Overview

A Management Program for Loss Prevention and Control.

AXA XL Risk Consulting

11th Edition

Overview

A Management Program for Loss Prevention and Control.

AXA XL Risk Consulting publishes this *OVERVIEW* Manual for the benefit of its clients worldwide. Many of the Agencies referenced in the text are located only in the USA, however, counterparts of these Agencies are generally found in most countries.

OVERVIEW is a subset of the Property Risk Consulting Guidelines, Section 1 — Management Programs. Property Risk Consulting Guidelines provides AXA XL Risk Consulting's philosophy of and interpretations to, various nationally recognized standards that deal with all types of property loss prevention subjects. Where no standards exist, it provides broad guidance that identifies property protection requirements. Additional information on management programs and other topics can be found there. For additional information on Property Risk Consulting Guidelines contact your principal consultant or the Vice President – Director of Research at 100 Constitution Plaza, Hartford, CT 06103 or call +1 (860) 293-7900.

AXA XL Risk Consulting provide property loss prevention surveys and other property risk management services. Our personnel, publications, surveys, training and other services do not address life safety or third-party liability issues. The information contained herein is not meant to imply that every possible hazard has been identified or that no other hazards exist. We specifically disclaim any warranty or representation that any advice or recommendation contained in this material or otherwise will make a facility or operation safe or healthful, or put it in compliance with any law, rule or regulation.

MANAGEMENT PROGRAMS (OVERVIEW)

A MANAGEMENT PROGRAM FOR THE PROTECTION OF PROPERTY, PRODUCTION AND PROFITS

This Property Risk Consulting Guideline introduces the *OVERVIEW* Program and covers some of the philosophical concepts of the program. It is addressed to top management of a corporation or facility.

Management commitment to an aggressive program of loss prevention and control is the foundation of all serious efforts to reduce loss. Management is charged with the responsibility of producing a product or providing a service at a profit. However, when a facility or its equipment is seriously damaged by fire, explosion, mechanical or electrical breakdown or other peril, even the most effective management effort may fail to maintain profitability. Therefore, loss prevention and control activities must be managed as skillfully as production, inventory, quality, finances and resources.

A written statement of corporate management policy is of fundamental importance in making a commitment to properly manage loss prevention and control these problems. This statement, carefully worded, signed by the highest members of management and widely published throughout the organization, gives clear testimony that management has made loss prevention and controls a corporate objective worthy of everyone's attention and concern. (See PRC.1.0.1.A for suggested language.)

Once this solid foundation of management commitment is in place, loss prevention and control may be effectively managed through a series of interlocking programs that manage the interaction of people, hazards, and loss prevention and control activities.

One way to visualize these interlocking programs is to think of the defense against loss as a wall (see Figure 1) that stands between your facility and destruction. This wall is composed of separate blocks laid on a foundation and joined together with mortar to form an effective barrier against disaster.

While the absence of one block may not lead to a disaster, it can result in an opening that weakens the facility's defense against loss. The greater the number of blocks that are missing, the greater the probability that a major loss will occur. The morter that holds the blocks together is an effective management of change program. Without this adhesion it is difficult to hold the blocks in place. The sightest disruption or change in the facility or its processes can displace the blocks. Most importantly, if the foundation of management commitment is missing, the entire barrier may collapse leaving the facility completely vulnerable to loss.

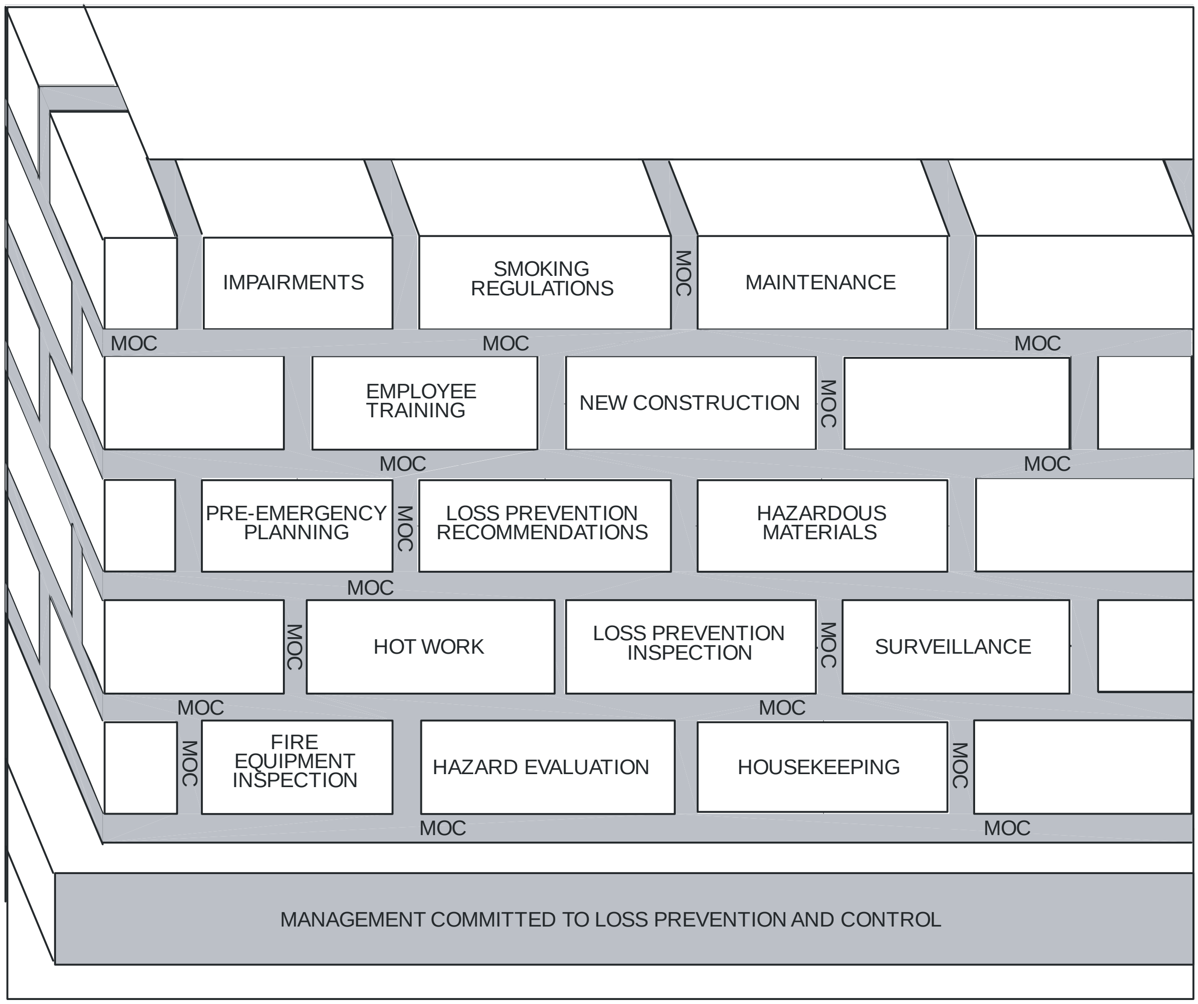

Figure 1. OVERVIEW Wall.

AXA XL Risk Consulting has developed *OVERVIEW* as a means of consulting with our clients and helping them measure the effectiveness of their existing loss prevention and control programs. *OVERVIEW* is a total management program for loss prevention and control. It provides for the foundation, the mortar and the blocks in the barrier against disaster.

OVERVIEW includes the following 14 programs:

1. Impairments to Fire Protection Systems (PRC.1.1)
2. Smoking Regulations (PRC.1.2)
3. Maintenance (PRC.1.3)
4. Employee Training (PRC.1.4)
5. New Construction (PRC.1.5)
6. Loss Prevention Recommendations (PRC.1.6)
7. Pre-Emergency Planning (PRC.1.7)
8. Hazardous Materials Evaluation (PRC.1.8)
9. Cutting, Welding, and Other Hot Work (PRC.1.9)
10. Loss Prevention Audit (PRC.1.10)

11. Fire Protection and Security Surveillance (PRC.1.11)
12. Fire Protection Equipment Inspection (PRC.1.12)
13. Hazard Identification and Evaluation (PRC.1.13)
14. Proper Housekeeping (PRC.1.14)

Each management program section in this Property Risk Consulting Guideline is presented in three parts: Introduction, Position and Discussion. Some of these sections also have appendix material or subsections to aid in program evaluation and development.

The Introduction sets the tone for each section and gives a summary of possible loss scenarios and suggested solutions. The Position provides AXA XL Risk Consulting suggested approach to setting up an effective program. The Discussion provides additional details to support the Position.

PRC.1.10.0, Loss Prevention Audit, provides a feedback mechanism that allows management to determine the effectiveness of the overall program for loss prevention and control. This is important since these individual programs must keep pace with changes in the facility. These programs must not be written, filed, and forgotten. If they are to accomplish their goal, they must be implemented and constantly revised and updated. The Management of Change Program covered in PRC.1.0.2 should be used to keep the other *OVERVIEW* programs current.

To implement an effective interlocking system of programs for loss prevention and control, management must convince all employees of the value of such a system. In doing this, the degree to which management is committed to these programs will strongly influence employee commitment. Managers should be aware of the effect their actions have on employees' support of the programs. If managers tolerate unsafe conditions or work practices, employees may actually believe that such conditions or practices are condoned.

Interactive (two-way) communication is a valuable tool in selling these programs. It is highly desirable for managers to tour the facility occasionally to talk to employees about preventing and controlling losses so they will see that management is serious about such issues. Such a tour can also give the manager firsthand knowledge of the effectiveness of these programs.

All employees should be encouraged to report unsafe conditions that indicate weaknesses in your loss prevention and control programs. Particularly important is the support of first-line supervisors, since they must disseminate information and carry out corrective actions in their areas of responsibility. Also, they should make appropriate parties aware of information about problems that they do not have the authority to correct. (A suggested organization chart that helps stimulate a free flow of information is shown in Figure 2.)

To supplement the material presented in *OVERVIEW*, AXA XL Risk Consulting, through its network of global Loss Prevention Consultants, is willing to aid in developing and implementing custom-tailored programs for loss prevention and control at our customers' facilities. Please do not hesitate to contact us for assistance.

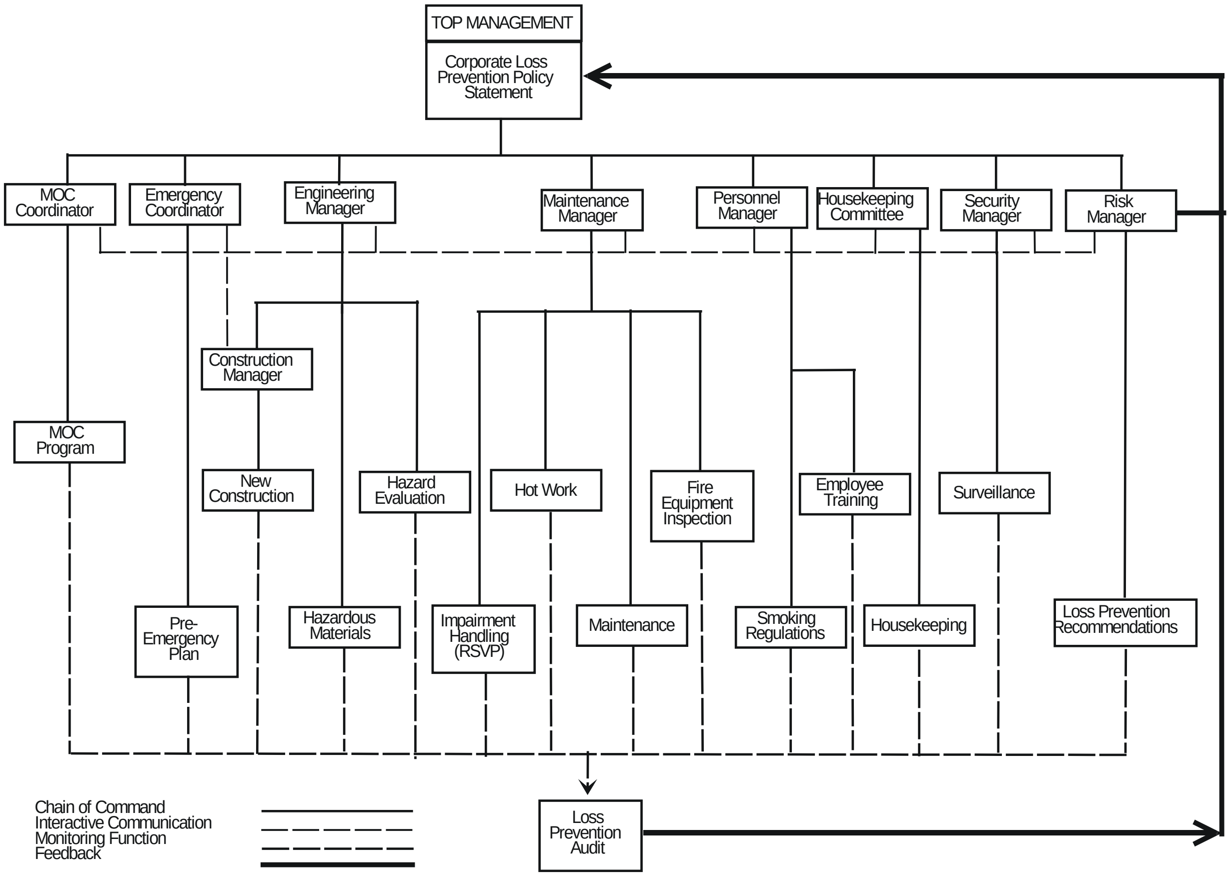

Figure 2. Organization Chart for Loss Prevention and Control Communication.

SUGGESTED WRITTEN STATEMENT OF CORPORATE MANAGEMENT POLICY REGARDING LOSS PREVENTION AND CONTROL

XYZ Corporation

1222 Madison Avenue
New York, NY 10048
(212) 555-1234

MEMORANDUM TO: All personnel

The Executive Committee, at its meeting of April 7, 1998, unanimously voted to present an objective statement of corporate policy regarding property loss prevention and control to the full Board of Directors for ratification at its meeting of May 2, 1998. At that meeting the Board of Directors unanimously ratified the following statement, and directed that the Executive Committee implement it immediately:

> The Board of Directors and Executive Committee of ***XYZ Corporation*** in carrying out its responsibility to preserve corporate resources – for the benefit of both stockholders and employees – recognizes that we must aggressively manage the prevention and control of property losses. To do this, we must give the same attention and dedication to managing these elements that we give to the management of the many other elements that contribute to our success as a manufacturer of a line of products of the highest quality.
>
> We hereby make the prevention and control of property losses an integral part of the overall objectives of the ***XYZ Corporation***. We intend to identify and evaluate all property hazards so that we may provide carefully designed, installed, and maintained protection features to offset each hazard. We also intend to develop and implement programs designed to oversee those elements that impact on the prevention and control of property losses.
>
> To accomplish this, we hereby direct the Divisional Vice Presidents to develop a written corporate program for each of the 14 intervening elements identified in the *Overview Manual* supplied by our property loss control provider, AXA XL Risk Consulting. Within 90 days of the issuance of this memorandum, the Divisional Vice Presidents should submit the details of these programs to a Corporate Property Safety Committee for review. The President shall appoint the members of this Committee and it shall report directly to him.
>
> Once the Committee approves the programs, the Divisional Vice President of each profit center shall assume the responsibility for maintaining the accuracy and thoroughness of each program's content, as well as for the effective implementation of the 14 programs throughout all facilities under his or her control. The annual performance appraisal for each Divisional Vice President shall henceforth include a critique of the success in fulfilling this objective.
>
> Further, the Position Description of *every* employee of the ***XYZ Corporation*** shall include this duty: "To make a positive and continual contribution to the success of the corporation's efforts to prevent and control property losses, recognizing that *every* loss has a detrimental effect on the ability to meet both our corporate and personal objectives."

Signed this 3rd day of May, 1998

P. Jay Taylor
President

PJT:eas

MANAGEMENT OF CHANGE

INTRODUCTION

The 14 parts of *OVERVIEW* that are laid out in the *OVERVIEW* Manual and in the following sections of PRC.1 have an important feature in common: they will fail if they are implemented once and then forgotten. Every time a change occurs in the facility, all 14 parts in the *OVERVIEW* Manual must be reapplied as needed because there is considerable evidence that failures to reapply *OVERVIEW* to changes have directly caused or led to many major accidents. The concept of change management and of the need to properly manage change is not new; many companies have adopted management of change (MOC) procedures. These companies are concentrated in industries where accidents have especially severe consequences such as the chemical process and aerospace industries. Yet incidents and near misses that are attributable to the lack of, or inadequacy of, MOC systems continue to occur. To improve the performance of MOC systems throughout industry, managers need to better implement MOC systems within their companies and plants.

Changes occur when modifications are made to the physical plant, operation, replacement equipment, personnel, or procedures. The most obvious changes occur when a new plant, or a major addition to an existing one, is constructed. Other, more subtle changes can occur when new suppliers are hired, when procedures are modified, when plant staffing is revised, and when equipment is repaired or replaced. All such changes, if they are not carefully implemented, can increase the risk of a loss. Experience has demonstrated that inadvertent, unintended, erroneous or poorly performed changes have resulted in many catastrophic fires, explosions and other losses.

Changes large enough to be considered capital projects are obvious candidates for MOC procedures. The construction of a new plant or new addition to an existing plant should automatically activate all the corporate MOC procedures.

A related problem is that the construction process itself poses dangers different from, and usually greater than, those of a completed operating plant. As a consequence, the execution phase of a large construction or renovation project itself constitutes a change that must be managed. See PRC.1.5.0.

Changes involving smaller expenditures and less obvious projects can cause unexpected losses if they are more likely to escape notice. For example, replacing electrical equipment with newer equipment meeting seemingly identical product specifications can introduce new hazards requiring increased protection.

The Property Risk Consulting Guideline listed in Table 1 contains additional information expanding upon the contents of this section.

TABLE 1
Supporting Sections

PRC Section	Title
1.0.2.1	Replacement in Kind
1.0.2.2	Processing Requests for Change
1.0.2.3	Request for Change Forms
1.0.2.4	Auditing Management of Change
1.0.2.5	Measuring Management of Change Performance
1.0.2.6	Management of Change at Small Facilities
1.0.4	Outside Contractors

This guide can be used to establish new MOC systems or to improve existing MOC systems. All the features described in this guide may not be appropriate for all MOC systems. This guide supplements those other loss prevention and loss control programs required by *OVERVIEW*, and which may contain specific MOC requirements.

Establishing communication between management and AXA XL Risk Consulting at the earliest planning stages of large projects is vital. This will allow AXA XL Risk Consulting to offer valuable consultation from our loss prevention and control experience.

POSITION

To manage change, take these steps:

Design the MOC System

- Establish terminology. Establishing appropriate and consistent terminology can help minimize confusion during implementation and operation of an MOC system.
- Define roles and responsibilities. Implementation and maintenance of an effective MOC system require actions by many different departments and individuals. The MOC design specification should describe the titles and roles for the key personnel in the MOC system. Identify all areas of expertise needed to perform tasks to aid the selection process.
- Define the scope of the MOC system. Establish the physical areas, equipment, processes, procedures, etc. covered by the MOC. Generally, the entire facility will be included so exercise care as to what, if anything, is excluded.
- Integrate MOC with company practices. The design specification for the MOC system should define anticipated interfaces with other systems, such as new construction (PRC.1.5.0) or the hazard evaluation system (PRC.1.13.0). The developers of an MOC system should coordinate their efforts with the plant personnel who are responsible for carrying out the requirements of other company guidelines.
- Establish requirements for review and authorization. The MOC design specification should recognize that some types of changes will require more or less review, based on potential safety variables (e.g., complexity of the change, magnitude of the change, hazards involved).
- Issue guidelines for key MOC issues. Within its MOC design specification, management should identify the key issues and special situations that they expect the development team to consider.
- Set up an MOC system development team to create the MOC system procedures, based on the MOC system design specification that is provided by management. Select team members from a cross section of company departments. Include people from several different organizations, with different types and levels of experience, and with specific day-to-day involvement in changes. For a small plant, the MOC system development might be conducted by an individual; however, others should then review the draft procedure.

Develop A Written Description of the MOC System Based on the Design Requirements

- Identify likely change situations. Based on the design specification supplied by management, the team must define what is, and is not, a change for the plant that will be handled by its MOC system.
- Coordinate the MOC system with existing plant procedures. Numerous other management systems interface with a company's MOC system. The MOC system development team should consider how the MOC procedure will deal with each of the other administrative programs.
- Establish "request for change" review and approval procedures. For each category of change, the development team determines the steps (i.e., reviews, actions and approvals) that will be necessary before a change can be implemented.
- Develop guidelines for key MOC issues. The development team should create specific guidelines to help MOC system users address some of the key MOC issues, such as evaluating hazards, communicating changes, tracking temporary changes, integrating MOC with hazard evaluation, and providing for an emergency change review protocol.
- Design MOC system documentation. The development team should establish the documentation format for the MOC system. The change documentation should describe proposed changes; establish what reviews, actions and approvals are necessary; document approvals for changes; track the status of temporary changes; and provide summaries of actual changes to affected organizations and individuals.
- Define employee training requirements. Define how each type of training will be developed and provided. Educate all employees to recognize which changes are within the scope of the MOC systems. Give initial training to employees who will be involved in the MOC system (e.g., personnel who are expected to request changes or provide initial reviews). Give initial training for personnel who will have major roles in MOC system operation (e.g., reviewers at other levels and approvers). Institute regular refresher training requirements for all MOC system personnel including those who initiate MOC requests.
- Establish a procedure to modify the MOC system. The procedure should address ways for employees to propose changes to the MOC system, the reviews and approvals necessary for making a proposed change, methods of communicating changes to employees involved with the MOC system, and the means for updating MOC system documentation.
- Compare the MOC system with its design specification. The development team and senior management should ensure that the MOC system meets the requirements. Furthermore, the development team and senior management should make certain that the MOC system is understandable to and convenient for the potential users.

Install the MOC System

- Integrate the MOC system with existing plant procedures. Resolve any conflicts or overlaps by modifying the existing procedures or the MOC system.
- Develop a phased implementation plan. The development team should plan a phased implementation, including a field test of the MOC system procedures and documentation to identify and correct any weaknesses. The field test should exercise all the major features of the MOC system, including special circumstances like temporary and emergency changes.
- Train all personnel. All employees involved in making changes at the plant should be trained in the MOC philosophy, procedures and documentation. This training should include individuals at all levels of authority, with special emphasis on the line maintenance and operating personnel as well as the front-line supervisors.

Operate the MOC System over the Life of the Plant

- Monitor the operation of the MOC system. This ensures that the phased implementation of the MOC system is progressing in a timely manner, the MOC system is working well with other systems and other site procedures, the MOC procedures are being followed as intended, and the MOC system is fulfilling its design intent. Monitor these factors through routine administration of the MOC system and periodic internal audits/reviews of the MOC system. Correct any deficiencies in the MOC system according to the procedures for modifying the MOC system. Monitor emergency changes particularly closely. Review any changes that are implemented on an emergency basis in more detail after their implementation.
- Resolve MOC questions and disputes. When uncertainties develop in the interpretation of MOC procedures (e.g., a proposed change does not fit into any category of changes that has a prescribed review process), or when multiple reviewers disagree over an MOC requirement, an MOC coordinator appointed by the team must resolve these issues.
- Maintain the MOC system documentation and records. Update the MOC procedures as necessary so that those with responsibilities under the MOC system are always aware of current procedures. The records of requested changes, change approvals, and tracking forms for temporary changes must be archived for use in monitoring the MOC system and for use by other systems (e.g., process hazard analyses [PRC.1.13.0], compliance audits).

Maintain the MOC System

- Collect and retain MOC system performance data. Collect only the data useful for making decisions about the MOC system's performance and making needed improvements. Review the data collected.
- Audit program compliance. Plant personnel should periodically review the MOC system by examining random samples of work that has been performed to see whether the correct MOC review protocol was used. They should also determine whether any MOC deficiencies exist.
- Monitor performance and effectiveness. Use key MOC performance indicators to determine the effectiveness of the MOC system.
- Identify opportunities for improvements. Based on the results of audits and on the results of analyzing key performance indicators, periodically review the MOC to determine whether any improvements should be made.

DISCUSSION

MOC systems are formal administrative procedures that mandate review and approval of proposed changes in designated areas of an organization. The objective of MOC is to prevent changes in structures, equipment, materials, operations, maintenance and supporting functions from introducing unacceptable risks. MOC systems encourage careful review of proposed changes. MOC systems avoid changes that compromise the design basis of carefully engineered equipment or that degrade the safety of processes that have operated safely for years.

Changes

Large capital projects such as new construction and major renovations are obvious candidates for MOC. *OVERVIEW* Manual (PRC.1.5.0) are devoted to them. Changes not involving capitol expenditures are smaller and less obvious than large capitol projects, but they can be even more hazardous because they can escape notice.

Incremental increases in the amount of combustibles can eventually render the existing fire protection systems inadequate. A more subtle change would be the gradual replacement of metal parts in a warehouse with plastic ones of the same size and shape. The MOC system must contain a mechanism that enables those people most likely to encounter change to initiate the MOC process. PRC.1.0.2.3 addresses this issue by giving examples of forms requesting change management.

Seemingly inconsequential changes to a process, such as a slight increase in temperature, pressure or speed, can lead to a major increase in hazards. Many fires have been caused by the replacement of a material or a part by what was assumed to be “equivalent.” The ability to distinguish between changes that require management and changes that do not is vital. PRC.1.0.2.1 addresses this issue.

The human factor is also important. Downsizing, layoffs, and retirements can lead to a decrease in the number or experience level of operating personnel. Over time, small “obviously unimportant” changes to operating or maintenance procedures can lead to hazardous practices.

The size or the complexity of the facility in which the proposed change is to be implemented does not limit the hazards associated with a proposed change. Thus, just because a plant may be small or have relatively simple processes (e.g., storage), the need to properly manage change is no less important than at larger or more complex facilities. Also, managing change at small plants is not necessarily easier than implementing an MOC system at a large facility. Each situation carries its own special challenges. Large facilities, where it is more difficult to make plant culture adjustments, usually find it difficult to gain consensus on the procedures for managing change. Smaller facilities, which are often more receptive to change, lack the resources (e.g., people, technical specialties) that large companies/facilities find more commonplace. PRC.1.0.2.6 discusses how to modify MOC systems to fit small facilities.

Implementation

Consistent and effective MOC is one of the most important, yet may be one of the most difficult, activities to implement in a company. MOC is important because improperly managed changes can directly cause or lead to catastrophic accidents as well as degrade the quality of manufacturing operations. Formal MOC systems implement administrative procedures for the review and approval of changes before they are made. This process helps ensure the continued safe and high-quality operation of facilities. PRC.1.0.2.2 addresses procedures for the generation and handling of MOC documentation and gives examples of flow charts for MOC systems for various sized facilities.

The scope, level of detail, and bureaucratic complexity of an MOC system can have a significant impact on its success. MOC systems must be designed to precisely fit the organizational structure, culture and work force of a facility. MOC systems designed in this manner are much less likely to be used in a perfunctory fashion or circumvented on a regular basis. Having an inadequate MOC system or one that is dormant is worse than having no MOC system at all because management can be lulled into complacency, thinking that they are effectively managing change when they are not.

Principles for successfully implementing MOC systems:

- Keep it simple. A modest MOC system that works is better than an elegant one that does not.
- Obtain widespread acceptance and commitment. Elicit all plant employee perspectives and concerns when developing an MOC system.
- Field-test the MOC system prior to its official implementation. Debugging it early will pay off in the long run.
- Provide adequate training. All personnel must be appropriately educated on the existence of the MOC system and their roles and responsibilities. Outside contractors in particular should not be overlooked. PRC.1.0.4 addresses this issue.
- Monitor the progress and performance of the MOC system through the use of audits and other means. Any management system that is never reviewed will eventually degrade. A program to measure, record and analyze key indicators relevant to the MOC system will help to detect deviations within the operation of an MOC system before these deviations can cause accidents. PRC.1.0.2.5 discusses ways to perform such measurements on an ongoing basis. PRC.1.0.2.4 discusses ways to periodically audit MOC systems. Use the results of such audits to improve your MOC procedures.
- Demonstrate management leadership and commitment. Properly support the MOC program by providing adequate resources and by making the hard decisions in favor of safety when

MOC reviews indicate a problem. Like most aspects of loss prevention and control, MOC success begins at the top.

REPLACEMENT IN KIND

INTRODUCTION

PRC.1.0.2, which covers Management of Change (MOC), states that one of the more basic problems associated with managing change is that of recognizing when a change has, or has not, taken place. Given the amount of maintenance and other activities that go on in any large facility, an MOC system would be overtaxed and soon break down completely if some way were not found to screen out those actions which were not true changes. One of those methods is to not require MOC review of those activities which are identified as “replacement in kind” (RIK). An RIK is a replacement of equipment, processes, procedures, personnel, etc. which meets the original design specifications and so does not change the hazards in kind or degree. Determination of RIK requires knowledge not only of the design specification, but also of unstated but related factors. It requires the judgment of the “Change Authorizer” or the “Initial Reviewer” as described in PRC.1.0.2.2.

POSITION

Establish a process, as part of the MOC system, to identify and screen from the MOC system those activities which are RIK.

Create a list of the most commonly encountered RIK actions at the facility, and sort them. Add to the list as necessary. Make the list available to those who need it to decide when to initiate a request for change.

DISCUSSION

There is a paradox in the concept of RIK because the purpose of the RIK designation is to permit an activity without review but the activity must be reviewed to be sure it is truly an RIK. This paradox is resolved by recording examples of those activities which have been identified through review as RIKs. New proposed actions can then be compared to those examples and if identical classed as RIK without further work. There are however qualifying circumstances:

- The process may have been adjusted or reworked due to wear in the part being replaced.
- The replacement part may not be identical in all respects to the part it is replacing. Manufacturers of parts frequently change manufacturing methods, gasket materials or other characteristics of parts. They also change a part’s pressure rating or their specifications for how a part should be installed or calibrated.
- The people installing the part may not have been present at the initial process setup. Their review of a new process hazards evaluation will familiarize them with loss scenarios involving that part as well as the rest of the process.

- A better part may have been developed and may have become available since the process was first set up. This option should always be checked before automatically assuming a straight replacement should be done.
- Complying with outstanding recommendations, such as those made by AXA XL Risk Consulting, may require a different approach than simply replacing a part. The need to replace a part should be an opportunity for completing such recommendations.

The examples that follow contrast between RIKs and similar ones which are true changes requiring use of the MOC system.

EXAMPLES

Replacement In Kind	**Change**
Sampling a process on Mondays and Thursdays instead of on Tuesdays and Fridays (assuming other related activities, environmental conditions, and resources are constant throughout the week)	Sampling a process once weekly instead of twice weekly
Relocating hot work to another area within a nonrestricted hot work site	Relocating hot work from an area that does not require a permit for performing hot work to an area that does
Delegating work order approval to a properly qualified substitute	Changing purchase order approval practice
Reducing inspection frequency based on accepted engineering methods (e.g., remaining life calculations)	Changing inspection method for metal thickness from ultrasonic to x-ray
Raising process temperature within specified limits	Reducing process cooling time below specified limits
Using identical process control format on different (but equivalent) computer hardware	Activating or deactivating advanced process control strategies
Changing material concentration within operating limits	Changing material type or concentration outside operating limits
Changing product purity within operating limits	Increasing or decreasing product purity outside operating limits
Promoting a properly qualified operator to chief operator	Changing chief operator qualification requirements
Replacing equipment with the same size, metallurgy, wall thickness, pressure rating, design temperature, etc.	Changing from carbon steel to stainless steel Changing from schedule 40 to schedule 80 piping Changing pipe diameter or vessel nozzle size Changing from ANSI 150-lb flanges to ANSI 300-lb flanges

Replacement In Kind	Change
Replacing a valve with one that is in all respects identical	Replacing a rising-stem valve with one that is not, when the procedure calls for the operator to open it "X" number of turns
Replacing rotating equipment with new equipment of the same material, capacity, flange rating, seal design, driver type, etc.	Changing material of construction Changing impeller sizes Changing seal design Changing driver type, motor electrical requirements, coupling, etc.
Changing from a spring turnaround to a fall turnaround within the run time limit for the unit	Postponing a unit turnaround beyond the design run time limit
Placing equipment back into the same service after a relatively short period of time out of service (assuming the equipment was properly decommissioned, normal periodic maintenance was performed, and personnel training was not out of date)	Placing equipment back into service after an extended out-of-service period in which the equipment was not maintained or during which other changes in the unit occurred, thereby altering the operating conditions for the equipment
Recharging a carbon dioxide extinguishing system	Replacing a building sprinkler system with a carbon dioxide extinguishing system
Replacing industrial trucks with identical units	Changing truck routing through a plant
Replacing filters with identical spares	Changing building ventilation air intake location
Painting a wall with the same paint previously used	Erecting scaffolding in an area where it alters access to other equipment or restricts egress from the working area
Replacing the current maintenance contractor with another qualified contractor	Replacing a maintenance contractor with another based solely on reduced cost
NA	Increase or reduction in the number of operators on a shift
NA	Changing from a decentralized control room to a central control room
NA	Changing from centralized maintenance to decentralized maintenance
Conducting weekly shutdown on Friday instead of Saturday	Changing from 5-day operation to 7-day operation
Operating a process with an interlock out for maintenance, as allowed by the written operating procedures	Continued operation with an essential safety system out of service (e.g., a relief valve)

PROCESSING REQUESTS FOR CHANGE

INTRODUCTION

PRC.1.0.2, which covers Management of Change (MOC), contains a requirement to set up a procedure for the generation and handling of the documentation. The documentation is a formal written request for permission to change a process, procedure, piece of equipment, personnel, etc. commonly called a Request for Change (RFC). The format for the RFC is described in PRC.1.0.2.3, Request for Change Forms. This section covers the variety of methods of handling this documentation.

