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What Does the Fire Department Need to Know About You and Why? Becoming Part of the Solution, Instead of Part of the Problem

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Introduction

"Praemonitus, Praemunitis" *(Latin proverb)* is loosely translated to "Forewarned is forearmed." (Amer. Herit.)

When smoke that can be seen for miles is billowing into the air from your facility, it is not the time to be guessing what is going to happen next. What resources is the fire department going to need to bring the situation under control? Or even worse: Do they have any idea what they may be up against? What happens next is the culmination of what has happened or failed to happen in the previous years, months and days leading up to that moment in time. There are two distinct pathways the event can follow. Either you, as the business owner or occupant, have chosen the course of inaction and been relegated to be part of the problem for the duration of the event, or you have taken a pro-active course of action and chosen to become part of the solution. Your role has already been defined. You and everyone involved must now live with the consequences.

Your local responding fire department should be engaging in an intelligence-gathering process commonly known as pre-incident planning. The scope of this activity can vary widely by department, based on their internal resources and department structure. Recent economic cuts at many departments may affect how often this is done and who within the department is assigned the task. Whoever is doing the pre-incident planning within the fire department should be working with you, the business owner's safety representative, to get specific pertinent information about what is going on inside and outside your business so they can assess what resources are going to be necessary to handle reasonably anticipated emergencies.

Purpose of Pre-incident Planning

Pre-incident planning should have begun long before the emergency call to 911 was placed. If that call is your first interaction with the fire department, you have chosen the wrong path. The preferred path involves pre-incident planning. As stated above, this is supposed to be an intelligence gathering process for both the fire department and the business entity. It is a time when the fire department is gathering information about your operations to determine what specific hazards they may face and begin the process of planning for a fire emergency. It is also the time when you, as the safety representative, should be assessing the adequacy of your emergency action plans and hazard controls that are in place.

To achieve maximum benefit for both sides, it needs to be a joint effort. Open communication from both sides needs to take place. If the business is not upfront about hazards that exist, they are doing a disservice to the firefighters and fire command officers who will be responding. Once the information is collected and reviewed, it is assembled into a written or electronic document that can be used by the responding fire department to quickly bring them up to speed about the specific hazards they may face during an emergency in your facility. This document is often termed a "Quick Access Pre-fire Plan." Some departments have these available in binders that are carried on the responding apparatus, located in chief officer's vehicles, or available electronically onboard. In any case, the information contained in these plans is vital to effective fire ground management.

Craig Schroll, President of Firecon, Inc., and a long-time member of the fire service, has stated in numerous ASSE PDC presentations: "If he rolls up to the front of burning building and this is the first time he has met the building owner/representative/occupant, he cannot be absolutely certain that his objective (of making sure every one of his personnel go home safely) is the same as yours." In other words, are you expecting the fire crew to take unnecessary risks to save your building based on inadequate information?

You, as the business owner, must be willing to step up and bluntly ask if the fire department is going to be able to address your specific emergency needs. The department, in turn, should be forthright in explaining why they can or cannot handle your exposures. If they cannot, you should be working together to develop strategies to help you minimize your risks, improve your in-house protection, as well as arranging for mutual aid from other departments if necessary. Also, they will now have the information necessary to determine what outside resources they will need to obtain through mutual aid agreements. However, be aware that there may be situations where unpopular decisions must be made if there are insufficient resources to control the problem, and a defensive posture by the fire department is the only option.

Inadequate pre-incident planning often results in poor fire ground decisions, due to a lack of accurate information in conducting a solid risk analysis. All too often these decisions have fatal consequences for the firefighters. This information gathered is critical to a process known as "size up," which is done by the responding fire officer(s) to develop their incident action plan by dovetailing it with what is observed upon arrival. If the only information available to the fire ground commander is what he can see visually, there is a significant risk of making decisions that can have grave consequences.

Employer Involvement

The business owner should make available several already mandated documents to the fire department in order to ensure all reasonably identifiable risks are disclosed.

As an employer you should already have some sort of emergency action plan (EAP) in place as required by OSHA standards. Whether the OSHA standard (29 CFR §1910.38) requires this plan to be formal and in writing is function of the size of your workforce, usually beginning with a workforce of ten or more. This document is a good place to start. If properly written this document should identify major hazards within the operation and how employees are to respond. If employees are to be trained in how to mitigate the situation, this can either be an asset to the fire service or become another strategic level of concern during the response. Employees who are well trained and well equipped, who know their limitations, and are aware of the scope of what they are competent to do can provide early intervention that helps control the situation until the fire department arrives. However, inadequately trained employees can become a liability through improper action that may aggravate the situation, or cause unnecessary re-direction of resources, such as unneeded search and rescue for those who may have become lost in the building.

The OSHA Hazardous Communication standard (29 CFR §1910.1200) requires employers to have information about chemical hazards in the facility. It is a good reference to help you identify hazards related to the use and storage of potentially hazardous products regardless of quantity, since some products can create significant hazards in very small amounts, especially those that may be water reactive. If this program is current, including the required chemical inventory, the fire department may have a quick way of determining the presence of specific hazardous products.

Another good source of information related to larger scale chemical hazards would be the EPA's risk management plan (RMP) as defined in 40 CFR Part 68, as required under §112 (r) of the Clean Air Act of 1990. This plan for reporting quantities and controls must be prepared and filed with governmental agencies such as your local emergency planning committee (LEPC) when certain storage thresholds have been reached for hazardous materials kept on site.

Detailed building drawings, plans, or diagrams are also vital information. These should include specific details, such as the location of utility services, access drives, interior separation walls, doors, vertical openings, hazardous chemicals storage rooms, product warehousing, and dangerous equipment. Each of these aspects will be discussed in detail below.

Some fire departments do a better job than others in this area. Some have very sophisticated systems in place for gathering and formatting the information; others may only be gathering cursory information; and some may be doing nothing at all, at this point. You, as the business owner, should champion this effort with your responding department if they are not yet proactive with regard to pre-incident planning. If your department has little experience, you should enlist a professional to assist with this process. You may be able to use resources provided through your property insurance carrier (loss control, risk management or engineering services) to assist with development of this plan, as they are also a significant stakeholder in this process.

