Assessing Fire Risks and Steps Toward Mitigation

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This meeting's theme centers on strategies for emergency preparedness, response and salvage. No one should disagree that these important topics need to be included as part of any long range preservation plan. The focus of this paper, however, is to emphasize **prevention** measures that should be followed to avoid one of the most prevalent threat faced by all cultural institutions - FIRE. No institution is immune from fire. Until the owners/trustees of these institutions develop plans for dealing with the fire threat, they place the building and its occupants, visitors, and collections at risk. The complexity of these plans may vary from a simple evacuation plan, to a fire prevention program, to a more complex plan that includes passive and automatic fire protection systems.

Property damaged by floods can often be dried out and restored. Structural damage from an earthquake might be repaired. Stolen property always has a chance of being recovered. Damage from fire, however, is usually permanent and irreparable. Museums or museum collections, once reduced to ash, can never be restored. Fire is more cunning and less discriminating than a thief. It can travel (spread) through very small openings and concealed spaces to reach other parts of a building, deprive occupants of a life supporting environment, and cause partial to total destruction of property.

There exists a cavalier attitude in this country that "fire won't happen to me," that "it is someone else's problem." Americans also place a lot of blind faith in their local fire department to save them and their property from any fire that may occur, and believe insurance will cover the rest. Reality is very different, and our daily fire statistics bear this out

At the very least, every institution should have an emergency self-protection plan that spells out how to report a fire and safely evacuate the premises.

Life Safety

More important than the preservation of the museum and its collections, is safeguarding the lives of its staff and visitors. Life safety must always come first. Management must ensure that employees know what to do in the event of a fire.

Instruct employees on how to turn in an alarm (phone, manual pull station, etc.). This is the first action that should be taken upon discovery of a fire. If the alarm is not sounded first, the lives of co-workers and visitors are needlessly endangered.

o Make sure they know what the building fire alarm sounds like(bells, horns, chimes, speakers with recorded instructions). Fire drills should be conducted at least twice a year.

o Ensure employees can hear the alarm. Extend alarms to locations where the alarm cannot be heard and make provisions in the interim to alert employees in those areas.

o Ensure all employees know their primary and secondary exit routes. Every museum or university should have an evacuation plan and provide it to all employees. Walk through exit routes to make sure they are clear and available for use. Conditions may change daily due to construction, renovations, repairs, etc. Check to make sure of the following:

Egress paths are not obstructed by storage, etc.

Exit doors are accessible, unlocked, and not blocked from the other side.

Exit signs are operating and visible.

Emergency lights are functional and adequate to illuminate the exit path in case of a power failure.

o Appoint fire wardens (and back-up wardens) and task them with ensuring a particular area of the building is “clear” before they themselves evacuate. Have them report in to an

o Ensure staff knows where the meeting point is outside the building so they can be accounted for.

o Ensure an introduction to fire prevention is given to all new employees.

Fire Prevention

Cultural institutions are just as susceptible, if not more so, to the wide variety of common ignition sources that are responsible for most fires elsewhere. The most important factor in preventing a fire loss is through the maintenance of a good fire prevention program. The fire protection program (policy) needs to be in writing and updated periodically. Management and staff responsibilities need to be defined, and fire prevention procedures established. This program must be based on a high standard of housekeeping, orderliness, maintenance of equipment and continuous staff training and awareness in both recognizing and eliminating fire hazards (ignition and fuel sources).

Safeguarding Ignition Sources

Much can be done to minimize the chance of a fire starting or spreading with little or no expenditure of monies. All you really need to know about *assessing fire risks and taking steps toward mitigation*, you probably learned in kindergarten. While I don't believe this topic is covered in Robert Fulghum's book, your early education training should have taught you that it takes fuel, air, and heat (an ignition source) for fire to occur. You cannot do much about air, but you can control both the fuel and the ignition sources in your facilities.