POSITION

Establish a procedure as part of the MOC system for processing requests for change (RFC). Disseminate a description of the process in the form of a flow chart with attached instructions to all concerned parties.

DISCUSSION

The following figures show sample flowcharts for MOC systems of varying complexity. In practice, each of these MOC system flowcharts would be accompanied by written procedures (not supplied here).

Figure 1 shows a very simple system, with a single reviewer who also serves as the change authorizer. This type of MOC system is sometimes found in simple process systems with limited staff. A key to its success is for the reviewer to recognize the limitations of his or her expertise and to obtain outside help when appropriate.

Figure 2 is a slightly more sophisticated MOC system, involving an initial reviewer, an MOC coordinator, and separate review and authorization personnel.

Figures 3 and 4 are sample flowcharts for detailed and emergency MOC procedures. The detailed MOC process (Figure 3) uses the concept of a change sponsor, who is responsible for guiding the request for change through the process. The sample emergency procedure (Figure 4) simply requires three appropriately designated personnel to agree on the need and acceptability of the change to allow immediate implementation. The emergency procedure then must be validated by processing the change through the normal MOC procedure in a timely manner.

Figure 5 illustrates the separate review steps that this guide describes. Different people would generally conduct each review; however, the objectives of each review apply even if two or more reviews are conducted by the same individual or team.

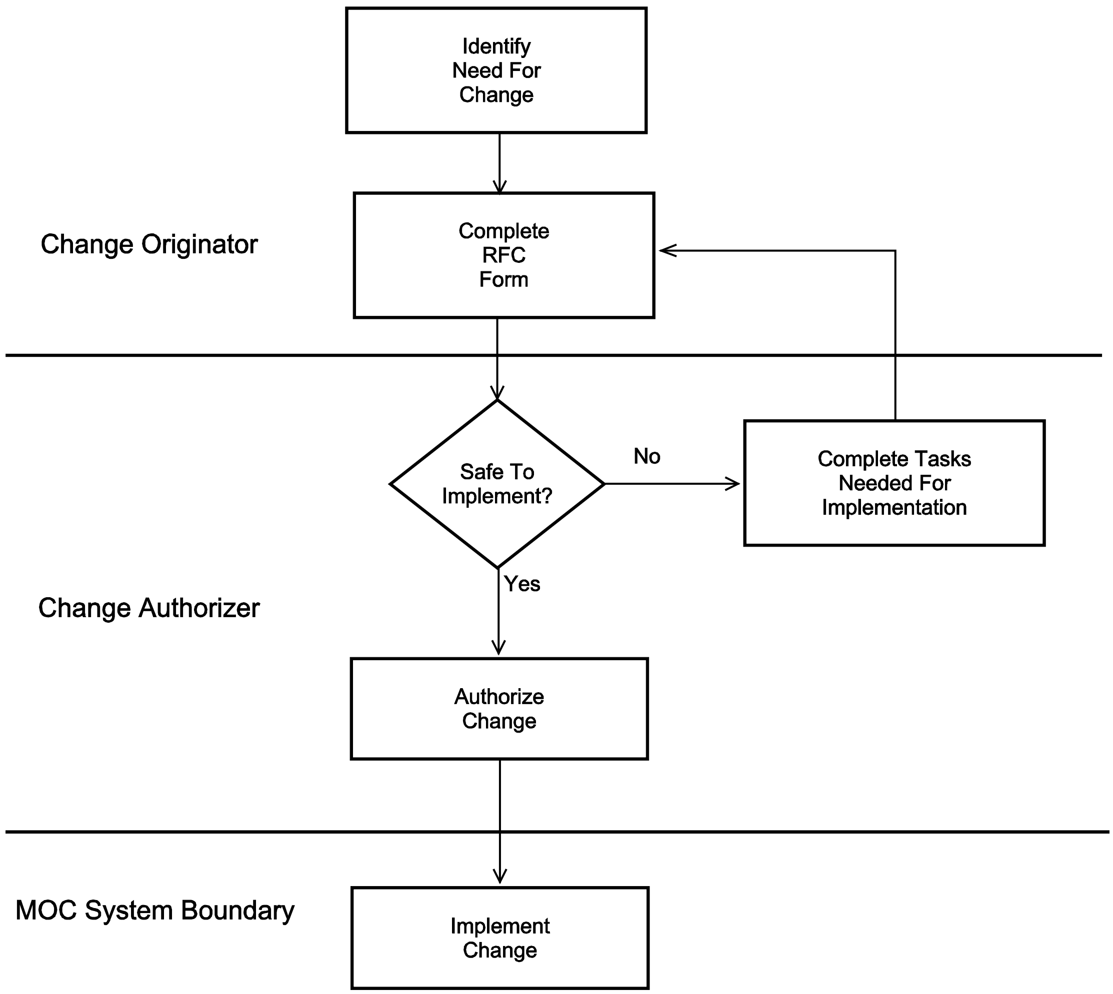

Figure 1. Simple MOC System (Single Reviewer/Authorizer).

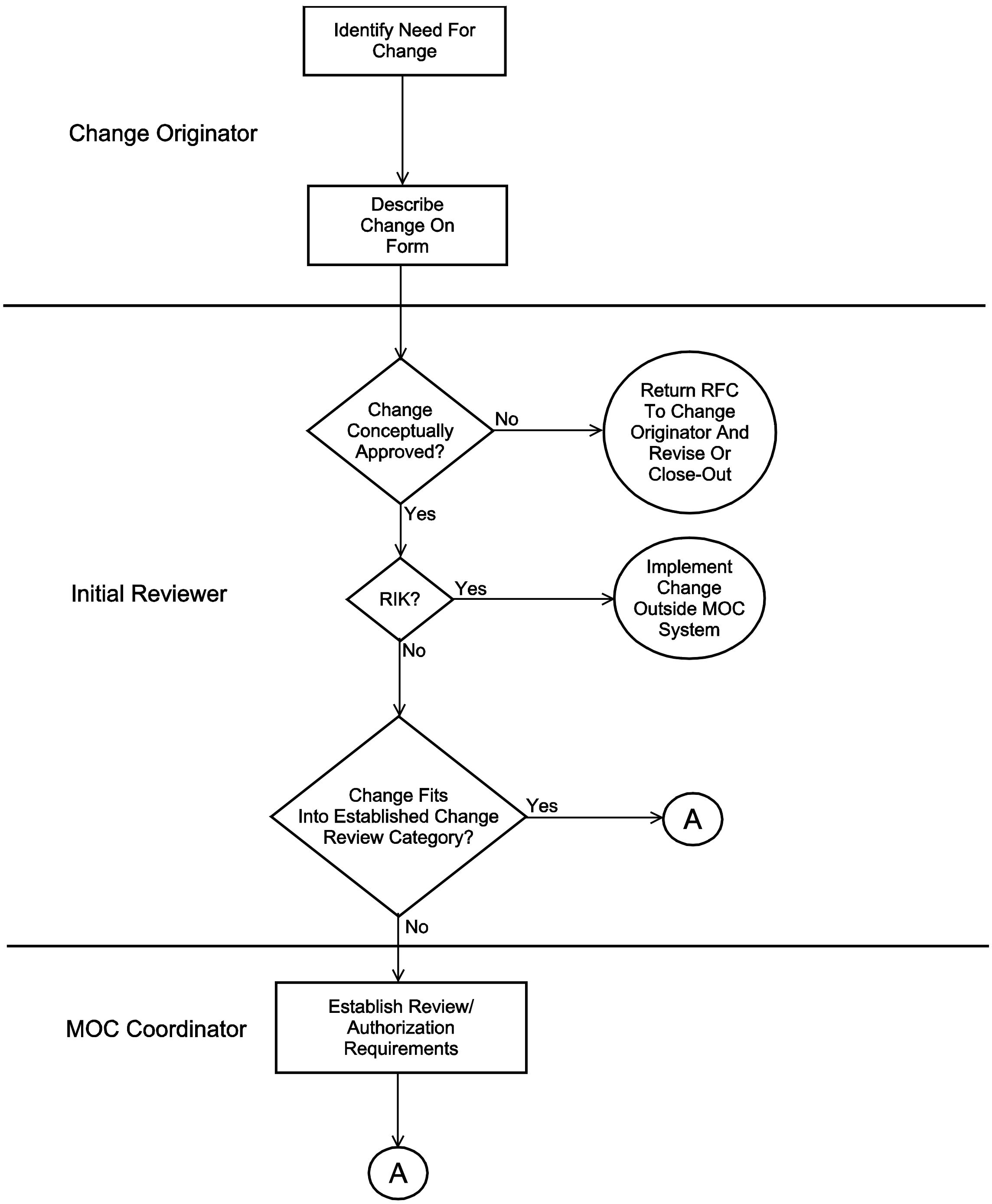

Figure 2 (a). Moderate MOC System.

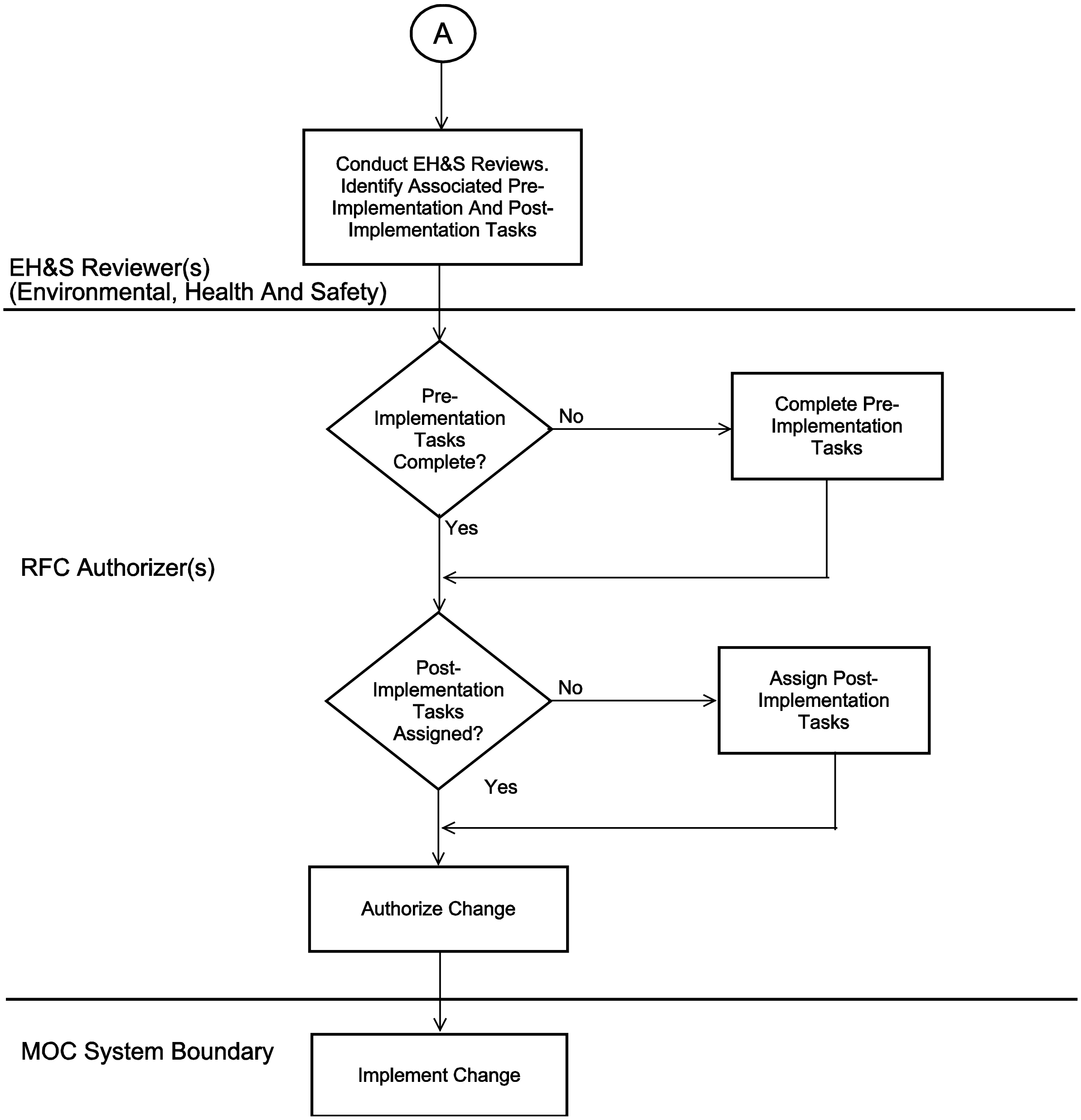

Figure 2 (b). Moderate MOC System.

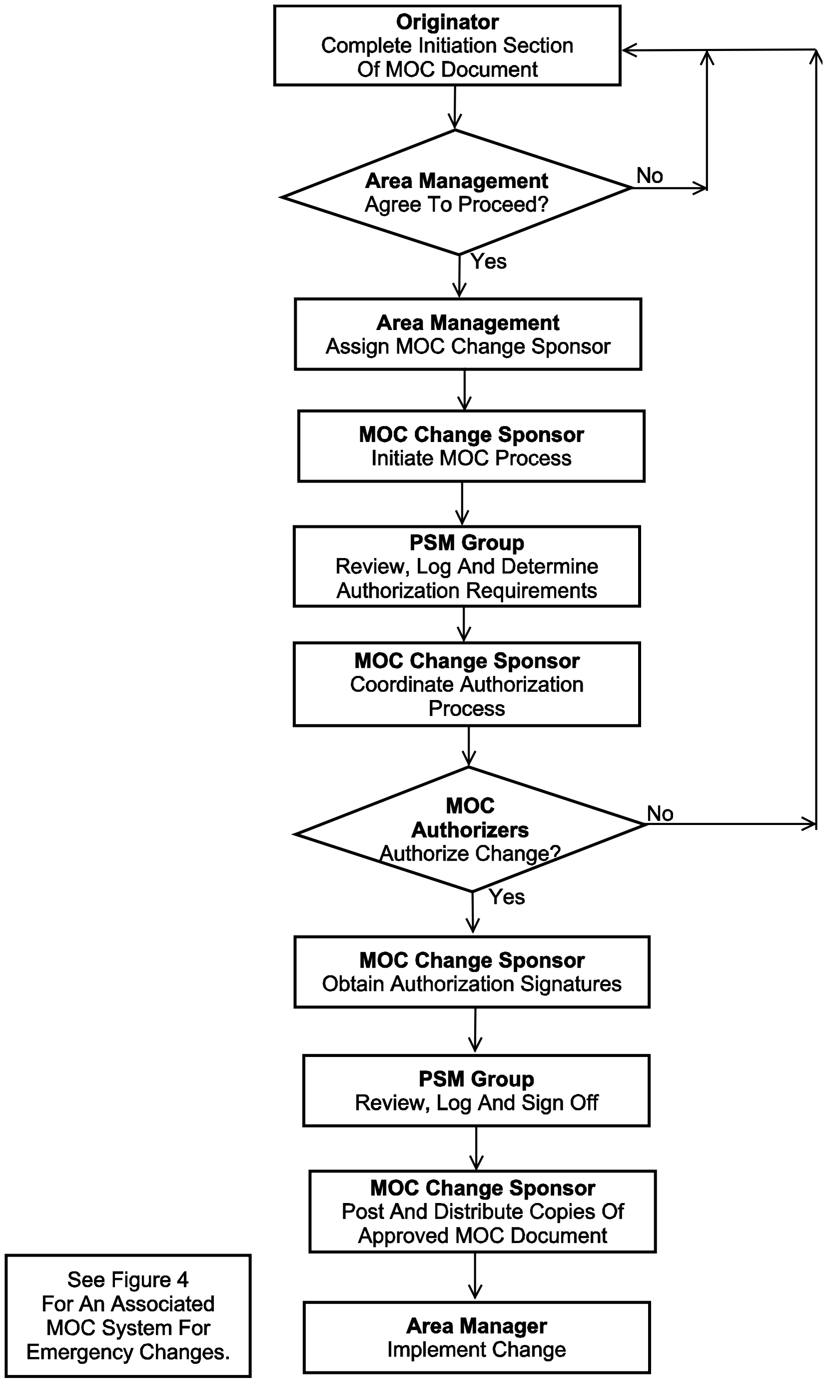

Figure 3. Detailed MOC System.

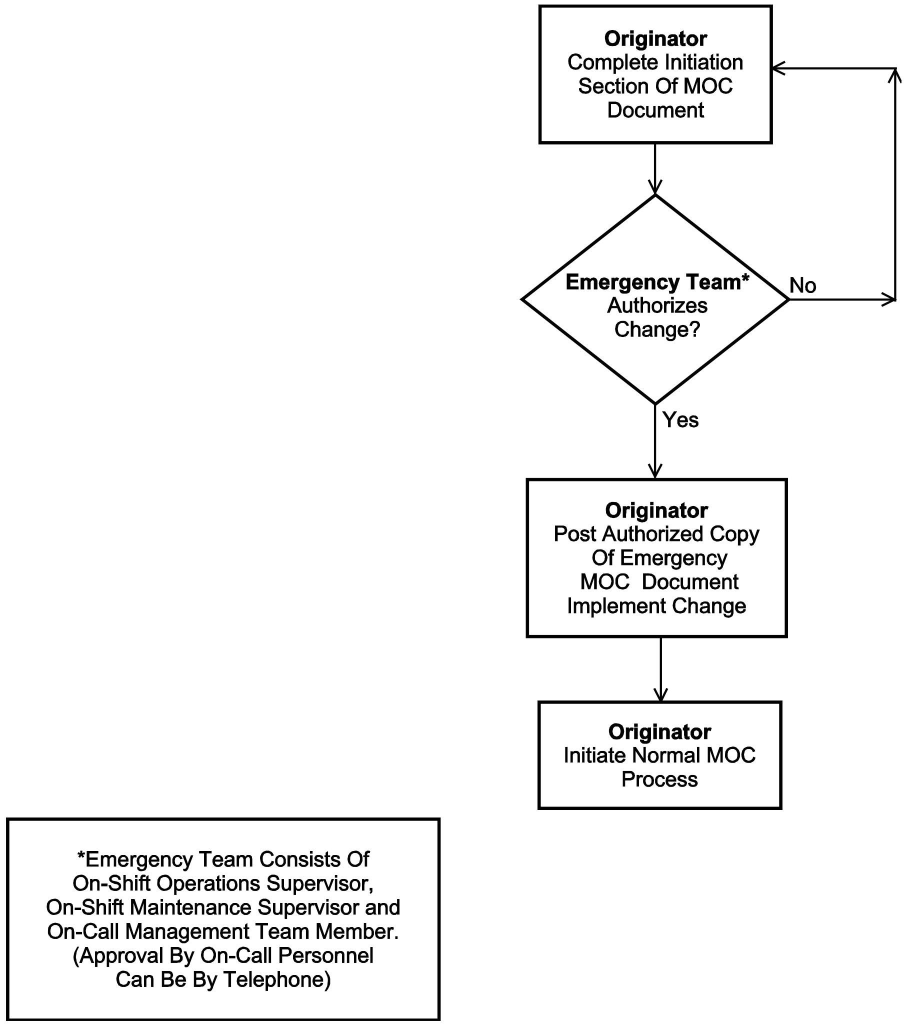

Figure 4. MOC System for Emergency Changes.

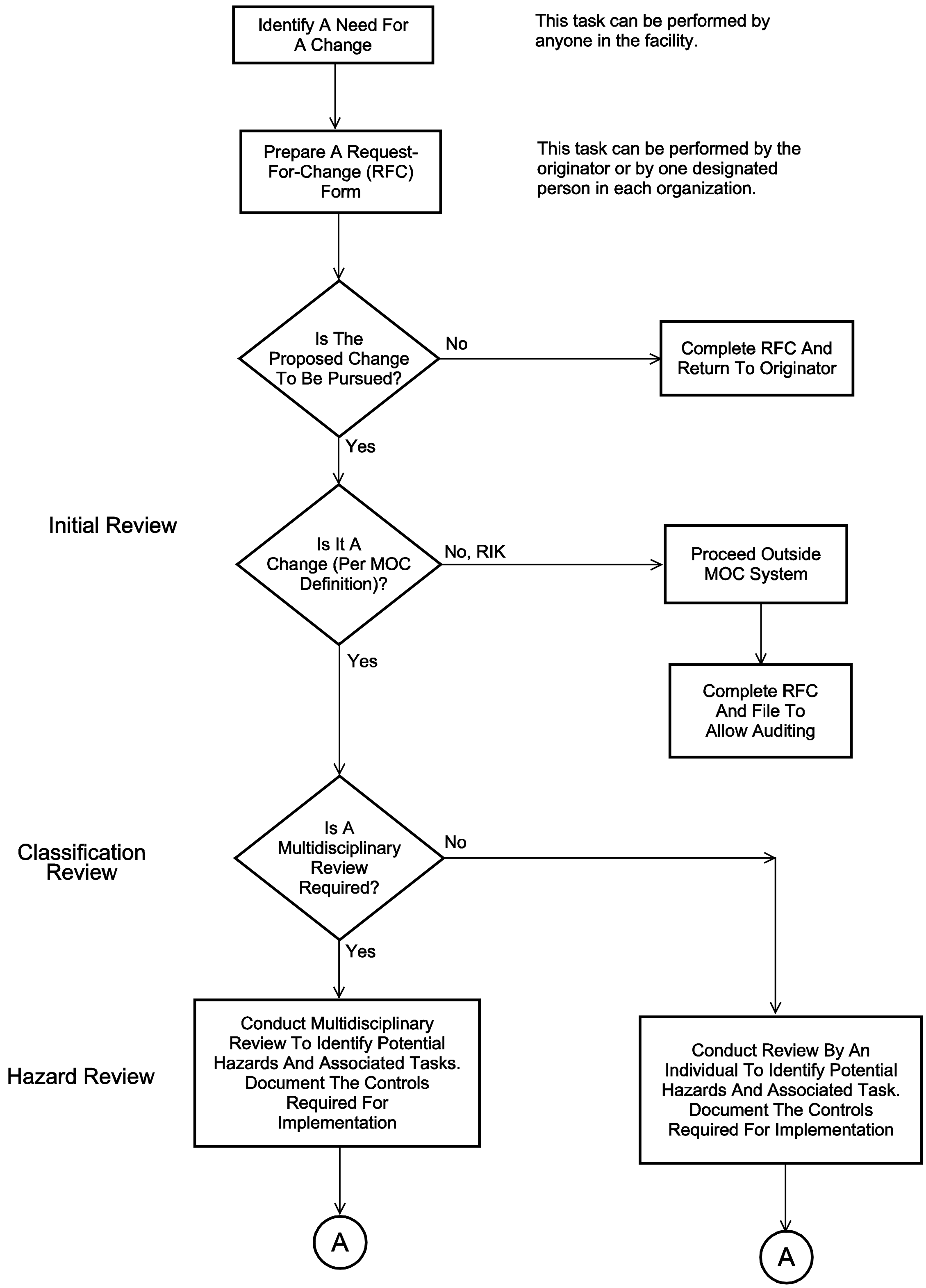

Figure 5 (a). MOC System Illustrating Review.

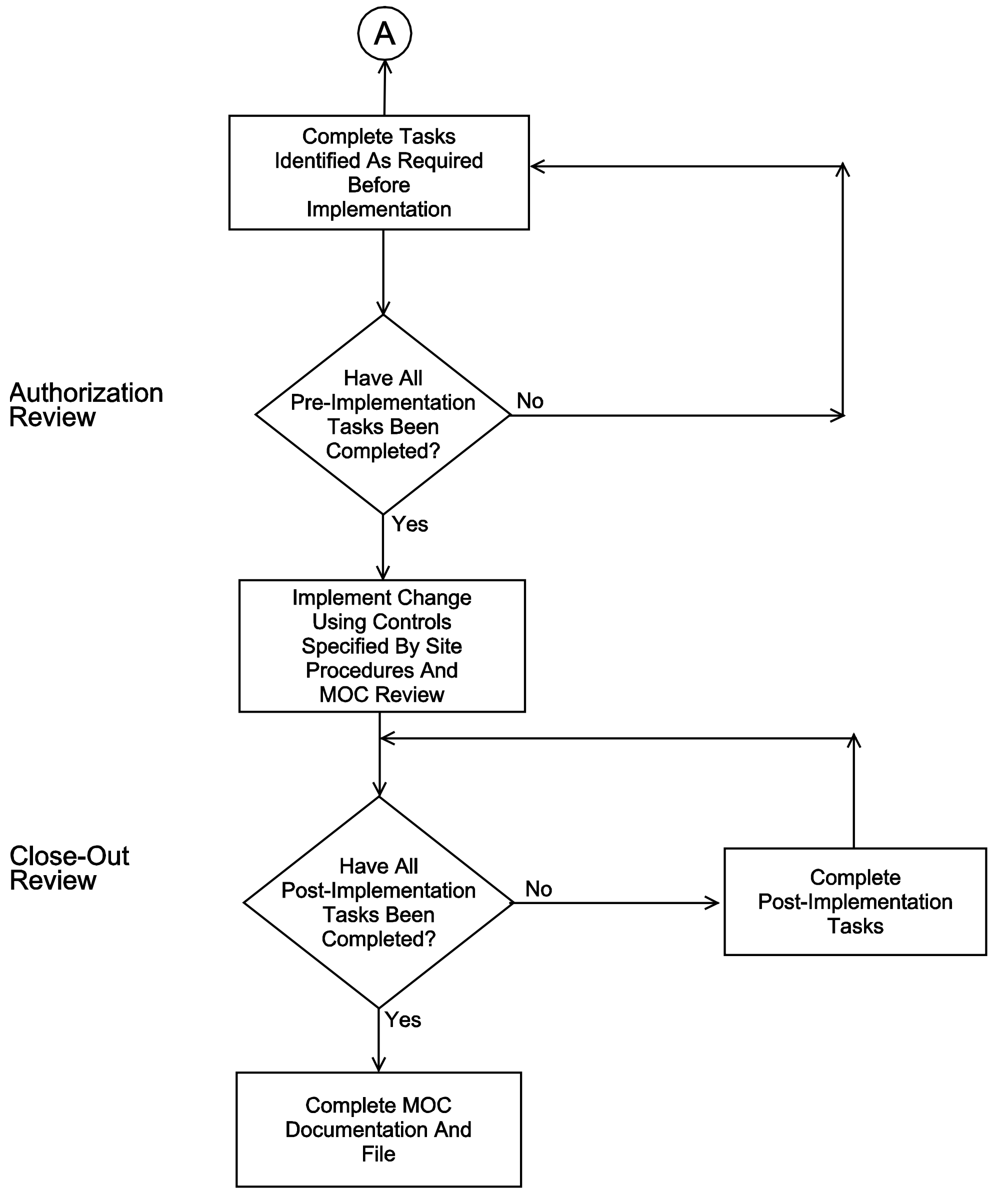

Figure 5 (b). MOC System Illustrating Review Steps.

REQUEST FOR CHANGE FORMS

INTRODUCTION

PRC.1.0.2, which describes Management of Change (MOC), contains a requirement to set up a procedure for the generation and handling of the documentation. The documentation is a formal written request for permission to change a process, procedure, piece of equipment, personnel, etc. commonly called a Request for Change (RFC). The process flow for handling the RFC is described in PRC.1.0.2.2, Processing Requests for Change. This section covers the various formats for the forms themselves.

POSITION

Design, as part of an MOC system, an RFC form appropriate to the facility.

DISCUSSION

Three sample RFC forms of varying complexity are shown. Each of these forms requires a corresponding procedure. The sample forms are provided here to illustrate the variety of approaches that might be appropriate for a given facility.

Change description and rationale: Date:

If the change is temporary, list the pertinent dates. Dates valid:

Originator

This change has met the appropriate review requirements and has been approved.
Safety, health and environmental concerns have been addressed, procedures have been revised, the appropriate training and/or communication activities have occurred, and all affected process safety information is being updated.

RFC Authorizer

Figure 1. Simple MOC Form.

Unit or Area:________________________ RFC No.:___________________

Description and reason for change: Date:___________________

____
Originator

☐ Temporary Change Removal Date: _______________

Environmental. health and safety reviews are complete and all concerns have been addressed,

____
EH&S Review Team Leader

Operating, maintenance and emergency procedures have been reviewed.

____
Area Procedures Coordinator

All affected personnel have been informed of the change. The appropriate training has taken place.

____
Area Training Coordinator

All affected process safety information is scheduled for revision.

____
Unit Engineer

☐ PSSR Required PSSR No.:

This change has met the appropriate review requirements and has been approved.

____
Area Manager

Figure 2. Typical MOC Form.

REQUEST FOR CHANGE FORM

Standard Change — RFC No.______________

Emergency Change — Date Requested ______________

Temporary Change — Date Required______________

Unit ________________________ System or Equipment__________________________

Description (include technical basis for change):

Originator

1. Temporary Changes (skip for permanent changes). 'This information may be provided in a temporary procedure (attach copy)

   Why is this designated a temporary change?

   Additional precautions required:

   Contingency plan:

   Date valid:

   Person responsible for removing the change:

II. Safety, Health, and Environmental Reviews

	Req'd (Y/N)	Responsible Party	Target Date	Date Complete*	Initials
Process Safety (specify method)	Y				
Occupational Safety/Industrial Hygiene					
Environmental Review(s)					

*Complete - Action items with immediate impact are resolved and plan is in place to address long range items.

III. Procedures Revised

	Req'd (Y/N)	Responsible Party	Target Date	Date Complete**	Initials
Startup/Shutdown/Emergency Shutdown					
Normal Operation					
Maintenance					
Emergency Response					
Other (e.g., administrative)________________					

**Complete - Revised procedures issued; any obsolete procedures discarded.

Figure 3. Complex MOC Form Including Checklists.

IV. Training.

	Req'd (Y/N)	Individuals or Groups to be trained	Responsible Party	Date Assigned	Date Complete	Initials
Operations						
Maintenance						
Contractor						
Other ________						

*Complete - All specified personnel have received and understood training. Responsibility for any change to permanent training materials (e.g., learning blocks) is assigned and scheduled.

V Process Safety Information Revised

	Req'd (Y/N)	Responsible Party	Date Assigned	Target Date	Initials
P&ID					
Process Flow Diagram					
Electrical System Documentation					
Relief System Documentation					
Spare Parts List					
MSDS					
Documented Operating Limits-tits					
Other ________					

Complete if there are any Yes responses:

Follow-up Responsibility ________________

PSSR Responsibility________________

PSSR No. ________

VI. Authorization

This change has met the appropriate review requirements and has been approved.

Area Operations Manager ________________ Area Engineering Manager ________________

VII Close-out Review

All of the indicated process safety information revisions (Section V) have been completed. This MOC action is complete.

Figure 3. (Con't.) Complex MOC Form Including Checklists.

AUDITING MANAGEMENT OF CHANGE

INTRODUCTION

PRC.1.0.2 describes Management of Change (MOC). It includes a warning that, as with all other management programs, it is subject to failure at the individual level. The only defense against such failures is periodically auditing the MOC system to make sure that procedures described on paper are being implemented in the field.

POSITION

Develop and implement an auditing protocol for each MOC system. Perform the audits. Then, utilizing the results of the audits, correct any deficiencies found.

DISCUSSION

A good auditing protocol for MOC systems addresses many issues. The following list divides these questions/issues into four categories: program verification; document review; field interviews, and equipment verification. The auditing protocol should also address other factors, such as availability of audit personnel, company/plant culture and regulatory concerns. The exact questions and issues addressed during an audit will depend on a variety of factors, including:

- Specific MOC system design;
- Availability of MOC records;
- Frequency of MOC reviews in the plant;
- Time since the last audit.

Sample Questions

Program Verification

- Is there a written program that describes the MOC system? Does it specifically address roles and responsibilities, scope, activities, authority and necessary documentation?
- Does the MOC system address the following types of changes: Technology? Equipment? Facilities? Chemicals? Procedures?
- Are the following issues specifically addressed in the MOC system:
  - Technical basis of the proposed change?
  - Safety and health considerations associated with the proposed change?
  - Authorization requirements for the specific class of change?

  - If temporary changes are allowed, does the MOC system address the following issues:
  - Maximum time limit that the change can exist without further review?
  - Monitoring of special conditions required for the proposed change?
  - Explicit field verification that the change and any associated special conditions are removed at the end of the time allowed for the change?
- If emergency changes are authorized by the MOC system, do the requirements of the procedure meet the minimum regulatory requirements?
- Are specific means addressed for ensuring that affected plant personnel are trained prior to their involvement with the change?
- Is an explicit mechanism provided for ensuring that affected plant documentation is updated, if needed, in a timely fashion?
- Is MOC effectiveness considered in the performance reviews of people who participate in the MOC system?

Document Review

Scrutinize a representative sample of the MOC records on file for each plant area in which the audit is performed. The following issues should be considered.

- Are the documents complete? Is there a pattern for any information missing from the records?
- Do the change requests contain all of the proper authorizations?
- Were all the required reviews/analyses performed?
- Are all appropriate review documents appended to the MOC documents?
- As indicated by the MOC documents, were the analyses of safety and health considerations of adequate quality, thoroughness and depth?
- Are there any anomalies apparent with the times/dates associated with the reviews and authorizations?
- Was the emergency change review procedure frequently used? Is there a trend? Were the uses of the emergency change review procedure appropriate?
- Have there been any documented failures of the MOC system? Have any change situations not been reviewed by the MOC system as evidenced by the following types of surveys/inspections:
  - Logs of instrumentation “jumpers” installed;
  - Shift logbooks;
  - Incident investigation results;
  - Procedure reviews/certifications;
  - Preliminary Hazard Analysis (PHA) team reviews;
  - Periodic walk through safety inspections.