Fire Department Involvement

As with most fire department operations, activity is often predicated on an National Fire Protection Association (NFPA) recommended practice or standard. In the case of pre-incident planning, NFPA 1620, *Recommended Practice for Pre-Incident Planning* (2003) is the guidance document most commonly used. By the time this article is printed, this document will have completed the transition from a "recommended practice" to an NFPA "standard" with the planned release in February 2010 of the latest version. It is designed to provide a framework for the fire service, other government agencies, public business owners, and private consultants to be more effective at determining what information is vital for incident mitigation and how it is best communicated.

NFPA 1620 (2003) arose in the aftermath of a large warehouse fire in Ohio in 1987. Fire service and insurance officials met at NFPA headquarters to discuss how such incidents could have a more successful outcome. They developed a report titled "Before the Fire," making several recommendations related to large sprinkler protected properties. One of the recommendations was for the NFPA to develop a document to address the need for pre-incident planning. In 1993, NFPA 1420, dealing with pre-incident planning for warehouses, was adopted and was the forerunner of the current NFPA 1620 standard with its expansion to address issues with all occupancies, not just warehouses. In 1998, the first edition of NFPA 1620 was adopted.

How the fire department arranges, stores, and accesses the pre-incident plan is as important for the business owners as what they do with the information. As previously stated, it is intended to provide them useful data on just what hazards they may face as well as critical details on how or where to best mount a successful attack on the problem. The more detailed the information used to develop the plan, the more effective the plan can be. As stated above, some departments do a far better job than others in this area, having very sophisticated systems in place for doing this. If you are in a jurisdiction that is doing little or nothing related to pre-incident planning, now is the time for you to become part of the solution.

Why is the Information Critical to a Successful Outcome? The Consequences of Failure

The fire department has been charged with the task of restoring order from chaos, returning the situation as close to normal as possible and preventing further destruction of property or loss of life. Accurate information is vital to proper decision making on the fire ground. The pre-incident plan is a key piece of the information necessary to make those decisions.

In recent years, firefighters have been killed as a result of inadequate pre-incident planning. For instance on June 19, 2007, nine city of Charleston (SC) firefighters died in the infamous Sofa Super Store fire. The detailed investigation that followed this tragic event (Baker 2009) uncovered the fact that the fire department had not been doing an effective job of pre-incident planning. Only a partial preplan was discovered; it did not address literally 35% of the structure containing high-rack storage of highly combustible, foam-filled upholstered furniture, the lack of proper exits, and a compromised fire wall. If it had, the fire department would have realized the scope of what they were up against and hopefully would have made different decisions about placing personnel inside the building with only a marginal water supply available (Routley, 2008).

In December 2009, a Wisconsin firefighter was killed when a dumpster on fire exploded. It is believed that a mixture of aluminum chips reacted with other chemicals and the water used to extinguish the fire to cause the explosion. Aluminum is a known combustible metal that reacts in a fashion similar to magnesium when water is applied to extinguish a fire. The result is a superheated fire that can separate the water into its chemical elements of oxygen and hydrogen to feed the fire in an explosive reaction.

The first arriving fire officer, in the course of conducting the initial on-scene size-up, must attempt to identify the scope of the fire problem, predict its behavior and make initial decisions on how to apply the available or needed resources to the problem. Questions that need to be answered include: "Where is the fire now? Where is the fire going? Who or what is in its way?" The answers will determine if confinement and extinguishment are possible (FEMA, 2004). If it is determined that there is reasonable likelihood of success with the resources that can be mustered, then a risk/benefit evaluation must be conducted. Questions asked during this process will include: "Are the risks being taken worth the benefits being gained?" and "If it is worth the risk, for how long?" (FEMA, 1991a)

Fire Chief Alan Brunacini of the Phoenix, Arizona, Fire Department is credited with development of an early risk-based decision policy that has long since been integrated into their standard operating procedures. It defines the extent of risk that is acceptable in a given situation as follows:

- "Each emergency response is begun with the assumption that "they can protect lives and property."
- They will "risk their lives a lot to save savable lives."
- They will "risk their lives a little, and in a calculated manner, to save savable property."
- The will "NOT risk their lives at all to save lives and property that have already been lost" " (Goodson & Sneed,1998, 285).

Many fire departments have used this basic tenant to develop more detailed guidelines or internal practices known as standard operating procedures or guidelines (SOP or SOG) to assist in the decision-making process of how a fire event will be managed. Use of these basic guidelines has allowed progressive departments to develop strategies that provide for best firefighter safety when using a risk-based decision-making process. Some of these specific areas include ensuring firefighters are effectively managing their SCBA air supply, limiting the distance to which they will stretch hose lines inside a large structure, or ultimately deciding certain property is not worth the risk to personnel (Baker, 2006).

The Process

Before embarking on this venture, both the business owner and the fire department should be familiar with what specific information is going to be needed to successfully complete this project. Those items are outlined it the headings below, but include: building construction and features; unique occupancy characteristics; protection systems in place; capabilities of the fire department and in-house personnel for mitigating anticipated incidents; mutual aid availability; water supplies; and the effect exposures can have on these effective control of the situation. Once gathered and organized, the steps of establishing an effective pre-incident plan can begin (NFPA, 2003).

During development of the pre-incident plan, NFPA 1620 suggests the following items be given significant consideration: potential life safety hazard; structure size and complexity; value; importance to the community; location; presence of chemicals; and susceptibility to natural disasters. These elements will be critical in making decisions as to how to handle specific situations with the resources available (NFPA, 2003).

The amount of information that can be gathered during the process is critical. Too little information will result in planning which is incomplete. Don't be afraid of getting too much information as what is later determined to be not pertinent can be excluded from the document. However, be careful that the document does not become unwieldy and too long to be useful in an emergency.

Identifying the stakeholders in an emergency situation is vital to getting solid information about what exposures are present. Not only is the business owner one of the most obvious stakeholders in this situation, but their insurance carriers are as well. Insurance safety, risk management, loss control and engineering professionals may be helpful in the process. Some have fire service backgrounds and can interface easily between the fire department and business owner to assist with the communication and information gathering. Insurance professionals will also have insight as to how to address the financial issues where there is a high likelihood of having to "write off" the property due to lack of appropriate resources or environmental impact from surface water run off.

Once developed, the plan should be shared among all the stakeholders. It is important for the business owner to know what plans are in place by the fire department for their property. As stated above, insurance carriers will need this information to determine proper programs and pricing if resources to protect the property are not going to be available. Of critical importance is the knowledge of what has been planned for, and when changes in the operations will warrant notification of the fire department to cause the plan to be updated. Lastly, this is an ongoing process. The pre-incident plan, once in place, needs to be tested, maintained, and periodically reviewed.