Some of the leading causes of fires in cultural institutions are heating devices, such as space heaters, heating and air conditioning equipment, and heating and cooking stoves; arson and suspected arson; electrical wiring and appliances; and smoking. Through care and diligence, many of these ignition sources can be guarded against, however, the risk of fire will always remain a distinct possibility to be reckoned

To reduce the likelihood of fire, start by controlling potential ignition sources:

o Welding, cutting or burning perhaps represent one of the greatest causes of fires in museums properties, as so many fires occur to buildings under renovation or repair. A daily "hot work" permit system should be established and strictly enforced. This system should require a contractor or other person wanting to perform hot work, to have a signed permit from a responsible staff person after it has been determined/agreed upon that:

- all combustible materials are protected [This can be accomplished by covering all combustibles with fire retardant blankets, or constantly wetting the area down],

- a fire watch is established [this involves having a designated person or persons standing by with a portable fire extinguisher for the duration of the work, plus half an hour beyond, to extinguish any blazes that may start] , and

- the area is carefully inspected afterwards to detect any fire or smoke.

- Fuel fired portable heaters should be prohibited. Portable electric heaters also should not be permitted because of their high potential as an ignition source, possible electrical circuit overloads, and high operating costs.

- Electrical appliances such as hot plates, toasters, coffee makers, etc., should be restricted and allowed only with written management approval. The authorizing official should ensure the appliance: is listed or approved by a recognized testing laboratory (these products must pass tests to help assure they are fire safe); has a visual light to indicate when the appliance is "on"; is installed on a non-combustible surface and separated from other combustibles by at least 18 inches. Appliances and electrical cords should be routinely inspected for obvious problems (burn spots, frayed wires, etc.), and immediately repaired or disposed of when problems are found. It is also a good practice to look for and purchase appliances that incorporate an automatic shut-off after so many minutes/hours of non-use, and to unplug electrical appliances when they are not in use.

- Heating, air conditioning, and other mechanical equipment and major appliances should be installed by professionals in compliance with codes. This equipment should also be maintained, inspected, and tested in accordance with recognized safe practices.

- Electrical wiring should be installed in strict accordance with code and only by qualified electricians. Extension cords and multiple plug adapters should be avoided. If a circuit keeps tripping off or a fuse keeps blowing, it is overloaded with too many electrical appliances. Never try to remedy the problem with a higher rated fuse, penny under the fuse, or taping open the circuit's breaker. Either reduce the electrical load or have additional circuits added.

- Consider installing arc-fault circuit interrupters on your electrical circuits. This is a relatively new (1998) product that will shunt power to a circuit upon detection of any arcing in the wires - a usual occurrence prior to an electrical fire. This product is not to be confused with ground fault circuit interrupters, which help prevent electrocution.

- Smoking should be prohibited throughout all cultural institutions - No exceptions! Large noncombustible ash trays, preferably filled with sand, should be provided on the exterior of the building, to preclude staff and visitors from tossing their live cigarettes into the surrounding dry mulch or vegetation.

- Lightning protection should be checked by an expert to ensure that it is adequate, in good repair, and properly grounded.

These are just some of the more common ignition sources one can and should guard against. One must also strive to separate combustible materials from potential ignition sources and minimize the amount and continuity of combustible materials in any one area.

Safeguarding Fuel Sources

- Safe containers (metal cans with tight fitting metal lids) should be used for collecting waste papers, oily rags, and other refuse, and for storing packing material in. Waste materials should be removed from the building on a regular basis (daily as a minimum).

- Store important papers or collections in fire resistive safes or cabinets storage. Even good, well constructed cabinets that are not labeled "fire resistive" will help protect their contents to some degree from fire, water, and other possible types of damage.

- Flammable liquids should be stored in and dispensed from approved safety cans only. These containers have a spring loaded cap and a wire mesh screen (flame arrestor) inside the can. In addition, the quantities of these materials permitted in the building should be held to an absolute minimum, and stored in approved flammable liquid storage rooms or within flammable liquid storage cabinets.

- Hallways, stairways, and access aisles must be kept clear of all storage; DO NOT USE THESE AREAS FOR STORAGE, EVEN TEMPORARILY! Housekeeping and storage in all other areas should be neat and orderly.

- Do not store or place materials against electrical outlets, light fixtures or heat producing equipment.

- Storage should be prohibited in mechanical equipment rooms, electrical closets, telephone closets, and within 3 feet of the front of electrical circuit boxes and panels.