Scrutinize a representative sample of the work orders/maintenance requests/capital change requests on file for each plant area in which the audit is performed. The following issues should be considered.

- Take a representative sample of work orders, etc., and verify whether the proper MOC documentation exists.
- Review some of the Piping and Instrument Drawings (P&IDs) for the subject plant area and see if changes to these drawings can be traced back through an MOC request.
- Review some of the procedures for the subject plant area and see if changes to these procedures can be traced back through an MOC request.

Field Interviews

Perform several interviews with plant personnel responsible for using the MOC system (e.g., operations, maintenance, engineering, and safety).

- Are they aware of the MOC procedures? What is their role in the MOC system? Have they received the appropriate MOC system training?
- Have them explain the basics of the MOC procedures. Do they know who can approve changes? Do they know how to originate a change request? Do they know how to have changes approved during an off-shift?
- Do they feel the MOC system is being implemented in a reliable manner?
- Do they have personal knowledge of any failures of the MOC system (e.g., changes that have been implemented without appropriate review)?
- Have they received any process-specific training as a result of a specific change? Was the training performed before they had to interact with the process change while on the job?
- Was MOC effectiveness considered in their most recent job performance review?

Equipment Verification

Select a number of recent changes to equipment and confirm the following.

- The equipment arrangement in the field is consistent with the approved change.
- The updated P&IDs actually reflect the field installation.
- Isometrics and other diagrams used for inspection purposes have also been updated.
- Equipment specifications in the official files match the equipment items in the field (e.g., data sheets match nameplates).

MEASURING MANAGEMENT OF CHANGE PERFORMANCE

INTRODUCTION

PRC.1.0.2 describes Management of Change (MOC) and PRC.1.0.2.4 describes auditing of those MOC systems. However, while MOC systems should be audited periodically to help ensure that the practices described on paper are being implemented in the field, these audits are typically time consuming and are usually only performed once a year, or less frequently. As an alternative, measures of performance can be used to assess the quality and effectiveness of management systems on an ongoing basis. Performance measures that explicitly identify "key indicators" can be used to assess system performance on a near real-time basis and with a more reasonable expenditure of effort. "Key indicators" are numbers whose sudden change indicate that a problem is likely, although not certain.

POSITION

As part of any MOC system, chose key indicators for the MOC system and establish a program to measure, record and analyze them. Monitor these key indicators to help detect when deviations occur within the operation of an MOC system before these deviations can cause accidents. If these indicators suggest the likely existence of a problem, perform a full audit in accordance with PRC.1.0.2.4 and correct any problems found.

DISCUSSION

The following is a list of several indicators that may be relevant to many MOC systems. The indicators chosen for a specific MOC system will depend upon a variety of factors, including the specific MOC system design and the availability of MOC records and data. Some indicators can be used individually to help evaluate system performance, while other indicators must be used jointly.

Key Indicators

- Unexplained deviation in the number of MOC change requests from previous monthly averages (% over a month)
- Unexplained deviation from previous monthly averages in the percent of work requests classified as a change by the MOC system monitor (% over a month)
- Percent of RFC forms were misclassified as RIKs (or were not classified) and are really changes
- Percent of changes that were reviewed with the MOC system were reviewed incorrectly
- Percent of change requests that were reviewed were not documented properly

- The ratio of undocumented changes to the number of changes processed by the MOC program
- Percent of recent changes involved the use of backup MOC personnel
- Percent of changes were properly evaluated, but did not have all authorization signatures on the change control document
- Percent of changes has been processed on an emergency basis
- The variation in the percent of changes that are processed on an emergency basis
- Percent of personnel involved in the MOC system believe the system is effective
- The difference between the percentages of senior managers and routine users who believe the MOC program is effective

MANAGEMENT OF CHANGE AT SMALL FACILITIES

INTRODUCTION

PRC.1.0.2 discusses Management of Change (MOC). It recommends that an MOC system appropriate to the facility be put in place. However, small facilities do not have the resources of large ones. As a result, several modifications to the usual MOC approach must be made.

POSITION

Modify the standard MOC system as described in PRC.1.0.2 as necessary to fit the needs and resources of a small facility.

DISCUSSION

Small plants usually have one or more of the following characteristics:

- Few engineers are on staff. Usually, they fulfill all of the typical engineering needs. They are project engineers, process engineers, operations engineers and maintenance engineers usually all rolled into one person. Moreover, many times these personnel have administrative jobs as well.
- Operating staffs are small. There are no intermediate layers of supervision in the operating units and maintenance staffs. Sometimes the operations supervisors function as maintenance planners, using outside contractors to perform maintenance work.
- There is no dedicated process safety or loss prevention technical staff.
- There is little time for formal documentation of procedures or for routine paperwork.
- Everyone works long hours. Everyone pitches in to get the job done. Jobs are shared.
- Plant modifications are usually done by outside engineering firms.

Even with these apparent limitations, effectively managing change at these facilities is possible. It does take a very efficient and creative strategy to implement a formal MOC system in a plant where formal programs have been considered too costly or wasteful.

Smaller facilities should consider modifying the MOC system as follows. These concepts are presented using the same organization as in PRC.1.0.2 but with much of the explanation and options omitted to meet the needs of the lean organization. This leaves the essential features of and ideas for managing change. The explanation and background contained in PRC.1.0.2 may prove useful when combined with the advice contained in this section.

Suggested Modifications

Designing an MOC System for a Small Facility

Do not spend a lot of time putting together a team to design the MOC system. Several existing resources can be used to guide the development of a small MOC program. For example, use the essential features of OSHA's Process Safety Management (PSM) regulation as a guideline to create the MOC system. The system should:

- Be in written form;
- Cover changes to process chemicals, technology, equipment and procedures;
- Address the technical basis of each change;
- Evaluate the safety and health considerations associated with each change;
- Train operators, maintenance workers and contractors whose jobs could be affected by the change before they interact with the changed process;
- If the change is temporary, explicitly state a time limit for allowing the change to exist without further review;
- Update operating procedures, drawings and other process safety information affected by the change.

Developing an MOC System for a Small Facility

One effective way to minimize the amount of effort required to develop a written MOC procedure is to adopt the informal total quality "slogan" of "don't reinvent the wheel." Find an existing well-written MOC procedure for a small facility and revise/adapt it as needed. Consider using the examples listed in PRC.1.0.2.3. Or ask a similar facility for a copy of their written MOC program and pattern procedures after theirs. However, be careful not to mindlessly adopt a procedure that is inappropriate for a specific plant culture (e.g., too complicated).

If a suitable example can not be found, create a simple MOC form that combines the actual MOC procedure along with the means intended to document the MOC review. Then every time an MOC review is done, the procedure is readily available on the form that is to be used to document the review. If creating a form from scratch, consider including the following elements:

- Name of person making request;
- Date of request;
- Process/unit name and related equipment number;
- Reason for the proposed change;
- Brief description of the proposed change;
- Potential safety and health considerations associated with the proposed change;
- Names of people who need to review the change;
- Special conditions or requirements placed upon the proposed change by the reviewers Authorization/date for proceeding with the proposed change;
- Routing slip or multiple copies to personnel responsible for training and updating procedures and drawings.

The procedure used to explain the use of the form should list job titles (e.g., Area Supervisor, Department Head) and not the specific names of people who hold these positions. Consider putting the procedure in flowchart format. Examples of procedures are given in PRC.1.0.2.2.

Installing an MOC System at a Small Facility

Try a brief field test of the MOC procedure on a single operation in the facility to work out the bugs. Solicit opinions of all plant disciplines and revise the procedure as necessary. Hold a short (e.g., 1 h) training seminar to educate all plant personnel with the new procedure. Provide the procedure to contractors in bid packages so they will know their obligations.

Operating an MOC System at a Small Facility

In all likelihood, the administration of the MOC system will fall to someone who already has plenty to do. Even though the day-to-day operation of the system may be orchestrated by area supervision or department heads, consider having an overall “owner” of the system. This person will likely be the one who created the initial written program. He or she should be available as a resource to plant personnel in case there are questions or disputes concerning the MOC procedures. Often, this person will also be the plant PSM “guru.”

Auditing an MOC System at a Small Facility

Periodically, someone should perform an audit of the MOC system as detailed in PRC.1.0.2.4. The plant PSM or MOC “guru” normally does this. Audits can be performed at random, but it is often convenient to do them concurrently with a process hazard analysis that is being performed on the unit/operation. Review the work order file quarterly or annually to see whether changes that were not considered by the MOC system are being made. MOC auditors should also seek the opinions of the work force to see whether they believe the MOC system is being used and whether it is effective and not burdensome.

OUTSIDE CONTRACTORS

INTRODUCTION

All of the 14 points of *OVERVIEW* plus management of change should apply to outside contractors as well as company employees. Control of outside contractors is just one more aspect of doing business that must be managed to have an effective management program for loss prevention and control.

POSITION

Make certain that the employees of outside contractors working at a facility, whether for major construction, renovation, remodeling or routine maintenance, follow the same loss prevention rules that apply to the facility's employees. Detail these rules in written loss prevention instructions. Attach these instructions to all bid specifications and all signed work contracts to help ensure that the contractor is aware of the value management places on loss prevention.

DISCUSSION

The written loss prevention instructions should be discussed with the contractor's employees when they first arrive on the job site. Many companies use special booklets and orientation sessions to give the contractor's employees this necessary information. Topics covered might include:

- Fire notification procedures;
- Availability and operation of fire and explosion protection equipment;
- Impairment handling procedures;
- Hot work permit requirements;
- Smoking regulations;
- Housekeeping practices;
- Hazards alarm signals procedures;
- Emergency phone numbers;
- Lists of employees who can be contacted with questions;
- Procedures for handling changes from working plans;
- Windstorm precautions;
- Flooding precautions;
- Security concerns.

A representative of the contractor should be assigned to ensure that all the contractor's employees follow the facility's loss prevention procedures. It should be made clear that if the stated loss prevention procedures are not followed, the representative will be expected to immediately stop the improper practice, have the deficiency corrected, and promptly discipline the employee responsible.

When developing written loss prevention instructions for outside contractors, introductory paragraphs similar to the following should be included. These have been adapted from a booklet published by a large corporation and clearly define corporate policy with respect to the loss prevention instructions to be followed by an outside contractor's employees.

LOSS PREVENTION INSTRUCTIONS

For Contractors and Their Employees: The management of (facility name) believes that loss prevention is an individual responsibility. Interest and alertness on the part of each individual will help prevent property damage and other incidents. As a result, we have established programs and procedures to protect our employees and property and we require that all employees follow these programs and procedures.

Contractor and subcontractor employees on (facility name) property are temporarily a part of the (facility name) team and are expected to work to the same superior loss prevention standards.

This booklet outlines the primary loss prevention procedures to be observed while on (facility name) property. Practices, which are contrary to these procedures, will not be tolerated and those responsible for such practices will be removed from the job site.

IMPAIRMENTS TO FIRE PROTECTION SYSTEMS

INTRODUCTION

A protection impairment occurs when a fire (or explosion) prevention, protection, alarm or supervisory system is shut off, impaired or otherwise taken out of service completely or in part. The protective, alarm or supervisory function then cannot be met. Fire protection systems include sprinkler, water spray, carbon dioxide and clean agent systems. Two examples of protection impairments are: a valve supervisory device that is jammed and cannot function, and a sprinkler system that has been shut off in order to replace a sprinkler head. While process monitoring, control, safety and security-entry systems also serve protective functions, their impairment is not considered a protection impairment as defined herein.

While planned protection impairments may be necessary during maintenance, renovation and new construction, it must be understood that when any protection impairment occurs, the facility is in jeopardy. Many large losses might have remained small if the protection impairments had been properly managed. When an impairment is planned or occurs accidentally, precautionary measures are necessary to minimize the risk. These may include arranging temporary protection, reducing hazards and ensuring continual and speedy progress on restoration efforts.

At this moment, somewhere fire or explosion protective systems are impaired. Throughout industry, tens of thousands of impairments occur each year. In fact, a number of them may occur at any one facility.

Protection might be impaired for one of many reasons, such as maintenance, renovation, new construction, equipment failure, vandalism or malicious mischief. Regardless of the reason, a facility is in jeopardy from fire that may start in an area covered by the impaired system.

There are three types of impairments: emergency; planned; and hidden.

The likelihood of fire or explosion occurring while protection is impaired increases with the duration of the impairment. Thus, proper procedures must be followed to minimize the duration and scope of the planned and emergency impairments and to reduce the possibility of a hidden impairment.

POSITION

Implement an impairment management program such as AXA XL Risk Consulting RSVP (Restore Shut Valves Promptly) Program with these basic steps:

1. Assign responsibilities for impairment supervision;
2. Adopt a detailed system for supervision;

3. Educate appropriate personnel as to the importance of impairment handling and the facility's procedures.

The responsibilities may be assigned to one person such as the Emergency Coordinator or the Fire Brigade Chief (see PRC.1.7.0). They may also be assigned to several people, as would be the case where the Maintenance Manager handles Planned Impairments and the Emergency Coordinator handles Emergency Impairments.

DISCUSSION

An Emergency Impairment occurs when an unforeseen event partially or totally impairs the effectiveness of a fire or explosion protective system. A sudden break in sprinkler system piping is an example.

A Planned Impairment occurs when it is necessary to shut down a fire or explosion protective system for maintenance or modification. Shutting down a sprinkler system to add sprinklers is an example. While this may seem to be a straightforward operation, previous loss experience has shown that improperly handled planned impairments greatly increase the extent of a loss that occurs while the system is impaired.

A Hidden Impairment is not known to exist and is therefore the most serious type; e.g., a system shut down and inadvertently left out of service upon completion of work, a system shut down without proper notification, or a system maliciously shut down. Proper impairment notification and handling procedures can reduce the chance of experiencing this type of impairment. A good inspection program can reveal the hidden impairment, allowing prompt restoration of vital protective equipment.

AXA XL Risk Consulting recommended impairment supervision program is the RSVP (Restore Shut Valves Promptly) Program. See PRC.1.1.0.A. It provides all the basic elements necessary for the proper handling of impairments.

Appropriate personnel should be educated in properly implementing RSVP procedures. This will help ensure that management will be aware of system impairments and will reduce the likelihood of a hidden impairment.

Appropriate personnel, in conjunction with AXA XL Risk Consulting, should take every practical step to:

- Limit the frequency, extent and duration of all impairments;
- Work continuously on impaired equipment until it is restored to service;
- Reduce the possibility of fire or explosion during the impairment by shutting down hazardous processes;
- Enhance surveillance and firefighting capability during the impairment;
- Restore all fire protection systems promptly after the impairment;
- Verify by appropriate test that all fire protection systems have been restored.

Specific procedures for handling emergency, planned, and hidden impairments include the following.

The Emergency Impairment

Immediately notify management and AXA XL Risk Consulting and initiate repairs promptly. Provide temporary protection, if possible. Work without interruption until the system is restored.

Good pre-emergency planning includes having the telephone numbers of contractors who are equipped for, and willing to provide, emergency repairs on a continuous, round-the-clock basis. See PRC.1.7.0.

Personnel designated by management should:

- Notify the AXA XL Risk Consulting Impairment Center. (Notification can be made by phone, fax, or e-mail.)

- Fill out the RSVP Red Tag and hang the Shut-Off Tag portion on each closed valve or other piece of impaired equipment. Keep the RSVP Office Reminder portion in a visible place in the office of the representative responsible for supervising the impairment.
- Inform department heads in the buildings or areas where protection is out of service. They should tour areas to identify and correct unsatisfactory housekeeping, storage or special hazard conditions.
- Shut down hazardous processes or maintenance operations such as cutting, welding and other hot work until protection is restored.
- Prohibit smoking throughout the affected area.
- Notify the Central Station or other agency supervising the fire alarm system.
- Notify the Fire Brigade Chief or Shift Captain.
- Notify the public fire department that protection is shut off so that they may act effectively if a fire occurs.
- Use emergency measures, such as temporary connections to hydrants or adjoining sprinkler systems, to keep as many sprinklers in service as possible.
- Station someone at the shut valve, if it is an excessive distance from the work area. This person should be ready to open the valve upon instruction from the person supervising the impairment.
- Expedite completion of the work. Work continuously from shift to shift until protection is restored.
- Make a continuous fire patrol throughout the affected area.
- Supplement manual firefighting facilities by the temporary addition of extra fire extinguishers and charged hose lines.
- If the scope of the impairment must be increased, immediately discuss the changes with AXA XL Risk Consulting.

When work on the protective system is completed, reopen and seal all valves that have been shut or otherwise restore the protective system to service in accordance with procedures described in the RSVP booklet.

The Planned Impairment

In addition to handling the items listed for the emergency impairment, it is necessary to carefully plan each impairment when modifying or conducting maintenance on a fire protection system. Additions or alterations to fire protection systems must be reviewed through the Management of Change System, see PRC.1.0.2, and reviewed by AXA XL Risk Consulting.

Management should not allow outside contractors to impair protection equipment by themselves because contractors are not responsible for safeguarding plant operations, minimizing impairment duration, and expediting work progress. Outside contractors cannot institute the type of extra precautions that management can authorize, nor do they have the same interest in the property as the owner. Therefore, outside contractors must be effectively supervised by appropriate personnel using the facility’s Management of Change Program.

Schedule work so that the impairment is of minimum duration. Be sure that all equipment and personnel are ready and that preparatory work **is complete before the impairment begins**. In the case of sprinkler system extension, install everything up to the point of final connection to the existing system. Then, close the sprinkler valve, make the new connection as quickly as possible, and restore the shut valve promptly. **Schedule only one impairment at a time**!

Planned Impairment procedures include:

- Notify the AXA XL Risk Consulting Impairment Center at least 48 hours in advance of the impairment. (Notification can be made by phone, fax, or e-mail.)
- Keeping as much protection in service as practical for as long as possible.

- Laying out work and arranging in advance to have all workers, materials and tools ready when protection is shut off so that the job can be pushed vigorously to completion. In the case of major building renovations, restore the system to service at the end of each day's work.
- Using sectional valves where possible, rather than main valves, to reduce the number of shut-off sprinklers to a minimum and to take all possible advantage of multiple water supplies.
- Confirming, prior to starting the impairment, that the procedures listed under "The Emergency Impairment" will be followed.

When work on the fire protection system is completed, reopen and seal all valves that have been shut or otherwise restore the protective system to service in accordance with the procedures described in the RSVP booklet.

The Hidden Impairment

If personnel discover a hidden impairment during a fire protection or loss prevention inspection or at some other time, they should:

- Confirm that protection should be on.
- Restore protection immediately.
- Report the discovery to their supervisor.
- Attempt to learn the reason for the occurrence.
- Notify AXA XL Risk Consulting of the discovery.

ELEMENTS OF RSVP (RESTORE SHUT VALVES PROMPTLY) PROGRAM

The RSVP (Restore Shut Valves Promptly) Program is an important part of basic loss prevention planning. More specifically, it is a program designed to help AXA XL Risk Consulting's clients manage their impairments safely.

The RSVP package, available from AXA XL Risk Consulting includes:

Booklet The booklet defines impairments and tells how the RSVP Program can help manage planned, emergency and hidden impairments.

Riser Labels These labels provide a constant alert at every point of shutoff. They contain the AXA XL Risk Consulting's toll-free telephone number for impairment notification, and include areas to record valve number, system number, and protected area.

Shut-Off Tags These tags present step-by-step procedures for safe impairment handling. They are printed on bright red card stock, and are punched, wired and perforated for ready use. The Shut-Off portion should be placed on impaired equipment and the Office Reminder portion posted in the office of the management representative supervising the impairment.

File Folder Prominently displayed, the folder becomes a daily reminder of impairment procedures. It lists the toll-free number for reporting an impairment at any time. A pocket holds the red Shut-Off tags meant to be used on impaired equipment.

SMOKING REGULATIONS

INTRODUCTION

Each year, numerous fires are attributed to carelessly discarded-lighted smoking materials that set fire to combustible materials. These materials have always been a notorious cause of industrial fires. This source of ignition must be controlled. Management must develop an enforceable program that limits smoking to the areas of the facility in which it can be properly supervised. Smoking as a health hazard can also be a concern and as a result, a totally smoke free environment may be established. Because the smoking habit is hard to control, people will smoke, prohibitions notwithstanding. The problem intensifies when there is a total prohibition on smoking because designated smoking areas do not exist.

POSITION

Develop and strictly enforce a written policy regarding smoking. If management establishes a smoke free environment:

- Establish a smoking policy that includes disciplinary penalties for violations.
- Clearly mark the facility as “Smoke Free.”
- Promote observance of the smoking regulations. Discourage violating the regulations. Those who violate the regulations must be promptly disciplined.
- Inform visitors, particularly outside contractors, of the smoking regulations, and make sure they observe them.

If smoking is to be allowed, management must conduct a survey of the facility and determine where smoking can be permitted and where smoking is to be prohibited. Once these areas have been properly classified, management must:

- Establish a smoking policy that includes disciplinary penalties for violations.
- Clearly mark “No Smoking” zones and inform employees of the reasons for the prohibition.
- Clearly mark areas in which smoking is permitted. Provide for the proper disposal of smoking materials within the smoking area.
- Discourage breaking the smoking regulations. Those who violate the regulations must be promptly disciplined.
- Inform visitors, particularly outside contractors, of the smoking regulations, and make sure they observe them.

- Implement Management Of Change procedures so the policy keeps pace with changes in the facility. See PRC.1.0.2.

The smoking policy must apply to everyone. Smoking, if allowed at all, must be regarded as a privilege that the employees can enjoy only if they properly observe the smoking policy.

DISCUSSION

Discuss the reasons for prohibiting smoking with employees. Understanding the reasons helps to establish a fire-safe attitude. If careless smoking is viewed as the possible cause of a disastrous loss, employees will most likely support management's efforts to enforce the established policy. Management must be willing to enforce the smoking policy. If the policy is not enforced, employees will come to believe that management will tolerate smoking even in areas where the reason for prohibition is obvious.

The extent of the prohibited areas is to be based on the hazards present. There are areas containing severe hazards were smoking cannot be permitted under any circumstance. Such areas include those where explosives, flammable gases or liquids, or combustible dusts may be present. One method of control frequently employed in these areas is the prohibition of matches and lighters.

There are other areas with somewhat different hazards, such as neatly arranged warehouse facilities with good housekeeping and substantial aisle spaces. Here, smoking can be allowed only within a properly arranged room because a smoldering cigarette could lead to a well-established fire in the presence of easily ignited combustibles. In other areas where hazards are minimal, smoking may be allowed throughout with an emphasis on proper disposal practices.

Where a "No Smoking" area has been established, extended the area beyond the actual hazard, and base it on reasonably adverse conditions such as the malfunction of ventilation facilities or a spill of flammable liquids. Post signs to identify the boundaries of such a zone, indicate the nature of the hazard and the penalty for violating the prohibition.

To ensure strict enforcement of the smoking policy, segregated areas where employees may be allowed to smoke should be established. Discuss safe smoking habits with employees. Inform employees that careless discarding of smoking materials will not be tolerated. Smoking areas must be clean, free of accumulations of combustibles, and provided with proper automatic sprinkler protection and portable fire extinguishers. Provide positive pressure to smoking rooms, established close to hazardous areas that contain vapor, dust, or fiber hazards, so that the room is clear of the hazardous atmosphere. If matches and lighters are prohibited throughout the facility, equip the smoking area with electric lighters. Provide an ample number of ashtrays or other proper containers for discarded smoking materials. Use ashtrays that hold cigarettes in such a way that they will fall only into the ashtray, as they burn unattended. Tell employees not to empty ashtrays into wastebaskets or other ordinary trash containers.

If smoking is permitted, Management of Change requires that changes in occupancy, production methods, products being manufactured or products being used be reviewed. The review will determine if there is a need to change the classification of the effected area.

MAINTENANCE

INTRODUCTION

Machines degrade as they age. Degradation causes failures and shutdowns. Buildings also age, however, static structures generally age much more slowly than does machinery.

Effective maintenance manages the aging process. Managing the aging process helps prevent failures that occur during service. These are the failures that are most likely to cause extensive damage.

Most losses occur during shutdown, startup and off-normal operating conditions. Effectively managed equipment experiences fewer unnecessary shutdowns, startups and off-normal conditions. Therefore, such equipment is less frequently exposed to the increased risk that is associated with these operating modes.

Building failures are rare, but they can be catastrophic. Buildings will, however, serve their purpose for a much longer time if they are effectively maintained.

All buildings and equipment must be maintained, however, a maintenance program that attempts to prevent all failures will be unjustifiably costly. On the other hand, "run-to-failure" assures unnecessarily frequent and severe failures, equipment outages and loss exposures. Neglected standby and emergency systems and equipment, including fire or explosion prevention and control systems, will not perform reliably. A cost-effective maintenance program controls loss probability and failure consequences by concentrating maintenance resources on the most risk-significant equipment.

POSITION

Maintain all facilities and their equipment in a way that cost-effectively controls the probability of failure-induced losses and their likely consequences. To accomplish this, develop and support a written maintenance policy for each facility. Appoint an experienced professional maintenance manager who will establish:

- A maintenance organization and management structure that will implement and support an effective maintenance program and a maintenance team that will consistently "do the job right the first time, on time."
- An ongoing risk analysis and risk ranking function that will focus and support the maintenance program.
- Risk-based maintenance priorities that ensure sufficient resources are applied to items which PRC.1.13.0 has identified as "critical." Critical equipment maintenance and testing require

clear management support and commitment because these activities often require or may cause production interruptions.

- An efficient work order system that delivers complete, fully planned job packages, tracks all maintenance resources, and feeds the maintenance information system and machine history files.
- Written impairment-handling procedures, similar to the RSVP Impairment Handling program (see PRC.1.1.0), for notifying other persons, departments and management when safety-related components and systems are out of service. The reports must detail the steps that are being taken to promptly restore such components and systems to normal operation and the interim safety precautions that have been applied.
- Detailed written procedures to explain how maintenance is to be done, how maintenance quality will be controlled, and which safety programs, such as hot work permits (see PRC.1.9.0), system isolation and lockout/tagout will apply.
- Precautions, including inspection department or management signoffs, to ensure that equipment on which work has been performed is restored to its normal conditions before it is returned to service.
- A maintenance information system that details equipment and component maintenance scope and frequency, records maintenance procedure results and provides feedback on maintenance program and procedure effectiveness. (See PRC.1.3.0.B for more information.)
- A maintenance engineering function that uses the information system and other resources to:
  - Continually improve the maintenance program.
  - Design modifications that eliminate repetitive failures.
  - Provide maintenance input to new facility and equipment selection decisions.
- Maintenance planning, work-measurement, scheduling, auditing and cost-control functions.
- Maintenance training programs, including maintenance program awareness and appreciation for nonmaintenance employees (see PRC.1.4.0).
- Controls and surveillance procedures that ensure contractors adhere to all facility loss prevention programs.
- Controls and signoffs in the work order system that ensure management of change procedures are followed.
- Maintenance material support and other logistical support systems as needed.

A well-designed facility requires less maintenance than a poorly designed one, and well-designed equipment is easier to maintain. Therefore, before building a new facility or modifying an existing one:

- Use life-cycle cost analysis to help balance initial cost and reduced lifetime maintenance.
- Select construction methods, materials and equipment that require a minimum amount of maintenance and are conservatively designed for the intended use.
- Arrange equipment with enough spacing for maintenance access and, when applicable, to make cascading failure events unlikely.

When purchasing and installing equipment, consider:

- The frequency and scope of required maintenance.
- The ease with which maintenance can be performed, and
- The equipment’s accessibility for inspection and repair.

Also, specify equipment that will withstand its intended operating environment.

See PRC.1.5.0 for more information about maintenance concerns that are related to new facilities and equipment.

DISCUSSION

Background

Buildings deteriorate and equipment wears. All facilities have maintenance programs that address these issues, however, some of these programs merely react to failures and breakdowns. Wholly reactive maintenance incurs excess direct maintenance costs. These include straight and overtime labor, contract services, overhead and benefits, and maintenance materials. Reactive maintenance also incurs vastly inflated indirect maintenance-related costs, such as those that are associated with:

- Unnecessary startups, shutdowns and equipment failures in service, and their associated higher probability of fire, explosion and injury;
- Excess downtime;
- Missed schedules;
- Lost good will and business opportunities;
- Unnecessary production of seconds, scrap and defective goods;
- Customer complaints and product liability exposures; and
- Possibly avoidable cleanup, waste disposal and environmental damage costs and regulatory fines.

To reduce these costs and exposures and to make maintenance a positive force in the facility's overall loss prevention and control efforts, maintenance must be proactive. The maintenance function and organization needs to be a fully integrated partner with the operating departments in the accomplishment of the facility mission. Maintenance needs unequivocal senior management support.

Proactive maintenance prevents premature building and equipment deterioration and failure, and thus avoids unnecessary replacement costs, reduces maintenance costs and prevents or reduces losses. A good maintenance program:

- Anticipates failures.
- Assesses the risk associated with each possible failure.
- Prevents or mitigates failures that present intolerable risk.
- Effectively expedites repairs and helps identify alternate means of production when failures occur.
- Provides the tools for self-diagnosis and correction where the program is ineffective.
- Tracks building and equipment remaining life and applies life extension techniques when they are needed.

Maintenance must not focus merely on the urgent. Applying the entire maintenance resource to today's problems can do no better than to perpetuate the status quo. Instead, maintenance must focus on the important. Properly applied maintenance resources will make an operation more reliable and will therefore contribute directly to the ongoing preservation of the business entity.

Effective maintenance reduces the serious failure probability by managing the aging process. An effective maintenance program begins with operational tasks such as equipment cleaning and lubrication. It continues with both on-line and off-line monitoring and testing techniques that detect deterioration before failures can occur. An effective maintenance program preemptively shuts down equipment before it fails and then preserves, repairs or replaces "wear parts," such as bearings, and also any other worn or corroded parts before their failure in service can cause major component damage. This proactive approach is the essence of effective maintenance. Such a program requires management commitment and a substantial supporting infrastructure.

Some equipment failures are likely to cause a dangerous condition directly; other equipment failures are likely to initiate cascading failure events that could lead to catastrophic loss. This "high-risk" equipment needs to be identified so that maintenance can apply the resources that are needed to prevent equipment failure. Specifically, "critical" components, systems or procedures, if they are out of service or not followed, could cause or allow a catastrophic loss. Catastrophic losses include fire, explosion, loss of hazardous material containment and extended unscheduled shutdown. If critical components or systems are out of service, the process or operation must be shut down in order to remain safe. A risk-based decision process will also determine how frequently critical components and systems should be tested to ensure that they will function as designed when needed.

Many equipment failures will cause costly production outages. Each possible failure must be considered, its risk-significance determined, and a risk-informed priority attached to the measures that would prevent the failure or control its consequences.

Risk is a two-dimensional measure of failure occurrence probability and consequence. Risk significance is a measure of risk level. Qualitative measures, such as very low, low, medium, high and very high can be used to estimate the probability and consequence for each machine, component or failure mode being considered. Placing each item being considered in a plot like the one shown in Figure 1 provides a measure of the item risk significance. Items toward the upper right are the most risk significant. Figure 1 is a risk plot for tubes in a large water tube boiler. The shaded regions in the plot represent areas of approximately equal risk. The plot clearly risk-ranks the various kinds of tubes in the boiler.

What must be recognized, however, is that sometimes a minor maintenance expenditure can reduce failure probability or consequence severity. For example, a cost-benefit analysis might justify some minor maintenance action to avoid the nuisance of frequent failures or high severity events.

Quantitative risk analysis methods are also available. In quantitative analysis, risk is generally calculated by multiplying failure probability by the cost of failure consequence. Quantitative methods vary in complexity. Relatively simple spreadsheet-based analysis can use probability and consequence estimates that are obtained from experts. Statistical probabilities are valid only when the all the equipment to which they are applied is equivalent in terms of type, materials, loading, environment and other factors. Whether two or more pieces of equipment are “sufficiently” equivalent causes controversy even among experts.

