Fire Protection

Fireground Strategies & Tactics

Understanding how the private sector can help improve fire outcomes

By Frank Baker

Abstract: *This is Part 2 of an article that provides a general introduction to fire department operations. This part covers the impact of building protective systems and construction, explains the salvage, overhaul and investigation functions, discusses firefighter safety and suggests actions that companies can take to improve the outcome of fire events.*

AS READERS MAY RECALL, Part 1 of this article (*PS*, Feb. 2008, pp. 20-31) focused on the capabilities and limitations of local fire departments and examined how these departments approach and respond to a fire scenario. Part 2 picks up with a focus on the impact of building construction, incident stabilization and firefighter safety. Several actions that building owners and managers can take to improve the outcome of fire events are described as well.

Building Construction

How a building is constructed will determine how long it can endure exposure to fire. Fire-resistive construction (NFPA Type I) offers the best resistance to fire exposure, while wood frame (NFPA Type V) offers the least. In between are noncombustible (NFPA Type II), ordinary masonry (NFPA Type III) and heavy timber (NFPA Type IV) construction. Each has advantages and disadvantages based on unique construction features. Knowledge of building construction features, and the limitations and hazards associated with each will help the incident commander (IC) determine how long fire crews can safely work within the structure before collapse becomes likely (FEMA, USFA & NFA, 1991a, p. SM 4-3).

Compartmentalization or open spaces can significantly affect fire spread. While compartmentalization can make access to the fire area difficult for maneuvering hose lines, it can help fire crews hold the fire in place by using the existing physical barriers to slow its spread. Conversely, open spaces make it easier to advance hose lines, but do not provide any barriers to the lateral spread of a fire throughout the structure.

Compromised building construction features, such as removal of draft curtains in large open areas, failure to maintain and test fire doors, and breaches in fire walls and partitions, are primary reasons for extensive fire spread. Improper storage of items such as flammables and aerosol cans can cause fires to move so rapidly through a structure that they get ahead of the main body of heat that would otherwise activate the fusible links of fire doors or automatic sprinkler systems. Contractors working in the building can unwittingly remove fire protective materials on metal components such as open web bar joists or I-beams. Penetrations in firewalls for ventilation ducts without fire dampers or holes cut for piping or conduit without proper sealing around them can permit fire to spread from one side of a firewall or partition to the other as well.

Building Protective Systems

If building protective systems such as automatic sprinklers or standpipes and hose stations (for fire department use) are in place, their support and use can be critical to effective control and extinguishment of a fire. In the case of automatic fire sprinklers, their intent is only to control, not to totally extinguish, the fire—although they often provide complete extinguishment. If the fire load is much higher than the level for which the sprinkler system was designed, the system may be overwhelmed and not hold the fire in check with only the municipal water pressure.

Years of data indicate that about 96% of all fires are controlled or extinguished by an automatic sprinkler system if the building is properly equipped. The remaining 4% are usually the result of water being shut off prematurely, inadequate sprinkler protection, insufficient water supply, faulty building construction, obstructed piping, disrupted flow from heads, hazards of the occupancy, outdated equipment and/or inadequate maintenance (FEMA, et al., 2004, p. SM 2-28).

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To operate effectively and safely on site, a fire department will need access around all sides of a building. This permits positioning apparatus as needed to reduce the distance of hose stretches to the building for interior fire attack and for placement of aerial ladders for roof or upper floor access.

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Automatic sprinkler systems should be fitted with a fire department connection on the exterior of the building or in a freestanding configuration away from the structure. This inlet can either be a 3-in. Siamese or a 5-in. Storz connection, depending on the mandates of the local authority with jurisdiction or local fire codes. The valve that controls water to the sprinkler system from the public water supply also controls whether the fire department can provide additional water volume and pressure to the system. These should be locked in the open position and monitored to detect and prevent tampering. Removable covers should be in place to prevent debris from entering the piping system, where it can obstruct the flow of water.

Once it is established that the fire department can provide water to the system, supply lines are attached from one of the first responding engines/pumpers. This provides additional water volume and boosts system pressure. In these cases, the normal water main pressure is exceeded and the engine/pumper will become the sole water supply for the sprinkler system. A check valve will keep the water from flowing back into the municipal main. The additional pressure and volume cause the system to flow significantly more water into the fire area where heads have activated. Increasing the municipal pressure by two to four times (up to 150 psi) can help overcome deficiencies caused by fire loading that exceeds the original design criteria. In addition, it should be noted whether on-site fire pumps designed into the system activate automatically or need to be manually started (FEMA, et al., 2004, p. SM 5-9).