- Interior finishes (carpeting, ceiling, tiles, acoustical wall coverings, etc.) that can be ignited with a match should never be used. Ask manufacturers or distributors to provide fire retardant products, with certification of flame resistance.

- Exhibits, as well as any interior/exterior modifications, should be constructed of fire safe materials to reduce the fire risk. Always ask your designer, fabricators, or supplier if they can offer the material you want in a fire retardant variety. These materials may be a little more expensive but can substantially reduce the risks to your collections and building.

- Treat combustible materials with a fire retardant chemical or paint to reduce the chance of ignition.

- Holiday decorations should only be the fire retardant type, and well separated from lights and other potential ignition sources.

While an outstanding fire prevention program will effectively preclude most fires from starting, the risk of a fire remains. The best protection against fire will include a good fire prevention program, together with passive and active fire protection systems. Passive fire systems are those physical barriers that may limit the spread of fire. They include both fire-rated and non fire-rated walls, ceilings and floors, as well as enclosed cabinets. Active fire protection systems include both fire detection and fire suppression systems.

Passive Fire Protection Measures

Proper disaster planning should consider the possibility of all active fire systems failing. Should this occur, it is often the building's passive fire protection features that may determine the extent of fire spread. The more a building is divided into compartments, the greater the chance to limit fire spread. All cultural institutions should evaluate how they can further incorporate vertical and horizontal barriers to resist fire spread. Collection storage and handling areas, to include walls, floors, and ceilings, should be constructed of 2 hour, fire-rated construction. Since all walls, floors and ceilings risk being compromised over time, due diligence is needed to maintain their integrity.

Fire doors protect openings in fire walls. Make sure fire doors are not propped open, that they positively latch, and that they close without assistance. If they are in need of repair, have them fixed. When it is absolutely necessary to prop these doors open, have electromagnetic door hold-open devices installed. These devices release the doors when the fire alarm system is activated.

Make sure penetrations for duct work, electrical wiring and plumbing in fire-rated walls, floors, and ceilings are sealed around their perimeter to prevent the passage of smoke and flame.

Placement of collections into enclosed cabinets and containers is another form of compartmentation that is highly desirable. The cabinets and containers not only help deter fire, but water incursion as well.

Fire Detection Systems

Fires produce a variety of products and byproducts, including smoke, heat, light, sound, and various gases. There are a variety of fire detectors available today that can sense for each of these products, and usually one can mix and match detectors on a common fire detection system. For most historic properties, however, smoke detectors usually offer the best means for detecting a fire at its very earliest stages.

The most common types of smoke detectors available and used in buildings today are spot-type photoelectric or ionization. Without going into detail as to their principles of operation, photoelectric detectors react more quickly to smoldering fires that produce visible smoke, whereas ionization detectors react more quickly to invisible products of combustion and flaming fires. The type of detector(s) selected for use may vary from room to room depending upon the construction, furnishings and operations encountered. A fire protection specialist should be consulted for advice. A single spot-type smoke detector can generally protect a room up to 900 square feet. If a room is larger than that, or you want more optimal detection, consider using a mix of photoelectric and ionization detectors in the space.

Smoke detection systems have become rather sophisticated with the advances in computer technology. Today's systems can often list/adjust the sensitivity setting of the detector, adjust for dirty conditions, provide an exact address of the detector [e.g. "Green Room - Second Floor"], and perform specific actions upon activation [e.g. close doors, shut down power, etc.], among other things. Wireless systems are also available, which can be a benefit in historic structures where running wiring may be difficult.

Perhaps the most sensitive smoke detection systems available are the air sampling systems that continually draw and examine the air from a room or rooms. These types of smoke detection are very expensive, and do not readily lend themselves to protecting an entire building. They do, however, offer an aesthetic advantage, in that no visible devices need be installed in the area(s) being protected. Instead, a very small diameter tubing can be discreetly inserted into the room, with nothing visible showing.

Prior to installing a fire detection system, a decision has to be made as to what purpose it's to serve. If the fire detection system is strictly for life safety (the building can burn down as long as everyone gets out in time), then the system need only to sound an alarm in the protected premises. If, however, the intent of the system is to not only sound a local alarm, but also summon trained personnel to fight the fire, then the system must be monitored around the clock. This should preferably be done at the local fire department or a certified control station.