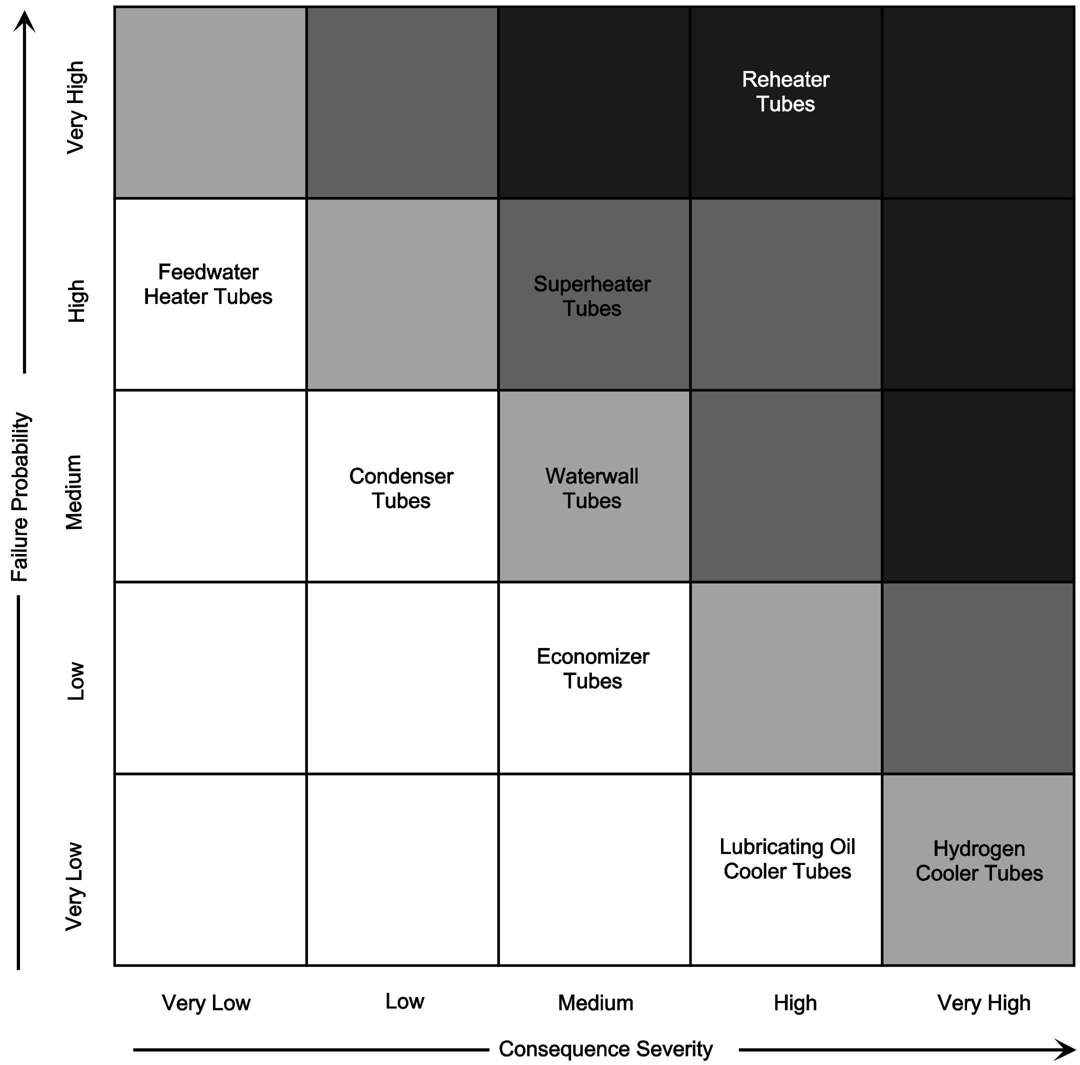

Figure 1. Qualitative Risk Plot For A Boiler (example).

More sophisticated techniques are also available. These techniques might use probabilities that are based upon component engineering models and consequence estimates that are based upon probabilistic analysis of actual predicted failure events. Many of these methods can estimate the probable facility net present value change that a proposed maintenance strategy is likely to produce. This capability is desirable because probable net present value can bridge the communications gap that is often found between engineering-oriented maintenance analysts and financially-oriented management decision makers.

Risk analysis focuses resources where they will be most effective and helps to avoid the tendency to maintain the most easily maintained items rather than the most important ones. Using calculated or estimated risk values or risk-significance measures will also ensure low probability/high consequence events like building collapse receive appropriate maintenance attention and resources.

History

Historically, maintenance was viewed as a necessary evil. Machines were simple, labor was cheap, and failure was perceived to be either unavoidable or of little consequence. The only maintenance that was normally performed was routine or operational maintenance, such as cleaning, lubricating moving parts, tightening loose bolts and joints, and watching and listening for signs of trouble. Additional maintenance took place only when wear progressed to the degree that performance was intolerably poor or when an actual breakdown occurred. In effect, the machine controlled outage timing and duration. Incredibly, this philosophy is still applied to whole facilities. It is variously referred to as “run to failure,” “breakdown maintenance” or “reactive maintenance.”

The earliest attempts at scheduled shutdowns involved programmed, or time-based, maintenance systems. The planned maintenance system (PMS) established by the U.S. Navy is probably the best-known example. Under such a system, all maintenance, whether operational tasks or complete overhaul, is scheduled based on elapsed time or on a specific number of operating hours or cycles. The interval between performances of a task is based upon experience, and, in theory at least, all activity can be planned. These systems worked well with equipment of slight complexity, particularly when components were standardized. Two problems emerged, however.

The first problem was how to set the maintenance intervals. When the intervals are too large, failures occur before the maintenance that is supposed to prevent them can happen, and breakdown maintenance results. When the intervals are too small, resources are wasted, and the shutdown of equipment to replace good parts quickly results in the perception that the program is nothing more than “going through the motions.” Sooner or later, the persons responsible for the tasks will do nothing but “go through the motions,” or worse, will feel free to document work that is not actually performed, and breakdown maintenance will again result.

The other problem involved system variation. While establishment of appropriate intervals for equipment in a single service (e.g., ship’s propulsion) with at least some standardization (e.g., Military Standard parts) is manageable, it is quite difficult with less standardized procurement and virtually impossible with a wide variety of applications and operating environments.

Those time-based systems were a step toward the goal of proactive maintenance. Now, better inspection techniques and on-line machine condition measuring tools allow a more focused and cost-effective approach. Rather than basing all maintenance decisions on time or number of operating cycles, these techniques and tools allow such decisions to be based on measured deterioration. Vibration amplitude in rotating machines, differential temperature in heat exchangers, and insulation resistance in electrical windings all indirectly measure equipment conditions. These measures often permit corrective action before failure. (See PRC.1.3.0.A.) However, this approach requires management support for taking the necessary maintenance action based upon measured conditions, regardless of the elapsed time.

An effective maintenance program properly applies all three approaches. “Condition-based” or “predictive” maintenance can be used in risk-significant equipment that has failure modes that are reliably measurable on-line or at least externally. “Time-based” or “programmed” maintenance can be used in risk-significant equipment in which failure probability can reasonably be expected to increase with time and particularly without maintenance. “Run to failure” or “breakdown” maintenance can be used when the failure consequences are low enough to be deemed acceptable to management, particularly when the expected failure mode is a random event.

Random failure modes that do not have acceptable consequences are the biggest challenge to maintenance decision makers. Equipment with such failure modes may require frequent “preventive” inspections and possibly redundant equipment for satisfactory risk control. Also, turbines, motors and other complex machines have components with all three — measurable, time-based and random — failure modes. These machines require condition monitoring commensurate with their importance and a pre-determined maximum overhaul interval.

Life Extension

An additional consideration has arisen in many industries that use large machines, most notably the electric utilities. Because of the manufacturing surge during the last World War and the period that followed it, many major machines are simultaneously approaching the end of their design lives. The large efficiency increases that for years were available in the “next generation” of equipment and that financed replacements for old equipment either no longer exist or are unaffordable, motivating owners to continue operating aging equipment rather than replacing it. “Life extension” refers to techniques that, by some combination of inspection, repair, and operating restrictions, allow use of equipment beyond its original design life. It has four steps:

  - Design the extension — Determine what to inspect, re-engineer or derate, perform appropriate calculations and establish test criteria.
  - Inspect and test — Examine the identified critical components or areas by appropriate means, which might include intrusive techniques such as destructively testing samples.
  - Assess feasibility — Use the design information, inspection data and any other pertinent facts to decide whether the equipment, when refurbished by available techniques, will perform as expected. Also, determine whether the proposed rework will indeed extend the life of the machine as a whole. Finally, calculate whether the investment in the modification is likely to produce an adequate return.
- Perform the necessary work — Reblade the rotor, replace the super-heater pendants or do whatever has been established as the right thing to do for the limiting component(s).

Maintenance Priorities

A good maintenance program does not allow production-oriented maintenance to supersede safety-related maintenance. A proactive maintenance environment includes regularly scheduled opportunities for safety instrumentation maintenance.

The maintenance program must set priorities by identifying critical components and systems (see PRC.1.13.0) and promptly establishing procedures to oversee their integrity. Ventilation systems for flammable liquid handling, combustion safety controls on fuel-fired equipment, overpressure protection on boilers and pressure vessels, overspeed protection on turbines, and the master shutdown system for a chemical process unit are examples of critical systems. In each case, the maintenance program must give special attention to testing and maintaining these critical systems and their components.

To set priorities and develop schedules for other equipment, evaluate each process or equipment component to determine its failure risk, then rank the equipment according to its risk significance. Use the risk ranking to help prioritize maintenance work. Consider these factors, however:

- “Predictive” activities, like taking vibration readings, are only valuable if they are regularly conducted on time. Their priority should be handled accordingly.
- “Backlog” items are almost always known deficiencies that will eventually cause more and possibly serious problems if they are not corrected. Therefore, jobs need to automatically rise in priority as they age.
- Some maintenance actions are taken to lower the overall cost of maintenance.

Assign a high priority to the inspection, service, and repair of instrumentation that is installed to prevent losses or of systems and equipment that handle emergencies. Although this assignment is often made initially, such maintenance may be subsequently neglected because safety instrumentation and fire protection equipment have a low “visibility factor.” This means that such equipment is not often called upon to operate unless adverse circumstances exist.

Maintenance priorities are often influenced by external factors such as seasonal changes (see PRC.1.3.0.C) or legal requirements. These influences must be included in the overall maintenance evaluation.

Spares

Spare parts should be available so that critical components or systems that fail will be returned to service as quickly as possible. For other equipment, spare parts management depends upon the failure risk and upon the cost, availability, and lead time for the parts.

For large pieces of machinery, such as compressors and turbines, or for equipment made of exotic materials, the spare parts needed may be very costly. Companies that have identical pieces of equipment sometimes try to reduce these costs by pooling their major spare parts. Manufacturers of machinery may at times maintain spare parts for customers. While these spare parts managing methods are not as secure as on-site storage, they can provide an effective alternative solution if contractual provisions are properly drafted.

Chemical analysis should be used to ensure that important replacement parts are made of the proper materials. Similarly, nondestructive testing methods such as dye penetrant testing, ultrasonic examination or radiography should be used to ensure that these parts do not contain defects. The quality of maintenance operations such as welding can also be verified by inspection.

Management Of Change

There are occasionally reasons to substitute parts that differ from the original parts in design, material of manufacture, or source. For a trivial example from every-day life, think about how many things once made from welded, riveted or bolted metal parts were more recently die cast metals and are now plastics. There is nothing wrong with a similar pursuit of more economical and perhaps more closely engineered parts in the industrial setting, as long as the changes are properly managed. History is full of failures and disasters caused by improperly managed material and other changes. See the management of change discussion in PRC.1.0.2.

Groups of items like valves, motors or switches, which appear to be alike, may in fact contain some that have unique performance and maintainability features. Review of the maintenance information system often reveals instances where more costly items have a lower life-cycle cost than the “same” items from the lowest bidder.

The philosophy that “if it ain’t broke, don’t fix it” receives occasional unwarranted support from managers who have taken smoothly running machinery down for maintenance only to have a failure soon after its return to service. More often, the statement is disproved by the discovery of incipient failures during properly scheduled overhauls. Furthermore, in an enlightened, risk-based maintenance management environment, an inspection that reveals no adverse condition is valuable. A “clean” inspection measurably increases confidence in the rest of the maintenance program, reduces failure probability uncertainty, and provides a data point that, when factored into the risk analysis program, can result in significant long term savings. The key is a highly skilled, aggressively proactive maintenance organization that does the right jobs and does them right the first time, and which is an accepted partner with the operating departments in accomplishing the facility mission.

MAINTENANCE INSPECTIONS

Inspections and tests are a necessary part of maintenance. Use them to determine the degree and rate of equipment deterioration. A good inspection program, aided by computer and maintenance engineering analysis, can predict the probable time of failure of a piece of equipment so that the equipment can be replaced or repaired prior to that time. Inspections and tests that reveal no deterioration may help avoid unnecessary maintenance.

Inspections are most effective when they are conducted by qualified, preferably certified, persons in accordance with a written procedure or protocol that has been proven to provide consistent and repeatable results. Nationally recognized certification programs are available for many types of inspections.

Inspection techniques are being developed continuously. Some newer techniques include:

- Ferrography and wear particle analysis — analyze the contaminants in a lubricating oil system. These tests are sensitive to changes caused by abnormal wear. If the composition of the various parts of the machine are known, the source of wear products can be identified and maintenance scheduled before a failure occurs.
- Vibration monitoring and analysis — detect gross problems such as imbalance, misalignment and looseness. When coupled with modern computer analysis, vibration analysis becomes an extremely effective tool for diagnosing and predicting machine ailments including some rotating element cracks.
- Acoustic emissions analysis — can detect incipient flaws and small leaks by detecting sound in a structure. Acoustic emissions analysis can often be performed on equipment while it is in service.
- Infrared inspection — allows the user to “see” the heat being radiated by an object. This technique is excellent for detecting incipient faults in electrical equipment, refractory and insulation. The same equipment can be used to locate heat imbalance in equipment such as engines, leaking valves in compressors, leaking steam traps, and a host of other adverse conditions. Under certain conditions, it can even locate leaks in roofs.

Because of the sophistication of some test methods, it may be advantageous to develop an inspection department. The inspection techniques that are used depend upon the type of equipment and materials that are being inspected, the condition of the equipment at the time of inspection, and, where applicable (generally for equipment such as cranes, elevators, boilers and pressure vessels), requirements of the governmental authority (jurisdiction). Operating equipment often requires different inspection methods than idle equipment requires.

Some inspection techniques, such as eddy current analysis, radiography or acoustic emission, may best be done through a contract service in all facilities except those with the very largest inspection departments.

Inspection results provide feedback to the maintenance system. Assign the inspection frequency based upon:

- The importance of equipment and its failure risk.
- Previous inspection results and failure history.
- Service conditions.
- Time in service.
- Legal requirements.
- Insurance company recommendations.

- Recommendations of standards bodies and manufacturers.

The inspection force may also provide quality control monitoring for work in progress. This includes audits to verify that plant and vendor personnel are adhering to written procedures, safety programs, corporate standards, jurisdictional requirements, and good engineering practice. One frequently-overlooked aspect of quality control is tool control. Strictly limit access to open machinery casings and maintain accountability of all tools and parts, so that nothing is inadvertently left in the machine.

Finally, maintenance of almost any piece of equipment requires abnormal configurations of some sort. Examples include gagged safety valves for hydrostatic tests, blanked flanges and missing valves for piping system isolation or flushes, and extra filters in steam and lubricating oil systems. Ensure normal conditions are restored before equipment is returned to service.

MAINTENANCE INFORMATION SYSTEMS

A maintenance information system is a necessary part of a good maintenance program. Such a system makes the maintenance program more effective and reduces its cost in the long run. A suitable system allows the maintenance manager to gather data to support maintenance decisions. It includes equipment failure data that may be fed back to designers or manufacturers, used for process hazard evaluation (see PRC.1.13.0), or sent to the purchasing department to support changes to specifications or to support the selection or avoidance of particular vendors or equipment types. The maintenance information system is also a valuable resource for the planning department to use when preparing job packages for future maintenance work.

The maintenance information system provides:

- An easily retrievable historical record for each major piece of equipment or group of similar equipment. This record should include the original specification information, manufacturer, a history of operation time and conditions, and a record of inspection results and of all maintenance performed.
- Equipment inspection and service schedules that specify the inspection and service scope and standards. The schedule should indicate which safety precautions apply and which permits are required during each activity (for example, see PRC.1.9.0). When fire protection equipment or systems are involved, proper backup procedures should be required (see PRC.1.1.0).
- A persistent follow-up or tracking system to ensure that proper inspection and maintenance service are being performed according to schedule.
- An equipment repair and maintenance task priority assignment system that automatically increases the priority of deferred jobs.
- Specifications for special replacement parts and materials for individual pieces of equipment so that proper parts and materials are used during maintenance procedures. A list of qualified suppliers for these items should be maintained. Management of change procedures should be followed before any substitutions are authorized. See PRC.1.0.2.
- An inventory of spare parts and an inventory control system. The control system should include written procedures for proper storage of large, complex or sensitive parts such as turbine rotors, electric motors or coils, or electronic modules.
- Programs to analyze the effectiveness and cost of inspection and maintenance procedures.
- Written notification to management and other affected departments so they will be promptly alerted when critical or safety-related components and systems are out of service for maintenance or any other reason.

In most organizations, the maintenance information system uses computers to assist in program management. With the present state of the technology, there is no reason that even small organizations cannot benefit from the relatively low-cost computer equipment and maintenance management software available.

Operating Logs

Operating logs are not generally a part of the maintenance information system; however, they may provide valuable information to it. To be effective, any log program requires the following attributes:

- The information must be gathered regularly. Even less desirable information, regularly collected, may be better than the right information, gathered haphazardly. For example, consider a pump that is being pulled out of alignment by process temperature changes. While daily vibration readings might be the most efficient way to disclose this condition, it is also true that reliable hourly bearing temperature readings may bring the problem to the attention of an astute reviewer faster than vibration readings which are taken "as the opportunity presents."

- The information that is selected for collection should be complete enough for intelligent interpretation. For example, turbine bearing temperatures are more valuable if the load on the turbine at the time of the reading is also recorded.
- The information is periodically reviewed by a maintenance engineer. Too often, loss investigations reveal meticulously gathered data showing a steady, unexplained rise in vibration level or a steady, unexplained drop in performance — that no one noticed until the crash.

Operating logs for any but the most rudimentary equipment must be custom designed. Logs are so important that preparation or review by an independent specialist is recommended. As examples, sample log sheets for small, low-pressure heating boilers and small, compression-type, fluorocarbon air conditioning machines are shown in Figures 1 and 2.

OVERVIEW FORMS PACKET
(See GAP.1.3.0 in the OVERVIEW Manual)
Published as part of Global Asset Protection Services LLC

SUGGESTED BOILER LOG SHEET

NOTE: This log is suitable only for boilers in heating systems which return 100% of the condensate to the boiler or which circulate hot water. It is not suitable for steam boilers with safety valves set higher than 15 psi (1.03 bar) or water boilers operating at greater that 160 psi (11 bar) or 250°F (121°C).

Boiler Number ______________ Person Responsible for Boiler ____________________________ Phone Number ______________

Inspector's Name/Agency ____ Phone Number

Last Inspection ____ ____ ____ Operating Certificate Expires ____/____/____

Location of Certificate (if not posted) ____________________________________

Annual Service ____/____/____ Service Firm ____________________________________ Phone Number ______________

The following tests and inspections may be recorded on the chart on the reverse side.

☐ **SAFETY OR RELIEF VALVE TEST**. With pressure in the boiler, fully open the valve, using the test lever provided, and let it snap shut. If the valve does not reseat properly, repeat. **If the safety or relief valve cannot be lifted, the boiler must be shut down immediately until the valve can be repaired or replaced.**

☐ **LOW WATER FUEL SUPPLY CUTOUT (LWFCO) RAPID DRAIN TEST**. With the burner in operation, rapidly flush the LWFCO chamber using the drain valve provided. The burner **must** shut off when the device is drained. **If the boiler does not have at least one properly functioning LWFCO, it must not be left unattended until repairs are made.**

☐ **LWFCO SLOW DRAIN TEST**. With the burner in operation, verify the function of the LWFCO by **slowly** reducing the level of the water in the boiler. Great care must be taken to prevent actually firing the boiler with insufficient water. This test should be performed quarterly for steam boilers and annually for water boilers.

☐ **DRAIN WATER GAUGE GLASS**. If necessary, drain and flush the water column and gauge glass.

☐ **BURNER CHECK**. Observe the boiler and burner for a long enough period to be certain that the burner operates normally. Test the combustion safeguard system (if possible).

☐ **CIRC OR COND PUMP CHECK**. For steam boilers, when testing the LWFCO, verify operation of the condensate pump and/or emergency feeder.

☐ **CHECK SYSTEM FOR LEAKS**. The entire system should be examined for leaks of steam and water with particular attention paid to pump and valve packings, automatic air vents, and condensate tank overflow lines. Leaks, in addition to possible water or humidity damage, are wasteful of energy and, over time, will result in scale buildup in the boiler.

☐ **WATER CHEMISTRY CHECK**. Test the boiler water as appropriate for your area. Quarterly is normally sufficient. The frequency must be determined by experience.

CALL YOUR SERVICE FIRM OR BOILER INSPECTOR IF YOU NEED ASSISTANCE WITH ANY OF THESE ITEMS

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GAP.1.3.0

Figure 1. Simple Boiler Log Sheet (front).

RECORD YOUR TEST AND INSPECT DATA HERE:

	SAFETY OR RELIEF VALVE TEST	LOW WATER FUEL SUPPLY CUTOUT RAPID DRAIN TEST					LWFCO SLOW DRAIN TEST	DRAIN WATER GAUGE GLASS	CHECK BURNER	CHECK CIRC OR COND PUMP	CHECK SYSTEM FOR LEAKS	CHECK OR VERIFY WATER CHEMISTRY
SEP												
OCT												
NOV												
DEC												
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												

Figure 1. Simple Boiler Log Sheet (back).

OVERVIEW FORMS PACKET
(See PRC.1.3.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

CENTRIFUGAL AIR CONDITIONING LOG SHEET

NOTE: This log is recommended for fluorocarbon (Freon, Genetron, etc.) air conditioning systems with hermetic centrifugal compressors. With minor modification, it is suitable for similar equipment separately driven by a motor, turbine or engine.

Unit Number ____________ Person Responsible for Unit ______________________ Phone Number ____________

Inspector's Name/Agency ______________________ Phone Number ____________

Startup Service ____/____/____ Winterizing (if applicable) ____/____/____

Service Firm ______________________ Phone Number ____________

	COMPRESSOR							MOTOR			EVAPORATOR				CONDENSER				PURGE		AIR TEMP.		INITIALS
		Bearing Temp.		Oil							Refrigerant		Water		Refrigerant		Water						
Date/Time	Vane Position			Level	Reservoir Temp/Heater*	Cooler Outlet Temp.	Pressure	Volts	Amps	Vibration Level	Pressure/Level*	Temp.	In.et Temp.	Outlet Temp.	Pressure	Temp.	Inlet Temp.	Outlet Temp	Run Time	Water Level	Outdoor	Air Conditioned Space	Operator

On the back, list any additional information, including leakage or abnormal conditions observed, oil or refrigerant added, purged fluid drained, and any tests, repairs or adjustments performed. Record any automatic shutdowns, including their time and cause. "If the unit is not running, enter the refrigerant level in the evaporator and the status of the oil reservoir heater.

 PRC.1.3.0

Figure 2. Log Sheet for a Centrifugal Air Conditioning System.

SEASONAL MAINTENANCE

COLD WEATHER MAINTENANCE

Cold weather and freezing temperatures normally occur each year in most of North America and much of the rest of the world. In some areas, however, cold weather is usually not considered a matter of concern. Temperatures in these areas seldom reach freezing, and, when they do, they remain there for a relatively short period of time, usually no more than a few hours.

Such lack of concern may not be justified. Loss experience illustrates that shifts in the jet stream can cause bitterly cold arctic air masses to press deeply into the warmer climes, sustaining freezing temperatures for periods of several days. At the same time, these unusual arctic air masses may cause temperatures in normally cold areas to drop far below freezing for periods of up to three weeks.

Facilities located in all but tropical areas (latitude less than 23.5°) must carefully consider precautions to be taken before the cold-weather season each year. Unless proper precautions are taken, cold weather can cause problems. Building roof and structural systems may be loaded beyond their design by snow and ice accumulations. Sprinkler piping and fire mains may freeze, leaving major portions of a facility without fire protection. Pipes can burst and cause liquid damage. Boiler feed and condensate systems can freeze, rendering the major heat source inoperative and perhaps even causing it to be damaged by dry firing or freezing.

Prior to and during cold weather, take the following precautions:

- General
  - Plan ways and obtain equipment to remove snow from flat roofs or other structures which might collapse.
  - Make all doors, windows, skylights, ventilators, and other openings weather tight so they will not admit cold air that could cause water piping, radiators or sprinkler systems to freeze.
  - Install antifreeze, heat or steam tracing, or simple and effective means for draining all exposed service, process and fire protection lines and vessels such as air conditioning or compressor cooling jackets or heat exchangers which may contain water, condensate or solutions subject to freezing. Equipment in penthouses and other out-of-the-way areas needs particular attention.
  - Water can accumulate in service and instrument air and process-gas line low points. Such accumulations might not rupture the piping when they freeze, but they will block or reduce flow. Locate and eliminate, drain, or freeze-protect these low points.
  - Boiler, pressure vessel, and tank vent and safety or relief valve discharge lines often terminate outside of buildings or at least outside heated spaces. Pitch these lines so that they gravity drain to the warm area if possible, otherwise, provide antifreeze or auxiliary heating.
- Heating Systems
  - Examine all systems and correct any deficiencies to ensure the systems are in proper operating condition. Clean and service burners, boilers, and flues. Remove any obstructions from pipes, radiators, and unit heaters. Test heating equipment controls for proper operation.
  - Where possible, keep an adequate reserve supply of fuel on hand at all times. Investigate safe alternative energy sources.

  - Maintain temperatures above 40°F (4°C) at all times in buildings equipped with wet pipe sprinkler systems, domestic water, or any other water-filled systems; in all dry pipe, pre-action, and deluge valve closets; and in all pump houses.
  - Maintain clearances between heating system components and combustible floors, walls, partitions, platforms, and stock.
- Fire Protection Systems

NOTE: Some of the following maintenance procedures involve valve operation or other activities that will impair fire protection systems. Proper procedures should be followed in all such cases (see PRC.1.1.0).

  - Plans to clear snow promptly from access ways, control valves, hydrants, hose cabinets, and other essential equipment to permit effective operations during an emergency.
  - Convert wet pipe sprinkler systems in areas which are inadequately heated to dry pipe or pre-action systems.
  - Remove any condensation that collects in low points in the dry pipe or pre-action sprinkler piping. Also remove any excessive priming water.
  - Test solutions in all antifreeze sprinkler systems and add antifreeze as necessary.
  - Convert any “shut-in-winter” systems to either a dry pipe or a pre-action system.
  - Shut off, drain, and tag all wet standpipe systems that have piping located in areas subject to freezing.
  - Properly drain water motor gongs, piping, and fire department pumper connections.
  - Repair leaking gravity tanks.
  - Flush tank heating systems and place them in good working order.
  - Drain hydrants and fire pump hose headers. Leave outlet hose valves half open to prevent freeze damage.
  - Properly drain hose.
  - Check post indicator valves for leaky packings and repair them where necessary.
  - Ensure valve and meter pits are dry and frost proof.
  - Properly service automotive fire apparatus for winter.
- Freeze Protection System Maintenance
  - Inspect heat tracing equipment. Replace any cracked or deteriorated heating tape. Service traps in steam tracing systems.
  - Review all work packages in the backlog to ensure that any out-of-service protective equipment is promptly restored.
  - If any equipment is to be shut down during the cold season, plan in advance and provide any needed extra freeze protection.

WARM WEATHER MAINTENANCE

During more temperate periods of the year, there are a number of preventive maintenance steps that should be taken:

- General
  - Remove grass and brush from around such hazards as combustible gas or liquid storage tanks or metering stations, transformers, and switchgear.
  - Clean obstructions from roof drains.
  - Inspect and, where necessary, repair roof coverings and flashings.
  - Inspect and service lightning protection systems (see NFPA 780) and electrical grounds.

- Inspect screens and fences and otherwise survey outdoor transformers and switchgear for indications of animal entry.
- Inspect and service seasonal cooling water, air conditioning and refrigeration systems well in advance of anticipated use.
- Clean and service boilers; arrange for certificate inspections where applicable.

- Fire Protection Systems

NOTE: Some of the following maintenance procedures require valve operation or other activities that will impair fire protection systems. Follow proper procedures in all such cases (see PRC.1.1.0).

- Lubricate, close, and reopen all fire protection valves.
- Flush out private hydrants and check them for proper drainage. Lubricate each operating mechanism.
- Check dry pipe valve system piping for obstruction in accordance with NFPA 25. If the quantity of debris is excessive, flushing is required.
- Examine internally at five-year intervals check valves, backflow preventers, meters, and pressure regulators, and clean as necessary. The health department having jurisdiction might also require tightness testing for backflow preventers and double check valve installations.
- Cut high grass around all outside fire protection equipment.
- Paint gravity and suction tank interiors and exteriors if inspections indicate this is needed. Inspect cathodic protection systems and repair them as needed. If tanks are filled from a raw water source, clean them to remove collected residue from the tank bottom riser.
- Clean open reservoirs and suction cribs.

MAINTENANCE PROGRAM ELEMENTS

INTRODUCTION

Maintenance is the most important factor in equipment availability and reliability. Equipment can and should be properly designed for its purpose; carefully built, installed and protected; and skillfully operated. However, the day that equipment is installed, it begins to age. Foundations settle. Corrosion occurs. Ambient temperature changes loosen connections. Oxygen, humidity, heat and light degrade electrical insulation and other organic components. Placing equipment in service provides other stresses that accelerate aging.

Effective maintenance manages the aging process. Some maintenance activities, like cleaning and painting, lubricating, aligning and balancing, help slow aging by minimizing wear and corrosion. Other maintenance activities, like vibration and wear particle monitoring and analysis, on-site and replication metallography, and all forms of nondestructive testing, help detect the effects of aging. Still other maintenance activities, like repair and restoration, seek to reverse aging. A successful maintenance program minimizes aging-related costs.

PRC.1.3.0 describes maintenance philosophies that include breakdown, scheduled and predictive methods and describes how these philosophies might be applied in a complete maintenance program. This section discusses 21 maintenance program elements and characteristics that are found in successful maintenance programs in a variety of industrial facilities. It describes and supports functions that will deliver state-of-the-art maintenance, but it does not provide guidelines for specific facility types.

Maintenance program elements that loss investigations regularly find lacking are further discussed. To fully develop specific program elements, users will need more information. Sources for this information include textbooks, courses and consultants on principles of management and on maintenance.

Be skeptical and carefully examine resources before investing in them. Effective maintenance is not an easily-installed feature that will deliver immediate cost savings. Although names and buzzwords are generally public property, resources that espouse “total quality maintenance” (TQM), “reliability-centered maintenance” (RCM), “total productive maintenance” (TPM) and “planned and predictive maintenance” (PPM) tend to be safer choices than those that offer to immediately cut your maintenance budget.

Although buildings and other structures also age, this section does not deal directly with their maintenance needs. However, a soundly conceived and rigorously executed maintenance program can effectively and efficiently maintain structures as well as equipment.

Remember that maintenance excellence is not the ultimate goal. The ultimate goal is a loss-free, safe and profitable facility. In the present business environment, achieving that goal means competing successfully with every similar facility in the world. A world-class facility cannot make world-class product unless it has a world-class maintenance program, because maintenance is a key contributor to quality as well as to reliability, availability and loss prevention. In addition, formal quality certification programs such as ISO 9000 require documented procedures for all activities, including maintenance.

POSITION

Loss prevention and control programs cannot succeed without effective maintenance. Maintenance is Section 3 of *OVERVIEW*, the AXA XL Risk Consulting management program for loss prevention and control and PRC.1.3.0. Most losses, and also most accidents, happen during startups, shutdowns, upsets and emergencies. Effective maintenance helps minimize the number of startups, shutdowns and upsets and helps enable a facility to deal with emergencies. AXA XL Risk Consulting encourages effective maintenance because maintenance is a powerful loss control and safety-enhancing tool, however, effective maintenance is also a key to effective resource use. A facility with poor maintenance that wishes to upgrade its program may initially spend more on maintenance, however, good maintenance will in the long run save money.

Good maintenance is local. Although a good corporate maintenance program can greatly help an individual facility have good maintenance, local maintenance program effectiveness depends upon the skills and enthusiasm of the facility management or, in facilities with decentralized maintenance programs, upon the skills and enthusiasm of each production unit management or team. Therefore, maintenance program evaluation can be an important part of maintenance management. Maintenance program evaluation is further discussed in PRC.1.3.0.2.

Maintenance Decision Making

Some facilities are new and have unlimited maintenance resources; others are not so new but have always had unlimited maintenance resources. Some corporate cultures explicitly embrace the long view and a proactive stance, and value maintenance people just as much as production people (all the time, not just when they respond effectively to a breakdown). Such facilities have no maintenance decision-making problems. However, equipment aging, shifting markets and competition or management changes might force hard choices upon them. Most facilities already have limited maintenance resources. All facilities should use risk-based analysis to help guide and support maintenance decisions.

Proactive vs. Reactive Maintenance

Maintenance should be proactive. A typical standard for a well-maintained facility is for 85% of work to be performed proactively. Reactive or breakdown maintenance or “run to failure” does have a place, but in a well-maintained facility, that place is strictly limited to equipment that a formal risk analysis has identified as having acceptable business interruption and direct damage risks.

Deferred Maintenance And Maintenance Backlog

Deferred maintenance is controlled in a well-run facility. A well-maintained facility will have at least 85% maintenance schedule compliance overall and at least 95% schedule compliance on preventive and predictive maintenance tasks. A well-run maintenance department will always hold its backlog within established lower and upper control limits, typically two and four weeks.

Contractors

Thoroughly train contractors in and require that they comply with all facility loss prevention programs, such as hot work permitting and control, system isolation and inerting, confined space entry and lockout/tagout. Ensure that training costs and compliance requirements are part of the contract.

Maintenance Program Elements

A maintenance program that is integrated with the facility mission, actively participates in that mission, and is proactive contains certain sub programs or elements. Not all of the listed elements will be discreetly identifiable in every effective maintenance program, however, careful examination of any state-of-the-art maintenance program will reveal that all the elements are there. In small facilities, many people serving the maintenance function will necessarily “wear more than one hat.” All facilities, but especially smaller ones, need careful planning and carefully written procedures and job descriptions to avoid a slide into deferred maintenance and a purely reactive operational mode.