Standpipes and hose stations also need supplemental pressure and volume to flow the required 500 gallons per minute (gpm) for those rated as NFPA Class I or III. Standpipes are preplumbed vertical water mains, usually located in a stair tower; they provide a readily accessible location for connecting hose packs carried into the building. A hose station is a remote point on an internal water main that either has hose preconnected to it or has fittings to which the fire department can connect its hose packs.

A standpipe or hose station significantly cuts the time and effort required to bring supply hose to a remote location. High rises and large buildings can benefit from such a system as it limits the amount of hose each firefighter must carry into the structure for at least the primary attack line, conserving valuable energy and time. However, backup hose lines will still be taken into the building from a secondary source such as the next nearest engine/pumper that is not supplying the building standpipe system. Central control valves for these systems also must be locked in the open position and remotely monitored for tampering (FEMA, et al., 2004, p. SM 5-8).

Despite these benefits, the presence of hose stations has been declining in many occupancies for several reasons: lack of knowledge about the advantages in incipient-stage firefighting; inability or lack of funding to properly train occupants in their use; and local authorities permitting—or in some cases mandating—their removal.

Apparatus, Manpower & Site Access

The total quantity of apparatus and manpower that an individual department can muster may be limited strictly because of the department's size. This forces the department to rely heavily on mutual aid from nearby departments. The National Incident Management System (NIMS) requires departments to have mutual aid agreements in place. In some cases, these are on a "call only" basis; in other areas, departments may be automatically dispatched together on the same call when the location is near the district borders.

While Insurance Services Organization (ISO) evaluates mutual aid in its rating system, a company should know what capabilities its responding department has and what must come via mutual aid agreements. Using the basic fire flow formula of square footage divided by 3 to arrive at the 100% single floor demand (see *PS,* Feb. 2008, p. 29), one can determine how much water will need to be supplied. So, for example, if the need is 4,168 gpm at 100% involvement, does the local department have enough pump capacity to flow that much water? Pump capacity of a given engine/pumper may vary from 750 gpm to 2,000 gpm depending on its age, design and maintenance history. If the needed capacity is not available, mutual aid is the only alternative. If the mutual aid agreement does not provide for automatic response, valuable time may be lost waiting to decide upon arrival on the scene that an incident is too large for the resources at hand.

Manpower is another critical area often affected by shortages. On average, the number of personnel needed to carry out fireground operations is one firefighter for each 25 gpm to 50 gpm of required fire flow. This takes into account other operations, such as search and rescue, ventilation, rapid intervention and relief crews. Therefore, in the example with 4,168 gpm required fire flow, a minimum of 21 firefighters—and as many as 42—are needed if the building is only 25% involved in order to adequately staff all required functions to successfully attack and extinguish the fire. Extra alarms on fires are often called to bring additional manpower to the scene, not necessarily the equipment on which they arrive (FEMA, et al., 1991b, p. IG 5-39).

Depending on a department's manpower resources, a piece of apparatus may arrive on the scene with anywhere from one to six crew members. The ISO PPC rating takes this into account as far as regular staffing and the availability of personnel when they are on a "call" basis. In such cases, ISO uses data from prior fire reports to see how many personnel respond in order to calculate an average since it impossible to tell how many people might respond to any given call.

OSHA does not require a specific number of personnel on an individual apparatus (for those states where municipal employees are covered), but it does require that a minimum number be on scene before interior fire attack can be initiated [per 29 CFR 1910.134(g)(4)—also known as OSHA's two-in/two-out rule]. NFPA 1710 addresses staffing for career fire departments and recommends a minimum of four people on each apparatus. NFPA 1720, the counterpart standard for volunteer departments, recommends four crew members on the scene before interior fire attack can begin.

To operate effectively and safely on site, a fire department will need access around all sides of a building. This permits positioning apparatus as needed to reduce the distance of hose stretches to the building for interior fire attack and for placement of aerial ladders for roof or upper floor access. Since fire apparatus cannot be taken off a hard surface, this access must be paved or at least compacted gravel that is not subject to seasonal softening (such as that caused by subsurface frost).

Fire apparatus or personnel should be located no closer than 1.5 times the height of the building as there is always the risk of collapse as fire weakens the structure. Another concern is the potential for exposure to radiant heat on the fire apparatus.

