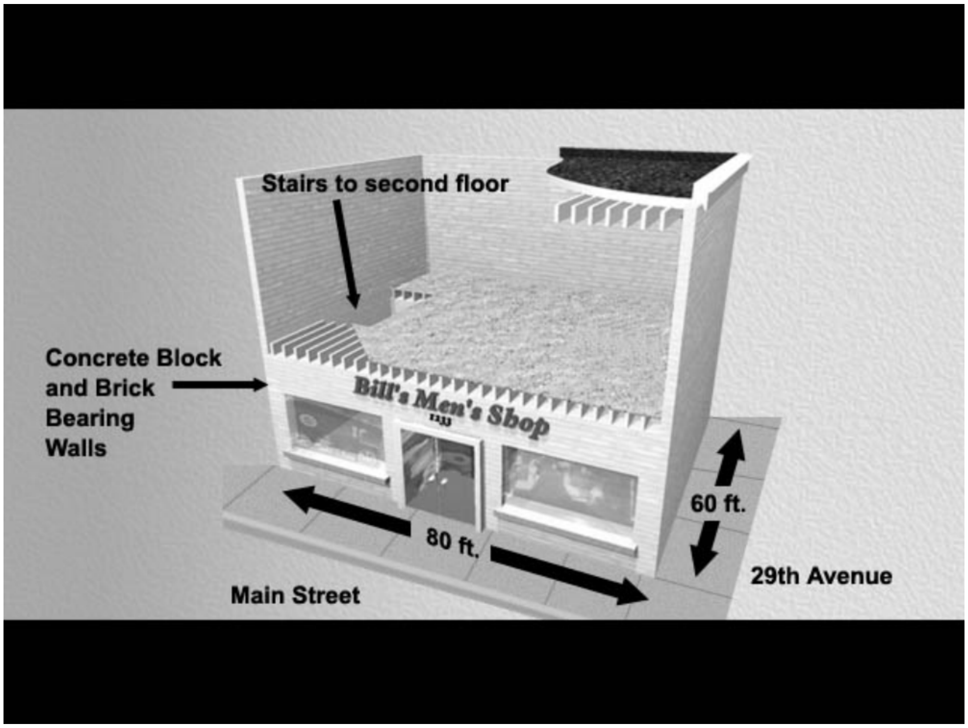
To provide an overview of the NFA's QAP.