Management Commitment

Management commitment is the bedrock upon which any successful management program stands. Use an unequivocal statement of support signed by senior management to communicate this commitment throughout the facility. The statement of commitment may be part of the overall commitment to loss prevention and control described in *OVERVIEW* or it may be a free-standing document. Senior management must support the maintenance program not only in the material ways outlined in the following element descriptions but by regularly encouraging program efforts and by publicly recognizing maintenance’s role in the success of the facility mission.

Cooperative Maintenance/Operations Partnership

In recent years, an attitude has developed that maintenance exists to “serve” operations or production. This attitude cannot be tolerated in a well-managed facility. Senior management should treat maintenance and operations as equal partners in accomplishing the facility mission. Proactive maintenance depends upon operations to keep maintenance informed of its requirements and to bring problems to maintenance attention at the earliest manifestation. Operations need to trust maintenance to correct problems efficiently and in a timely manner; to “do the job right, the first time, on time,” consistently. Maintenance depends upon operations to make equipment available when proactive maintenance is needed. Operations depend upon maintenance to keep equipment capable of reliably producing quality product. None of this can happen except in a partnership.

Having a maintenance/production partnership clearly benefits quality. In a statistical quality control environment, product quality is maintained between upper and lower control limits. If there is a barrier between production and maintenance, whether because of management practice or because of production lack of faith in maintenance, problems are not reported to maintenance until quality degrades to the lower control limit. At that time, production effectively ceases and maintenance is faced with a reactive, or emergency job. In a proactive, partnering arrangement, operators bring quality problems to maintenance attention early enough in the aging/degradation process to allow maintenance to proactively correct the condition with minimal down time. The interfaces and responsibilities shown in Table 1 are typical for successful partnering arrangements.

TABLE 1
Typical Interfaces And Responsibilities

Operations	Maintenance
Operate equipment properly	Provide effective support
Suggest and communicate priorities	Develop a responsive schedule
Anticipate repair work before jobs become emergencies	Develop a maintenance program that will address all levels of equipment needs
Have equipment ready for work when work is scheduled	Provide the labor, material, supervision and technical expertise to complete the job
Project future needs	Develop the master schedule
Assess the quality and timeliness of work performed	Feedback information on completed jobs

Governing Principles and Concepts

The maintenance department manifesto is the maintenance department mission statement; the commitment to act proactively, to be a full partner in the facility mission. The following statements should describe the facility approach to maintenance:

- The concept of operator custodianship is basic to facility philosophy.
- The maintenance department, through technically qualified knowledge and advice, is responsible for determining how to best satisfy maintenance needs.
- Process, equipment and facility maintenance responsibility is shared by all organizational units.
- Maintenance is a cornerstone of the operation. Management policy statements ensure that maintenance is an integral part of the operating strategy.
- Maintenance philosophies and functions, and information about how they support facility strategies, are communicated to all concerned departments.
- Operating and maintenance department primary and supportive responsibilities are clearly defined.
- Cooperation is excellent and mutual understanding is achieved. Important procedures, such as the work order system, welding and hot work authorization, fire protection and other protective equipment impairment reporting and management, and lockout/tagout are uniformly followed. (Section 1 of *OVERVIEW* [PRC.1.1.0]) describes a program for fire protection equipment impairment handling.)
- The proactive approach to maintenance is maintained, even when there is pressure to meet output targets.

Status Assessment

The status assessment tells management how effectively maintenance programs are performing. The status assessment measures the maintenance function against concrete standards. It also needs to measure, against concrete standards, maintenance effectiveness in supporting the facility mission. This section provides a few suggested objective and subjective measures. PRC.1.3.0.2 contains more of these guidelines.

Objectives, Goals and Targets

Maintenance objectives, goals and targets should be synchronized with the departmental mission statement and be consistent with the facility strategic and operational plans.

Objectives describe a desired state of organizational being. Some examples of maintenance department objectives:

- To continually reduce equipment downtime and increase equipment availability by establishing and implementing a preventive/predictive maintenance program designed, directed, monitored and continually enhanced by effective maintenance engineering.
- To ensure that work is performed efficiently through organized planning, optimal material support and coordinated work execution.
- To provide meaningful management reports that enhance control of maintenance operations and resource use.

Goals are quantitative, ultimate and strategic long-range aims. They must be attainable. Properly selected goals can be motivating as well as productive tools. In a team environment, goals should be set by the team.

Targets are short-term, quantitative milestones to be reached while progressing toward goals. Targets should be time-related, and should have defined individual or specified group responsibilities. For example, one measure of overall department effectiveness is “wrench time,” the percentage of time the average craftperson spends productively working on an assigned job. A desirable target is 55%. Another measure is unscheduled equipment downtime. A suitable target is no more than 2%; significantly less for important equipment.

Master Plan

The master plan defines the gap between the current conditions and the desired conditions and defines the short and long-range actions that are needed to close the gap. Master plan action items cover organizational, system, material, facility, equipment and procedural shortfalls.

Note that a large, effective and integrated management maintenance program requires about one year to install and another year or two of refinement and nurturing and continued pursuit of its ultimate goals and objectives before it is likely to be fully implemented and yielding its full potential.

The master plan should be acceptable to and adopted by all affected organizational units, and must have the active interest and support of the facility manager.

Budgetary Control

Maintenance is neither a fixed nor a variable expense. It changes with volume in a stepwise pattern. This is because of the incremental nature of the staffing requirements of an effective maintenance department. Ironically, the maintenance staff percentage of total facility employment is likely to be largest, as high as 25%, in facilities that have up to 100 operating and maintenance employees. For facilities with 100 to 250 operating and maintenance employees, economies of scale drive the percentage down to about 12%. For larger facilities, the need for more specialized support staff brings the figure back up to the 18% range. Some details are provided in the discussion of organization.

Maintenance budgeting often requires more detailed information than the facility general accounting system can provide; therefore, coordination between the facility system and the work order system is needed. Historical data analyses modified to cover planned improvements and business volume changes will result in a realistic budget. Maintenance costs need to be segregated, by requesting production units to obtain volume variances, and by maintenance unit to obtain productivity variances, by equipment type and by cost center.

Management Reporting and Control

Management uses maintenance reports to give direction, receive feedback, react and make corrections. Maintenance information includes decision-making information by which to manage the maintenance function as well as administrative information by which to handle personnel and accounting matters. Key maintenance reports include:

- Activity report — A weekly report of open work orders, sorted by priority and crew, which feeds the performance report, the backlog report and the work program. It also identifies departments that generate large numbers of urgent work orders.
- Distribution of labor by work type.
- Weekly performance report for each supervisor or crew.
- Weekly backlog report — Net remaining workload on all remaining work orders, sorted by crew and by originator.
- Work program — Compares the workload to the available labor resources; used to establish the overall work force level, balance crafts, plan for shutdowns, determine the available capacity to handle project work, and to decide if and when to use contract labor. Resources and work load must balance. If workload exceeds resources on an ongoing basis, the organization cannot become proactive.

Other typical reports include a schedule compliance report, predictive/preventive maintenance delinquency report, ratio of inspection to corrective maintenance, maintenance downtime by equipment, and administrative and budgetary reports.

Organization

After the commitment to a proactive approach to maintenance, the maintenance organization and structure might be the single most influential factor in program success. An organization that is tacked as an afterthought low in the organizational chart is unlikely to ever obtain the respect and prestige that it needs to deliver its promise. A poorly constructed organization will breed bureaucracy and frustration. A well-constructed organization will tend to synergise all that is positive. The following comments introduce a few key points.

The maintenance organization must address three essential functions: planned work preparation, supervised work execution and engineering dedication to repetitive failure elimination. There are several ways to organize a maintenance department that will deliver these functions, but AXA XL Risk Consulting recommends centralized maintenance leadership. A small portion of the resources can be assigned to specific production areas, but all maintenance personnel should remain under central leadership.

There are several reasons:

- The maintenance manager should be a dedicated professional, equal in status and level of authority to the production manager. This arrangement avoids having the maintenance manager routinely overruled by the production manager without equal access to senior management for appeal and adjudication.
- A centralized maintenance department is more likely to deliver uniform quality maintenance throughout the facility. When maintenance is decentralized, uneven levels of service often result. It is not very useful to have state-of-the-art maintenance in one step of an operation if another part of the same operation is always broken down. Poor maintenance in one of several linked facilities or in one unit of a single facility drags down the whole. No amount of quality on the part of the good performers can drive any more product through the bottleneck formed by the poor performer. Worse, the poor performer, by regularly providing unscheduled outages, deprives the good performers of any motivation to improve.
- If all maintenance is decentralized, vital central services, such as the main electrical distribution system, fire protection systems, and the plant air and water system, are easily neglected.

Another reason lies in the typical staffing ratios listed in Table 2. A centralized department can much more easily justify and support the specialized staff needed by a large facility than can several decentralized units, all of which lack the essential critical mass. Specialized crafts may also be more easily supported and balanced when there is a large organization within which to work.

Regardless of the organization used, there should always be a current and complete organizational chart that clearly defines all maintenance department reporting and control relationships, and any relationships to other departments. The organization should clearly show responsibility for the three basic maintenance responses; routine, emergency and backlog relief.

Training

A carefully planned and thoroughly documented continuous program of training is another key element in a successful management loss prevention program. Training is addressed by Section 4 of *Overview* (PRC.1.4.0) Here are a few key points and ideas specific to maintenance department needs:

Operators cannot possibly handle modern, complex equipment unless they are thoroughly trained and drilled in normal and emergency procedures. They cannot have the necessary awareness of off-normal and potentially dangerous conditions unless they are trained to recognize and report those conditions. Craftworkers are not kept up-to-date without training in the latest technologies. Vibration analysts, infrared thermographers, electrical insulation test apparatus operators — none of these become skillful and effective without training and practice. Planners and schedulers cannot provide sound estimates and ensure all resources are available for all jobs without training. Supervisors and managers cannot be effective leaders and motivators without training. And contractors cannot work safely in a complex facility without training, including site-specific procedures and rules.

Anyone who does maintenance work needs at least an indoctrination or awareness-level training course in safety-related matters such as hot work, proper mechanical and electrical isolation procedures, and lockout/tagout. The course could also address initial response procedures for dangerous conditions such as fires and leaks or spills of any hazardous materials present at the facility. See *OVERVIEW* Section 7 (PRC.1.7.0), "Pre-Emergency Planning," for more information.

TABLE 2
Typical Maintenance Department Span Of Control Ratios

Support Staff	Ratio to Mechanics (range)
Supervisors	1:10 (8 to 15)
Planner/schedulers	1:20 (12 to 30)
Maintenance Engineers	1:40 (40 to 70)
Maintenance Clerks	1:40 (20 to 55)
Training Coordinator	1:80
Composite	1:5
Planner, contract administrator or project engineer	Each $1,000,000 of outside contracts

Everyone in the maintenance organization needs general instruction in the organizational structure and in its mission, targets, goals and objectives. Each functional and organizational unit needs in-depth instruction in its specific mission. Operating and support management, supervisors and personnel need a course in maintenance appreciation and in any specific maintenance tasks in which they share responsibility.

Supervision and Practices

Good supervision, the art of getting average people to do superior work, is an essential part of maintenance. Whether within a traditional organization or one oriented toward self-directed teams, certain supervisory functions need attention in any successful maintenance department. Some of those key functions are:

- Point contact for production; an easily contacted, good communicator who is receptive to suggestions and new ideas, and has an appreciation for urgent needs yet has the vision to understand conflicting needs and the wisdom to balance them.
- Jobsite safety monitor, counselor, arbitrator, quality control monitor and troubleshooter.
- "Learning leader;" able to recognize and arrange to correct any skill-level deficiencies and to recognize the need for and to implement any developing needs for new skills and techniques.
- Shift-change coordinator and management point contact.
- Planning and scheduling coordinator; ensures that the planners receive the feedback needed to continuously refine and improve the planning process; ensures no changes are authorized without proper management-of-change procedures.

Pride, Quality and Workmanship

No facility can afford to take quality product for granted; neither should it assume quality maintenance will occur unless management takes positive action to ensure it. The pride and workmanship that make good product also make good maintenance. Pride, quality and workmanship flow from concerned and responsive management, good organization and properly trained and motivated people working in a smoothly operating facility. Management needs to address pride and workmanship problems on a case-by case basis; quality assurance often requires a free-standing program of its own, such as ISO 9000.

Good housekeeping is both a cause and a symptom of pride and quality. Doing the job right includes jobsite cleanup. Proud mechanics will generally keep their equipment in good order if allowed; they certainly will if management expects good order. The loss prevention aspects of housekeeping are further discussed in *OVERVIEW* Section 14 (PRC.1.14.0).

Facilities and Equipment

The old adage, "It's a poor worker who blames the tools" is only true for a worker who has the correct tools. No craftperson can do quality work without the right tools and equipment and a well-located and equipped shop. Facilities and equipment involve other considerations than tools and a shop, though:

- Hot work is less likely to be done in the wrong places if the right place is properly located and equipped. See Section 9 of *OVERVIEW* (PRC.1.9.0) for more information.
- Many lubricants, fluids and other materials are flammable, combustible or otherwise hazardous. Personnel need to know the hazards and how to control them; properly designed storage, dispensing and disposal facilities are needed. See *OVERVIEW* Section 8 (PRC.1.8.0) for more information.
- Machines will eventually need to be dismantled and moved. When installing machines, plan ahead; if there is a crane in the area, make it strong enough; if this is not practical, provide portable crane access, and ensure management-of-change procedures will not allow a later project to block the access.
- Maintenance tools require maintenance. See, for example, that standard gauges and other test equipment are kept calibrated and that rigging equipment is regularly inspected and proof tested.
- Maintenance training often needs shop facilities. If a dedicated training shop is not practical, provide training space and resources in the main shop.

Work Order System

The work order system must efficiently handle huge amounts of information and many kinds of input and output, yet be understandable at its interface by the least-skilled operator, clerk and maintenance worker. In other words, the internal complexity of a good work order system is transparent to its users.

Work order systems should control three basic functions:

- Authorize and define work: Provide information about work type and scope, location, urgency and cause.
- Plan and control work: Measure and record the amount of incoming work; assign priorities; provide the information that is needed to plan; schedule and coordinate methods, materials and labor; supply supervisors and technicians with instructions and time estimates; accumulate job progress information; and record and measure the amount of completed work.
- Accumulate maintenance history: Collect the time, cost and performance data from which time estimates and cost, performance and schedule compliance measures can be developed and improved.

Elements of a typical work order include:

- Work order number: Must be unique; may or may not have any coded meaning.
- Work type: Breakdown/emergency, general repair or maintenance, preventive maintenance (PM) inspection, corrective repair work from PM inspection, operator support and modifications, etc. Provides meaningful expenditure division for budgeting, control, and variance calculation and for PM effectiveness analysis.
- Priority: Separates plannable from unplannable work, indicates available lead time for planning, facilitates work order execution sequencing. Easily abused if not well-defined, audited and controlled.
- Crafts/skills needed and crew to which the job is assigned.
- Status: Waiting to be planned, waiting for engineering/design, waiting for materials, waiting for downtime, scheduled, completed but awaiting materials rebuilding or print revision, closed, etc.

- Failure cause: Entered by the assigned craftperson or by a root cause analyst upon job completion.
- Authorization: Screen unnecessary work, approve scope, authorize resources, control priority system use. Special authorizations for repairs, alterations, modifications, improvements (management-of change) and capital expenditures.
- Condition(s) found.
- Action(s) taken.
- Component(s) involved.
- Time and materials.

A superior craftperson might “make do” with inferior tools, but no maintenance organization will succeed without a good work order system. Work order systems can be home grown, using available literature and consultants for assistance when needed, or they can be purchased and modified. In all cases, consider the following:

- The system must be user-friendly. Unique jobs need separate work orders that can be initiated easily and correctly by anyone, including operators, housekeepers and inspectors who are responsible for identifying maintenance needs. Standing work orders may be useful for ongoing and routine jobs having known content and frequency, such as: machine lubrication and adjustment; relamping; housekeeping and custodial work; transportation; and fire prevention inspections. Work order logs might be used for jobs scheduled within a short time frame that are too simple to benefit from planning. However, in general, less than 20% and preferably less than 10% of work should be on nonstandard work orders.
- Emergency work should be entered into the work order system during or after the fact.
- All work orders must be reviewed to ensure that management-of-change procedures are followed as appropriate. See PRC.1.0.2.
- Regularly audited priority assignment procedures should ensure the lowest priority consistent with the job is assigned. Job priority should automatically increase as jobs age. Operating departments should periodically justify their requested level of emergency work.

Reliable maintenance cost reporting depends upon effective systems that charge labor, material and service costs to individual work orders and then in turn to items of equipment, cost centers, accounts and budgets. Maintenance management needs cost distribution information to calculate or detect:

- Total equipment repair cost by type of work, labor and parts.
- Above-average maintenance costs for groups of similar equipment.
- Comparative maintenance costs among like pieces of equipment.
- Maintenance cost trends that facilitate rebuild/replace decisions.
- Purchase cost versus maintenance cost for selected similar pieces of equipment, or life cycle costs.
- Reports by failure type.

Computer Support

A large industrial facility can have hundreds of machines, thousands of components and possibly a million parts, any of which can shutdown or seriously inconvenience the facility by catastrophically failing. No person and no paper system can possibly manage the maintenance information that such a facility place requires. Collecting and effectively analyzing maintenance information for even a large office building, hospital or university campus requires a computer-based maintenance information system.

The computer database needs to be intelligently designed, with limited options allowed for most entries. For example, “air tank,” “air tnk,” and “air tk.” are all different to a computer. Uncontrolled data entry results in chaos and a failed system. Plain-text entry should be minimized and carefully controlled.

In addition to managing and analyzing maintenance-based information, the maintenance information system needs to communicate with the systems used by stores, purchasing, payroll and the facility cost distribution and budgeting systems. Implementing such a system is a major undertaking, however, when functional, the system should perform the following functions and analyses:

- Planning and work measurement
  - Work order generation
  - Work measurement (to established job standards)
  - Backlog management
  - Preventive maintenance scheduling
  - Weekly master scheduling
  - Major project scheduling
  - Daily job scheduling
  - Personnel deployment
  - Labor planning, forecasting and balancing with the workload
  - Material planning, forecasting and allocating
  - Component maintenance forecasting
  - Critical path scheduling
- Scheduling and work assignment
  - Job loading
  - Job scheduling
  - Equipment access
  - Labor assignment
- Equipment History
  - Job costs
  - Materials usage history
  - Labor usage history
  - Payroll linkage
- Control reports
  - Work program, to keep resources balanced with workload
  - Work-in-progress status
  - Inventory status
  - Labor efficiency
  - Materials trends
  - Actual versus planned status
  - Equipment performance
  - Overtime control
  - Vendor analysis
- Control accounting
  - Maintenance indices
  - Budgets
  - Payroll

    - Labor and material allocation by equipment
    - Plant property database
    - Facilities cost forecasting
- Engineering Calculations
    - Simulations
    - Mean time between failure
    - Statistical evaluations

Using a fully integrated computer-based maintenance information system can benefit the loss control program in several ways. For example:

- The system can be linked to up-to-date drawings and procedures, and can be arranged to automatically provide these items as part of the work order package.
- Hot work permits and authorization, required isolation and lockout/tagout instructions, pre-and post-maintenance valve and switch lineups and other safety-related items can also be incorporated.
- Feedback from previously-performed jobs can be provided almost automatically, thereby avoiding repeated errors.

Work Planning

Each dollar invested in planning saves three to five dollars during work execution. A planned job typically requires only half as much time during execution as does an unplanned job. No organization would survive very long if it regularly sent production crews into the facility and, without the right materials, the appropriate mix of skills, the right tools or enough time, expected the crews to produce product. Planning pays; the need for planning should be obvious, yet, the planning function seems to be one of the first to disappear during corporate reengineering and downsizing efforts. A stable facility with a substantial inventory of previously-planned job packages that cover all its essential tasks might be able to do without; but any other facility needs planners.

Maintenance is managed by managing the backlog. It is impossible for a facility to be proactive if resources are not kept in balance with the workload. If the overwhelming majority of jobs are not planned, there is no effective way to know what the backlog is; therefore it cannot be managed. Two to four weeks of planned backlog is considered the norm, based upon 80 to 90% of jobs being planned.

Planning is critical to loss prevention, because the planning stage is the time to incorporate safety program support into the job package, before the pressure to finish the job begins.

Work Measurement

Work measurement systems support planning. Work measurement and analysis produces maintenance labor and resource estimates that are essential to the entire planning, scheduling and control process. In order of increasing sophistication, work standards and estimates may be produced by:

- Supervisor or planner estimates
- Historical averages
- Averages or estimates adjusted by work sampling
- Analytical estimates (based upon job element computations)
- Engineered job standards

Material Support and Control

This element is intended to get the right materials to the right place, at the right time, at the lowest cost; avoid excess inventories; charge stock and direct-purchased items directly to jobs; and be accessible to supervisors, planners and craftspeople.

Inventory management is a management specialty for which numerous resources are available, however, it is important to consider that maintenance stores pose special problems. Expensive items that do not move are anathema to scientific inventory control systems, and yet, failing to stock large spare motors, spare rotating elements for turbomachines, spare rolling mill gears and the like can impose a heavy penalty in downtime and expediting expenses should a failure occur. Risk-based analysis should be incorporated into stocking decisions for such major items. Also, proper preservation of major spare parts is a specialized task that requires maintenance and store room coordination.

Finally, the normal business reflex to seek the lowest cost needs to be tempered by performance feedback from the maintenance department and by the need to follow management-of-change procedures whenever material substitutions are considered.

Scheduling and Coordination

Scheduling is the marketing arm of the successful maintenance organization. If maintenance does not schedule effectively, it will not consistently do jobs right, the first time, on time. If maintenance cannot produce an acceptable schedule and live by it, the maintenance department is likely to see nothing but emergency jobs and be forced into a reactive posture.

Maintenance staff who know what they are going to do before they are expected to do it have time to prepare mentally and otherwise and are therefore likely to be more effective, and safer.

Equipment History and Records

This a fundamental maintenance management element and the primary maintenance engineering tool. Maintenance departments that do not study equipment history are more likely to suffer repeated failures. Equipment history helps:

- Identify equipment that requires abnormally high maintenance levels
- Analyze repetitive failures
- Compare projected maintenance cost with replacement cost
- Justify and refine the overall program

Equipment records include up-to-date drawings and specifications for all equipment and systems. A facility that cannot provide an up-to-date electrical distribution system drawing cannot be considered highly protected.

Maintenance Engineering

This is the maintenance program central intelligence. Maintenance engineering uses the information that is collected and managed by the other elements to refine and continuously improve the facility and equipment reliability. Maintenance engineering:

- Administers and applies equipment history; analyzes the data to ensure maintenance program effectiveness.
- Defines, develops, administers and refines the PPM program; adjusts intervals and procedures to optimize maintenance resource use.
- Manages lubrication programs (PRC.6.0.8.3), vibration monitoring programs (PRC.6.0.8.1.1) and infrared inspection programs (PRC.1.3.1).
- Manages transformer oil testing programs (PRC.5.4.5) and other electrical preventive maintenance programs (PRC.5.0.5).
- Writes work and safety procedures.
- Analyses proposed new equipment and facilities for life-cycle cost and maintainability.
- Uses accumulated information to identify modifications that cost-effectively maximize equipment reliability and minimize maintenance and its associated downtime.
- Performs remaining life and life extension analysis (PRC.1.3.2).

- Checks out new installations and approves them for maintenance acceptance.

Maintenance engineering needs access to the facility hazard analysis to ensure all process hazards are considered and, where possible, reduced or eliminated. Section 13 of *OVERVIEW* (PRC.1.13.0) discusses hazard identification and evaluation. Maintenance engineering is also a good place to assign management of loss prevention recommendations. See Section 6 of *OVERVIEW* (PRC.1.6.0).

If the same engineers are responsible for project work or for production engineering and also for maintenance engineering, they are likely to be consumed by the other demands. A dedicated maintenance engineering staff is more likely to be proactive in its approach to problems and responsive to requests for assistance.

Preventive/Predictive Maintenance

This element is often poorly understood. Worse, the terms are victims of ever-changing fads and buzzwords.

NFPA 70B describes preventive maintenance for electrical equipment as “any managed program of inspecting, testing, analyzing and servicing electrical systems and equipment for the purpose or maintaining safe operations and production.” PRC.5.0.1 expands that definition. But other reputable groups define the term differently. Some limit preventive maintenance to actions performed on fixed schedules. These groups often coin new terms to suggest newer, better programs.

This section uses the term “preventive/predictive maintenance (PPM)” to avoid confusion with any currently-existing fads or buzzwords. PPM refers to the subset of maintenance activities that inspect, test and measure equipment to detect adverse conditions in advance of failure. PPM is not intended to endorse any specific concept or philosophy.

As a stand-alone program, PPM is worthless. As one element of a complete management maintenance program, it is the program keystone. However, PPM only identifies conditions for the other elements to correct.

Effective PPM must be conducted as a controlled experiment. This means a schedule compliance of at least 90%; better 95%. Most PPM provides data points that mean very little individually. These points acquire high value when aggregated and their trends and patterns studied. If, for example, lubricant wear particle samples are not collected in a consistent manner under proper conditions on a regular frequency, they will provide little or no indication of a problem until failure is eminent. Properly conducted lubricant wear particle analysis can be a more sensitive early warning system than vibration analysis. Lubricant wear particle analysis teamed with vibration analysis in a controlled and coordinated PPM program can precisely monitor the aging process.

Routine, scheduled or planned maintenance has traditionally referred to maintenance performed on a time schedule. It can effectively manage failure mechanisms that are real-time or operating-time dependent. Sliding surfaces, such as sleeve bearings, piston rings, cams and followers, and some gears; and eroding or corroding surfaces such as vessel internals, pump impellers and wearing rings, and turbine blades were candidates for time-based procedures. While performance-based and predictive tools have been developed that can better measure the actual condition of many of these components without an overhaul, time-based maintenance is still the only way to control aging of some components, for example, those in combustion turbine hot gas paths.

Predictive maintenance refers to tools and techniques that directly measure machine or component condition. These tools include vibration monitoring and lubricant wear particle analysis.

Some components, such as gears and electrical insulation, have both measurable and random failure modes. These components require careful maintenance engineering study, to establish baseline data for all the available tests that can detect the random modes and to ensure sufficient physical inspections or overhauls early in life to obtain confidence in an estimated wear rate for the linear modes.

Various techniques have developed that allow confidence-improving inspections without overhauls. For example, flexible borescopes, or endoscopes, can partially inspect properly-equipped turbines without lifting the casings.

Some equipment, because of its particular design, failure modes, accessibility, environment or other factors defy cost-effective maintenance. This equipment, if its associated risk is low enough, might be allowed to run to failure. Otherwise, installed duplicate or standby equipment might be the only way to manage the risk.

All equipment needs to be maintained. New equipment does not have a “honeymoon period” during which no maintenance is required. Assuming that it does squanders the opportunity to collect baseline data; it also allows a random failure event, which might have been proactively detected, to cause an unscheduled outage. Further, it could allow the equipment to deteriorate to the point that a major overhaul is needed before PPM can be effective.

The PPM program must also address fire protection equipment inspection, which is further discussed in Section 12 of *OVERVIEW* (PRC.1.12.0).

DISCUSSION

Risk-Based Methods

Risk is a two dimensional combination of failure probability and consequence. A risk-based analysis starts by defining systems and their success criteria. It continues by breaking the systems into components and using the system success criteria to define component success criteria. Then, for each system and component, it defines the risk of failure. Once risk values have been assigned or calculated, components are sorted by risk level, or risk-ranked. Then, inspection and maintenance programs are designed that focus resources on the highest risk components.

Risk-based decision making can be qualitative or quantitative. Qualitative methods rank failure probability and consequence in broad categories, such as “very high,” “high,” “medium,” “low” and “very low.” The analyst plots the items being ranked on a grid like the one shown in Figure 1, in which the highest-risk items fall in the upper right-hand corner of the plot. Quantitative risk-based methods base ranking and other decisions upon calculated or estimated failure probabilities multiplied by consequence costs. Qualitative methods are much more easily applied, and are suitable for preliminary risk analyses in all cases. They are often used to “pre-screen” major facility units. Such methods may also provide enough analytical depth for uncomplicated facilities or for moderate-risk facilities. Quantitative methods are needed for complex and high-risk facilities. They are also required when risk-rankings from dissimilar facilities need to be compared.

The formal risk-based method is a living process. When maintenance activities reduce risk on the first cut of high-risk components, the focus naturally shifts to another set of components. The risk-reduction process continues until all components meet management-defined acceptable risk criteria.

Basing maintenance programs on properly calculated failure risk is the only safe and effective way to achieve the optimum maintenance level. When there is a high level of maintenance, maintenance costs are high, but operating costs are reduced, and at some extreme maintenance level, repair costs disappear. When maintenance costs are reduced, operating and repair costs increase. Efforts to optimize the balance by looking only at maintenance, operating and repair costs fail because of the way these costs are often calculated. Reducing maintenance reduces direct costs such as labor, overtime, contract services, overhead and benefits, and maintenance materials. However, avoiding failures also reduces indirect costs that are not normally considered as maintenance costs. Using a formal risk basis for maintenance decision-making brings into the equation costs associated with:

- Unnecessary startups, shutdowns and equipment failures in service, with their associated higher probability of:
    - fire, explosion and injury;
    - unnecessary cleanup,

    - waste disposal and environmental damage costs
    - and regulatory fines;
- Excess downtime,
- Missed schedules,
- Lost good will and business opportunities,
- Unnecessary production of defective goods, seconds and scrap,
- Customer complaints and
- Product liability exposures.

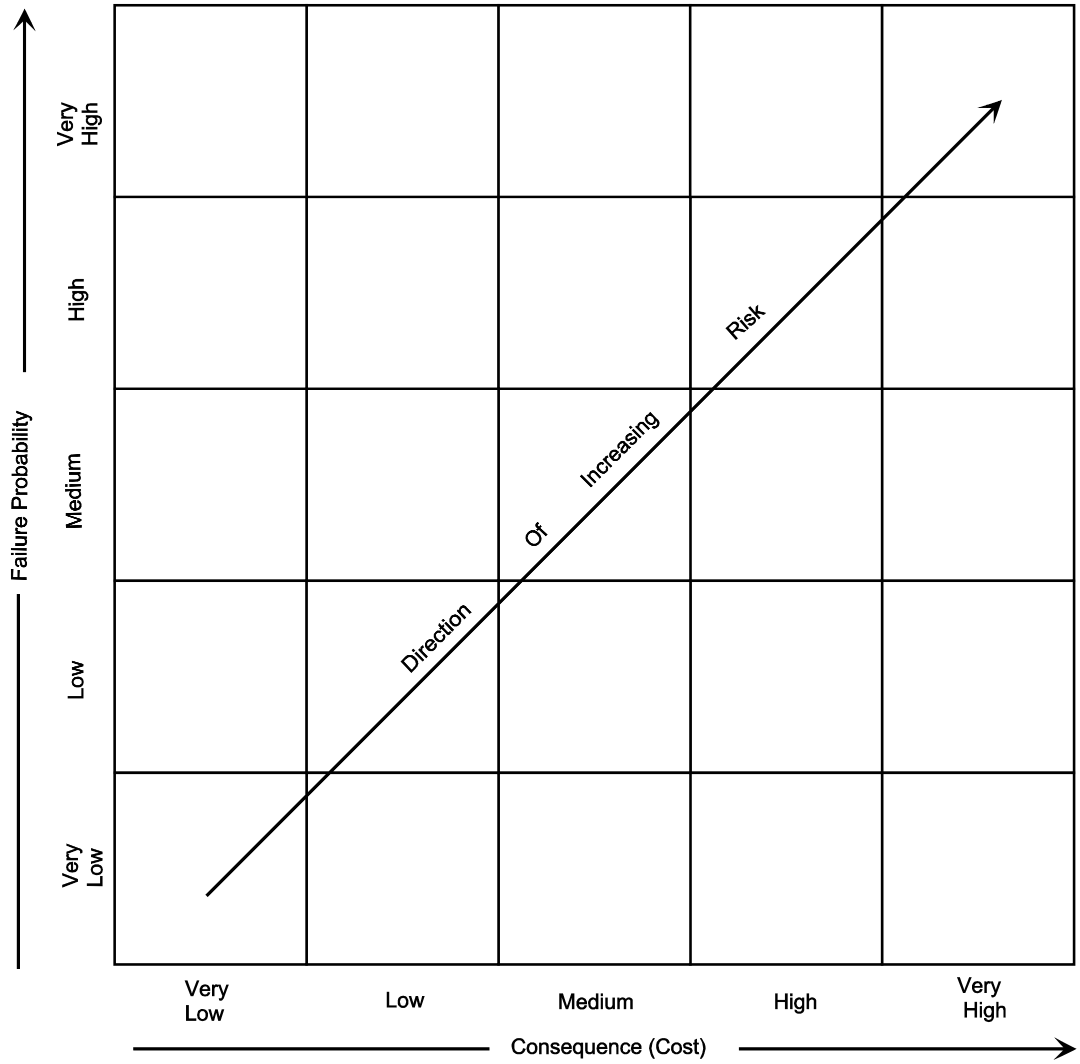


Figure 1. Matrix For Qualitative Risk Plot.

Failure to consider all these costs will make maintenance cost reduction look more attractive than it really is.

Proactive vs. Reactive Maintenance

Proactive maintenance is work that is planned and scheduled and is completed at a time in the aging process when the condition being corrected can be restored with a minimum investment. Consider a rolling-element (anti-friction) bearing in an important piece of equipment. Proactive maintenance lubricates the bearing to ensure that it ages as slowly as possible and monitors it to detect the onset of failure as early in the failure process as possible. Proactive maintenance then schedules bearing replacement at an early opportunity, before the bearing fails. The proactive approach has several clear advantages:

- The probability is maximized that only the bearing needs replacement, and not the shaft, rotating components, bearing housing and possibly the casing.
- Engineering has time to determine what other work should be done at the same time. Engineering also has time to study the machinery history and, while the bearing is being replaced, implement other changes that could improve overall performance and reduce future maintenance needs.
- Planning can ensure that the procedures, parts, tools and skills needed to do the job right the first time will be available.
- Management, not the machine, decides when to do the job.