Furthermore, once a fire apparatus is placed, pumps are engaged and hose is on the ground, it is difficult to move this equipment. Therefore, paved accessibility to all sides of the building—extending three to to four times the height of the structure—is recommended. This provides enough space to position multiple pieces of apparatus in close proximity if needed, yet far enough away to be outside the potential collapse zone. Separation of the building and access route by too much grass area or physical barriers can limit the reach of aerial ladders. This might result in a 100-ft aerial being able to only reach to the second or third floor instead of the eighth floor.

Salvage, Overhaul & Investigation

Salvage and overhaul operations may also be tied to final fire extinguishment in searching for any fire extension in hidden areas inside of wall spaces and above ceilings. Overhaul is the search for hidden fire to ensure that it is completely extinguished. The primary goals are to ensure that the fire is completely out and to reduce the amount of collateral damage to a structure and its contents by opening concealed spaces in the fire area. Salvage is the work performed to preserve property and protect it from further damage by evacuating smoke and water to the extent possible. In some jurisdictions, special crews perform these tasks; in other areas, it may be performed by truck company personnel or by any available personnel on the scene (Hall & Adams, 1998, pp. 587, 596).

Salvage and overhaul operations are most commonly conducted after the fire has been determined to be under control or completely out. The most effective method of reducing damage to the structure and its contents is to extinguish the fire as quickly as possible. Equipment used in salvage and overhaul includes ventilation fans, salvage covers or tarps and various hand tools such as brooms, squeegees, pike poles to remove drywall and shovels. While these operations are intended to help the property owner with immediate property conservation efforts, they do not reduce or eliminate the need to have qualified property restoration services secure the area to prevent further damage caused by exposure to the elements.

If salvage and overhaul operations are not conducted properly, critical evidence can be destroyed or displaced before it is properly evaluated and documented. This can be of critical importance where a third party may be responsible for fire through action, failure to act or product liability. Crews must negotiate a fine line in ensuring fire extinguishment while not destroying evidence, thereby making it impossible to determine the point of origin or cause.

The property owner will not be permitted into an area involved in a fire until it has been deemed safe and fire investigation is complete; this enables investigators to maintain a chain of custody for any evidence recovered. Depending on the fire's size, damage to the

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structure and difficulty in determining the cause, it may take several hours to days or weeks before the property owner is permitted inside.

Firefighter Safety

The Protective Ensemble

The protective (turnout) gear worn by today's firefighter is drastically different from that worn just 40 years ago when a helmet with no internal shock-absorbing system, rubber coat, hip boots and rubber-coated gloves were considered to be adequate PPE. The average cost for NFPA-compliant PPE for a single firefighter can now easily surpass $6,000—which does not include costs related to training, maintenance or cleaning.

Most fire departments now use protective gear that is compliant with the current or a previous edition of NFPA 1971, Standard on Protective Ensemble for Structural Fire Fighting. Protective gear that meets this standard includes a pant and coat that fully covers the body and extremities. It must be able to protect the firefighter from exposure to limited flame contact by the outer shell, extreme heat through insulation and steam burns by a modern vapor barrier lining.

A fire-resistant Nomex or other aramid fiber hood is also required to protect skin areas not covered by the helmet liner, self-contained breathing apparatus (SCBA) facepiece and coat collar. The latest turnout gear has built-in features such as drag harnesses to facilitate rescue of a downed firefighter. Supplemental protective equipment that complements the ensemble is specified in NFPA 1972 (helmets), NFPA 1973 (gloves) and NFPA 1974 (footwear).

The SCBA provides a supply of fresh breathing air from a tank of compressed air through a pressure regulator and facemask. The intent is to prevent inhalation of the toxic products of combustion and other air contaminants during the fire attack and salvage/overhaul operations. The rated service period of these ranges from 30 to 60 minutes depending on the working pressure and the bottle's cubic foot capacity. The mobility provided by using a tank is offset by capacity limitation, which reduces the amount of time a firefighter can spend in a hazardous environment.

New NFPA requirements stipulate added safety features such as an integrated personal alert safety system (PASS) device that activates automatically when the SCBA regulator is pressurized; an emergency pressure equalization fitting to permit transfer of air from one unit to another; and a lighted heads-up display inside the mask to keep the firefighter apprised of air supply status in poor visibility situations (NFPA 1981).