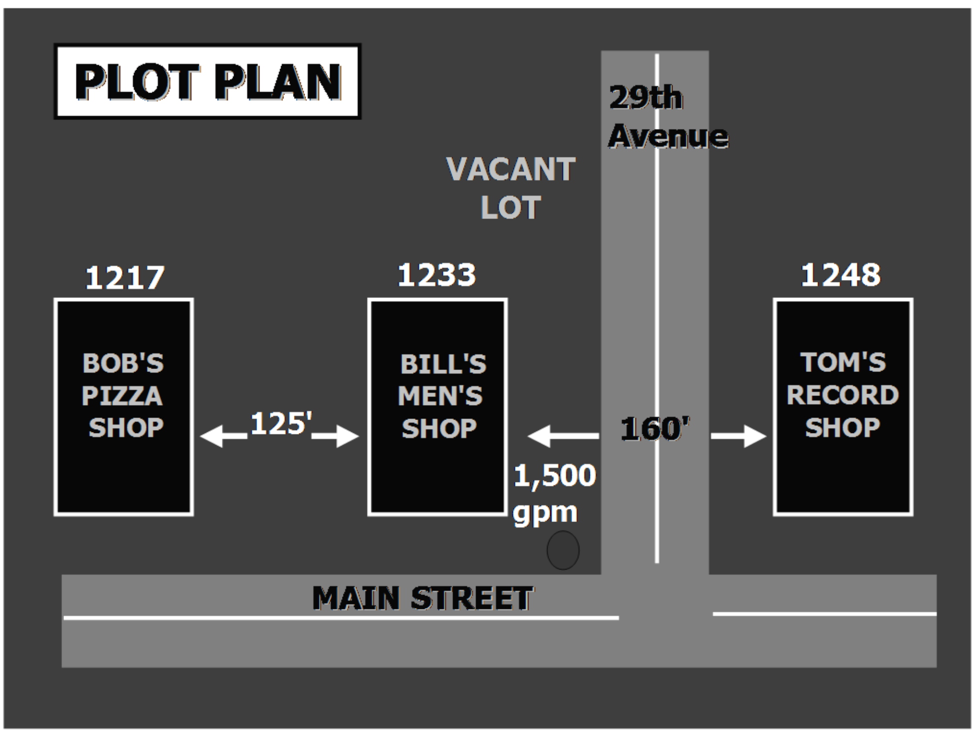
Directions

1. Review the floor plan for "Bill's Men's Clothing," which is a two-story, ordinary constructed building.

2. Follow the instructor's directions to complete the QAP for 1233 Main Street.

Plot Plan/Floor Plan





Quick Access Prefire Plan

Building Address:
1233 Main Street

Building Description:

Roof Construction:
Built up (tar and paper) over 2" boards

Floor Construction:
1" boards over 2" x 10" joist

Occupancy Type:
Mercantile "Men's Clothing"

Initial Resources Required:

Hazards to Personnel:

Location of Water Supply:

Available Flow:

	Estimated Fire Flow			
Level of Involvement	*25%*	*50%*	*75%*	*100%*
Estimated Fire Flow				

Fire Behavior Prediction:

Predicted Strategies:

Problems Anticipated:

❑ **Standpipe:**

❑ **Sprinklers:**

❑ **Fire Detection:**

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Activity 5.2

Command Sequence #3: Grocery Store

Purpose

To develop a sizeup report of fireground conditions, complete the Primary Factors Size-Up Chart, and document progress using the Command Sequence Tactical Chart.

Directions

1. You will be working in teams of three for this simulation exercise.

2. A Command Sequence Tactical Chart for each team position is included here.

3. The instructor will designate two students per team jointly to assume the role as the first-due engine CO.

4. The instructor will designate one student per team as a team recorder; this position will rotate among team members when doing the large simulations.

5. Team recorder will record all actions taken by the first-due CO onto the Command Sequence Tactical Chart.

6. The instructor will review the Command Sequence Tactical Chart preparation process with the class.

Part 1

1. View the slides to assess primary sizeup factors and visible cues.

2. Complete the Primary Factors Size-Up Chart and develop the sizeup report.

   a. Primary factors.

   b. Initial objectives.

   c. Initial strategy.

Part 2

1. View the grocery store fire slides and read the simulation messages.

2. Complete the Command Sequence Tactical Chart.

3. Be prepared to present your sizeup report and charts to the rest of the class.

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Activity 5.2 (cont'd)

Command Sequence Tactical Chart

To be completed during simulation:

Tactical Assignment	Assigned To	Progress Report

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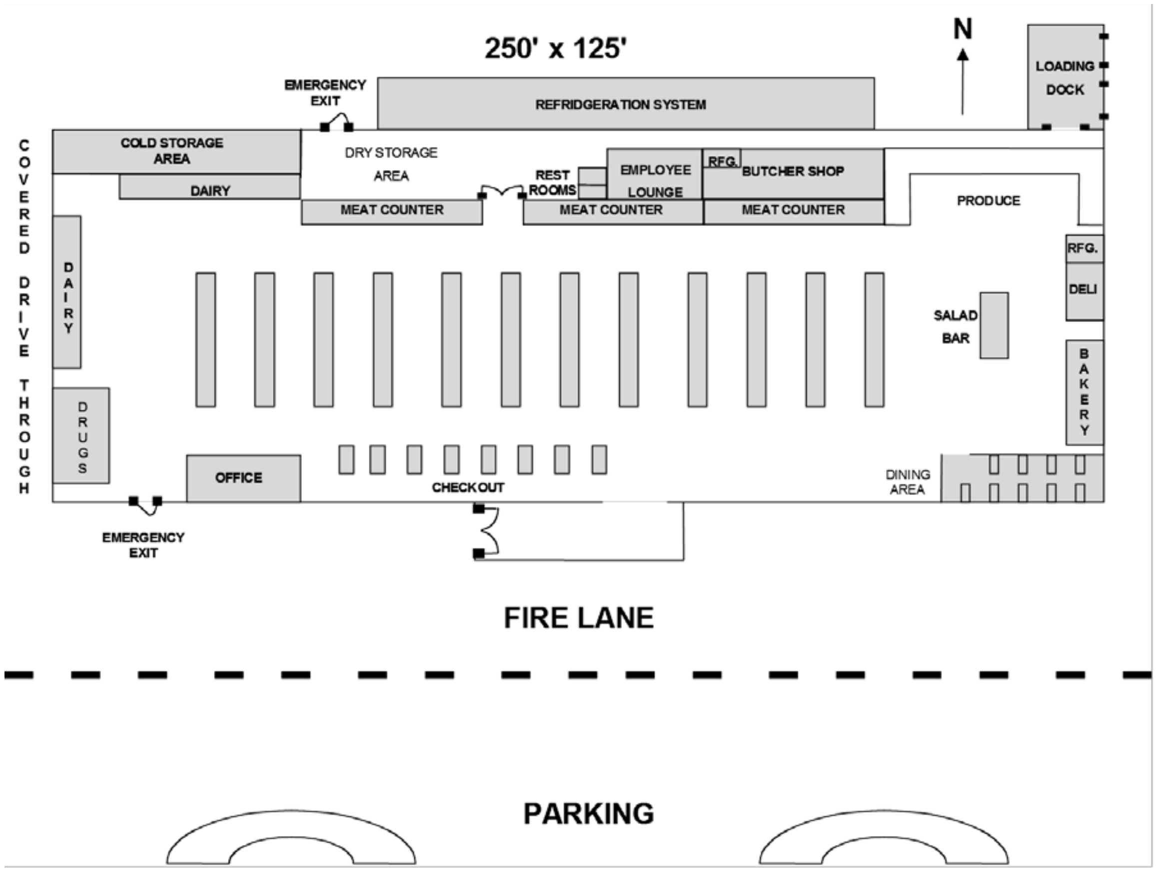
Activity 5.2 (cont'd)

Transfer of Command Chart

To be completed upon transferring command:

Location and Extent of Fire:	
Control Efforts:	
Deployment of Resources:	
Need for Additional Resources:	

Grocery Store
Plot Plan



Quick Access Prefire Plan

Building Address:
222 Kelly Drive

Building Description:
One-story/Noncombustible; 125' x 250'

Roof Construction:
Steel bar joist with asphalt deck and covering

Floor Construction:
Poured concrete with tile floors

Occupancy Type:
Meat/Grocery store

Initial Resources Required:
3 engines, 1 truck, 1 squad

Hazards to Personnel:
Moderate to heavy fire loading throughout occupancy; natural gas and commercial refrigeration; concealed storage and work areas; large unbroken floor area

Location of Water Supply:
Hydrant, 8-inch municipal system 400' apart

Available Flow:
1,200 gpm per hydrant

	Estimated Fire Flow			
Level of Involvement	*25%*	*50%*	*75%*	*100%*
Estimated Fire Flow	2,600	5,200	7,800	10,400

Fire Behavior Prediction:
Rapid spread of fire due to large unbroken floor area; potential for flashover; potential gas-fed fire

Predicted Strategies:
Rescue/Confinement/Extinguishment, ventilation, salvage, and overhaul

Problems Anticipated:
Safe removal of occupants; limited means of ingress; high fire loading in storage areas; potential roof collapse; potential natural gas or refrigerant leak

☐ **Standpipe:** *None*

☒ **Sprinklers:** *Yes*

☒ **Fire Detection:** *Smoke detectors*

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Activity 5.2 (cont'd)