Physical Elements and Site Considerations

Construction

The construction of a building has a major impact on fire behavior. The size of the building and various construction features will determine where a fire can travel, how fast it can move through the structure, and what the potential impact the fire may have on the structure. Each type of construction has its own advantages and disadvantages when it comes to cost and the ability to withstand the effects of fire. The trade off is usually lower cost in exchange for the ability to withstand the damaging effects of fire. The overall size and height of the structure play a critical role in fire ground operations. The total square footage per number of stories will determine potentially how much water may be necessary to successfully extinguish a fire. How the building is segregated internally provides some information on where forward progress of a fire may be controlled. Fire can travel very readily both horizontally and vertically if the building is open in design. This can result in more of a single structure without fire separations being exposed to the fire and thus may either demand more resources to ensure containment or prevent containment all together (NFPA 2003).

The construction details describe the types of materials used and how they are assembled or held together to keep the structure from falling down by forces of gravity or wind pressure. Two major building classification systems exist. One classification system was developed by the Insurance Services Organization (ISO) and another by the National Fire Protection Association (NFPA). While these two systems describe the same buildings, they are polar opposites in how the buildings are identified by numerical classification.

Common Name / Construction Details	ISO Classification	NFPA Classification
Wood Frame: Combustible wood framing members for roof and sidewalls, combustible floor and roof decking, with or without non-bearing masonry veneers; includes wood pole structures	**Class 1**	**Type V**
Ordinary (Joisted Masonry): Bearing masonry walls, usually of brick or block, supporting floor and roof structural members of combustible wood construction	**Class 2** incl. Heavy Timber or Mill	**Type IV** incl. Heavy Timber or Mill **Type III** Ordinary
Light Non-combustible: Unprotected steel frame structure, with metal or non-combustible exterior cladding	**Class 3**	N/A
Masonry Non-combustible: Fully or partially bearing masonry walls combined with unprotected structural steel and unprotected non-combustible floor and roof decking	**Class 4**	**Type II**
Modified Fire Resistive: Structural steel with at least 1-hour-rated fire protection coatings or encased in concrete with reinforced concrete floors and roof decking at least 4" thick	**Class 5**	**Type II**
Fire Resistive: Reinforced concrete structural members, floor of at least 2-hour-rated material, roof at least 1 hour fire-rated material (often misnamed "Fireproof")	**Class 6**	**Type I**

Table 1. Building Classification Systems (ISO c.2008; Hall, 1998, 65)

The ISO building classification system uses six categories and is based more on the use of specific types of materials with commonly known fire resistance ratings or durability. The NFPA system and each of the model building codes classify building construction in different terms, but are essentially dividing them into five classifications, and are generally based on prescriptive requirements of fire resistance of the construction elements and less so on the particular materials used (Hall, 1998, 65).

Because of the conflicts and overlaps of these systems, the remainder of this paper will deal with those classifications commonly assigned for purposes of insurance classification. Each individual type of construction has its own strengths and weaknesses, depending on the intended use of the building as well as from the standpoint of limiting the damage from a hostile fire. A detailed analysis of the advantages and disadvantages of each will not be covered within the scope of this paper.

Building Features

Other features of building construction include: exterior access doors to lessen interior travel distances to the fire; interior chases or openings that may allow fire to travel undetected; exterior facades that may collapse well before the building; and other buildings the structure directly exposes that may require onsite resources. Other building features have a direct impact on fire spread through the structure.

Fire walls and parapets are a critical construction feature for limiting the fire spread from one area of a large structure to another. A fire wall or separation by definition is: a wall of sufficient fire resistance, durability, and stability to withstand the effects of an uncontrolled fire exposure, which may result in the collapse of the structural framework on one side or the other. It must have a specific fire resistance rating, based on the materials used for its construction and how they are arranged. Variations in the material and wall thickness affect the ratings, which can be from ½ hour to 4 hours. A rated fire wall must include protection of the openings with rated assemblies of doors and windows that provide a complimentary degree of resistance to fire as set forth in NFPA 221, *Standard for Fire Walls and Fire Barrier Walls* (NFPA 2006).

Parapets are features of a true free-standing firewall that help to prevent the fire from traveling across the fire wall along the roof surface. They consist of vertical and horizontal extensions of the main wall that rise above or extend past the edges of the building roof by at least 30 inches if constructed to NFPA 220 and Factory Mutual Research Corporation standards, but many local codes allow them to be a low as 18 inches above the roof surface (NFPA FPH, 7-20).

The "big box" is a fairly recent term in firefighting practice. It is not uncommon to find single fire division buildings exceeding 100,000 square feet with high ceilings equaling two stories in height. Usually these are ISO Masonry Non-combustible Class 4 construction, using current construction technology that allows large roofs supported by multiple, often unprotected, steel columns. This type of building is commonly known as the big box when it comes to retailing operations, but manufacturing facilities can be five or ten times larger. This amounts to a building that is too large to reach much of the interior under the new firefighting rules of engagement. The new rules on how fires will be fought have resulted in limitations on the amount of hose that can or will be stretched into a building from the nearest doorway. Many departments have adopted the rule due to air supply management for firefighters that no hose lines longer than 150 feet in total length will be extended past the outermost door opening. This will greatly limit the effective reach of suppression activities. For this reason placement of additional exit/egress doors need to be strategically located to provide access with less interior travel distance to reach the seat of the fire or to access critical systems, such as the sprinkler controls, electrical and natural gas disconnects.

Combustible concealed spaces are commonly found in those buildings of ISO Class 1 – Wood Frame construction. If these spaces are not properly "draft stopped," fire can spread unchecked throughout the space, consuming the structural members without ever breaking through the surface materials, such as floors or ceilings. Controlling fires that are located in these concealed spaces is often difficult as they are hard to find without the aid of a thermal imaging camera. Once located, they require a great amount of manpower to open up the space and suppress the fire at the same time. Therefore "draft stopping" is required when these concealed spaces reach specific square footages, depending on the occupancy of the building and local codes. When the floor support system is made up of dimensional lumber and the concealed space runs only in one direction, draft stopping may not be required unless unusually large spans occur. However, when an open web truss of wood construction is used to support the building, fire can spread in any or all directions without draft stopping. Although draft stopping in a wood frame structure is not usually a fire-rated material, it does help to significantly slow the progress of the fire through the confined space.