Incident Safety Officer

NFPA 1521, Standard for Fire Department Safety Officers, specifies that an incident safety officer be appointed at all fire incidents where there is an identified need because of the size of the event or activities being conducted (Foley, 1998, p. 112). Under NIMS, the safety officer is designated as a command staff position that reports directly to the IC (FEMA, 2004, p. 13).

The person staffing this position on the fire scene acts as a risk manager and is directly responsible for oversight of firefighter safety. This person has the authority to alter, suspend or terminate activities that present an imminent danger situation before notifying the IC. Therefore, s/he must be knowledgeable in building construction, fire behavior and fireground operations. S/he is looking for unsafe acts by firefighters and unsafe conditions caused by fire damage to the structure. S/he also acts as another set of eyes on the constantly changing situation. Typical on-scene concerns include freelancing, improper tool use, unsafe positioning of personnel and lack of proper PPE.

The incident safety officer is also responsible for ensuring that a personnel accountability system is in place for firefighters and that precautions are taken to prevent injury or illness due to heat stress, overexertion and fatigue. In cases where the hazard does not pose an imminent threat to the safety of personnel, the safety officer will take action through the IC (Foley, 1998, pp. 114-115).

Fire Travel Predictions: Forecasting Tools

The ability of the IC, operations officer and safety officer to predict the speed and direction of fire travel directly affects their ability to stay ahead of a fast-moving fire and properly direct the resources to extinguish it. Depending on incident size, the IC and operations officer may be the same person or multiple persons. These individuals must work in concert to ensure the safety of trapped building occupants and firefighters.

A building's age, occupancy hazards, construction, unique features and postconstruction modifications largely determine where and how fast a fire spreads. The amount of fire present on arrival also determines whether enough resources can be brought to bear on the situation to change the eventual outcome.

How the fire moves and the rate of spread can be controlled to some extent by certain tactics. As noted in Part 1, a fire can be pushed or drawn by use of ventilation to move the fire direction away from what would be its natural path. However, improper use of ventilation practices can easily spread a fire; therefore, these practices must be implemented with great care when used other than in the immediate proximity to or directly over the fire.

Reading the smoke produced by a fire is both an art and a science. The ability to identify what stage the fire is in and whether a building is about to undergo what is called a "hostile fire event" are critical to effective risk management on the fire scene. Reading smoke is based on knowledge relevant to fire behavior, but it relies on observation of four critical factors—volume, velocity (pressure), density and color—to determine the approximate location of a fire in a building and imminent signs of a hostile fire event such as collapse, rapid fire spread, backdraft or flashover (Dodson, 2005).

Smoke as a product of combustion is volatile since it is comprised of unburned and incompletely burned solid fuels that have been converted to particulates, aerosols and gases, and can cause conditions within the building to change rapidly, although usually with some warning. The ability to see these warning signs and quickly change strategies or tactics in response is how firefighters' lives are saved. While this is an obvious knowledge need for the incident safety officer or IC, every firefighter must understand what has happened inside the building and be able to, with a reasonable degree of certainty, predict what will happen with or without intervention.

Safety & Rules of Engagement

As noted in Part 1 of this article (*PS*, Feb. 2008, p. 25), Brunacini's SOPs to ensure firefighter safety offer guidelines as to when the life hazard justifies specific action. Many other departments have developed similar "rules of engagement" for this purpose.

IC guidelines taught in fireground tactics courses advise that tactics should be reevaluated every 10 minutes. Another common practice is called the 20-minute rule, which states that if a fire is not under control after 20 minutes, consideration should be given to withdrawing firefighters and beginning defensive mode operations.

For example, a fire-resistive construction building could stand longer, while one of lightweight metal construction may be safe for only 10 minutes before collapse becomes imminent (NIOSH, 1999). Some consider this rule to be outdated because of the preponderance of lightweight construction types that cannot withstand direct exposure to fire as well as some older building methods. Therefore, the time frame must either be reduced or expanded based on construction type, building condition and other factors addressed during the size-up.

NIOSH (2005) warns of hazards related to the presence of truss construction and unpredictability with collapse. It recommends that work above a truss floor or under any truss roof be suspended and the area be evacuated immediately when it becomes apparent that the structural members have become exposed to fire. This eliminates the 10- and 20-minute rules because of the inherent unpredictable nature of this construction once compromised by fire.

Roof operations conducted to ventilate the structure are extremely dangerous because crews are working almost directly over the fire. The roof will likely be the first area of the structure to fail due to fire impingement on the structural members or weakening caused by indirect exposure to heat.