Column #1 Primary Factors Size-Up Chart			Column #2 Incident Objectives Specific/Measurable/Attainable Results Oriented/Timed	Column #3 Activities (Strategies)		Column #4 Evaluate Effect of Activities (Strategies) every 10 minutes EFFECTIVE	INEFFECTIVE
Pertinent Factors (P) Check Appropriate boxes		P	Examples of Incident Objectives • Removal of all occupants within 10 minutes • Contain & control fire to building of origin in 30 minutes • Contain, control, limit fire in exposure within 1 hour • Remove all smoke within 20 minutes List Incident Objectives	(R) Rescue • Interior/Exterior			
Life Hazard	Occupants			(E) Exposure Protection • Exposure Examination			
	Firefighters						
Location/Fire	Fire Bldg/Exposures on Arrival			(C/E) Confinement/Extinguishment • Hoseline Placement			
	After Arrival - Burn Time						
Construction	Fire Building			(O) Overhaul • Expose Hidden Fire			
	Exposures						
Occupancy (Contents)	Fire Building			(V) Ventilation • Removal of all Occupants • Fire Control			
	Exposures						
Height	Fire Bldg (Front/Rear)		#1 Provide for the safety of all Responders for the duration of the incident.	(S) Salvage • Water run-off • Apply salvage covers			
	Exposures (Front/Rear)						
Area	Fire Bldg/Configuration		#2				
	Proximity of Exposures/Config.						
Structural Collapse	Fire Building		#3	List Incident Strategies	Assigned to	Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor. • ______ • ______ • ______ • ______ • ______ • ______	
	Exposures						
	Apparatus Placement						
Weather	Visibility		#4	#1			
	Temperature/Humidity			#2			
	Wind – Direction/Velocity						
Resources	Apparatus/Personnel/Equip/RIC		#5	#3			
	Water Supply/Suppression Agent						
Auxiliary Appliances	Fire Building Supplied		#6	#4			
	Exposures Supplied						
Topography	Street Conditions		#7	#5			
Explosion Backdraft	Flashover Conditions		#8	#6			
				#7			
Time	Duration of Incident		#9				
	Time of Day						
	Time of Alarm						

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NOTE-TAKING GUIDE

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NOTE-TAKING GUIDE

Slide 5-1

Slide 5-2

Slide 5-3

Slide 5-4

FIRE FLOW REQUIREMENTS

- Fires extinguished by absorbing the heat with water
- Application of water will
  - – Absorb heat
  - – Reduce temperature
  - – Extinguish fire

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Slide 5-5

FIRE FLOW FORMULA

Calculates theoretical fire flow.

- Large amounts of heat absorbed.
- Reduces temperature below ignition temperature.
- Fire is "blacked-out," ready for overhaul.

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Slide 5-6

FIRE FLOW FORMULA (cont'd)

With high percents of involvement interior operations are not possible.

- 100-percent involvement answer is theoretical.
- Starting point for realistic flow rate.
- Starting point for defensive operations.
- Tactical operations must be evaluated.

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Slide 5-7

Basic fire flow formula:

$\frac{L \times W}{3}$ **= gallons per minute (gpm)**

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Slide 5-8

FIRE FLOW FORMULA (cont'd)

- **Flow for one floor fully involved.**
- **Estimate length/width to nearest 10 feet.**
- **Multiply L x W then divide by 3.**
- **Theoretical fire flow for 100-percent involvement.**

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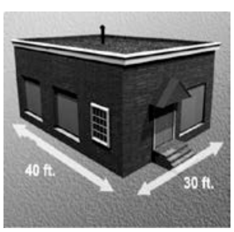
Slide 5-9

USING THE BASIC FORMULA



- **gpm** $= \frac{L \times W}{3}$
- **gpm** $= \frac{40' \times 30'}{3} =$
- $\frac{1{,}200'}{3} = 400$ **or**

fire flow = 400 gpm

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Slide 5-10

USING THE BASIC FORMULA (cont'd)