Reactive maintenance might or might not lubricate the bearing, but otherwise takes no action until intolerable performance or breakdown occurs. The reactive approach has several clear disadvantages:

- More, possibly much more, than the bearing will probably require attention.
- Opportunistic work probably cannot be arranged.
- The required parts and other resources may or may not exist, much less be available at the facility.
- The necessary people will almost certainly have to be pulled off other jobs to perform what will be an emergency job.
- The machine, which has no respect for production schedules or anything else, decides the scope of work and schedules the job. Management is a guilty bystander.

Breakdowns will occur; legitimate emergencies will arise. However, the immediate reaction to a breakdown signals very strongly the facility commitment to proactive response. If restoring production is the only consideration, commitment to proactivity is lacking. A proactive approach will first determine the root cause of failure so that maintenance engineering can, during the restoration or later if absolutely necessary, eliminate the cause of failure.

Deferred Maintenance and Maintenance Backlog

Deferred maintenance is the best way to move further into the reactive mode. Deferred maintenance spends down the capital invested in equipment. Consider an automobile. It will probably run for some time, possibly a long time, beyond the recommended oil change interval. However, the probability steadily increases that, when maintenance is finally performed, an engine change will be needed as well as an oil change. Short of that extreme is the probability that the deferred maintenance will unnecessarily age the engine.

The maintenance backlog is the work, measured in craft hours, that has been requested but not yet performed. Too little backlog means that the maintenance staff does not have enough work to stay effectively employed; too much backlog means that maintenance is being excessively deferred. For example, facilities have been surveyed in which maintenance on the most important machinery had been deferred for years because it was the most difficult machinery on which to work. An efficient priority system with an automatic job aging feature will prevent individual items in the backlog from being indefinitely deferred.

Maintenance Job Types

Maintenance departments must respond to three distinct types of maintenance request:

- **Routine maintenance** includes preservation activities such as cleaning, lubrication, visual inspection and testing and also planned and preventive maintenance activities such as taking vibration readings and lubricant samples for analysis.
- **Backlog relief** is the bulk of the maintenance department work. It is the investigation, repair and restoration activity the need for which is identified by operators or by persons performing routine maintenance work.
- **Emergency response** takes immediate action to address breakdowns and other suddenly-developing conditions.

Traditionally, the emergency response has consumed excessive maintenance resources. Although absolutely necessary, emergency response is a wholly reactive function. Proper attention to the routine work and timely backlog relief will minimize the demand for emergency response.

The Role of Contractors

Contracted service use is growing for several good reasons. Payroll and its associated costs are reduced. Specialty skills and equipment are not "carried" during the intervals between use. New or different technologies can be tested without equipment purchase or training costs and without risk of being stuck with unsatisfactory equipment following an unsatisfactory trial. However, contractors have played a significant role in several major losses. Some factors to consider:

Contractors must be thoroughly trained in and comply with all facility loss prevention programs, such as hot work permitting and control, system isolation and inerting, and lockout/tagout. Training costs and compliance requirements must be part of the contract.

Contractors are often used for routine maintenance. This has certain management advantages; this work is by definition predictable and is often specialized. However, persons performing routine maintenance can provide important "sensory input" to the maintenance program. If the routine maintenance providers are not wholly invested in the facility mission, they are unlikely to report adverse conditions that are outside their assigned scope of work. For example, the person taking vibration readings can also detect and report leaks and abnormal noises. If contractors are doing a lot of routine maintenance, the added burden on the facility loss prevention inspection program needs to be addressed. See Chapter 10 of *OVERVIEW* (PRC.1.10.0) for more information.

Contractors can obviously help with timely backlog relief. The jobs in the backlog are planned and therefore fairly easy to specify and schedule; however, management needs to control job performance and ensure that correct procedures are followed, nondestructive testing methods are used, and that any conditions requiring attention that are outside the job scope are detected and addressed.

Contractors are seldom used for emergency work; the facility emergency response is often looked upon with pride. This attitude needs further thought. Emergency maintenance is often specialized. It is not planned by the facility, but it could be work that has been previously well-planned and performed by an available contractor. Emergency work is the enemy of proactivity. Therefore, once the root cause of failure has been determined and any necessary engineering input made to scope the corrective work, "jobbing out" emergency response work might make sense.

The final consideration is responsibility. The attitude occasionally becomes evident that, because a contractor is doing a job, "It's not management's problem." This attitude is dangerous. Management is always responsible for the facility. Suppose that a contractor could be assigned legal liability for a fire or for a post-job failure. Few contractors, if any, have the financial resources to rebuild a multi-million dollar facility or to make good several hundred thousand dollars per day of business interruption costs, lost orders and goodwill and the rest. Contractor activities in some ways require more management oversight than in-house activities may require.

MAINTENANCE PROGRAM EVALUATION

INTRODUCTION

Maintenance programs seek to avoid structural failures and unplanned equipment outages by managing the aging process. Maintenance begins with operational tasks, such as cleaning, lubrication and on-line monitoring. It continues with the scheduling of outages for inspection and for taking corrective action before failures occur. Finally, it involves stocking parts, identifying alternate means of production, and otherwise being prepared for the “unpreventable” accident.

A proper maintenance program is a formal and fully documented plan, as described in *OVERVIEW*. Those plans which have proven effective are based upon the principles of preventive maintenance. They contain elements of planned maintenance, predictive maintenance and pre-failure planning. To be of value, a maintenance program must have visible and unmistakable management support.

Risk assessment and continuing review are vital elements of good maintenance. The most serious fault of many maintenance programs is the tendency to maintain items that are easy to maintain rather than those which are important, or those items which are highly visible rather than those which are most prone to failure.

POSITION

Every facility should have documented management programs for maintenance. Maintenance activities may be performed and managed by the facility owner or a contractor. In all cases, means should be provided for monitoring, control and support by top management.

The maintenance program should include the following elements:

- A **written maintenance policy**, which has the unequivocal support of all levels of management including the highest in the organization. The maintenance and inspection department(s) should report directly to top management. If either or both of these functions report to or through production management, there should be an aggressive audit and control program installed by top management to ensure that maintenance schedules are followed and that conflicts are not routinely resolved in favor of production.
- An experienced **maintenance manager**, dedicated to loss prevention, of sufficient stature within the organization to be credible in disputes with production staff, who has authority over all maintenance activities, whether they are performed by maintenance staff, production staff or contractors.
- Detailed **maintenance procedures** describing what is to be maintained, how it is to be maintained, and how often it is to be maintained, including standards to be met and the quality controls to be used. All safety-related and key equipment will have operational, predictive and

preventive maintenance principles applied. The procedures should include restoration of all systems and equipment to a normal lineup. All contracts for maintenance work should require compliance with these procedures.

- A computer-based **maintenance information system**.
- An **impairment program**, similar to the RSVP Impairment Handling program (see *OVERVIEW* Section 1 [PRC.1.1.0]), to control conditions of compromised protection. It should be rigorously followed to ensure notification of management, operating staff and other concerned persons when safety-related components and systems are not in service for maintenance or any other reason. These procedures should include persistent follow-up to ensure that this equipment is restored to service as soon as possible and that appropriate safety precautions are taken in the interim.
- Documented **maintenance personnel training programs**, including specialty and periodic refresher training where appropriate. (See *OVERVIEW* Section 4 [PRC.1.4.0].)
- Maintenance department sign off on new construction and facility modifications to help ensure that maintainability and loss control features are not neglected. (See *OVERVIEW* Section 5 [PRC.1.5.0].)
- Input from the Hazard Identification and Evaluation (see *OVERVIEW* Section 13 [PRC.1.13.0]) to set priorities by identifying critical components and systems and promptly establishing procedures to oversee their integrity.

While by no means a complete list, the maintenance program for any facility should address:

- Maintenance and inspection of fire protection equipment, as outlined in Section 12 of *OVERVIEW* [PRC.1.12.0].
- Jurisdiction-required inspections of boilers, pressure vessels, refrigeration systems and piping.
- Infrared examination, insulation resistance monitoring and trip calibration of electrical equipment.
- Conventional and gas chromatography analysis of transformer and circuit breaker insulating fluids.
- Vibration monitoring for all critical rotating equipment and for any rotating equipment larger than 1000 hp (750 kW).
- Standards for recommissioning of equipment which has been idle.

AXA XL Risk Consulting is convinced that a maintenance program appropriate to a facility will have a sufficient payback in loss prevention and control, however, such benefits are difficult to measure. Installing a proper maintenance program may increase overall maintenance costs for 12 to 18 months, but should substantially reduce them thereafter. Intangible benefits include:

- Improved morale in the work force.
- Better reputation in the community.
- More reliable delivery of product or service.

DISCUSSION

The ultimate objective of a maintenance program is to keep a facility operational. A good maintenance program will employ the techniques of management to prevent losses and to minimize the scope and consequences of those that do occur. Such a program will also minimize maintenance and repair expenses. The distinction is necessary because even facilities that practice “breakdown maintenance,” or operation of equipment to failure, seek to keep equipment on line.

A good maintenance program will reduce costs because it will:

- Anticipate failures, allowing down time to be scheduled when it will cause the least disruption.

- Assess the consequences of failures, allowing maintenance resources to be targeted in a manner to minimize the probability of occurrence of the worst consequences.
- Prevent failures if the consequences are intolerable or more costly than the effort to prevent them.
- Expedite repairs in the most effective way and identify alternate means of production to be used when failures occur. (See *OVERVIEW* Section 7 [PRC.1.7.0].)
- Provide the tools for self-diagnosis and correction where the program is ineffective.

Breakdown Maintenance

Breakdown maintenance refers to the practice of operating until failure occurs. The following characteristics of breakdown maintenance should be considered before selecting it for anything that does not have at least one installed spare:

- Maintenance is scheduled by the machine; maintenance activity will more likely occur on premium time than on straight time.
- Due to machine loading and possibly operator fatigue, breakdowns are most likely when production demands are greatest.
- There is no reason to expect that breakdowns will limit themselves to the capability of the work force. In other words, a staff of any size and collection of skills will almost always be either swamped or looking for work.
- Failure to correct minor and incipient problems often increases the probability of the eventual breakdown being catastrophic.

It is generally not economical to have a program which attempts to prevent all breakdowns of all components of all pieces of equipment in all systems. While most maintenance programs are combinations of preventive and breakdown maintenance, the latter should be confined to parts which are considered expendable and the failure of which will not cause unacceptable consequences or an outage of unacceptable duration.

The determination of expendability is a management decision which involves price, availability, and the consequences of failure. Critical and safety-related components certainly should not be considered expendable. Components whose failure does not cause significant loss or increase the facility’s exposure to loss may be considered expendable if management determines that the cost of maintenance exceeds the cost of unscheduled failure. For a meaningful analysis, the costs must include the cost of maintaining a sufficient stock of replacement components and in-process product to cover the expected failure rate.

Preventive Maintenance

The philosophical opposite of breakdown maintenance is preventive maintenance. This is an excellent name, because, in addressing the shortcomings of breakdown maintenance, preventive maintenance prevents, or at least tends to minimize, maintenance. Preventive maintenance tools include operational, planned and predictive maintenance, maintenance records analysis, quality control, pre-emergency planning (*OVERVIEW*, Section 7 [PRC.1.7.0]), and maintenance input into equipment specifications and designs.

Operational Maintenance

Operational maintenance refers to activities performed while equipment is in service. Typical activities include:

- Lubrication.
- Changing duplex filters or strainers.
- Testing alarms and other safety features.
- Tightening loose bolts and joints.
- Vibration monitoring.

- Watching and listening for signs of trouble.

For most equipment, it will include maintaining logs of:

- Important parameters.
- Maintenance and preservation activities.
- Any changes and significant observations.

An effective log program should include:

- Regular gathering of information.
- Collection of enough information for intelligent interpretation.
- Periodic review of data.

Operational maintenance is often the province of the operating staff, however, the logs and records should be subject to review by the maintenance department. Performance of operational maintenance should be verified by audit.

Planned Maintenance

Planned maintenance systems (PMS) are those in which maintenance is scheduled based on elapsed time or on a specific number of operating cycles. Selecting correct intervals between performances of maintenance tasks is critical to the success of the program. If the intervals are too large, breakdown maintenance results. If too small, the shutdown of equipment to replace good parts quickly results in the perception that the program is nothing more than “going through the motions.” Sooner or later, the persons responsible for the tasks will do nothing but “go through the motions,” or worse, feel free to document work not actually performed. Breakdown maintenance will again result.

When intervals in a PMS have been selected, extensions should not be allowed without compelling reasons, supported by sound engineering and based upon analysis of the equipment. Valid support for such an extension might include documenting a careful review of operating parameters to detect any subtle deterioration, an analysis by an outside consultant, or an “on the fly” borescope or other examination of critical areas. Requests for extensions should be documented and require the approval of top management. Production convenience must not be permitted to dictate.

Inspection frequencies should be assigned based upon:

- The importance of equipment and the consequences of its failure.
- Previous inspection results and failure history.
- Service conditions.
- Time in service.
- Jurisdictional requirements.
- Loss prevention company recommendations.

Predictive Maintenance

Predictive maintenance is similar to planned maintenance, however, activities are performed upon the deterioration of a selected parameter rather then upon lapse of time or number of operating cycles (though maximum values must be established). Examples of appropriate parameters are vibration amplitude for rotating machines, differential temperature for heat exchangers, and insulation resistance for electrical windings. Management support for taking the necessary maintenance action whenever the selected value is reached, regardless of the elapsed time, is crucial to the success of a predictive maintenance program.

Both planned and predictive maintenance systems depend upon feedback through a maintenance information system. If the conditions found during maintenance operations are collected and monitored over time, there will be a sound basis for adjustments to maintenance intervals or critical parameter values, increasing the effectiveness of the maintenance program and reducing its cost.

Maintenance Information Systems

A maintenance information system should allow the maintenance manager to gather data that will be used to evaluate all maintenance decisions. It will include equipment failure data which may be fed back to designers or manufacturers, used for process hazard evaluation (see *OVERVIEW* Section 13), or sent to the purchasing department to support changes to specifications or the selection or avoidance of vendors or equipment types.

A computer-based maintenance information system should be installed to provide:

- An easily retrievable historical record for each piece of equipment, group of similar pieces of equipment or system.
- Schedules for the scope and frequency of inspection and service for all equipment.
- A method of persistent follow-up to ensure that inspection and maintenance services are being performed according to schedule.
- A means of assigning priorities to equipment repair or maintenance tasks.
- Specifications for special replacement parts and materials. A list of qualified suppliers for these items should be available by cross-reference.

A computerized information system can easily and routinely focus attention on areas of need by identifying, for each machine, component or group, statistics such as:

- Highest/lowest cost to maintain, overall and per unit.
- Highest/lowest downtime and failure rate.
- Spare parts usage.
- Lost production hours or units.

Analysis of data may reveal various equipment and failure modes which are not preventable by planned or predictive maintenance. Events which occur at random intervals or which give no outwardly measurable symptom prior to failure may, depending upon their consequences, require:

- Process redesign.
- Redundant equipment or containment boundaries.
- Automatic shutdown systems.
- Fixed fire or explosion protection.

Solutions of this nature are also necessary when some components of a facility are demonstrated to require shorter inspection or maintenance intervals than the facility as a whole or various critical operating units. Utility equipment, such as boilers, deaereating feed tanks, transformers and switch gear, well pumps and compressed air systems require careful consideration in this regard, because most of these must operate if any part of the facility is on line.

Contract Maintenance

The arguments for contract maintenance are persuasive. Tasks can be performed by personnel who specialize in them and perhaps do no other work. This is attractive to smaller facilities which cannot keep most specialists busy at their specialties. The arguments against contract maintenance are also persuasive and often emotional. Having vital plant functions performed by outsiders does not appeal to some.

The need for a contract service must be carefully analyzed. The contractor must be carefully selected, considering competence, hiring practices, compatibility, financial responsibility and safety record. All the areas of responsibility of the contractor and of the facility personnel must be clearly specified by the contract, particularly the requirement that the contractor adhere to all facility safety and quality control procedures.

It must be clear from the beginning of negotiations and be constantly reinforced by planned oversight and audit that management is committed to the highest standards of performance and of loss prevention. In particular, management should retain the right to discipline contractor personnel who violate loss prevention regulations. This should include the right to exclude individuals from the premises and to terminate the contract if violations persist.

For additional information on control of outside contractors, see Appendix B to *OVERVIEW* Section 5 and Appendix C to *OVERVIEW*, Section 11.

Maintenance Quality Control

Failure of equipment shortly after overhaul can give maintenance a bad reputation, reinforcing the erroneous notion that it is always better to let a smoothly running piece of machinery continue to operate than to open it for inspection and risk causing problems. The fact is that properly performed maintenance contributes to reliability.

Just as top management insists upon quality in production, management from the highest level downward should insist upon quality in maintenance. The following should apply to all maintenance, whether performed in house or by contractors:

- Loss prevention is paramount. This requires hot work permits, proper fire protection impairment procedures, and shutdown or additional staffing of operating equipment whose protection is compromised by any activity.
- Maintenance management has the authority to take the time to do the job correctly the first time. It trains its staff in proper practices and insists that they are followed.
- Maintenance activities are performed in accordance with detailed written procedures, updated in response to any problems encountered and to reflect advancements in the state of the art.
- Deviations from written procedures for any reason must have the prior written approval of facility management.
- Access to areas, such as gear and turbine casings, switchgear cabinets, boilers and vessels, is strictly controlled, such that no person, tool or material can enter without being documented in a log to ensure proper disposition. Lanyards are used when appropriate to keep tools from being dropped into inaccessible areas.
- Installation and removal of safety devices, such as valve gags, switch and shaft locks, jacks and wedges used for personnel and equipment protection during maintenance activity, are documented.
- No “design modifications,” such as reinstalling only a fraction of the bolts in a flanged connection, are made without sound and documented engineering analysis.

Maintenance Inspections

Inspections are a necessary part of all maintenance systems. They determine the degree and rate of equipment deterioration. An inspection program, aided by computer analysis, can predict the probable time of failure for most equipment so that prior replacement or repairs can be made. If inspection reveals no deterioration, unnecessary maintenance may be avoided.

The maintenance or inspection department may also provide quality control monitoring of work in progress and oversight of contracted services. This activity should include audits to verify that plant and vendor personnel are adhering to written procedures, corporate standards, jurisdictional requirements, and good engineering practice.

Spare Parts

Efficient performance of most maintenance activities requires a facility to have a stock of spare parts on the premises or otherwise to be readily available. Some parts, such as seals and bearings, regularly require replacement due to normal wear. Other parts, such as valves and small drive motors, are replaced from stock and reconditioned so that the downtime can be minimized. Major machinery units, such as turbines, may require a spare rotating element because the lead time to obtain a replacement is excessive.

Spare parts should be available so that important components or systems that fail will be returned to service as quickly as possible. For other equipment, management of spare parts will depend upon the consequences of failure, and the cost, availability, and lead time for the parts.

The parts should be maintained and should be managed by an inventory control system. The control system should include written procedures for proper storage of large, complex or sensitive parts, such as turbine rotors, electric motors or coils, or electronic modules.

INFRARED INSPECTION

INTRODUCTION

Many loss-producing conditions, like high resistance at electrical connections and accelerated wear in bearings, cause abnormal temperatures in the area of incipient failure. An infrared (IR) thermometer or imaging system can often detect these abnormal temperatures in equipment while the equipment is in service.

IR inspection is the most effective tool currently available for detecting many electrical equipment problems. It can efficiently detect conditions such as wet or damaged thermal insulation, leaking steam traps and compressor valves, or unequally-performing cylinders in internal combustion engines and some compressors. It can support mechanical equipment maintenance tools, such as vibration analysis and lubricant wear particle analysis that detect mechanical misalignment and worn or damaged bearings in machinery.

POSITION

IR inspection is an essential part of an effective maintenance program. IR inspection is a nondestructive test (NDT) method; any such method is most effective when applied in accordance with a written procedure or protocol. SNT TC-1A provides guidance for NDT procedure development. NFPA 70B describes how to apply IR inspection within an electrical preventive maintenance program.

Using an IR imaging system or thermometer, operated by in-house staff, a centralized corporate support team or a contractor, apply IR inspection as follows:

- Perform IR inspections on facility equipment in accordance with Table 1.
- IR inspect newly installed and repaired electrical equipment while under load soon after placing it in service.
- Promptly investigate and correct any adverse conditions found during an IR inspection.
- Provide IR inspection results to maintenance engineering for analysis.

IR thermography is only one of the many tools a complete maintenance program will include. If IR thermography does not prove beneficial in a particular application, substitute another tool.

Local overheating may have more than one cause, particularly in mechanical equipment. Therefore, after correcting a condition located by an IR survey, arrange a follow-up IR survey soon after the repaired equipment is returned to service.

TABLE 1
Suggested Infrared Inspection Frequencies

Equipment To Examine	Where To Look	Initial Frequency (1)	Typical Conditions Found	Alternate Or Supplemental Tests
All electrical power distribution switchgear and transformers, 480 volts AC or higher and all DC including rectifiers	Panels; breakers and their “stabs” or connections; cables, bus ducts, and bus structures; bushings and other connections; fuses and fuse clips; transformers, including their tanks and heat exchangers	Annually	Loose or otherwise defective connections, incipient ground faults, hot spots (10 -20°C [18-36°F] rise)	None
Electrical equipment in hot atmospheres or exposed to corrosive, conducting or insulating particles such as chaff, water, corrosive chemicals, oil or carbon	As above in, for example, paper, textile or steel mills, foundries and smelters	Quarterly	As above	None
Severely exposed and heavily loaded electrical equipment	Arc furnace transformer secondaries, aluminum smelter busses	Weekly	As Above	None
Large motors and other large loads and their connections and controllers	As above, also windings and bearings	Annually	As above, also deteriorating bearings	Vibration and wear particle analysis, bearings only
Generators, exciters and their associated switchgear	As above	Annually	As above	As above
Mechanical equipment	Bearing housings, couplings, belts, conveyor drives and support rollers	Quarterly	Parts running abnormally hot or hotter than similar parts	Vibration and wear particle analysis
Compressor valves	Valve housing temperatures	Quarterly	Abnormally hot (leaking) valves	Dismantle
Engine and compressor cylinders	Compare cylinder head and exhaust temperatures	Quarterly	Cylinders hotter or colder than others	Cylinder balance or compression test
Insulated equipment (2)	Inspect outer surfaces	Monthly (3)	Hot spots; wet or damaged insulation	Surface pyrometer, strip and inspect
Primary reformer tubes	Tubes	Weekly	Over heating, unbalanced performance	None
Flat roofs	Whole roof	Annually	Leaks	None

NOTES:

1. Adjust the IR inspection scope and frequency as needed to obtain the greatest benefit.
2. Insulated equipment, particularly that in which internal refractory protects a load-bearing or pressure-containing metal structure from fire or other internally produced heat of reaction, should be IR inspected on a frequency determined by experience. A monthly frequency is suggested until experience indicates a more appropriate interval.
3. IR inspections for this type of equipment are most cost-effective for in-house IR programs but may also be effective if performed in conjunction with electrical equipment IR inspections.

Electrical equipment can be effectively IR inspected only while it is under load or within 1 min – 5 min after it is unloaded. Inspection may require removing back panels and other protective covers from energized switchgear and defeating or bypassing door safety interlocks. Appropriate personnel and equipment safety precautions are necessary, and jurisdictional restrictions may apply. Consult NFPA 70E and the local jurisdictional regulations for more information.

AXA XL Risk Consulting recommends purchasing IR equipment appropriate for the location and intended use. Operator dedication, training, experience and enthusiasm will influence program effectiveness. A management commitment to the program as well as a capital investment in equipment is necessary for success. If equipment purchase cannot be justified, or if desired for other reasons, contract IR services are available. This Property Risk Consulting Guideline should help specify services and evaluate offers of service.

DISCUSSION

IR radiation is an electromagnetic radiation similar to light. Its wavelength is longer than that of visible light. IR radiation is emitted by a body in proportion to its temperature. The amount of IR radiation emitted by a body at a given temperature also depends upon the emissivity of the body. Emissivity is a measure of the efficiency with which a body radiates. A lightly-colored, polished surface will tend to have a low emissivity and a dark-colored, dull surface will tend to have a high emissivity.

Emissivity is a number between zero and one. It is the ratio of the emissivity of a given surface to that of a perfect emitter, or blackbody. Most surfaces encountered in industrial work may be considered as having a 0.95 emissivity. If an accurate reading of absolute temperature is needed, standard tables are available to help more closely estimate the emissivity of a given surface. Some IR thermometers are designed to measure the emissivity of a surface having a known temperature. Such a device could be calibrated on a part whose temperature can be measured with a surface pyrometer, then used to accurately measure other locations having the same surface characteristics. Surfaces with an emissivity less than 0.5 generally cannot be measured accurately. Very low emissivity surfaces, such as polished aluminum, may not even reveal hot spots. Shiny surfaces may also reflect IR radiation from other sources that will make the surface appear hotter than it really is.

Most portable IR inspection devices are either thermometers or imaging systems. An IR thermometer indicates the temperature of the surface at which it is pointed. An IR imaging system produces a modified image of the object of interest. Different temperatures of the different portions of the object appearing on the display are discerned by using either a gray scale or a color scale. Either type of IR instrument is used by “scanning” all surfaces of the object to be inspected, looking for hot areas.

Temperature differences are the normal focus of an IR inspection. This is because the normal temperature of an object can vary with the applied load, ambient conditions and possibly the position of the sun and the cloudiness of the day. Hot spots are generally worth investigating regardless of their absolute temperature. If the absolute temperature is important, or for recording purposes, IR thermometers or imaging systems may need to be adjusted for object emissivity.

Other factors can influence absolute temperature measurements or the repeatability of results. For example:

- The apparent emissivity of an object varies with the viewing angle. For example, when inspecting the curved surface of a cylindrical object, only the portion of the surface directly facing the instrument can be measured accurately.
- Painted areas, rough spots, shiny spots, holes and threads all have different emissivities than the rest of an object being inspected and will therefore appear warmer or cooler than their surroundings.
- Varying insulation thicknesses can cause an object with a uniform temperature to appear to have several different temperatures.
- Wind and rain can cool an object; sunlight can heat it or be reflected from it.

Equipment Selection

IR thermometers are suitable for most loss prevention survey work, however, IR imaging systems are more versatile and are generally faster and easier to use. An appropriate IR thermometer can be obtained for between $500 and $800; fully-featured IR imaging systems generally cost between $20,000 and $60,000. To place the equipment cost in its proper perspective, consider that one hour of avoided downtime at most large facilities will pay for the finest IR instrument on the market. Further, as a bonus, a suitably accurate IR instrument may also have a variety of process or quality control applications.

AXA XL Risk Consulting strongly recommends IR imaging systems, particularly for manufacturing facilities. This type of equipment has significant advantages:

- It simplifies evaluation of the “big picture,” an important advantage in applications like thermal insulation surveys.
- When combined with a recording device, it provides a permanent survey record.
- An imaging system is less likely to miss hot spots, particularly small ones.

Many options and features are available for IR imaging systems. Persons interested in more information about this equipment should contact an IR imaging system manufacturer or vendor.

If the purchase and training costs for an IR imaging system cannot be justified, consider an IR thermometer. When selecting an IR thermometer, consider accuracy and temperature range, and also the following features:

Emissivity adjustment - While not necessary for most loss prevention activities, this feature allows more accurate measurement. It is necessary if absolute temperature measurements are required, particularly in process measurement or quality control applications.

Resolution - An IR thermometer is an optical device and, like a camera, has a focal length. Resolution is generally stated as “spot size” at a given distance. The spot size is the diameter of the circular area the detector “sees.” Most general purpose instruments have satisfactory resolution for loss prevention work, unless the instrument is to be used for viewing very small objects, such as circuit board-mounted parts or their connections, or objects which cannot be safely approached, such as outdoor high voltage lines or furnace internal components.

Sighting method - Unless an instrument has unusual resolution characteristics, the instrument “aiming” method is a matter of personal preference. Some instruments have “open” or “peep” sights and others have optical sighting systems. The simple sights are easier to use and possibly less fatiguing; the more complex ones are intended to be more accurate. Laser-sighted units are also available.

Ambient temperature compensation - This feature is not required unless readings will be made of objects located in areas where radiation from other objects at different temperatures may reduce accuracy. For example, accurately measuring the temperature of tubes in a furnace requires an instrument capable of compensating for the background radiation from the furnace walls.

Alarms - These may help reduce operator fatigue when large areas are to be inspected. If an alarm is set a few degrees above the “normal” temperature of the equipment being examined, the operator can direct full attention to a careful inspection without worrying about specific readings.

Latching - The ability to “latch” or retain the highest temperature found during an IR inspection may also help reduce operator fatigue.

Data logging - If many readings are to be taken on a regular tour, it may be convenient to obtain an instrument that will store a quantity of data and transfer it directly to a computer.

Auxiliary outputs - Analog or digital outputs may allow the unit to be used with a separate data logging device. They allow the instrument to monitor a piece of equipment by recording the temperature of a point of interest over time, or to act as a supplemental or backup input to an alarm or protective circuit.

Applications

Electrical equipment loss prevention surveys are an important loss prevention application of IR. Most electrical failures occur at either fixed joints, such as bolted lugs or bus connections, or at moveable joints, such as switch, controller or breaker contacts. Joint deterioration is characterized by an increase in resistance; this increase will cause a local temperature increase. The nature of electricity makes surface contact measurements hazardous to the equipment being examined as well as to the persons making the measurements.

An IR inspection may locate contacts that are slightly warmer than the associated conductors, especially if the contactors have recently operated, without causing concern. If the difference is more than 10°C – 20°C (18°F – 36°F), however, the condition should be investigated. Any detectable difference between the temperature of a fixed joint and that of the associated conductors should be investigated. A fixed joint which is 10°C – 20°C (18°F – 36°F) warmer than the adjacent conductors may be in critical condition and should be inspected as soon as possible. In contacts, temperature rises are generally caused by pitted contact surfaces or weak closing springs; in fixed joints, such rises are normally caused by looseness or corrosion.

Other electrical problems that IR inspection readily detects include phase imbalances, harmonics and overloads. If a temperature difference between phases is found, arrangements should be made to promptly obtain phase voltage and current readings that will indicate whether an imbalance or other adverse condition exists.

Although most electrical equipment is designed to operate at a temperature up to 20°C (36°F) and possibly as much as 150°C (270°F) above the ambient temperature, this much temperature rise is seldom found. Experience with a facility’s equipment will determine at what value further investigation of a given object is necessary. Logging the temperatures at a series of fixed points when inspecting equipment will help develop the needed data.

In some locations, an adequate IR inspection can be performed with an IR thermometer. Operators of the severely exposed electrical equipment described in Table 1 or those with extensive electrical systems, particularly those who own and operate the high-voltage distribution system, should perform a periodic inspection with an IR imaging system.

IR temperature measurement can also help mechanical equipment loss prevention. Here are a few ways:

- In conjunction with a vibration monitoring program, IR inspection can assist a rotating machinery condition monitoring program by quickly detecting overheated or possibly overloaded bearings and couplings.
- Periodic examination of reciprocating compressors may detect leaking valves or cylinders by detecting the temperature rise caused by recompressing air or gas that leaks back into the compression chamber.
- Internal combustion engine IR inspections may conveniently detect cylinder imbalance caused by poorly performing valves or out-of-adjustment diesel injection or spark ignition equipment.
- Radiators, transformer cooling fins and coils, and other heat exchangers and cooling jackets can be easily inspected while in service for performance losses caused by clogging or fouling.
- Rolling mills can employ IR methods to prevent rolling “cold” product.

Several applications have direct economic benefits in addition to preventing losses. Fired and pressure equipment IR inspection is very likely to have a direct payback. For example:

- While internal refractory failures may only cause heat losses, they may cause a fire hazard or strength loss if they severely overheat casings and structures. In pressurized high temperature reactors, such as ammonia secondary reformers, such failures may be critical.

- Monitoring tube temperatures in boilers and fired heaters is a convenient way to detect poor performance caused by internal fouling; it may be the best way to prevent rupture of tubes carrying flammable materials. IR thermography may be employed heavily in applications, such as reformer furnaces, where heating rates as well as temperatures are important.
- Waterlogged paper dryers are readily detected.
- Steam traps, including those located in ceiling-mounted equipment, can be readily surveyed for proper performance.

An inspection with an IR imaging system can also locate leaks in a flat roof before leakage can damage the roof system, deck or structure. Such an inspection can also identify where insulation can help conserve energy. Contact the imaging system manufacturer or a specialty contractor for more information.

LIFE EXTENSION

INTRODUCTION

This material examines techniques for determining equipment expected remaining life and, when necessary, extending that life. The goal is to assist management in determining when increased catastrophic failure probability, caused by aging of major structural parts, requires attention.

A life extension program provides technical rationale for allowing aging equipment, particularly equipment beyond its nominal life expectancy, to continue to operate. Such a program is distinctly different from routine maintenance. Routine maintenance prevents losses by detecting and correcting problems with "wear parts" such as bearings.

POSITION

Management should establish programs to determine and monitor the expected remaining life for major equipment. Proper maintenance will provide much of the data needed to calculate expected remaining life; however, the analysis required to control remaining life must begin before 75% of the nominal life expectancy is over.