Multiple roofs are common on older buildings where the structure was originally built with a flat roof, and through age or neglect has fallen into a state of disrepair, and has been replaced with a second structure above it that is often sloped or pitched. This modification creates a significant problem for ventilation directly above a fire inside. The outermost roof can be breached effectively, but the one below cannot be reached to open it up and allow the products of combustion to rise upward. This modification can include any combination of wooden and metal structures to form the first and second roofs. In any scenario, the interior cannot usually be effectively breached as it cannot be reached with power ventilation saws from the upper deck. Without vertical ventilation the fire will spread laterally throughout the structure until stopped by firewalls. Not only is effective vertical ventilation nearly impossible in this situation, but it also creates a confined space, that, depending on the materials, can enable the fire to run unchecked from one length of the building inside the space.

Compromised fire protective materials and fire stopping occur during renovations, remodeling, building additions, and updating of utility or wiring services in a building. This leaves critical structural members exposed to the effects of fire. In some cases this damage to the fire-resistive materials, commonly spray on fire retardants, plaster and metal lathe or concrete cannot be avoided to do the work necessary. However, it is crucial that the protective features be restored immediately upon completion of the work. Some occupancies, such as JCAHO-accredited healthcare facilities, are required to conduct regular inspections of all fire-rated partitions and walls within the facility for integrity of the fire-stopping materials at all penetrations.

Vertical and horizontal opening protection is important to stop the unchecked spread of fire and the products of combustion throughout the building. Whether these are planned openings, such as those needed for doorways and ventilation ducts, or unplanned openings, like those for plumbing and wiring that are not placed in dedicated utility chases, both require proper protection. Doorways, stairwells and elevator lobbies, etc., require fire protection of a specific rating and includes self-closing mechanisms to ensure the protection is in place when needed. Other situations where the openings are created out of need, but the exact location is not specified in construction plans, require "as built" fire stopping to be put into place. This usually takes the form of a fire-rated caulking or foam product that is used to fill the voids surrounding conduit or piping that has penetrated the fire wall or partition. Both NFPA and local fire and building codes will dictate where the firestopping is to be used and what fire rating is required. In typical wood frame construction, firestopping can be as simple as two-inch-thick (nominal) lumber. In other applications it should be of noncombustible materials with a sufficiently high melting point to remain in place during a fire (NFPA FPH, p 7-89).

Collateral loading of building structures is very common. One of the most common situations involving collateral loading is that of the roof structure by equipment such as HVAC units, dust collection systems, etc. If installed when the building was originally constructed, the building design should have accounted for this additional loading. However, if later modifications are made, their impact on the roof design and safety factors of loading may not have been contemplated.

Another area is that caused by weather situations. In northern climates, extreme snowfall may increase the roof loads beyond the design parameters. If a fire erupts inside the structure and causes heating under the roof, this can rapidly melt the snow, causing water to mix with it and form slush, which is much heavier and cannot escape through the normal roof drainage system.

Building Services

Various building utility services must also be identified in the plant. These would include the location of HVAC units and how they are powered. Although common on just about every building, the type and presence of fire dampers or automatic shut down sensors is critical to controlling smoke spread through the structure. In addition to HVAC, there may be industrial refrigeration units used for cold storage facilities that utilize flammable ammonia refrigerants.

Although electric power is common to almost all facilities, the configurations vary as to how many locations exist where power is fed into the building, as well as specific power controls in the form of circuit breakers and switchgear. Transformers can create significant hazards, especially those which are oil filled that can catch fire, explode or may even contain toxic PCBs. Emergency power can engage automatically and create back feed problems into the municipal grid or energized electrical circuits within the building that are believed to be de-energized.

Water supplies within the building can consist of the potable domestic water for drinking and industrial processes, as well as that used for fire protection. It is important to note the locations of these specific control valves to prevent accidentally turning off fire protection water unless deemed necessary due to hazards created by water-reactive chemicals, or until the fire is confirmed to be out.

Many plants also have compressed or liquefied gases on premises. These could be contained in piping systems or in individual storage containers comprised of either compressed gas cylinders or liquefied gas is stored in dewars. Compressed gas cylinders present their usual obvious hazards of becoming uncontrolled missiles. Dewars, which are used for the storage of the refrigerated gases, can become a problem if the container is compromised to release the refrigerated liquid at temperatures reaching several hundred degrees below zero, as well as where the vaporized liquid may concentrate due to its physical properties.

Boilers can be found in many locations to produce process steam and for heating purposes. High-temperature, saturated steam under high pressure cannot be seen with the naked eye and can inflict serious injuries to personnel due to unseen leaks. The locations of the boilers, as well as any control valves, must be noted in the plant.

Any specific fuels that are used in the facility, including natural gas, LP gas, fuel oils, and alternative fuels, need to be noted, as well as the position of any shutoff valves. Any interior storage tanks should also be identified due to the explosion or BLEVE hazard depending upon product present.

The number, type, location, and floors served for any elevators on premises should also be included. Especially important are the ability for services, such as elevator recall, service override, and emergency power equipment features. Individual elevator lobbies ideally should have smoke or fire containment construction to help eliminate the risk of an elevator opening up on a fire floor with no additional protection for the occupants (NFPA, 2003).

Site Conditions

Typically, site conditions are those things that are unique to that particular property or operation. However, some additional factors of concern are those things that may be encountered in route to the location.

The ability for the fire department to drive heavy apparatus to and around the building is critical in proper placement of the rolling stock resources. The most commonly traveled routes to a particular location from the responding fire stations may or may not have sufficient weight-bearing capacity on older bridges or on roadways due to weather conditions during the spring thaw. There may be other situations where roads are narrow and parking along such streets might hinder apparatus movement. Low bridges with inadequate clearance present problems with fire apparatus as well as railroad grade crossings, which may be too steep and cause a piece of fire apparatus with a long wheelbase to become "high centered" (stuck) and further delay response times. Planning the appropriate routes based upon all of these factors, while increasing response times over the most direct route, may avoid an unneeded delay due to identifiable roadway issues.