Studies have shown that lightweight construction using engineered wood products can fail in as short a time as 5 minutes after fire impingement on the assembly. Steel bar joists have been known to collapse in as little as 9 minutes (FEMA, et al., 2005, p. SM 1-10). Steel expands about 1 in. per 10 ft of length when heated to 1000 ºF. This can cause it to push against masonry walls that have very limited shear strength in this plane, contributing the risk of collapse. It can also be anticipated that steel heated to temperatures above 1000 ºF is subject to potential failure (Hall & Adams, 1998, p. 70). Therefore, protection of any steel members with a fire-resistant or insulating material is critical to extending the structure's life expectancy.

Due to the hazardous nature of roof operations or working above the ground floor, a secondary means of egress is essential to crew members' ability to escape a dangerous situation. At least two ladders should be available for emergency egress. In addition, if possible, ventilation activities should be performed directly from the aerial ladder or roof ladder to provide more support for the firefighter's weight and eliminate concentrated loads on a compromised roof. Once ventilation is complete, the roof should be evacuated immediately (Hall & Adams, 1998, p. 356).

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Rapid Intervention Teams & OSHA's Two-In/Two-Out Rule

The assignment of a dedicated team—made up of at least two firefighters—that is immediately available to enter the structure and rescue a downed firefighter during extinguishment operations has been part of NFPA 1500, Standard on Fire Department Occupational Health & Safety Programs, since 1992. This dedicated team is called a rapid intervention crew (RIC) or rapid intervention team (RIT). In most cases, an entire company of four or more firefighters will be assigned this responsibility if there is sufficient manpower available on scene.

The RIC/RIT should be equipped with a thermal imaging camera and a universally adaptable air supply to provide the downed firefighter(s) with additional breathing air for the trip out of the building (Foley, 1998, p. 75). The experience of many fire departments has shown that it can take as many as 12 firefighters to accomplish the rescue and removal of a single firefighter, which reinforces the need for the RIC/RIT function to be well staffed and ready to perform during all phases of fireground operations.

In the 24 states and 2 U.S. territories that have state-administered OSHA programs covering the municipal sector, 29 CFR 1910.134(g)(4) requires that a similar rescue capability be in place. This is commonly known as the OSHA two-in/two-out rule. It stipulates that a minimum of two firefighters, ready to make entry, be standing by before interior fire attack can begin. It does not require an arithmetic progression where one person is required outside for each person inside, nor does it preclude entry into the building for purposes of conducting the primary search for potential victims before the RIC/RIT is ready.

As noted in Part 1 (*PS*, Feb. 2008, p. 26), this search is usually conducted with a protective hose line to ensure the safety of the firefighters and potential victims and to prevent fire spread that would compromise their path of egress. Enforcement of this rule began in April 1998 after issuance of a new final rule amended OSHA's Respiratory Protection Standard.

Workers should be properly trained and equipped to handle on-site fire emergencies. A company should also participate in the preincident survey process and comply with any required fire safety inspection orders.

Personnel Accountability: Mayday

The ability to account for the whereabouts and activity of all personnel on the fire scene is critical for their safety as well as for efficient allocation of available resources. NFPA 1500 requires use of an accountability system at all incidents. This system, like NIMS, should incorporate a modular ability to expand with the complexity of the incident. As an incident grows in size and scope, an accountability officer may need to be assigned to ensure the safety of and ability to monitor the whereabouts of all personnel. Personnel are tracked by their location on the fire scene and function with regard to tactical operations or assigned tasks (Foley, 1998, p. 72).

The personnel accountability report (PAR) is a verbal report given to the IC or accountability officer by each crew or company officer that all personnel in their charge are safe and accounted for. If it is determined that a firefighter has gone missing and is unaccounted for, all other operations are suspended and an immediate search begins to rescue the downed individual or crew. The IC or accountability officer should ask for PAR on a regular basis during the incident so that an extended period does not pass before discovery of a missing firefighter.

Many fire departments use *mayday* as a distress signal to be communicated should a firefighter or crew encounter trouble at the fire scene. The call, "Mayday! Mayday! Mayday!" is used to alert command of the situation. This term was adopted from ship and aircraft navigation terminology. Activation of a mayday also causes all other operations to be suspended until the firefighter or crew in trouble can be rescued.

Improving the Outcome

How can the private sector help the fire service improve the outcome of a fire incident? The first step is to be proactive and address priorities in the same order as the fire service—life safety, followed by incident stabilization, then property conservation. While the outlined action items take place before the incident, some must either be designed into the facility at the conceptual phase of the project or be done in conjunction with retrofitting, remodeling or renovations.