Accurately calculating expected remaining life requires knowing the operating history. To accurately calculate expected remaining life, all operating parameters must stay within the design limits, and local conditions in critical areas must be continuously monitored. Document any abnormal operation. Table 1 lists examples of parameters that must be controlled and monitored.

Life extension programs should be based on risk. Risk is the product of the failure probability and consequence cost, and is the basis for selecting areas or components for improvement or further inspection.

Unless otherwise clearly specified and justified by the manufacturer, nominal life expectancy should not exceed the limits shown in Table 2.

TABLE 1
Example Of Critical Control Parameters

Object	Parameter	Control(s)	Measure(s)	Potential problem(s)
Boilers	Pressure	Pressure control, pressure limiting control, safety valve	Pressure gauge	Plastic deformation
	Metal temperature	Firing rate, fireside condition, water chemistry	Local thermocouples	Creep, local plastic deformation, metallurgical damage
	Temperature rate-of-rise	Firing rate	Calculated	Plastic deformation, thermal fatigue
	Chemistry	Operating practice	Regular analysis	Corrosion and erosion; has system-wide affects
Steam Turbines	Pressure	Boiler controls, blading conditions	Pressure gauges	Plastic deformation
	Temperature	Boiler controls	Local thermocouples	Creep, local plastic deformation, metallurgical damage
	Temperature rate-of-rise or -fall	Operating procedures	Calculated	Thermal fatigue
	Speed	Governor, overspeed trip	RPM (Hz) meter	Plastic deformation, crack initiation
Combustion turbines	Temperature	Various	Local thermocouples, calculated	Creep, local plastic deformation, metallurgical damage
	Temperature rate-of-rise	Operating procedures	Calculated	Thermal fatigue
	Speed	Governor, overspeed trip	RPM (Hz) meter	Plastic deformation, crack initiation
Generators	Temperature	Load, cooling system	Local thermocouples	Insulation system degradation
	Speed	Governor, overspeed trip	RPM (Hz) meter	Plastic deformation, crack initiation
Transformers	Temperature	Load, cooling system	Thermometer(s)	Insulation system degradation
	Insulating fluid condition	Various	Periodic analysis	Insulation system degradation

TABLE 2
Nominal Life Expectancy For Selected Equipment

EQUIPMENT TYPE	NOMINAL LIFE EXPECTANCY
Power and rectifier transformers	30 yr
Arc Furnace Transformers	12 yr
Combustion turbines 0.2 or more starts/fired h	10 yr
Combustion turbinesless than 0.2 starts/fired h	20 yr
Steam turbines	30 yr
Water turbines	35 yr
Internal combustion engines	30 yr
Generators, mechanical parts only	Same as driver
Generators, windings	30 yr
Electric motors	30 yr
Boilers and pressure vessels greater than 900°F (480°C) 30 yr	20 yr
Piping greater than 900°F (480°C)	20 yr

Include the following components in life extension programs for equipment listed in Table 2:

- Rewind transformers, motors and generators at the end of their nominal life expectancy.
- Sample or replicate any metal component, including superheater components, high pressure turbines, etc., that operate above 900°F (482°C) to establish the present state of creep-related damage. Stress and fracture mechanics analysis should be used to predict probable remaining life based upon crack initiation and propagation.
- Sufficiently inspect any component subject to mechanical or thermal fatigue to establish the present state of damage. Stress and fracture mechanics analysis should be used to predict probable remaining life based upon crack initiation and propagation.
- Inspect thoroughly any component subject to environmentally assisted corrosion, such as austenitic stain less steel tubes or 18Mn-5Cr generator retaining rings for onset of cracking. Spot check pressure components and completely inspect rotating components.
- Evaluate forged or welded turbine rotors. Perform complete nondestructive testing of rotor surfaces, rotor bores and blade attachment points. Stress and fracture mechanics analysis should be used to predict probable future performance based upon crack initiation and propagation. Contour adjustments should be provided as needed.
- Unstack and inspect built-up turbine rotors for disk bore and keyway cracking and fretting.
- Deblade all turbines and perform complete nondestructive testing, and stress analysis. Redesign nozzles, diaphragms and blades or buckets for any turbine with adverse experience. Completely inspect and perform a stress analysis for casings, throttle valves and other steam or hot gas path components.

DISCUSSION

Background

Most plant equipment was normally expected to have a 20 yr – 30 yr life for at least three reasons.

- Most equipment failure rates follow the “bathtub curve.” (See Figure 1.) After an initial high failure rate, there is a long period of low failure rate, followed by an increasing failure rate signaling “wear out” or end of life.
- Technological developments have made new units available that are significantly more efficient.
- Until recently, analytical tools available to designers have not allowed for life expectancy predictions beyond 20 yr – 30 yr.

Upgrading equipment rather than replacing it has become an increasingly favored option. Improved inspection techniques and analytical tools have opened the door to more accurately determine local stresses and predict long term performance.

Aging

Equipment deteriorates during operation. Bearings degrade, boiler tubes thin and electrical insulation becomes brittle. Maintenance personnel manage deterioration by inspecting and repairing components that are expected to deteriorate. Local deterioration that is expected, based upon previous experience, is called wear.

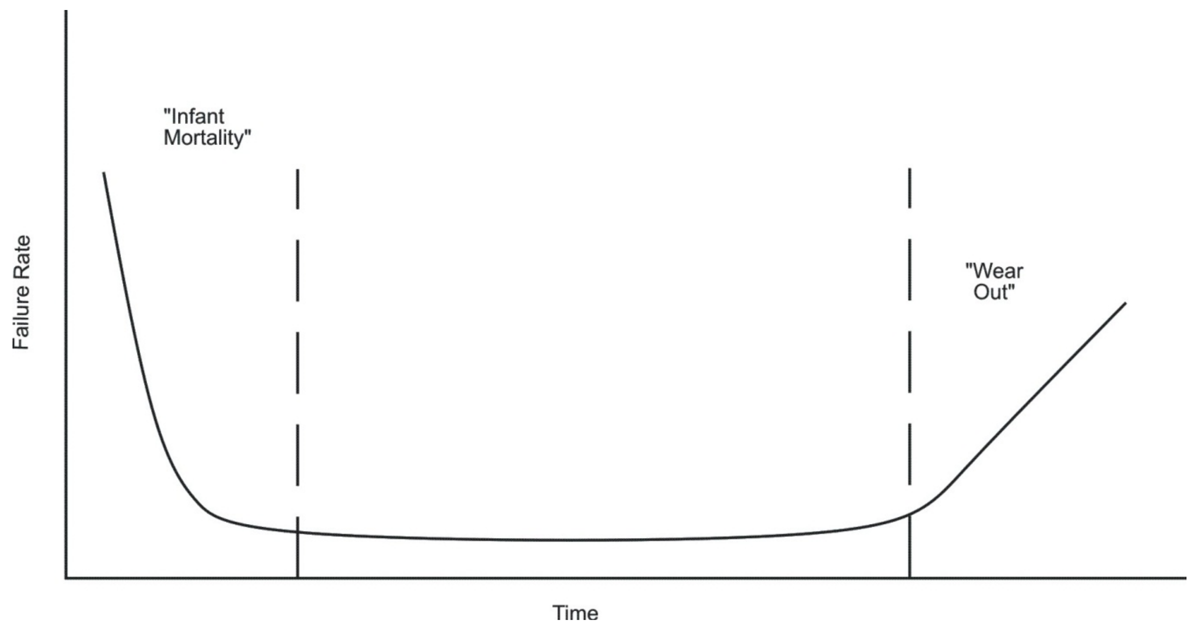


Figure 1. Typical Equipment Failure Rate Curve.

However, major components can accumulate damage that normal maintenance inspections do not detect. Or, grouped components, such as boiler tubes, can deteriorate and, as a result, large numbers of components can be found deficient during a single inspection. Large-scale deterioration over time, caused by service and the environment is called aging.

Wear and aging are related. Economic factors often determine whether a particular form of deterioration is considered wear or aging. For example, a few boiler tubes thinned by erosion and requiring replacement would clearly be wearing. All the tubes in the boiler thinned by erosion and requiring replacement would clearly be aging. If 50% of the tubes in the boiler are thinned by erosion and require replacement, two choices are possible: eliminate wear by replacing the eroded tubes, or eliminate the aging due to boiler tube erosion by replacing all the tubes.

End Of Useful Life

Uncontrolled wear and aging will eventually produce equipment conditions that will no longer allow the equipment to operate safely. Even if wear is controlled by proper maintenance, aging may render equipment unsafe.

Every piece of equipment ages differently and can reach its end of useful life in three ways:

- Accumulated damage can produce conditions in a major component that prevent the equipment from being safely operated.
- Grouped components can deteriorate to the point where the effort needed to inspect and replace individual components becomes intolerable, or the components begin to fail in service between inspections.
- A catastrophic failure can damage the equipment beyond repair.

Nominal Life Expectancy

Equipment has a nominal life expectancy determined by accepted industry practice and experience, based on design specifications. The design life may or may not equal the nominal life expectancy.

Nominal life expectancy and design life are point values.

Expected Remaining Life

Each piece of equipment also has an expected remaining life. Expected remaining life is a range of values or a probability distribution. It is the period of time after which the probability of failure becomes unacceptably high. The expected remaining life of new equipment is a relatively wide band, generally centered on the design life. (See Figure 2.)

As equipment ages, damage accumulates. The accumulated damage can be measured, the equipment operating history analyzed, and a more refined estimate of remaining life calculated, using techniques described in this section. The sum of operating time and the most probable expected remaining life may or may not equal the original design life. And the expected remaining life, while still a range or probability distribution, will probably be more precise. (See Figure 3.)

Calculating expected remaining life generally involves identifying four areas:

- Part(s) of the equipment that will limit its continued service.
- Damage mechanism(s) that will cause the limiting part(s) to fail.
- Inspection techniques that will locate damage and characterize the extent of damage.
- Mathematical model(s) of the equipment or its structure that can use the equipment history and existing condition to calculate its expected remaining life.

The basis for calculating expected remaining life may not be clear. An original equipment design life may not have been specified, or the basis for the original design life may never have been defined in easily measurable terms. The life status may be further complicated by equipment operating and maintenance history.

Life Extension

Although some 100 yr old equipment is still in service, other equipment cannot be safely operated beyond ten years. If the calculated expected remaining life is not acceptable, repair techniques can stabilize or eliminate the damage. It is possible to replace components, or to perform heat treatment, isostatic pressing, reshaping and weld overlaying and other damage reversing or damage limiting operations.

The calculated expected remaining life shown in Figure 3 indicates that the equipment will probably not reach its design life. The cause of the unexpectedly rapid aging may be found and corrected and the damage may be repaired, increasing the expected remaining life. (See Figure 4.) This is called “life extension.” Note the expected remaining life, while longer than before, is less certain.

If the life extension program continues, with further inspections, repairs, and expected remaining life recalculations, the situation may resemble Figure 5. The expected remaining life is well beyond the original design life.

Figure 2

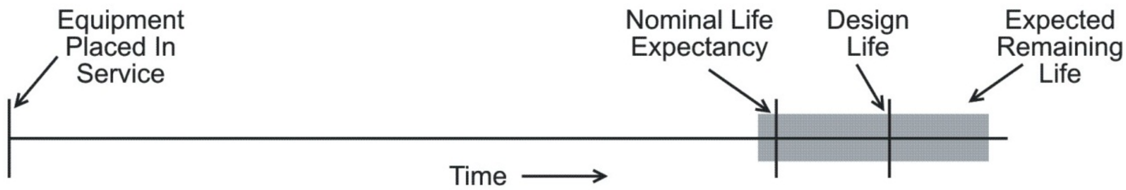


Figure 3

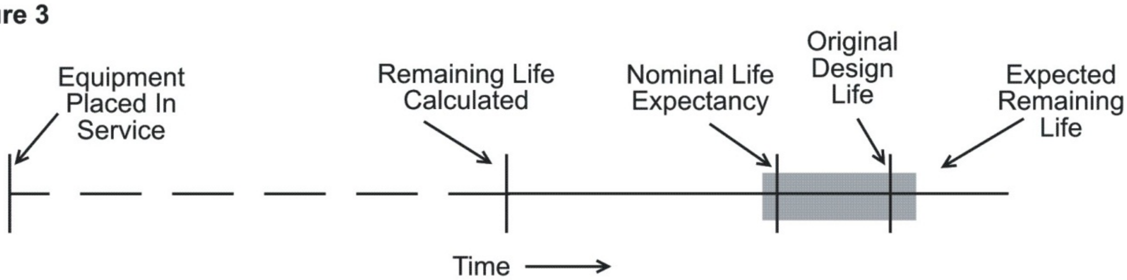


Figure 4

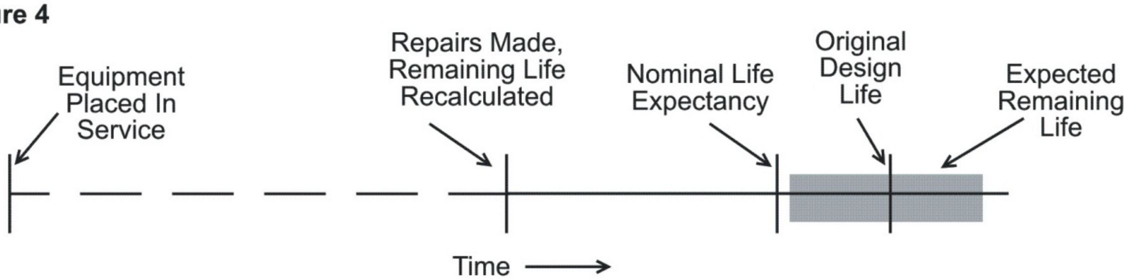
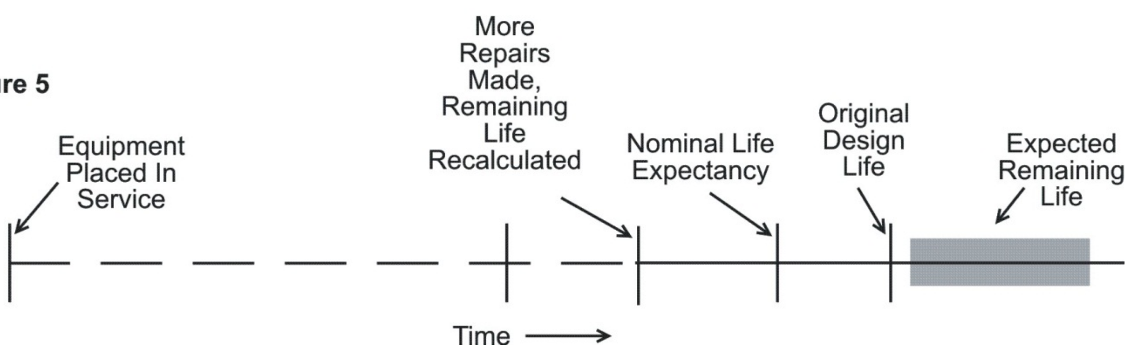


Figure 5



Figures 2-5. Expected Remaining Life (With And Without Life Extension).

A life extension program can increase expected remaining life by:

1. Demonstrating that component integrity allows continued operation, or
2. Repairing or replacing components with unacceptable failure probabilities.

Not all equipment can be analyzed for remaining life. For example, motors, generators and transformers have electrical winding insulation systems that cannot be economically and reliably modeled.

Life Extension vs. Maintenance

Inspections are key activities in both life extension and maintenance. The program framework determines whether an inspection extends life or merely manages wear.

Maintenance inspections are generally designed to determine whether the equipment being inspected will operate safely until the next scheduled inspection. Particularly in new equipment, maintenance inspections are life extension inspections, because they focus on the components that are likely to fail at that time of equipment life.

In the context of a life extension program, inspections have added significance. Each inspection is designed to add confidence to a calculated estimated remaining life. Before equipment reaches the end of its nominal life expectancy, inspections that are more complete than normal maintenance inspections will be needed to determine the state of aging.

A sound life extension program will establish the state of equipment aging and demonstrate that equipment failure probability will remain at an acceptable level during one or more routine inspection intervals. Even if no conditions are found that require correction, a life extension program requires a commitment to reinspect at least selected areas to confirm the aging assumptions made in the initial expected remaining life analysis.

Determining the expected remaining life for plant equipment is a complex process, and life extension programs have limitations. Furthermore, increasing the expected remaining life may not be feasible for some equipment. Options to repair or replace components may be needed.

Risk

Life extension programs should be based on risk. Risk is the product of the failure probability and consequence cost and is the basis for selecting areas or components for improvement or further inspection.

Failure consequence cost is not necessarily more easily determined than probability of failure. The events following a failure, such as a turbine blade break, are not predictable. The blade may or may not penetrate the casing. Or, the blade may break 100 other blades, half of which penetrate the casing. The uncertainty of the scope of damage impacts several calculations including estimated consequence cost, repair cost, length of outage, and cost of replacement power, all of which have uncertainties of their own. Probable risk, therefore, is most valuable for comparison purposes.

Risk-based analysis can be easily updated and refined. Refinement reduces uncertainty by starting with areas of highest risk having the greatest uncertainty.

The American Society of Mechanical Engineers (ASME) has published two useful guides, CRTD Vol. 20-1, Risk-Based Inspection—Development of Guideline, Volume 1, *General Document*, and CRTD Vol. 20-1, Risk-Based Inspection—Development of Guideline, Volume 3, *Fossil Fuel-Fired Electric Power Generating Station Applications* for developing risk-based programs. These guides provide information that may help develop risk-based inspection and maintenance programs for many types of structures, including plant equipment.

Calculating Estimated Remaining Life

Equipment is not designed to fail, nor is it expected to last forever. Unfortunately, the life of most items cannot be predicted accurately while they are being designed or constructed. But some analysis is possible. Designs for components vulnerable to fatigue can be based on laboratory tests that provide an “S-n” curve. The S-n curve relates the maximum stress level to the number of cycles of stress reversal the material can withstand. Designs for components vulnerable to creep can be based on laboratory tests that relate the creep rate to stress and temperature levels. Designs for components vulnerable to erosion or corrosion can be based on predicted erosion and corrosion rates.

Unfortunately, tests can be expensive and can take a long time to run. For example, a test to establish a 30 yr life typically requires at least three years of equivalent wear.

Even if a design life estimate basis is rational, the estimate is still likely to be extremely conservative, because large safety factors are needed to cover uncertainty. And, unless at least two sets of equivalent data are available, an inherently inaccurate single-point extrapolation is needed. Even with multiple data points, extrapolation may provide questionable results.

Design, construction, operation, maintenance and repair can change the component aging rate. For example, the following conditions may create a positive or negative change:

- Off-specification materials may have been used.
- Materials from different heats or lots may perform differently.
- Unexpected environmental reactions may occur.
- Poor workmanship, poor quality welds, or faulty machining, improper heat treatment, dropping during handling and sloppy installation can introduce unintended stresses.
- Operating problems can be involved which are not intended by the designer.
- Materials may be contaminated with chlorides or other potentially harmful materials. Contamination leading to failure has been caused by improper marking and paints, lack of control of materials in process, fire protection water or flood water.
- Equipment may be rerated with or without the designer’s concurrence.

Predictive and preventive maintenance techniques can identify minor deterioration before a serious condition develops. Good repairs can prolong life by arresting damage or replacing damaged components. Inappropriate or poorly performed repairs can shorten life.

State-of-the art technology for predicting equipment life can be both helpful and harmful. Improved analysis can reveal deficient design, and improved inspection methods can discover deterioration better than older methods. But reduced life or unnecessary repair damage can result if the ability to evaluate findings does not develop simultaneously with the ability to find suspected flaws.

Design and remaining life prediction is uncertain. Deterministic methods must be very conservative to cover the uncertainties, which can result in unnecessary repairs. Probabilistic rather than deterministic methods are recommended. Probabilistic methods use probability distributions as input rather than point estimates of values. The output of a probabilistic analysis is a probability distribution relating failure probability to time. Determining failure probabilities is a specialized task requiring considerable experience and computer support.

Service Limiting Components

Calculating expected remaining life goes hand-in-hand with continued safe and economic operation, but the distinction between the two is seldom clear. Consider a water tube power boiler. After annual inspections are performed, obvious deficiencies, such as tube blisters, eroded or corroded areas, cracked attachment welds and ligament cracks in drums and headers are corrected. Calculating the expected remaining life involves a more in-depth study, which might include making the following assessments:

- Analyzing the condition of tube groups as a whole, considering their long-term ability to perform. This analysis might include measuring oxide thickness, analyzing operating history, analyzing accumulated damage in dissimilar metal weld joints and doing metallurgical studies of tubes in high-temperature areas.

- Studying stress, operating history and metallurgical aspects of drums and headers. This might include performing a finite element analysis of transient-induced stresses in selected areas and testing samples or replicas from selected areas.
- Examining and evaluating the support structure.
- Studying accessories, such as attemperators and valves.
- Surveying associated piping, including verifying material specifications, analyzing stresses imposed under “as-found” conditions of hangers and supports, and condition testing.

Some equipment, such as turbines, may not have routinely serviceable parts. Failures of the casing, rotor, blading, throttle assembly — even accessories such as the steam strainer — all can be catastrophic. The difference between a remaining life determination and a “routine” overhaul may not exist.

Damage Mechanisms

Physical and chemical factors in the equipment operating environment limit equipment life if the equipment materials lack resistance to the aging those factors cause. Physical and chemical factors that cause equipment aging are called damage mechanisms. In remaining life assessments, potential as well as actual damage mechanisms must be considered. For example, adjusting turbine rotor contours may be needed to reduce calculated local stresses, even though no cracking may have occurred.

Most aging mechanisms progress exponentially. To ensure no aging mechanism can run unchecked, life extension analysis needs to begin well before equipment reaches the end of its design life. Although benchmark data should be collected when equipment is new or early in its life, effective life extension analysis can only take place later in life, after some aging has taken place.

Remaining life determination programs are effective only when equipment is operated in a controlled manner that produces predictable stresses on the equipment. These programs are limited to situations involving time-based or operating cycle-based deterioration. The following terms identify several types of failure or deterioration mechanisms.

Plastic deformation is a change in shape caused by stressing a part beyond its elastic limit. The elastic limit is affected by the temperature. Plastic deformation in local areas contributes to local stresses and distortion. Plastic deformation accumulates over time, particularly during transient peak stresses, such as heat-up stresses.

Creep is plastic deformation at stresses below the elastic limit. Creep begins on a microscopic level where damage accumulates over time until it creates microscopic voids. The voids slowly link up, eventually forming crack-like defects and causing failure. Creep voids can also be crack initiation sites for other failures. The creep rate is highly temperature and stress dependent. Creep is not likely to be a problem below 900°F (480°C). At higher temperatures, the problem depends upon the alloy and temperature. Creep damage can be estimated if the time/temperature history and local stress levels are known and if long-term creep testing data is available. Creep damage can be determined by cutting, etching and polishing samples, and examining them under a microscope for creep voids. Replicating a part is a more practical method for estimating the creep state of the part based upon its actual condition, however, replication can detect only surface damage.

Metallurgical damage refers to any change in material microstructure that will result in degraded properties. For example, temper embrittlement reduces material toughness and raises its Fracture Appearance Transition Temperature (FATT), increasing the risk of brittle fracture.

Fatigue is failure of the material below its ultimate tensile strength, caused by progressive cracking. Cracking is caused by cyclic stress. Fatigue is classed high or low cycle fatigue. Generally, high cycle fatigue is related to machine rotational speed. Low cycle fatigue relates to startups and shutdowns or other operational cycles.

Crack initiation is the critical event in a fatigue failure. Once cracks have started, their propagation is relatively easy to model. When analyzing a model for fatigue, the analyst can assume an existing flaw, or better, assume a probability distribution for existing flaws or new cracks. Other failure mechanisms can initiate and propagate cracks.

Corrosion refers to a wide variety of electrochemical damage to metals. General corrosion attacks more or less uniformly whereas local corrosion produces pits or crack-like defects. General corrosion typically proceeds at a nearly constant rate and is therefore easily handled in remaining life determination studies. General corrosion often produces abrasive particles that can break away from the surface where they are produced and travel throughout the system. These particles will then contribute to erosion. Local corrosion presents a variety of difficult problems.

Corrosion fatigue is one of several hybrid mechanisms capable of producing failure under conditions where one mechanism alone would not be troublesome. Corrosion fatigue failures occur because stress levels are high enough to locally damage a passive anticorrosive material film, not the material itself. Damage to the film allows a local corrosive attack. Continued stress applications damage the passive layer, and failure eventually results. Other hybrid failure mechanisms include thermal fatigue and erosion corrosion.

Environmentally assisted corrosion is a form of local corrosion requiring a susceptible material and a specific environment. Almost any metal is vulnerable to some form of environmentally assisted corrosion. Most types of environmental corrosion produce crack-like defects. These defects are further exposed to either environmentally-assisted crack growth or fatigue-assisted crack growth. Stress corrosion cracking and chloride stress corrosion are among the types of corrosion that cause greatest concern to most equipment.

Erosion is caused by small-particle impact. Erosion in power plants is generally caused by water droplets or exfoliated corrosion products. Erosion in other facilities may be caused by materials in process or foreign materials.

Foreign object damage refers to damage caused by larger objects, and cannot be addressed in a remaining life study except as a probable result of an initiating failure.

Insulation system degradation refers to the total of mechanisms by which electrical insulation loses the ability over time to perform its function.

Inspection Techniques

Maintenance inspections generally use only nondestructive inspection techniques. Remaining life determination inspections routinely involve more in-depth procedures. For example, determining the creep rupture status of a high-temperature component may require cutting a sample to microscopically inspect the interior. Destructive testing may be needed to verify the mechanical properties. Not all remaining life determination testing is destructive. Considerable data is also acquired by hardness testing, replication and other on-site metallurgical techniques.

A remaining life determination program cannot be effective if there is no economical and reliable method of detecting any likely damage mechanism in any critical part.

Repair Techniques

When a local aging condition limits equipment remaining life, arresting or eliminating the local aging condition can extend the equipment remaining life. Accumulated damage caused by creep, fatigue, environmentally assisted corrosion and metallurgical changes generally cannot be corrected except by replacing the affected component or the affected part of the component. There are specific exceptions. For example, hot isostatic pressing has been used to reverse creep damage in combustion turbine blades. Contour adjustment by machining can remove cracks and reduce surface stresses enough to alleviate a life-limiting condition.

If part of a component is to be replaced by welding, carefully controlled procedures are needed. For example, a weld overlay applied to correct stress corrosion cracking can introduce surface stresses that make the structure more susceptible to fatigue cracking. Weld repairs to turbine rotors, turbine blades and other cyclically stressed parts require extremely careful design.

Rerating can be an alternative life extension method. Examples include pressure, temperature, capacity limits and heat up or load application rate restrictions.

Repair techniques include modifying controls and procedures as well as repairing, replacing, rerating and modifying components. For example, being assured a superheater header will last 20 yr is pointless if there are given limitations in temperature and in the number and severity of temperature transients. An exception exists if the temperature and its rate of rise can be measured on line and controlled.

EMPLOYEE TRAINING

INTRODUCTION

Studies of incidents in a variety of industries and activities have shown that about 85% of all accidents (unplanned or unexpected incidents) are caused by human error. Only 15% of accidents result from equipment failure. This split between human error and equipment failure can vary depending on interpretation of data when developing cause information. For example, accidents resulting from the selection of inadequate hardware could be classified either as hardware failure or as human error. However, in spite of these interpretative differences, the 85% – 15% split has remained fairly consistent among numerous studies.

Human error encompasses a broad range of problems including inadequate job skills, poor judgment, failure to obey safety rules, horseplay, proceeding too fast, abuse of drugs or alcohol, inadequate or improper supervision and distractions due to psychological or domestic problems. These problems can be addressed through employee training.

Most workers will not deliberately jeopardize their safety, the safety of others, or their jobs by using improper or unsafe work practices. Management should ensure that employees have adequate job skills, and that they are fully informed of company policies and safety requirements. Firm and skillful supervision is necessary for the control and direction of company efforts.

POSITION

To reduce loss caused by human error, employees must be trained in proper work practices. Management must be committed to employee training and dedicate the resources necessary to develop and maintain the program.

This training may include information on specific job skills, good safety practices, and company regulations and requirements. Train supervisors and managers in good leadership and supervisory skills to ensure that the proper work practices are implemented.

To develop an effective employee training program:

- Appoint a training director to supervise the overall program;
- Inform all employees of the need for proper training;
- Demonstrate support of the training program by making certain that no management decision relating to job performance and procedures violates those taught in the training program.

Duties of the Training Director:

- Establish the scope of all segments of the program, making certain that loss prevention aspects of a job and critical procedures to be followed are highlighted as well as routine job procedures;
- Write training program segments;
- Establish the degree of participation and input by line supervisors;
- Train the instructors;
- Establish training schedules;
- Establish retraining schedules;
- Implement feedback and follow-up programs.

The training program segments are categorized as Basic and Job-Specific. The Basic segments apply to all employees and the Job-Specific segments to individual job functions.

Include the following in Basic segments:

- Corporate operating policies;
- General plant safety rules;
- Facility layout, operations and hazards;
- Alarm and signaling systems;
- Emergency procedures.

Include the following in Job-Specific segments:

- Process equipment operation;
- Fire and explosion hazards associated with the operation;
- Familiarization with operating manuals for the equipment;
- Highlighting of critical procedures which must be followed.

Include training for outside contractors and visitors in training programs. Information specific to their duties and roles in the plant should be covered. (See PRC.1.0.4.)

DISCUSSION

AXA XL Risk Consulting's experience during a 10 yr period shows that errors by process operators accounted for 30% of the major property losses in the chemical and petrochemical industries. This indicates a need for training in relatively specific job skills. If operators were routinely violating safety rules, improved supervisory skills were needed. Even if an employer has a good training program, it is of no value if management allows employees to sense that unsafe work practices will be tolerated. Production short cuts that are encouraged by management without due consideration of the loss prevention aspects will negate the effectiveness of the best training program.

In today's increasingly sophisticated technological society, virtually every job requires training, much of it in-depth. An employee training program must be all-inclusive, anticipating and covering all jobs and all situations that might occur. For example, all operators in the chemical and petrochemical industry should be educated in the hazards involved in their job and in the functions of the safety control equipment. They should be forbidden to run the process when any critical systems or components are out of order, and trained in critical procedures and manual emergency shutdown procedures.

Training methods that may have been effective in the past may not be so today, due to changes in employees' attitudes toward their jobs. The routine of automation may dull employees' reactions during emergencies causing them to make slow or improper decisions under unusual circumstances. Training program can sharpen employees' reactions making their responses more effective.

Numerous articles discuss well-established training methods. These training methods, based on an understanding of behavior, suggest that:

- People behave in a manner that is sensible and logical to them.
- Behavior is influenced by its consequences.
- People will change their behavior if they know how and see a need to change.
- The training process must provide for the acquisition of knowledge and skills to enable people to change their performance.
- The job environment must allow sufficient practice and reinforcement to enable people to change their performance.

All training programs must have a clearly written format. Each segment of the program must be well defined. Training should be broken down into logical parts so that progress through the program may be readily measured. Trainees should be given feedback at frequent intervals to reinforce their progress.

Depending upon the number of trainees and the type of training needed, the program may involve formal classroom sessions, process simulators, self-study that employs such aids as videotape, audiocassettes, interactive computer programs, or a combination of these methods. On-the-job sessions with line supervisors can reinforce the training program. Where on-the-job training is considered the most appropriate and practicable type of training, a formal outline or method can ensure that all important aspects and safety related information are covered during the training period.

To obtain feedback on the effectiveness of the program, the training director can simulate problems using situations that will allow employees to respond as realistically as possible. Observing their response will give the training director an indication of the effectiveness of the training programs. Additional simulated problems given at carefully chosen intervals will indicate when retraining is needed. The training director can review loss reports, near-miss incident reports, production reports and product defect reports to gain additional feedback on the effectiveness of the training program.

NEW CONSTRUCTION

INTRODUCTION

New construction, remodeling or renovation involves hazardous work. As such, it introduces additional elements of risk to an existing facility. Application of loss control principles during design will improve reliability and maintainability of the completed work. Proper supervision of a loss prevention and control program at construction sites can reduce the number of fires and other losses during construction. An effective loss prevention and control program requires the cooperation of the architect, contractor, management and AXA XL Risk Consulting. In fact, AXA XL Risk Consulting welcomes the opportunity to consult with management whenever a construction project is planned.

POSITION

To achieve reasonable loss prevention and control at the construction site, management should:

- Incorporate loss control into the design and planning by submitting specifications and plans to AXA XL Risk Consulting for review prior to the letting of bids and contracts. Incorporate Management of Change principals in new construction projects. (See PRC.1.0.2.) Design the building or structure to the anticipated live and dead loads in accordance with ASCE Standard 7 or equivalent. Refer to the PRC.2 section of the Property Risk Consulting Guidelines manual. (See also PRC.1.1.0, PRC.1.2.0 and PRC.1.9.0.)
- Schedule installation of protection features to keep pace with the progress of construction.
- Designate an individual to coordinate loss prevention and control aspects of the construction project with the construction manager and other appropriate personnel. See PRC.1.5.0.A, PRC.1.5.0.B and PRC.1.0.4 for additional guidelines for loss prevention and control features.
- Appoint a Fire Brigade Chief or Emergency Team Coordinator. (See also PRC.1.7.0.)
- Appoint a person responsible for security and surveillance measures during construction. (See also PRC.1.11.0.)

DISCUSSION

A critical examination of the plans for facility construction or renovation can permit loss prevention attributes to be built into the very foundation. Arranging the electrical distribution system with redundant sources and feeds and providing extra cables in major wire ways can minimize downtime. Avoiding the placement of machinery in areas without overhead cranes large enough to move it or without sufficient headspace for mobile equipment can reduce delays in repair and replacement in case of breakdown.