Access completely around the structure on paved roads is ideal. This permits positioning of fire 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 of a hard surface, this access must be paved or at least compacted gravel that is not subject to seasonal softening due to subsurface frost. It must be noted though that roadways need to have adequate room for multiple pieces of apparatus to pass each other as well as being placed far enough from the structure that they do not fall within the normal collapse zone of 1 to 1 ½ times the building height. Accessibility for fire apparatus to all sides of the building from a level paved surface extending at least 3 to 4 times the height of the structure would be recommended. This would provide enough space to position multiple pieces of apparatus in close proximity to each other if needed, but far enough away to be outside the potential collapse zone. Once fire apparatus are placed at the fire scene, pumps are engaged, and hose is on the ground; it is difficult to move them without great effort and time. If the paved surface and the building are separated by too much grass or are inhibited due to physical barriers, it can limit the reach of aerial ladders to upper floors or the rooftop. This might result in a 100-foot aerial only being able to reach to the second or third floor instead of the eighth floor.

Fences and other perimeter protection may also impede fire department access. It is important that the fire department have the ability to enter through gates without delay. This can involve on-site personnel ensuring that the gates are opened during the evacuation process or by providing the fire department a method for unlocking or controlling the gate access upon arrival. If security personnel are on hand, it is recommended that they handle opening the gates as to not further impede the fire department operations. In some cases there may be electrically charged fencing or fencing containing razor wire that should be noted in the pre-incident planning as a physical barrier that must be dealt with.

Animals on premises that can present hazards to firefighters, such as guard dogs, should be noted. The building owner should have the responsibility for ensuring that someone can restrain the animals as well as the notifying fire department as to where the animals will be located in order to avoid those areas.

Building exposures usually refer to those structures immediately adjacent to the subject building. These particular buildings may present their own unique set of hazards and usually will draw resources away from fire suppression and rescue operations being conducted. Whether the initial fire attack is in an offensive or defensive mode will determine what kind of resources can be directed towards protecting these exposures. Most commonly they must be protected from radiant heat exposure and flying brands produced by the main fire. In addition to the manpower aspect, additional water supplies need to be secured usually amounting to about 25% of the total water demand of the fire building for each side with exposures. In some cases the building exposures may not be structures at all but could be such items as LP storage tanks or fuel tanks that, if not properly protected, can result in catastrophic explosions.

The impact on the environment from fire suppression operations can often be worse than allowing the structure and its hazardous contents to be consumed by fire. In some cases application of fire suppression water causes highly toxic runoff that may enter streams and water supplies. If this is the case, the decision is often made during the pre-incident planning process that if water flow exceeds a predetermined amount, the mode of operations will change to a strictly defensive posture and only enough water will be applied to prevent the fire from spreading to adjacent exposures.

With the advent of new radio systems that use higher frequency bandwidth, the problems encountered on the fire scene with radio communications have increased. These higher frequency radio systems do not penetrate as deeply into structures made of concrete and steel as older VHF systems. These dead areas often include areas well below grade, such as basements and sub-basements where no radio communications are possible. To combat this, some fire departments have invested in portable radio repeater devices to supplement the existing tower systems that they have already strategically located throughout their response districts (NFPA 2003).

Occupant Considerations

Occupant considerations are tied not only to the human occupancy of the building but also the business occupancy. The ability of the building occupants to self evacuate may have a great deal to do with the business occupancy itself. Situations individuals cannot be allowed to self evacuate include facilities containing healthcare for the infirm, or where persons with physical handicaps are present, or in detention facilities.

Life safety considerations will always take precedence over property protection. Many businesses have wide fluctuations in the occupant load for the building between daytime and nighttime. They may also a 24/7 operation with staffing round the clock. A typical manufacturing operation may have a heavy occupant load during the day and very limited or no occupant loading during the nighttime hours. Conversely, a nightclub would have a heavy occupant load during the evening and early morning hours and almost no occupant load during the daytime. Also the factor of occupants who may be impaired by physical disabilities or by alcohol must also be considered in planning for rescue.

Are there adequate means of egress in place? These means of egress serve not only the building occupants for self-evacuation but serve a secondary purpose, providing access for the fire department. Knowing where each of these means of egress may be located and their proximity to specific hazards or operational equipment within the building is critical in cutting down the interior travel distances required to reach the seat of a fire or reach building service shutoffs (NFPA 2003).

Emergency action plans (EAPs) are generally required under the OSHA standards to be in a written format if the employer has 10 or more employees at that facility. The EAP is a good place to start during the pre-incident planning process. If a solid EAP is already in place, it can provide a significant amount of information about issues such as how the business will account for the occupants once they have evacuated; where they will be meeting to ensure that it is not interfering with fire department operations, and who may actually serve as a reputable contact during the emergency event. Other information that may be helpful from the EAP would include the business organizational structure, emergency contact information and specifically what employees have been trained to do or not to do in the event of an emergency. If hazardous materials are present, the facility should have someone designated as a hazardous materials coordinator.

In some cases full-scale evacuations are not practical or possible. In those situations arrangements should be in place for defend-in-place protective measures. These are tied to building construction to provide areas of refuge for temporary safety of the occupants, and would typically be found in healthcare occupancies or situations where it is impractical to evacuate an entire building in a timely fashion (NFPA 2003).

Protection Systems and Water Supplies

Water is the most readily available fire suppression agent on the planet, and it can come from a number of sources. Regardless of its source, it must be evaluated for adequacy. Whether the business occupancy relies on a municipal water system or naturally occurring sources such as lakes or ponds, each have potential drawbacks and can be limited in availability related to time of year and quantity.

It is important for the fire department to understand which source they will be relying on and have the ability to tap into that source when needed. They must also take care not to deplete any sources that are being used for fixed fire suppression systems, such as automatic sprinklers within the building. Private fire hydrants are often located on a closed loop that also serves the automatic sprinkler systems, and pumping out of that loop is actually stealing water from the other fire protection systems (NFPA 2003).