To protect firefighters, the rules of engagement for the fire service are constantly evolving in a conservative direction. Time frames of how long a building is considered safe to enter when on fire have dramatically shortened with changes in building construction. Engineers and architects design buildings that are very strong when all structural elements of a building system are intact, not necessarily to withstand demolition by fire. Most will last long enough to evacuate the occupants in the event of a fire.

Whether the building will remain standing during the fire or after it is out will be a function of how much heat the structural members have been exposed to and for how long. Most modern lightweight construction, such as unprotected steel or engineered trusses, does not have much ability to endure direct fire impingement. Thus, failure of these unprotected materials is not a matter of if, but when. Unprotected steel and engineered trusses have replaced reinforced concrete and heavy timber construction method common 50 to 75 years ago, just as hollow concrete block has replaced solid load-bearing brick walls. These older methods of construction, while more expensive, had a greater ability to survive the damaging effects of a fire.

When considering the type of construction to be used in a new building, the owner generally makes decisions based on how the building will meet the various needs in the most cost-effective manner, not necessarily its survivability during or after a fire. These new construction methods are engineered systems that rely on the integrity of each component. Failure of any single component can have a catastrophic effect, in most cases resulting in total failure of the system manifested by total building collapse.

Life Safety Recommendations

A company should have an effective emergency action plan that includes training employees on what they need to do based on their responsibilities as outlined in that plan. This should follow OSHA 29 CFR 1910.38 and should address not only fire emergencies, but also any other reasonably anticipated event such as severe weather, bomb threats and HazMat incidents.

Another key element is an up-to-date accountability system that can be used for an accurate head count at each muster point. Determining who is in the building at any given time can be a challenge. Some organizations use preprinted rosters on a department-by-department basis that are carried by supervisors and updated for each half of the shift using check boxes for each scheduled worker and contractor. In addition, visitors may be tracked using log books at the reception desk or via more advanced methods; such tracking must be done diligently to ensure 100% accuracy.

When an organization must for logistical reasons have multiple muster points, radio communication between each location coordinator is crucial to tracking employees who may have reported to the wrong location. Each muster point must have a designated marshal or coordinator who is responsible for identifying missing workers and reporting this to the overall management IC. The management IC should be the single point of contact for the fire department IC to ensure accurate communication.

In addition, a company should ensure that its early detection and alert systems are properly maintained to make sure occupants will have the maximum time to evacuate. NFPA 72, the National Fire Alarm Code, provides specific requirements for how these systems are to be designed, installed and maintained. Fire detection and occupant warning systems must be distinct from all other warning or notification signals on the site to eliminate the possibility of confusion. Routine system maintenance and testing is also a good time to conduct fire drills. While the frequency of fire evacuation drills may be dictated by local ordinances or other regulatory requirements, if mock evacuations are slow or unorganized, more practice is needed.

Adequate emergency means of egress from all areas of the operation, protected as necessary to ensure their integrity during fire exposure, are required as well. Local and state fire codes often dictate the location of emergency exits. Exits added during any building construction project provide flexibility and redundancy for unanticipated changes in operations.

Maintaining the integrity of the required emergency exits is a constant concern in many facilities because of operational changes, seasonal stock fluctuations, inadequate marking of access paths from main aisles and in some cases lack of concern by supervisory personnel. In some cases, protected pathways or corridors must be constructed of appropriate fire-rated materials and methods to provide a safe path past an adjacent high-hazard area.

Depending on a facility's occupancy or size, local codes may mandate remote monitoring of alarm systems. This provides a backup to on-site personnel making initial contact with local emergency services in the event of a fire. However, the presence of remote monitoring does not eliminate the need to call the fire department in the event of a fire emergency.

The ability to quickly contact the local fire department dispatcher by phone can provide information critical for the size-up of the event. The information provided by the company contact is relayed by radio to responding crews en route. While some decisions about resource allocation will already have been made during preincident planning, important information that can be relayed includes details on specific location within the facility, size of the fire, product(s) involved, whether existing fire protection equipment is working and whether personnel are trapped. Such information is critical in identifying the need for additional resources—which can then be called before the first crew arrives on the scene.