- Quick calculations at the scene.
- Calculates water required for:
  - Confinement
  - Extinguishment
  - Backup lines

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Slide 5-11

FIRE FLOW FORMULA (cont'd)

Fully involved:
 1,000 gpm
50-percent involved:
 500 gpm
25-percent involved:
 250 gpm

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Slide 5-12

EXPOSURES

- Fire area adjacent to a firewall
- Should exposure become involved--calculate flow as new fire building

Slide 5-12

Slide 5-13

WATER FOR EXPOSURE PROTECTION

- **Interior exposures--floors above fire in "fire-resistive" construction**
- **Exterior exposures--buildings or other objects**

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Slide 5-14

EXPOSURE PROTECTION

- **Up to four floors above fire**
- **Buildings or other objects**
- **0 to 40'--usually an exposure**
- **40' to 100'--could be an exposure**
- **100' or more--usually not an exposure**

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FIRE FLOW FORMULA (cont'd)

Exposure protection

gpm = $\frac{L \times W}{3}$ x 25% for each exposure

Fire building = $\frac{30' \times 100'}{3}$ = 1,000 gpm

Exposures--Side A = 75', Side B = 20', Side C = 60', Side D = 15'

1,000 x 25% (Side B) = 250 gpm
1,000 x 25% (Side D) = 250 gpm

Total exposure protection = 500 gpm

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Slide 5-16

EXPOSURE "B" | FIRE BUILDING 1,000 gpm | EXPOSURE "D"

Base flow = 1,000 gpm
Exposure B = 250 gpm (25%)
Exposure D = 250 gpm (25%)

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FIRE FLOW REQUIREMENTS (cont'd)

Exposure Protection

EXPOSURE C
No Flow Required

EXPOSURE B
250 gpm

FIRE
BUILDING

EXPOSURE D
250 gpm

EXPOSURE A
No Flow Required

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Slide 5-18

PERCENTAGE OF INVOLVEMENT

$$\text{gpm} = \frac{L \times W}{3} + \text{Exposure} \times \%\text{ of Involvement}$$

FIRE BUILDING
1,000 gpm

EXPOSURES B and D
500 gpm (25%)

- **100% Involvement = 1,500 gpm required**
- **75% Involvement = 1,125 gpm (1,500 x .75)**
- **50% Involvement = 750 gpm (1,500 x .50)**
- **25% Involvement = 375 gpm (1,500 x .25)**

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Slide 5-19

INTERIOR EXPOSURE FIRE-RESISTIVE STRUCTURE

5	Exposure 25%
4	Exposure 25%
3	Exposure 25%
2	Exposure 25%
1	Fire Floor

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EXPOSURE PROTECTION FIRE-RESISTIVE STRUCTURE

Fire Floor
50' x 75'
Total Fire Flow Required for Fire Floor

1,250 gpm

EXPOSURE 5 = 312 gpm
EXPOSURE 4 = 312 gpm
EXPOSURE 3 = 312 gpm
EXPOSURE 2 = 312 gpm
FIRE FLOOR 1 = 1,250 gpm

Exposure
Floors 2-3-4-5
Total Fire Flow Required for Exposure Protection
1,248 gpm

Total Fire Flow = 1,250 gpm
Total Exposure Charge = 1,248 gpm
Total Flow Required = 2,500 gpm (rounded up)

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Activity 5.1 Quick Access Prefire Plan

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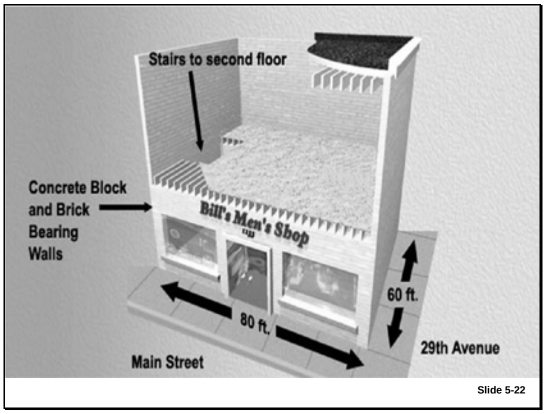