Calculating how much water is necessary requires knowledge of the size of the building and the total number of exposures. A rough estimate of the total amount of water required to extinguish a fire with the building fully involved is performed by calculating the building volume and dividing that result by 3:

Math Step 1: 10,000 square feet / 3 = 3,334 gpm for 100% involvement of the building
Math Step 2: 3,334 gpm × 100% maximum involvement = 3,334 gpm required fire flow

If the building has rated fire walls to create fire divisions, fire flow can be reduced to represent the smaller footprint exposed. For instance a four-hour-rated firewall and no unprotected openings separating the structure into two halves may allow for reduction in the basic fire flow. In that case each half could be calculated separately and reduce the demand by 50%:

Math Step 3: 3,334 gpm x 50% maximum involvement = 1,667 gpm required fire flow
(FEMA, 2005, p SM 5-4)

Additional water demand needs to be added for the calculated demand of the sprinkler system as well as for additional nearby building exposures. Building exposures on one side of the subject building would require an increase in water flow of approximately 25%. Exposures on two sides would require increased water flow of approximately 50%, and so on.

Once the amount of water that would be required is known, this is then compared to the available water supplies. Municipal fire hydrants often represent the most reliable water sources but, in situations where these are not properly maintained, they can become completely useless. Water supply test results should be obtained from the local water utility to determine adequacy of this source. If the building is located in an area where the municipal water source is inadequate, tanker shuttling of water may be necessary. A well-trained fire department with mutual aid assistance from similarly trained and equipped departments has the capability of delivering the same quantities of water that might be available from the municipal water system. This requires a great deal of planning and practice to achieve.

In order for the fire department to properly support any automatic sprinkler system, it must be fitted with a required fire department connection (FDC). The fire department will typically connect to this fitting and pump water into the fire suppression system to boost its performance. The type of FDC will be determined by the local authority having jurisdiction to ensure compatibility with the department's equipment. Supply lines are attached from one of the first responding engines/pumpers to provide additional water volume and boost the system pressure to about 150 psi. at the pumper. A properly installed check valve will keep the water from flowing back into the municipal main. By increasing the pressure by two for four times the typical municipal pressure, it may help to overcome limited deficiencies caused by excess fire loading beyond the original design criteria. An FDC is also used to provide water to a vertical standpipe system often found in multi-floor buildings, most commonly in stair towers. The FDC must be located where it can be readily accessed by the fire department and preferably not directly on the side of the building. Placement on the side of the building requires the fire apparatus to be placed closer and often close enough to be within the building collapse zone (FEMA, 2004, p SM 5-9).

Automatic sprinkler systems within the building are usually designed to control fire spread. Only a limited number of systems are designed with enough water flow to actually extinguish most expected fires, although this does occur in a large number of cases. Their ability to deliver water to a fire and how much they can deliver to a specified operating area is how they are classified. It is vital that the occupancy hazards created by operations and storage not exceed the design parameters of the sprinkler system. If the capacity of the sprinkler system has been exceeded, neither control nor extinguishment can ever be achieved, even with the extra pressure and water volume support from the fire department. All systems with over 20 sprinkler heads must have at least a local water flow alarm, but should be supervised off premises for early notification. All control valves should either be supervised through electronic monitoring or be locked in the open position to deter tampering that can disable the system and render it useless.

Older systems still in use today will likely have been designed using the "pipe schedule" method. Pipe schedule design relies on known values of friction loss for specific sizes of pipe to determine how many heads can be placed on a single branch line. Modern sprinkler systems are identified by the data plate attached to the riser containing design information. Ceiling sprinklers alone may not control hazards where high rack storage of product is involved. There are some common hazard scenarios that even exceed the capabilities of the schemes prescribed in the NFPA standards, such as those found in furniture warehousing (NFPA 2002a).

Maximum Number of Heads Supplied by "X" Diameter of Pipe					
Branch Dia.	**1"**	**1.25"**	**1.5"**	**2"**	**2.5"**
	Maximum Number of Heads per Branch Line				
Light Hazard	**2**	**3**	**5**	**10**	**30**
Ordinary Hazard	**2**	**3**	**5**	**10**	**20**
Extra Hazard	**1**	**2**	**5**	**8**	**Max. Limit**

Table 2. Pipe Schedule System (NFPA 13, 2002a)

Hazard Classification	Lower GPM/Sq. Ft. Delivery Volume in GPM	Upper GPM/Sq. Ft. Delivery Volume in GPM
Light Hazard (Offices, Schools, Residential, Public Assembly)	**.10 gpm / 1500 sq. ft 150 gpm**	**.07 gpm / 3000 sq. ft. 210 gpm**
Ordinary Hazard. – Group 1 (Canneries, Electronic Plants, Restaurant Service Areas)	**.15 gpm / 1500 sq. ft. 225 gpm**	**.10 gpm / 4000 sq. ft. 400 gpm**
Ordinary Hazard. – Group 2 (Dry Cleaners, Libraries, Repair Garages, Wood Product Assembly)	**.20 gpm / 1500 sq. ft. 300 gpm**	**.15 gpm / 4000 sq. ft. 600 gpm**
Extra Hazard – Group 1 (Combustible Fluid Use Areas, Printing w/ flammable inks, Upholstering with plastic foams)	**.30 gpm / 2500 sq. ft. 750 gpm**	**.20 gpm / 5000 sq. ft. 1000 gpm**
Extra Hazard – Group 2 (Flammable Liquid Spraying, Mfrd. Home Assembly, Plastics Processing)	**.40 gpm / 2500 sq. ft. 1000 gpm**	**.30 gpm / 5000 sq. ft. 1500 gpm**

Table 3. NFPA Hydraulically Calculated Systems—Area/Density Curve Values (NFPA FPH pp 6-141,142, 156)

If water pressure is inadequate to provide the required water flow for the automatic sprinkler systems, a fire pump will be employed to meet the need during a fire. Fire pumps are intended to boost the water pressure provided to the fire protection systems to a point where they operate effectively. Although it is necessary to know specific information about the fire pump itself, how it is powered, and what systems it may be connected to are of critical importance for the fire department pumper operator when supporting a sprinkler system to determine if water is actually flowing or not. Many pumps automatically start when water begins to flow in the system, but others must be manually engaged (NFPA, 2003).

Standpipe systems are primarily used for interior firefighting operations. They provide a point for connection of interior firefighting hose lines by the fire department. Only those standpipes with 2 ½ inch connection fittings are recognized under the OSHA standards and would be used by the fire department. Commercial fires are often fought using to a half-inch hose lines due to the need for larger volumes of water. An ability of flow at least 500 GPM is required. As noted above with sprinkler systems, the location of all control valves risers and their water supply sources must be documented in order for them to be useful in the event of a fire. Dry standpipes must be supported by the fire department to provide water to them (FEMA, 2004, p SM 5-8).