Two critical components for ensuring that a fire detection system functions properly are periodic testing and maintenance. Before selecting a system, inquire about service contracts, and check references. It is also very important to protect smoke detectors during operations that produce dust, smoke or spray (e.g., cutting wood, spray painting, welding, burning, etc.). Spray or dust can accumulate on the inside of the detectors rendering them inoperative or causing false alarms. Ensure protective covers are removed and the system is operating when work has been completed for the day. Never leave a detector or system out of service overnight without providing additional fire watches.

Many cultural institutions feel that an excellent housekeeping and fire prevention program, combined with a state-of-the-art fire detection system, constitutes an optimal fire protection program. This level of fire protection may be suitable for the protection of fine art galleries housed in fire resistive buildings, where the total fuel load within the gallery is limited to a few paintings on the walls or sculpture on the floor. In this environment, ignition sources are easily controlled, and spread of fire from one object to the next is unlikely due to the physical separation of the fuel sources. In almost any other environment, however, fire is too unpredictable. Arson or other incendiary fires may be difficult to guard against. Lightning is a

threat in certain parts of the world, and there is always the unforeseen careless actions we humans occasionally make. A fire detection system will be helpful provided that it: 1) responds quickly to the fire condition, and 2) human intervention is almost immediate. This latter point is especially critical since fire detectors can only detect a fire, and not extinguish it.

Fire Suppression Systems

If one were to examine every cultural property (historic building, museum, library, place of worship, etc.) lost to a fire, the only factor they would share in common would be lack of an automatic fire suppression system. Many would have had good housekeeping programs, or fire detection systems, or have been constructed of noncombustible materials, but they were still total fire losses. Being properly prepared for a fire often means incorporating an automatic fire suppression system. An automatic suppression system, designed to quickly control or extinguish a fire that is beyond the means of a portable extinguisher, is the best insurance against a large loss fire.

Generally speaking, only gas based or water based automatic fire suppression systems are suitable for protecting cultural properties. Gaseous systems are suitable only for protecting the contents of a tightly sealed room that can contain the gas once it is discharged. Any breach to the room, e.g. open door or window, operating ventilation system, wall/floor openings around pipes or conduit, etc., will permit the gas to escape and void its usefulness in extinguishing the fire. Up until ten years ago “Halon” was the only gas available that was “safe” for use around people and collections. Halon was found to cause serious damage to the ozone, however, so further production was banned worldwide. Several replacement gases have been developed and are available (FM 200®, Inergen®, FE 13®, etc.), although none of them can be used as a drop-in replacement for Halon. Each gas can provide an effective and “clean” method to control fire in an enclosure, as long as the system is properly designed, tested, and maintained. The drawbacks to these systems include: a limited amount of agent; they must be adequately confined within the room of discharge; the discharge velocity of the gas must be considered (most systems are capable of blowing objects about the room); they require above average maintenance; and they do not protect the building structure.

The alternative to a gas based fire suppression system is a water based one, a.k.a. a sprinkler system. Immediately after the Windsor Castle fire (U.K.) in 1992, the Cabildo fire (New Orleans, LA) in 1988, the Byer Museum (Evanston, IL) in 1984 (and probably many other cultural fires), government or museum officials were heard to have made remarks along the lines of "good thing there were no sprinklers, otherwise the (water) damage would have been much worse". Unfortunately, many myths and misunderstandings regarding automatic sprinkler systems are entrenched in the minds of many people in the cultural field today. Many people in the cultural field also have an innate fear of having pipes filled with water overhead, a disaster waiting to happen. This fear is probably grounded in the many mishaps that occur with other piping systems, e.g. domestic water lines, roof and other drains, condenser lines, etc.