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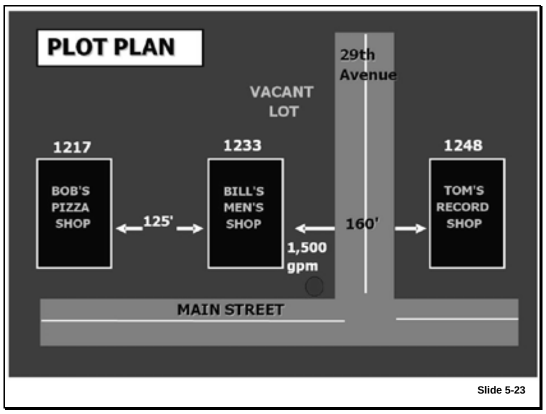

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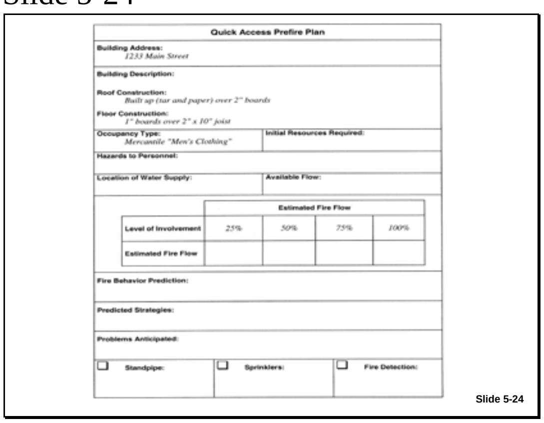

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Initial Resources Required:

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Location of Water Supply:

Available Flow:

	Estimated Fire Flow			
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Estimated Fire Flow				

Fire Behavior Prediction:

Predicted Strategies:

Problems Anticipated:

☐ **Standpipe:** ☐ **Sprinklers:** ☐ **Fire Detection:**

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Slide 5-25

Activity 5.2
Command Sequence #3:
Grocery Store

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COMMAND SEQUENCE #3:
GROCERY STORE
WALKAROUND

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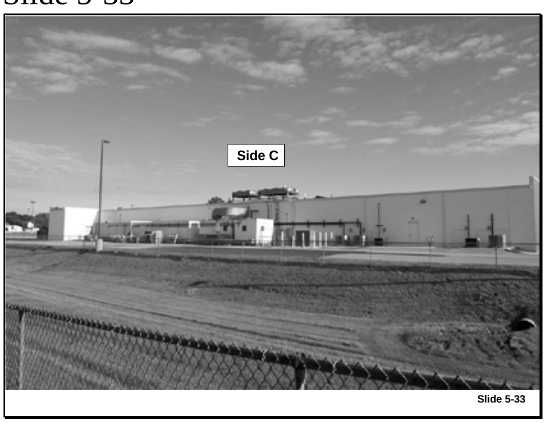
Slide 5-33



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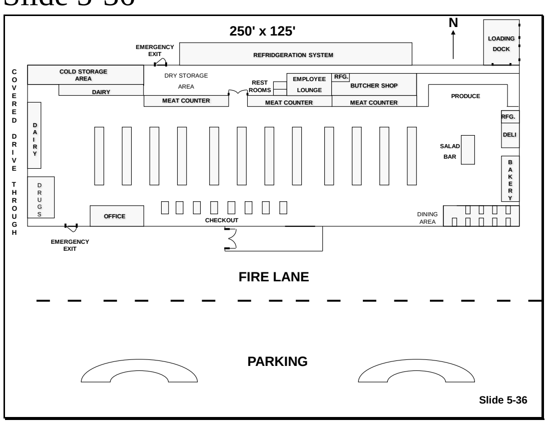