Incident Stabilization Recommendations

Employees should be properly trained and equipped to handle on-site fire emergencies. According to OSHA, if they are responsible for fighting incipient-stage fires with portable fire extinguishers or Class II standpipe hose streams, they must receive hands-on training in the use of this equipment at least annually. If workers are responsible for fire suppression activities beyond that of fighting incipient-stage fires, this is classified as structural firefighting and training requirements increase significantly and are subject to the mandates of OSHA 29 CFR 1910.156 (fire brigades).

The determination as to how an employee group is classified is based on the size of fire it is expected to fight and the equipment available to the group. Fire brigades must receive training which is equivalent to that taught in major firefighter training schools or NFPA Firefighter II, including specialized training to address unique facility hazards (such as storage tank or high-pressure pipeline fires).

A company should also actively participate in the preincident survey process and comply with any required fire safety inspection orders. This is a learning process for all parties involved and can be vital to ensuring that adequate resources can be directed in a timely manner in the event of a fire and that no party hinders the actions of another. In addition, if a company has an industrial fire brigade, it should schedule joint training with the fire department so that each group can become familiar with the other's operations and equipment.

A company should also ensure adequate access to the interior of the building through doors strategically placed to reduce travel distances to high-hazard areas. The new rules of engagement being practiced are that there will be no gated wyes taken through a doorway and hose packs will be limited to 150 ft—as measured around obstacles, which can result in not being able to reach much more than 100 or 125 ft inside the doorway.

It is also important to locate utility services and protective system controls near exterior doors where they can be readily accessed by the fire department and shut down if necessary. Design layouts with isolated rooms that have direct exterior access provide the best solution because these rooms can be accessed without exposure to the ongoing hazard inside the building.

Another step is to provide paved access to as many sides of the building as possible—and, as noted, to extend the paved area outward at least three to four times the building height to provide flexibility for apparatus placement and to maximize aerial ladder reach. As noted, the recognized collapse zone for any building is about 1.5 times its total height. Apparatus is generally set up outside this distance to protect it from the collapse potential and exposure to radiant heat. The extra distance beyond the collapse zone provides room to maneuver additional responding units around those already set up.

Where possible, it is best not to build facilities that exceed the capabilities of the fire department's reach with aerial ladders or access for their placement or total pumping capacity. The average 100-ft aerial ladder that most people expect to reach 10 stories can only reach to the top of a five-story building when parked outside its collapse zone. Total pump capacity of the responding department and automatic mutual aid should also be considered.

At least 90 minutes of reliable water supply is required for sprinkler systems. The same amount (if not more) must be available for direct fireground operations. Fire operations may last 12 to 24 hours with high volume flows required. The municipal or private water supply is often the limiting factor due to total reserve capacity in storage towers or flow available because of small water mains. Large fire incidents can demand so much water from the municipal water system that reserves in storage towers are depleted;

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this deficit must be made up with tanker shuttle operations. Therefore, it may be prudent to provide supplemental water supplies with surface ponds and dry (drafting) hydrants, elevated storage towers, surface or below-ground storage tanks connected to a building's water main system in order to properly protect exposures when defensive operations begin.

It is also recommended that, where possible, a company replace explosive, flammable and combustible products used in operations with less-hazardous alternatives. This is a basic loss control/risk management practice to reduce ignition risks and total fire loading. Doing so may have employee health benefits as well.

Another recommendation is to use a secure on-premises means (such as a lock box) to store detailed hazard information and access keys for the responding fire officer(s). This is especially important when a facility is unattended during parts of the day or night. The information in the box can assist fire scene decision making and the access keys reduce the potential for damage caused by forcible entry. It is always better for the fire department to use keys than to use forcible entry tools to gain access in the event of a false alarm activation after hours.

A company should also take care to not compromise building construction features such as fire doors, fire walls or draft curtains, as this can increase the rate of horizontal and vertical fire spread or reduce the effectiveness of protective systems. Building construction features can be compromised by accidents, intentional acts or improper maintenance so these items should be regularly inspected. After any facility modifications (e.g., new wiring, plumbing or sheet metal duct work) are made, the entire length of the work should be checked to verify that if it penetrates any protective structure proper fire-stopping materials are used to seal the oversized openings.

In addition, most fire codes do not permit removal of any fire protection device once installed. Therefore, maintenance personnel and contractors must be made aware of what constitutes a fire protection device or part of a fire protection system, such as draft curtains located in large open areas with sprinkler protection or heat-activated roof vents.

Another measure is to manage fire loading to reduce the risk of overwhelming property-protection features such as automatic fire sprinklers and fixed fire suppression systems. NFPA 13, Standard for Installation of Automatic Sprinkler Systems, specifies maximum quantities and configurations for storage of commodities in structures protected by automatic sprinkler systems.