An automatic sprinkler system is the single most important fire-safety system a cultural property can have. In its simplest form, a sprinkler system is a network of overhead pipes (with or without water in them) connected to a water supply. Attached to these pipes, at regularly spaced intervals, are automatic sprinkler heads. Each sprinkler is held shut or sealed by an element that will melt or break away at a predetermined temperature (normally 135-165^{o}F). In a fire situation, only the sprinkler head(s) nearest (exposed to) the fire will open and discharge water onto the fire. Not all sprinklers open, as many people believe. In fact, rarely does it take more than one or two sprinkler heads to control or extinguish a fire. Sprinklers can be looked upon as individual firefighters, standing by 24 hours/day. A typical sprinkler head, however, discharges about 20 gpm, while fire hoses may discharge 125-250 gpm. In addition, almost all water discharged from a sprinkler head goes onto the fire; whereas water from firefighting operations may not always be directed onto the fire, thus causing unnecessary damage.

The various types of automatic sprinkler systems, briefly described below, all have certain common features. Each has a control valve where the system can be turned off, a waterflow alarm that activates when water movement occurs within the pipes (and generally transmits the alarm to a constantly attended control room), and an automatic sprinkler head which distributes the water.

Wet-pipe system - Overhead pipes are filled with water and the system is always ready for operation. This type of system is both the simplest, and most reliable of all automatic sprinkler systems. A wet-pipe system should not be used in spaces subject to freezing temperatures or where mechanical damage to the pipes is likely.

Pre-action system - Overhead pipes are normally dry. A supplemental fire detection system must be installed in the same area as the sprinklers. Activation of this supplemental fire detection system releases a valve that allows water to fill the pipes, essentially converting the system to a wet-pipe system. Water is not released until a sprinkler head is activated. This type of system minimizes the possibility of accidental water damage due to a sprinkler pipe or head being mechanically damaged. However, since a pre-action system is dependent upon a supplemental fire detection system to get water into the pipes, and has other moving mechanical parts, it requires much more maintenance and is therefore its reliability in a fire situation, while very good, is not as high as the simple wet-pipe system. Pre-action systems are suitable for areas subject to freezing, provided the incoming water supply piping to the control valve is in a heated location.

Dry-pipe system - Overhead pipes are filled with air under pressure. The air pressure is significant enough to hold "closed" a valve that allows water into the system. Should a sprinkler head open, the air bleeds off and the water valve is allowed to open. Water then flows through the system and out the open heads. This type of system should only be used in areas subject to freezing. The use of dry-pipe systems in historic buildings should be limited to loading docks, unheated structures, etc.

Sprinkler systems can almost always be unobtrusively installed into historic buildings and other cultural properties. Automatic sprinkler heads are manufactured in a wide assortment of shapes, sizes, styles, and even colors, to meet practically any aesthetic consideration. . Concealed heads are completely invisible, hidden by small cover plates that are flush to and the same color as the ceiling. Some low profile and recessed heads only project out from the wall or ceiling a

fraction of an inch. Sprinkler piping can often be hidden along crown molding, or concealed within void spaces. Use of copper or plastic pipe can help reduce the size of the pipe, and sidewall sprinkler heads can be mounted along walls, often avoiding the need to run any pipes directly overhead. False soffits can also be created to hide piping and blend in architecturally. Of course hiring a sprinkler designer and installer sensitive to historic preservation needs is also important.

Many building and fire codes now require installation of sprinklers in because of their proven life safety capabilities. The odds of someone being killed by a fire in a fully sprinklered building are about as rare as those for sprinklers to accidentally operate due to manufacture's defect (practically nil). The advantages to installing a sprinkler system in a cultural institution should now be obvious:

- minimize fire damage (your greatest threat) to the building and its contents
- drastically reduce water damage (resulting from fire fighting operations)
- prevent injury or loss of life
- proven reliability

Water mist fire suppression systems have been getting some publicity of late as a replacement for both sprinklers and gaseous systems. As the name implies, these systems produce very fine water droplets (similar to fog) that have proven to be very effective in extinguishing engine room fires on ships. In fact, that is the only application their use has been listed for. Cultural institutions need to exercise extreme caution before purchasing and installing a water mist system, since there is no approved test protocols to go by for these occupancies. At the 1999 Annual Meeting of the National Fire Protection Association, a special forum on water mist technology was conducted by the experts in this field. The experts were unanimous in saying that this technology can not and should not be transferred to any other application, unless the end user is willing to invest hundreds of thousands of dollars in testing for the specific end use application. In addition, water mist systems have not yet proven to be effective in extinguishing small fires.