Fire hydrants, as previously mentioned, must be maintained in order to be ready when needed. In warmer climates, a wet barrel hydrant is used, and does not require as much maintenance as those found in colder climates. A dry barrel hydrant is used in colder climates, and has the actual valve assembly located below the ground frost line. This prevents the valve from freezing unless a leaking condition is present. In those cases, blocks of ice can freeze within the barrel at the hydrant and prevent its use during cold weather. Unless private hydrants are well maintained, they cannot often be relied upon by the fire department.

The presence of any protective signaling systems must also be documented. Where are the fire alarm panels, and what information can be gleaned from them? Modern systems can provide much more information than older, outdated systems as to the exact location of any activated detection equipment. If the systems are monitored off premises, this may be one of the methods by which the fire department is notified of a fire emergency. Maintenance of these detection systems is critical in ensuring that they function properly and are not subject to excessive false alarms.

The building occupancy may determine whether there are any special hazard protection systems in place. These could range from the fixed fire suppression system over a commercial cooking equipment line, special extinguishing systems over an industrial process or those commonly found in large data processing facilities. The specifics about what is protected, how it is protected, and how the systems operate are crucial in determining how to best support the fixed fire suppression system and not compromise its own capabilities.

Portable fire extinguishers are probably one of the most commonly found forms of private fire protection. In some facilities employees are not trained to respond with portable fire extinguishers, while in other facilities they are. Knowing whether the facility has an appropriate number of portable extinguishers and that they are properly rated for the particular hazards is good information to have. Fire crews, when conducting a preliminary investigation of the building, will often pick up portable fire extinguishers as they go through the building towards the area where the fire is suspected to be. In cases where special hazards exist, such as commercial cooking or combustible metals, the standard ABC portable fire extinguisher is not appropriate (NFPA, 2003).

Classification	*Primary Hazard*	*Examples*
Class A	Ordinary Combustibles	Natural fibers, paper, wood, cloth, plastics, etc.
Class B	Flammable & Combustible Liquids	Oils, grease, alcohols, ethers, gasoline, solvents, etc.
Class C	Energized Electrical Equipment (including Class A)	Any electrically powered equipment requiring a non-conductive extinguishing agent to reduce shock hazard potential
Class D	Combustible Metals	Aluminum, magnesium, sodium, potassium, lithium, etc.
Class K	Commercial Cooking Exposures	Commercial kitchen exposures protected by foam agents systems

Table 4. Classes of Fire Extinguishers and Their Primary Hazards (*Source:* NFPA 2003)

In no instance should the maximum travel distance ever be greater than 75 feet to the nearest portable fire extinguisher, and, in some cases, the distance should be as little as 30 feet, depending on the hazard involved. Ensuring that the maximum square footage per unit and total travel distances are not exceeded when locating these throughout your facility can take some creativity and mapping skills. In addition to the strategic locations to meet the minimum requirements, it is also recommended by many to locate them near exits and fire alarm pull stations for convenience in locating them during an emergency.

Fire ground operations depend upon good ventilation of a fire building to improve visibility and control fire spread. Smoke management is critical to controlling its progression through the building, as well as relieving heat and products of combustion from directly over the fire area to assist in confining it. Buildings may be equipped with automatic smoke vents to exhaust it, or automatic smoke control systems that provide positive pressure to prevent infiltration into areas of refuge such as stair towers (NFPA 2003).

Special Hazard Considerations

Many operations contain especially high-hazard activities or materials during either some or all of the year. It should be noted in the pre-plan documentation whether these are transient conditions or whether they exist at all times. If they are transient, specifically when will these conditions likely occur throughout the year?

One of the most commonly found special hazards includes flammable and combustible liquids. Specifically how are they stored, where are they stored, and are any particular special firefighting chemicals necessary to extinguish the fires.

Other items of particular concern would be explosives, toxic or biological agents, radioactive materials and any potentially reactive chemicals or materials. Of particular note would be those items that might be water reactive, since water is the primary extinguishing agent used by the fire service.

Particular electrical or mechanical hazards that need to be neutralized prior to entry or firefighting attack would involve equipment that, if left running, could cause injury to fire crews. Conveyors, augers, moving equipment, confined spaces, exposed high voltage equipment, etc., should be noted in the plan.

Special atmospheres such as those that may be inert and create a suffocation hazard for firefighters or those that may be potentially explosive should be specifically noted in the pre-incident plan. These are often found in situations where chemical storage tanks may be present, as well as in other confined spaces, such as chemical process tanks, material bins or equipment such as heat-treating ovens (NFPA, 2003).

Emergency Operations

Once the information has been gathered, the fire department will to be responsible for developing the plan and making sure that it is accessible for the responding fire personnel while in route. The format for this information should be consistent for all pre-incident plans that are generated, in the same philosophy as standardization of a material safety data sheet (MSDS) format is intended to be. If the responding personnel cannot adequately decipher the information under stress, critical details may be overlooked.

The fire department should incorporate methods for transmitting critical pieces of information into dispatch procedures, with the normal dispatch message to alert responders that a pre-plan is in place as well as some of the critical items of concern.

The fire department should consider all of the information they have gathered from the business owner and make logical assessments as to their ability to handle the anticipated situations. If they do not have the resources or question whether they have the resources available with in their own department, they should be incorporating an automatic mutual aid response into their plan. Specific considerations include the ability to muster the required manpower and apparatus.

The number or recommended firefighters to do the job is usually a function of how much water is going to be needed, or required fire flow. On average, the number of personnel needed to carry out fire ground operations is one firefighter for each 25 to 50 gpm of required fire flow. This takes into account the other operations, such as search and rescue, ventilation, RIT, relief crews, etc. Average responses will require a minimum of 20 to as many as 40 firefighters for each 1000 gallons of required fire flow order to adequately staff all the required functions to make a successful attack and extinguish the fire. Extra alarms on fires are often struck or called to bring additional manpower to the scene, not necessarily the equipment they arrive on (FEMA, 1991b, p IG 5-39).

OSHA does not require a specific number of personnel on an individual apparatus (for those states where municipal employees are covered), but does require a minimum number on scene before interior fire attack can be initiated per 29 CFR §1910.134 (g) (4), the OSHA Respiratory Protection Program Standard (two-in/two-out rule). However, NFPA 1710 addresses staffing for career fire departments and recommends a minimum of four persons on each apparatus (NFPA, 2004b). NFPA 1720, the counterpart standard to NFPA 1710 for volunteer departments, recommends four persons on the scene before interior fire attack can begin (NFPA 2004c), much like the wording in the OSHA Respiratory Protection standard.