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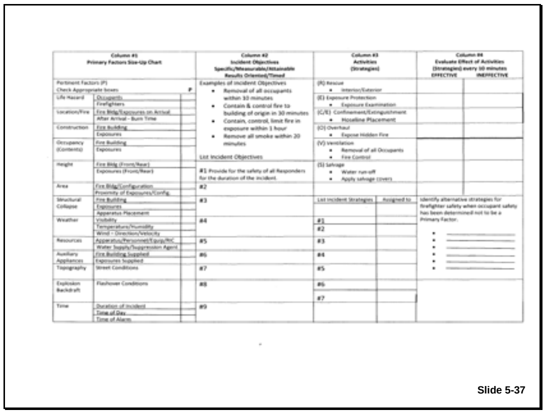

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	Exposures					
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	Temperature/Humidity			#2		•
	Wind – Direction/Velocity					•
Resources	Apparatus/Personnel/Equip/RIC		#5	#3		•
	Water Supply/Suppression Agent					•
Auxiliary Appliances	Fire Building Supplied		#6	#4		•
	Exposures Supplied					
Topography	Street Conditions		#7	#5		
Explosion Backdraft	Flashover Conditions		#8	#6		
				#7		
Time	Duration of Incident		#9			
	Time of Day					
	Time of Alarm					

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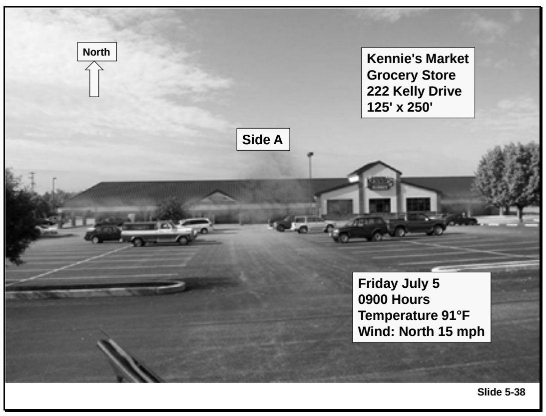

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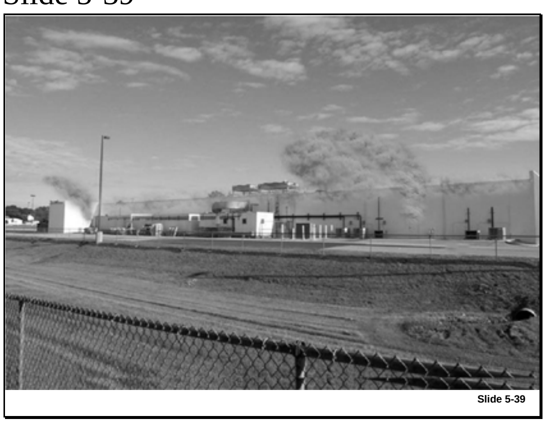

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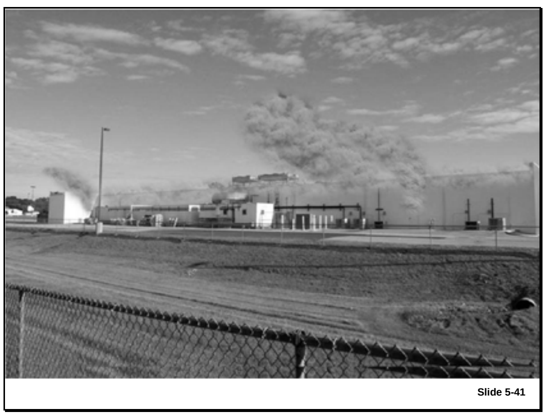

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Slide 5-44

SUMMARY

- **Fire flow requirements must be understood because of the effect on tactical decisions, resource needs, and safety concerns on the incident scene.**
- **Knowing your resource capability in terms of gpm per person on scene assists in decisionmaking.**
- **Prefire planning provides "must know" information, which increases one's ability to make correct decisions at an incident.**

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