If a facility was originally designed for a different type of occupancy hazard, the commodity classification and current configurations should be assessed by a qualified fire protection engineer or specialist to verify the sprinkler system's ability to hold a fire in check or extinguish it. High-hazard contents may require installation of fire pumps and large-diameter orifice sprinkler heads in cases where highly combustible plastics or rubber tires are involved. In some cases, such as idle wooden or plastic pallets, no system can overcome a well-established fire, so storage limitations must be implemented to control exposure.

In addition, fire protection and detection systems must be maintained and supervised to ensure reliable operation. Guidelines established in NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Extinguishing Systems, and NFPA 72, National Fire Alarm Code, should be followed to ensure that the systems will function properly when needed. Remote monitoring may be required for large systems. Many states require off-site supervision of water flow alarms and valve position when the system is larger than 50 heads; this provision is critical for situations where the fire may not otherwise be discovered quickly.

A company should also have protective systems set for automatic operation and should instruct security personnel not to shut down any protective system without direct orders from the fire department. Most protection systems, such as automatic sprinkler systems, are normally in an automatic response mode; however, equipment such as fire pumps may need to be manually activated. It is also important to ensure that workers do not prematurely shut down protective systems in an effort to reduce water damage. This should not occur without direct instruction of the fire department IC.

The in-house IC/management representative should meet the incoming fire officer outside the building or facility at a prearranged location to provide supplemental information about the situation and direction for the easiest access to the fire area. While doing so may take 30 seconds, it can help prevent significant delays in locating the situation and the best access. This brief report should include the nature of the emergency and its size, any special hazards involved, whether the automatic protection systems are operational and whether all employees have been accounted for—information critical to the fire officer's size-up decisions.

Property Conservation: Business Restoration

An employer should have a business recovery plan that is compliant with NFPA 1600, Standard on Disaster/Emergency Management and Business Continuity Programs. While many different business continuity and recovery models are available, the 2007 edition of NFPA 1600 is available as a free download at www.nfpa.org/assets/files/PDF/NFPA1600.pdf. It also provides a cross-reference table between the NFPA standard and the Business Continuity Institute and International Disaster Recovery Institute International Professional Practice Standards; and the Department of Homeland Security Federal Preparedness Circular 65 for Continuation of Operations of the Executive Branch.

In addition, critical data and records should be backed up at a remote location. This can include either daily backups that are manually moved to an off-site location or real-time backups through mirror server sites.

A company should also develop plans to secure and occupy alternative facilities, provide temporary access and replace critical equipment after the event. Some companies specialize in providing contracts for contingent office space, equipment and computer services. They work with an organization to make arrangements in advance for office facilities and support to be used following an event that makes its original location unusable. Specialized equipment may be a greater challenge as it may require long manufacturing lead times. In some cases, businesses that are normally competitors have entered into contingency agreements to provide excess manufacturing capacity or use of a facility during off-shift hours.

Business interruption insurance coverage should be included in the overall insurance and risk management program to provide financial relief, but it does not replace the ability to provide products and services to customers. The inability to quickly restore actual business operations may ultimately cost a company market share and impact its long-term survivability.

Another key step involves advance planning for removal of water and smoke contamination. While many vendors are available, a company must ensure that adequate resources will be available to secure their services. It is best to select a contractor that can provide around-the-clock service within a specified time frame. The contractor must have access to an adequate supply of equipment, cleanup materials and skilled manpower. Some operations share manpower and equipment with sister operations outside their geographic area. In other cases, it may be necessary to coordinate operations among several smaller locally owned service providers.

A company should also prequalify potential contractors for repairs that may be necessary to secure the building or stabilize the structure. It may be necessary to preapprove these expenses with the company's insurance carrier or to select from a list of approved vendors. It is best to learn this before an incident so the company is not stuck with bills for unauthorized services that may be excluded from coverage. Again, it is important that these vendors provide around-the-clock services and can get the materials needed to secure the facility. In some cases, this involves assessments by qualified engineers to determine structural soundness and recommend proper solutions.

Conclusion

Information about specific fire protection requirements and help in developing and implementing resources are available from many sources, including the local fire prevention bureau of the fire department, insurance carriers and broker loss control services, as well as the OSHA consultation programs available in many states. Networking with other SH&E professionals is another way to locate information and resources to address fire protection and prevention. ■

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