Questions the fire department should be asking of themselves include: Do they have enough engines (pumpers) to move the required amount of water and aerial ladders to address evacuations from upper floors, roof operations for ventilation, etc.?

If all parties involved in the incident have a working knowledge of each other's capabilities and limitations, useful information can be more readily shared during the event. An appropriate incident command system (ICS) should be employed to ensure proper fire ground management. The advantage of the standard ICS is that it is scalable according to the magnitude of the incident.

While it is difficult for the fire department to constantly update information on all businesses within their response district, technology has provided a solution for this problem. Secure boxes or lockers are commercially available that can be installed at the business location to provide the necessary keys for access or updated information. The fire department can access these secured boxes upon arrival and have the most up-to-date information available.

Provisions must be incorporated into the plan, usually obtained from the EAP, about how the business will account for all of their occupants. It also must include information as to how they will shelter any evacuated occupants in the event of inclement weather (NFPA, 2003).

Plan Testing and Maintenance

Testing and maintenance are critical to establishing an effective pre-incident plan and making it useful in the event of an emergency. NFPA 1620 outlines specific procedures to be followed related to testing, evaluating and maintaining effective pre-incident plans. These are a joint effort on the part of both the fire department and the business owner to ensure that up-to-date information is being used in relation to the specific hazards, expectations and capabilities of each party involved (NFPA 2003).

Becoming Part of the Solution

"Praemonitus, Praemunitis:" *Forewarned is Forearmed*. Addressing the pre-incident planning process is a joint effort. Both the business owner and the fire department must be working together to accomplish this process. If done effectively, both will benefit greatly from the open communication to be fully aware of what to expect in the event of a fire emergency.

The business owner should take heed of any issues raised by the fire department for implementing in house controls to address any safety deficiencies that increase risk of a fire or other emergency.

While the fire department is charged with protecting lives and property, the hazards belong to the business owner and there is only so much that they can do to protect you from yourself.

Tapping into to the resources provided to you through your insurance programs to lower your operational risks is another good way to become part of the solution. Often these services are provided free of charge to policyholders.

Also, implementation of a business recovery plan that is based on or compliant with NFPA 1600, *Standard on Disaster / Emergency Management and Business Continuity Programs,* can be beneficial for managing those issues outside the strict scope of what is addressed here. While there are many different business continuity and recovery models, the most recent 2007 edition is available free from the National Fire Protection Association at http://www.nfpa.org.

OSHA (http://www.osha.gov) also has a good reference document to assist you in understanding fire protection available on their website (OSHA 2006).

Proactive Steps for the Future

Construction

It is important to remember that any type of construction will have its own set of issues when it comes to how well it can withstand the damaging effects of fire. Regardless of the specific type of construction, there are protective measures that can improve the survival of the structure and reduce the overall loss:

- *Design*: Design for fire safety when considering new construction or renovations.
- *Fire walls and partitions:* Where possible use these to separate high hazard areas from lower hazard areas, or to separate large areas into smaller exposure units when constructing new buildings.
- *Fire stopping:* Inspect fire walls and partitions for penetrations that may allow fire to communicate from one side to another. This includes draft stopping in large concealed spaces to slow fire spread.
- *Opening protection:* Properly rated opening protection in place in fire walls and partitions to limit the spread of fire through the wall.
- *Protective coverings*: Ensure any missing or damaged protective materials are repaired such as spray on coatings over exposed steel, or plaster, drywall or concrete coatings over structural columns and beams.
- *Exits:* Provide additional exterior doors that can serve not only as emergency exits, but provide improved access by the fire department to locate the seat of the fire and conduct extinguishing operations or manage utility services due to the limited interior travel distances for firefighters caused by air management policies and limited hose lengths.
- *Multiple roofs:* Avoid multiple roof scenarios that create concealed spaces where, if not properly draft stopped, can permit fire to spread the entire length of the facility as well as make vertical ventilation of the fire area nearly impossible.

Occupancy

The primary factors related to occupancy involve the materials and processes that are part of the normal day-to-day operations:

- Reduce operational hazards by conformance with local and state safety codes as well as OSHA and NFPA standards.

- Replace highly hazardous operations with alternatives known to be less hazardous.
- Ensure that occupancy hazards not exceed the protection capabilities of either the private or public fire protection.
- Ensure that all personnel can evacuate safely and be accounted for quickly.
- Provide wide, clear aisles through the facility that will not be compromised by storage collapse.
- Pre-qualify contractors who will perform work in your facility to ensure they follow proper safety guidelines and pose a manageable risk.

Protection

Since the protection component consists of both private and public elements, some are within the control of the building owner, and others are not. However, for those situations where circumstances are out of the control of the owner, knowledge is power for advance planning.

Private Protection

- Automatic fire sprinklers should be installed (new construction or retrofit) as a first line of defense to prevent small fires from becoming large fires.
- Fire detection systems should be installed to provide early warning for employees and response by the fire department.
- There must be 24/7 supervision of all fire detection and control systems.
- All fire protection equipment and systems must be maintained according to NFPA standards to ensure reliability. This includes not only the fire extinguishers and sprinkler systems, but also fire doors, smoke and heat venting, and early detection capabilities.
- Employees should be trained in handling incipient stage fire control, even if response is optional for most.
- If the local fire department(s) will not be able to handle your anticipated fire emergency, serious consideration should be given to establishing an industrial fire brigade.
- If municipal water supplies will be inadequate, serious consideration should be given to alternative water sources, such as elevated tanks, ponds, or underground cisterns that will be accessible during a fire emergency.

Public Protection

- Work with the local responding fire department(s) in establishing their quick access pre-fire plan. Understand their capabilities and limitations such as equipment available, staffing and the ISO Public Protection Classification.
- Evaluate public and private water supplies for adequacy.

Exposures

The primary factors related to exposure include:

- Using sound principles of layout for buildings on your own property to limit how they expose one another
- Controlling outdoor storage of fuels, combustible materials, and natural exposures that can cause fire to be communicated to the buildings
- Providing large, paved driveways capable of supporting fire apparatus weights as far around the structure as possible, taking into account the potential collapse zone and additional traffic for extended fire operations.

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