Analysis of hazards (see PRC.1.13.0) should begin long before ground is broken so that all areas of serious loss potential can be minimized as much as possible. In fact, if loss control is considered sufficiently early in the design process, considerable savings in loss prevention equipment may be realized. Substituting a noncombustible solvent for a flammable one in an extraction process may considerably reduce fire protection system expenses. Relocating electrical equipment may reduce the need for hazardous-location-rated switchgear. Providing stronger pressure vessels may reduce the number of relief valves required. The term “inherent safety” has been applied to this line of inquiry.

Project management can plan to minimize loss as well as expense by taking care to avoid delivery of sensitive equipment before it can be protected or to plan temporary shelter when such delivery is necessary or prudent. Also, some activities such as boiler, pressure vessel and piping installation may require periodic formal inspection to meet legal (jurisdictional) requirements.

During construction, buildings are more vulnerable to such perils as fire, explosion, windstorm, collapse due to snow or water load, hail, vandalism and incendiarism. If not already established, this is the time frame in which training (see PRC.1.4.0) and preventive maintenance (see PRC.1.3.0) programs for new processes and equipment must be finalized.

Fire can be caused by hazardous construction operations. These include welding, cutting and other hot work; asphalt heating; woodworking; and the use of temporary electric wiring and heating equipment. Accumulations of combustible materials and their packaging spread a fire. Proper housekeeping is important. See PRC.1.14.0. In addition, carelessly discarded smoking materials can start fires. Smoking must be adequately controlled. See PRC.1.2.0.

Operations that are not hazardous in themselves may increase the exposure to various perils. For example, care must be exercised when excavating to keep from undermining adjacent foundations or disrupting utilities. A ruptured gas main could result in a fire or explosion beyond the capability of manual or automatic fire protection equipment. Damage to utility services can also interrupt the operation of heating or process equipment elsewhere in the facility.

The wind resistance of a building depends upon the proper interaction of its various structural components. Thus, the potential for wind damage and collapse is greatest during construction before all the components have been put in place and firmly fastened together. Similarly, this lack of structural integrity may lead to collapse when subject to excessive snow or water loads.

During construction, surfaces such as exposed roof or tank insulation are particularly susceptible to damage from hail.

Excavations for foundations are particularly susceptible to flooding, whether from rising streams or from heavy rainfall. Installation of machinery and equipment in such excavated areas before drainage or dewatering facilities are available can lead to substantial and unnecessary loss.

Control of personnel not in the employment of the facility is usually made much more difficult during periods of construction. Nevertheless, such control must be asserted in order to ensure adherence to the established principles and practices of loss prevention and control.

Because construction sites are open, they are inherently more vulnerable to vandalism and incendiarism. The number of outside personnel on such projects and the frequency and scope of access make surveillance more difficult than in completed facilities.

To make new construction less vulnerable to these perils, management must institute an aggressive program of loss prevention and control.

In spite of the significant hazards presented by a construction site, proper attention to loss prevention and control can minimize the likelihood and effect of a loss.

It is vital that communication be established between management and AXA XL Risk Consulting at the earliest planning stages of new construction or renovation. This will allow AXA XL Risk Consulting to offer loss prevention and control advice.

LOSS CONTROL DURING CONSTRUCTION

To control losses during construction, include the following points in the various management programs.

SCHEDULE PROTECTION TO KEEP PACE

Before construction begins, the following features must be scheduled for early completion:

- Installation of fire protection water supplies, such as fire pumps and reservoirs, underground piping and hydrants. Hose stream protection must be available when combustible construction materials arrive at the site. If permanent water supplies are not in service, suitable temporary supplies must be provided.
- Installation of automatic sprinklers to keep pace with construction progress. If portions of the building are to be occupied before the entire building is completed, arrangements should be made to install sprinkler protection in those portions first. This protection should be promptly connected to the water supply. Such connections may be temporary or permanent.
- Delivery of automotive fire apparatus to the site during the earliest stages of construction if such apparatus is to be a permanent part of the facility's overall fire protection. Temporary garages should be provided to protect the apparatus from the elements. Training in the use of the apparatus should also be provided.
- Delivery of combustible materials in such a way as to minimize unprotected on-site storage.

REDUCE THE HAZARDS OF CONSTRUCTION

The individual responsible for loss prevention and control must consider the following measures in order to reduce construction hazards:

- Instruct construction superintendents and supervisors in their duties and responsibilities regarding loss prevention practices.
- Keep automatic sprinkler protection in service for as long as practical in buildings that must be demolished.
- Keep combustible materials out of buildings until sprinklers are in service.
- Schedule frequent trash removal. Combustible crating and packing material should be disposed of safely. Restrict the burning of trash to areas well away from buildings and use properly arranged incinerators where practical.
- Minimize the building of temporary structures during construction. Those that are necessary should be sprinklered and located a safe distance from the construction.
- Implement proper impairment handling when altering or extending existing sprinkler systems. (See PRC.1.1.0.)
- Provide special fire protection equipment during hazardous construction operations.
- Properly distribute a sufficient number of portable fire extinguishers.
- Prohibit smoking in hazardous areas. (See PRC.1.2.0.)
- Strictly supervise all hot work. (See PRC.1.9.0.)
- Provide properly arranged temporary lighting and wiring in accordance with Article 590 of NFPA 70.

- Use only tarpaulins that have been flameproofed or made of flame-resistant material tested in accordance with Test Method 2 of NFPA 701.
- Provide safe sources of temporary heat.
- Locate bulk storage of gasoline, fuel oil, paint, solvents, welding gases and other flammable and combustible liquids or gases outside the buildings. No more than one day's working supply should be allowed inside the buildings. Only approved containers and dispensing facilities should be used.
- Keep roofers' tar kettles outside of and as far away from, buildings as practical. Suitable fire extinguishing equipment should be provided nearby.
- Take special care in the placement, operation and service of combustion engine-driven equipment. Refuel small gasoline units from listed or approved safety cans and large units from listed or approved containers in suitable refueling areas.
- Take measures to prevent collapse from windstorm. (See PRC.2.0.1.1.) These may include:
    - Providing temporary guying, cable crossbracing or other stiffening that can resist wind loading from any direction.
    - Bracing laterally unsupported masonry walls.
    - Permanently fastening roof decking, vapor barriers and insulation as they are placed upon the frame.
    - Lowering and/or securing all crane booms to appropriate anchor points at the end of each working day. (Note that a proper safety procedure on some tower cranes is to release the sluing mechanism so that the boom can weathervane with the wind.)
    - Establishing a maximum limiting wind speed for crane operations.
    - Providing wind relief panels, where appropriate to prevent windstorm damage during erection of structures.
- Take measures to prevent collapse from causes other than windstorm. These may include:
    - Maintaining a self-supporting steel framework.
    - Posting and observing instructions for the use of cranes, derricks and hoists.
    - Installing properly designed formwork and shoring for concrete construction.
    - Providing shoring, bracing or underpinning if the stability of adjoining buildings or walls is to be endangered by excavations or demolition.
    - Installing and connecting roof drains as soon as each section of the roof deck is completed.
    - Utilizing experienced riggers for all heavy lifts during construction and installation phases.
    - Implementing a test program to insure the proper curing of concrete before forms are removed or before new work is subjected to loading.
    - Providing temporary bracing for structures and equipment in earthquake-prone areas.
- Take measures to prevent damage from flood conditions created by rising streams or heavy rains. These may include:
    - Dikes or levees to protect open foundation excavations.
    - Pumps to de-water excavations.
    - Provisions to remove or protect construction equipment or newly installed equipment in excavations below ground level.
    - Providing temporary drainage facilities.
- Other loss prevention considerations should include:
    - Ensuring the availability on short notice of critical spare parts for cranes or other specialized heavy machinery.

- Winterizing all equipment, systems and machinery that will be exposed to freezing temperatures.
- Providing for additional security measures during strikes or labor unrest to prevent sabotage.
- Establishing a formal program for inspection and test of all major equipment and systems to prevent damage to electrical, heating, cooling or process equipment when initially energized or operated.

If the property under construction is a completely new facility, then it is necessary in the early stages to appoint a Fire Brigade Chief or Emergency Team Coordinator and to organize a Fire Brigade or Emergency Team in accordance with the recommendations found in AXA XL Risk Consulting's PEPlan. (See PRC.1.7.0.) However, if this is an addition or remodeling project, then all personnel should be notified that the responsibilities of the Fire Brigade Chief or Emergency Team Coordinator include the new area under construction.

While the Fire Brigade Chief's regular duties are defined in AXA XL Risk Consulting's PEPlan, any new construction creates a changing environment that requires the Chief to continually review the situation at the construction site. The fire attack plan should be updated as necessary and regularly reviewed with the public fire department.

SELECT A SECURITY DIRECTOR

The individual responsible for security and surveillance should review PRC.1.11.0. The specific duties of this individual should include:

- Instructing guards in their duties and responsibilities regarding loss prevention practices.
- Seeing that the site is enclosed with a fence where necessary. Gates should be properly monitored during working hours and secured during nonoperating hours. The construction area should be segregated from existing areas of the facility.
- Seeing that adequate lighting is provided for the entire construction area.
- Making sure combustible materials and structures are located a sufficient distance from the fenced perimeter to prevent easy ignition from outside.
- Developing identification procedures that control the access of personnel, vehicles and materials to and their travel in and about, the site.
- Providing guard stations and patrols that are designed to cover both security and fire protection surveillance during working and nonworking hours.
- Requiring the proper storage and security of construction explosives.
- Providing a temporary means of notifying the public fire department should an emergency occur.

To ensure the full benefit of AXA XL Risk Consulting's expertise, management should follow the advice of the AXA XL Risk Consulting's representative during site surveys.

DESIGN, INSTALLATION AND TESTING OF PRESSURE EQUIPMENT AND MACHINERY

The exposure to loss of production and service equipment may be reduced and the prospects for successful operation enhanced by precautions taken during installation. Special inspection of pressure equipment may also be required by law. The following items relate to past losses and/or delayed start-ups.

It is imperative that the time of acceptance and the test criteria for any equipment or machinery be clearly identified in writing before any commitment is made. Performance tests, inspection witness points and performance benchmarks should never be waived without the written agreement of all concerned parties, including the insurance carrier.

Boilers, pressure vessels and piping systems are frequently subject to jurisdictional (legal) requirements for design, fabrication, installation and for inspection during these activities. The installation of used pressure equipment may be severely restricted. The chief boiler inspector of the jurisdiction should be consulted early in the planning process to ensure that no laws are unwittingly violated. AXA XL Risk Consulting can assist in these matters.

In most parts of the world, a construction manager must keep an eye on the calendar, because the possibility of freezing will exist at some time of year. This means that arrangements must be made not only for completion of boilers and heating systems before they are needed but also for any tests and inspections required by the jurisdiction before licensing.

Air conditioning and refrigeration equipment may also involve jurisdictional requirements. For many facilities, the air conditioning equipment may be the heaviest machinery at the location. Advance planning for routine overhaul and emergency repair will reduce costs and expedite activity for the life of the facility.

Electrical distribution systems are not as passive as they might appear. In addition to considering current capacity and component protection, alternate feeds for critical equipment should be provided. A fault current analysis (also known as a relay coordination study) should be performed to insure that no fault to the system could possibly produce a current flow beyond the ability of the assigned fuse or breaker to interrupt.

Selective tripping should be employed to open, before others, the protection device nearest a fault, thus minimizing the extent of the resulting outage. On the other hand, some other tripping scheme, or perhaps electrical interlocking, may be needed for applications where loss of power to a single device results in an emergency condition if other devices continue to operate.

Before energizing any new or reworked electrical service or electrical device, an insulation resistance test and a test for a short circuit should be performed. More sophisticated testing may be in order for larger systems and certainly for major motors, generators and transformers. Not only are “smoke tests” (energizing equipment which is hopefully installed correctly, to see what happens) potentially expensive, but even if all is well, the opportunity to obtain baseline data for the maintenance record system is lost.

Construction or installation of any large or complex piece of equipment involves many types of quality control. One aspect which is frequently overlooked in the potentially bewildering activity at a construction site is tool control. It is important that access to an open machinery casing is strictly limited and that accountability of all tools and parts is maintained so that nothing is inadvertently left in the machine.

The following should be considered or accomplished prior to the initial start of any large rotating machine.

- All protective devices and systems must have been installed and tested to whatever degree is possible without machine operation.
- Supply and support systems, such as steam and lubricating oil, should be separately inspected, commissioned, flushed and reinspected before operation of the machine.
- Steam strainers, lubricating oil system fabric filters and any other precautionary devices recommended by the manufacturer or suggested by good engineering practice should be installed.
- The machine should be turned over by hand or a jacking device to ensure that no gross binding, interference or misalignment exists.

Whether the machine has a permanently installed vibration monitor or not, sufficient transducers connected to recording analysis equipment should be provided to detect flaws which may be present and to provide baseline “signatures” for the maintenance records. The initial testing may be the best opportunity in the life of the machine to collect data reflecting a variety of operating conditions.

Initial testing of almost any piece of equipment involves abnormal configurations of some sort. Examples include gagged safety valves for hydrostatic tests, blanked flanges and missing valves for flushes and the aforementioned steam and oil system filters. Great care must be taken to restore normal conditions before unrestricted operation is attempted.

MECHANICAL EQUIPMENT DESIGN AND INSTALLATION

INTRODUCTION

If facility owners and managers consider loss prevention and control when they design, install and test mechanical equipment, they will reduce the facility's loss exposure and they will:

- Make the completed work more reliable.
- Have more easily and effectively maintainable equipment.
- Minimize time and material during construction and operation.
- Maximize chances for trouble-free startups.

This section describes loss control principles to use while designing, installing or relocating mechanical equipment such as turbines, compressors, pumps, gear sets and mills. Fire and explosion protection and extra safeguards for certain types of equipment are covered in other Property Risk Consulting Guidelines. Section 5 of *OVERVIEW* discusses loss control for the overall construction project.

Facility management and AXA XL Risk Consulting should discuss projects that involve new equipment while the projects are being planned. The designer, the equipment manufacturer and installer, facility management, and insurer must all work together to minimize the potential for equipment damage or failure during installation, startup, testing or subsequent operation. Before work begins, management should provide AXA XL Risk Consulting with a project schedule so that a consultant can plan to witness key activities, such as casing closures, and performance and protective equipment tests. If the schedule changes, AXA XL Risk Consulting should be informed.

POSITION

Perform a preliminary hazard analysis as soon as practical, and use it to eliminate potential hazards when possible. (See Section 13 of *Overview*) Management can often reduce the required amount of loss prevention equipment by making relatively minor adjustments. Also, a facility can most economically incorporate protective devices when they are included in the initial specifications.

Design for reliability and maintainability. The pressure to minimize initial cost when buying equipment is intense, however, small initial investments in these areas provide substantial returns over the life of the equipment by reducing the number of breakdowns, the required length of maintenance outages, and the overall cost of maintenance and repairs. A variety of conflicting goals must be considered. For example:

- Installing single large machines or units may be economical, but two or more smaller machines or units may be more reliable and easier to maintain. Each smaller machine may also have less direct damage and business interruption loss potential.
- Installing fewer valves in a system may reduce its cost and eliminate potential leakage sites, but having too few valves can make the system less flexible and can make maintenance more dangerous and expensive.
- Some types of equipment, such as gas turbines and dynamic compressors, operate most efficiently in conditions that leave very little design margin, but the safety devices needed to operate this way may be sensitive enough to shut the machine down when it is not truly in danger.

Include document requirements in the contracts for the entire installation and for each piece of equipment. The following documents and their time of delivery should be specified by any contract for new machinery. The same documents should also be obtained for a used machine.

- Assembly drawings and instructions for initial assembly and subsequent overhaul. These must include:
  - Weights, weight distributions and dimensions of all major parts and subassemblies.
  - Rigging instructions, including tackle needed, points of attachment and any special precautions or instructions.
  - Specified piping load limitations for all connections.
- Foundation drawings and specifications. These must include any channels, conduits or connections to be located in the foundation. The drawings must also show the location and other requirements for bedplates, anchor bolts and grouting.
- Structural drawings of the machinery room(s). These must show the location and load-bearing ability of areas that may be used to store major components temporarily during overhaul. Room for both an incoming replacement part and the part coming out of service may be useful.
- Machinery manuals, including complete equipment drawings, descriptions and specifications, and instructions for installing, dismantling and reassembling, commissioning, operating and maintaining the equipment.
- Schematic drawings, equipment drawings and specifications, instruction manuals, commissioning requirements and maintenance schedules for all support systems.
- Benchmark inspection data, including “as-built” internal clearances, and all data from bench tests, including balancing runs, alignment tests, vibration signatures and performance curves.

Establish preventive maintenance (see Section 3 of *OVERVIEW*) and operator training programs before equipment startup (see Section 4 of *OVERVIEW*).

Plan for future removal or repair of complete machines or their major pieces. Provide adequate overhead cranes or ensure sufficient head space and accessibility for mobile lifting equipment. Provide suitable and secure laydown areas.

Equipment layout can affect its maintainability. Space units to allow piping arrangements that permit thermal movement with as few expansion joints as possible. Place piping and equipment so that equipment access is not restricted. Review piping and piping support design calculations to ensure that the loadings at connection points will not exceed the loadings allowed by the manufacturer.

Do not receive weather-sensitive equipment before it can be protected from the elements. This applies to projects requiring building or shelter construction. Plan temporary shelter when early receipt cannot be avoided.

Maintain strict quality controls during equipment construction and installation. Tool control is frequently overlooked. Strictly limit access to open machinery casings and account for all tools and parts used so that nothing is left in the machine by mistake.

Control the activities of contractor personnel. Doing so may be difficult when structures are being built or modified and machines are being installed. Nevertheless, contractors must comply with management's loss prevention and control programs. Use a contract inspection and auditing service, if necessary, to ensure compliance with specifications and applicable management loss control programs. Refer to *OVERVIEW* Section 5, Appendix B.

Clearly identify in writing the test criteria and the time and conditions of acceptance for all machinery. Performance tests, inspection witness points, and performance benchmarks should never be waived unless all concerned parties, including the insurance carrier, provide a written agreement. All startup and acceptance procedures specified by the manufacturer should be completed before any equipment is accepted for service.

Complete all of the following that apply before starting up any large rotating machine:

- Inspect the machine thoroughly and review the fabrication and construction records to ensure that all preliminary activities, such as leveling, cold alignment and balancing are complete.
- Install and test all protective devices and systems to whatever degree possible without operating the machine.
- Inspect, flush, reinspect and commission the supply and support systems, such as steam and lubricating oil, before operating the machine.
- Install steam strainers, lubricating oil system fabric filters and any other precautionary devices suggested by the manufacturer or good engineering practice.
- Turn the machine over by hand or use a jacking device before applying power to ensure that gross binding, interference or misalignment are not present.
- Provide sufficient vibration recording and analysis equipment to detect possible flaws and to obtain baseline vibration signatures for maintenance records. The pre-production testing period may be the best time during the life of the machine to collect data under a variety of operating conditions. See PRC.6.0.8.1.1 for additional vibration monitoring recommendations.

Be sure to restore normal conditions before attempting unrestricted operation. Most initial testing of equipment involves abnormal configurations. Examples include:

- Safety valves removed or gagged and piping hanger travel stops installed for pressure equipment hydrostatic tests.
- Flanges blanked and valves removed for fluid system flushing.
- Fine-mesh steam strainers and oil system filters installed for turbine pre-acceptance testing.

Learn as much as possible about used equipment before deciding to purchase or use it. Proceed as follows:

- Arrange a performance test and have a qualified representative witness it on the buyer's behalf.
- Witness a complete overhaul, including nondestructive testing of critical areas.
- Test samples of materials taken from critical areas, such as gas turbine hot gas paths, or use on-site testing methods to ensure that the parts have not been overheated or otherwise damaged.
- Have a third-party inspection and evaluation performed. Use a neutral contractor who specializes in the type of equipment in question.

DISCUSSION

A preliminary hazard analysis may reveal new ways to design a safer and more reliable facility. For example, some compressor applications can be designed with magnetic bearings to eliminate the lubricating oil system and its hazards. Dry shaft seals may eliminate seal oil systems. Applying new technology requires caution, however, and eliminating one hazard may introduce another.

It may be difficult to get documentation for equipment once it has been accepted and paid for. Complete drawings must be delivered on time while the equipment is being planned, built and installed.

During planning, rough drawings are needed to evaluate the overall equipment layout in detail. Rough drawings of the equipment and facility structures permit:

- Arranging equipment for operating efficiency and service accessibility.
- Designing connecting piping and piping support systems.
- Planning the construction sequence.
- Planning safe and efficient rigging.

Once the equipment is installed, detail drawings and specifications are needed for maintenance and repair, to help determine if damaged parts are repairable or to permit the quickest possible manufacture of replacement parts. If the correct drawings are available, either the original manufacturer or another contractor can usually provide these services.

LOSS PREVENTION RECOMMENDATIONS

INTRODUCTION

Recommendations made by loss prevention providers are aimed at reducing loss potential. Uncompleted recommendations reflect deficiencies. A plan for their review and resolution is needed.

Recommendations made by AXA XL Risk Consulting in the interest of reducing loss potential from a property protection standpoint have no value unless the actions recommended are completed and the deficiencies eliminated. There may also be jurisdictional implications in the case of some boiler and pressure vessel recommendations. While it is necessary to determine the cost of implementing a recommendation, this information alone is not necessarily a measure of a recommendation's worth. No matter how inconsequential or expensive a recommendation may seem, it must be taken seriously. A recommendation cost benefit analysis can provide a true measure of a recommendation's worth.

POSITION

When acting on a AXA XL Risk Consulting's recommendation, management should:

- Review the recommendation to make sure it is understood. If a governmental authority (jurisdiction) is involved, as may be the case with boiler or vessel recommendations, then ensure that this information, the mandated time frame, inspection and reporting requirements are included.
- Assign someone the task of making engineering and cost analyses. AXA XL Risk Consulting can provide a cost benefit analysis of each recommendation.
- Review the results of these analyses. Obtain the concurrence of AXA XL Risk Consulting before proceeding.
- Have specifications prepared and reviewed by AXA XL Risk Consulting. Once specifications have been finalized, obtain quotations for the work.
- Establish a suitable time frame for the completion of the recommendation.
- Make sure that proper construction and maintenance practices are followed.
- Arrange for an AXA XL Risk Consulting's representative to be present when the contractor conducts acceptance tests.
- Establish a policy whereby corporate management and AXA XL Risk Consulting account personnel annually review all unresolved or deferred recommendations.

DISCUSSION

AXA XL Risk Consulting's recommendations are generated in several ways. The greatest number result from surveys conducted by AXA XL Risk Consulting's loss prevention representatives. They visit the facility, consult with top management, review existing conditions, and prepare advisory recommendations outlining what is needed to improve substandard conditions.

The second greatest number of recommendations is developed in conjunction with and prior to new construction or a major renovation. The AXA XL Risk Consulting's representative reviews the proposed project, including the specification, and prepares the necessary recommendations.

Recommendations are also developed as a result of loss investigations. These recommendations are aimed at correcting such deficiencies as may have led to the loss or contributed to its extent or deficiencies that may exist as a result of the loss. They may document preferences when more than one repair method is possible and jurisdictional requirements when these apply.

Finally, recommendations are prepared as a result of special visits made to the facility to review various projects, operations or tests.

Regardless of the way in which the AXA XL Risk Consulting's representative develops the recommendation, it should be reviewed with the management of the facility at the time it is made.

If a recommendation is not understood during a subsequent review, the AXA XL Risk Consulting's representative should be contacted for clarification. Similarly, any alternate solutions suggested by the engineering analysis should be reviewed with AXA XL Risk Consulting.

This is particularly important with recommendations that involve boilers and pressure vessels because these may have legal implications to be considered. The governmental authority may require feedback within a specific time frame. In any case, failure to comply with the recommendation and properly advise the jurisdiction may result in loss of certification of the equipment.

The engineering and cost analyses should be reviewed at a management level which has the authority to approve the expenditure. When local management does not have this authority, the analysis should be forwarded to higher management with appropriate comments. It is vital that the timely completion of a recommendation not be delayed simply because local management does not have the authority to implement it.

The recommendation cost benefit analysis (RCBA) is usually accomplished by establishing a conceivable loss scenario that involves the specific recommendation. RCBA consists of four tasks:

- Estimating the cost of doing a particular recommendation.
- Determining the potential loss estimate if the recommendation is not done.
- Determining the potential loss estimate if the recommendation is done.
- Analyzing the cost-benefit of doing the recommendation.

Once this information is determined, the potential savings and recommendation-specific cost benefit ratio can be determined. This service is available from AXA XL Risk Consulting.

When obtaining quotations, contractors should be advised that AXA XL Risk Consulting is the property loss control provider and that working drawings should be forwarded to AXA XL Risk Consulting for review and comment. For boiler and vessel work, other credentials may need review and approval. It is therefore advisable to begin work only after AXA XL Risk Consulting has completed its review.

If it is necessary to impair fire protection systems to implement the recommendation, follow proper impairment handling procedures (see PRC.1.1.0).

Acceptance tests conducted by the contractor help determine that the equipment will perform as intended. AXA XL Risk Consulting welcomes the opportunity to witness these tests in order to compare the completed job with the AXA XL Risk Consulting reviewed drawings and to make certain the installation is acceptable from a property protection standpoint. To be certain that all necessary minor adjustments have been made to the equipment prior to the actual acceptance test, the contractor should run a preliminary test.

These detailed procedures primarily address the proper handling of major recommendations. Other recommendations may not require such thorough review; however, they must be handled in a timely manner. To take care of maintenance items properly, the necessary work orders should be promptly prepared. After all, the fire door that does not close could allow a fire to spread quickly beyond the area of origin. Or, the loose bus bar joint in the main switchgear could fail, shutting down operations at the entire plant.

If the recommendation concerns a management loss prevention or control program, it should be brought to the attention of the people who implement the program. This type of recommendation usually requires very little expenditure of money and often can be promptly completed.

A similar plan can be employed to handle recommendations made by other outside agencies.

PRE-EMERGENCY PLANNING

INTRODUCTION

No matter how extensive and thorough loss prevention programs and procedures, management must ensure that each facility is prepared to deal with any internal or external event that can lead to an emergency at the facility. An emergency is an event that requires immediate response to limit the threat to life, property, the environment and business operations.

By anticipating and preparing in advance for any emergency that might arise, the emergency can be managed to minimize its impact. The key to successful emergency management is a pre-emergency plan that is prepared and tested before an emergency strikes.

This Property Risk Consulting Guideline provides guidance for sound pre-emergency planning, response and recovery policies and procedures. Following this guide will help organizations achieve the same level of excellence in their emergency response planning efforts that they strive to maintain in their daily business activities.

Regardless of the term used — pre-emergency planning, emergency response planning, disaster management, emergency preparedness, or emergency management — it means anticipating and planning in advance for emergencies.

Past history vividly demonstrates that actions taken to confront emergency situations are seldom effective unless they have been planned in advance. The emergency response component of management programs represents the last line of defense against what may be catastrophic consequences caused by an emergency.

The keys to successfully managing an emergency are:

- Proper response of employees when the emergency occurs;
- Actions taken to recover from the emergency and return the facility to its normal state.

To ensure proper emergency response, the actions to be taken must be carefully planned, tested, revised and practiced so they become a matter of routine.

Emergency response plans that are hastily conceived, filed and forgotten, or not followed can be far worse than no plan at all. Plans of this type do little more than create complacency before, confusion during, and economic disaster after an emergency.

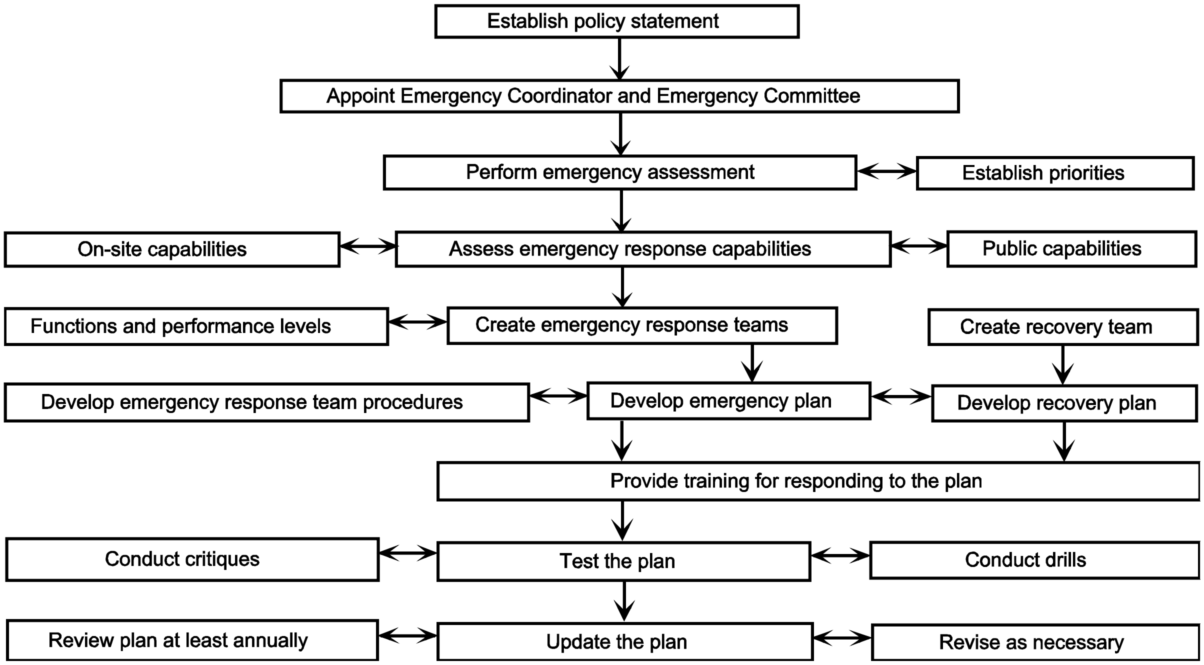


Figure 1. Steps To Create A Pre-Emergency Plan.

POSITION

Management must develop and maintain a written pre-emergency plan that clearly defines all facets of emergency response and recovery operations at the facility. Every facility is unique and encompasses a variety of site-specific hazards and potentials for emergency incidents.

Each pre-emergency plan must be site-specific. Figure 1 briefly outlines the steps necessary to create a pre-emergency plan.

To create a pre-emergency plan, follow these steps:

- Establish a written emergency response policy statement that clearly:
    - Reflects management's commitment to pre-emergency planning;
    - Defines the responsibilities and authority of the Emergency Committee;
    - Defines the goals and objectives of pre-emergency planning efforts.
- Assign the emergency response responsibilities to a qualified individual that will develop, implement, and administer the emergency response plan. (This document calls this person the Emergency Coordinator.)
- Appoint an Emergency Committee led by the Emergency Coordinator. Include key personnel from all functional areas expected to be involved with emergencies at the facility. Chose members having knowledge of the facility and the authority to commit resources from key functional areas. Additional duties include:
    - Identifying hazards and hazardous materials;
    - Identifying resources necessary for prompt recovery;
    - Keeping management informed of the latest methods of loss prevention and control;
    - Supervising and evaluating periodic property inspections;
    - Keeping the pre-emergency plan up-to-date.
- Have the Emergency Committee perform an emergency assessment to identify potential site-specific emergency situations that would affect the facility or its normal business operations.

Assess the risk of each potential emergency with regard to its probability of occurring, the consequences should it occur, and the priority for each potential site-specific emergencies.

- Have the Emergency Committee assess the facility's emergency response capabilities as well as the public-sector emergency response capabilities for handling each potential site-specific emergency.
- Organize the appropriate emergency response teams (ERTs) and recovery teams to provide the needed emergency response functions and the resources to return to full production following an emergency event. Determine the needed site-specific response functions and performance levels required for each emergency.
- Have the Emergency Committee develop a written emergency response plan that encompasses all emergency response procedures for each potential emergency. Distribute the plan to all parties expected to be involved in emergency response. Emergencies that should be addressed include:
    - Fires and explosions;
    - Natural disasters (hurricanes, tornadoes, flooding, earthquakes, winter storms);
    - Sprinkler leakage incidents;
    - Utility outages both on and off premises (water, electric, fuel, air, refrigeration, air-handling);
    - Bomb threats;
    - Riots and civil commotion;
    - Disruption of key production equipment or computer facilities (equipment malfunction and labor unrest);
    - Transportation-related accidents;
    - Other emergencies, including release of hazardous, radioactive, and molten materials.
- Have the Emergency Committee develop a written emergency recovery plan that encompasses all emergency recovery procedures for each potential emergency. Distribute the emergency response plan to all parties expected to be involved in emergency recovery operations.
- Train personnel for their assigned emergency duties.
- Test both the emergency plan and recovery response by conducting drills or exercises that simulate anticipated emergencies at least annually.
- Conduct a formal critique following each drill and actual emergency to determine:
    - Whether the pre-emergency plan worked as intended;
    - If revision to the pre-emergency plan is needed as a result of "lessons learned."
- Review the pre-emergency plan at least annually to ensure it remains current with facility needs.

DISCUSSION

Emergency Response Policy Statement

The emergency response policy statement is a critical component of any emergency plan. This statement must:

- Come from the CEO or corporate management;
- Define the goals of emergency response and restoration efforts;
- Establish confidence in the pre-emergency plan;
- Demonstrate corporate management's commitment and interest in emergency response;
- Assign responsibilities for emergency response efforts.

Emergency Coordinator And The Emergency Committee

Responsibilities for developing, implementing, and administering the facility's emergency efforts must be assigned to an individual who reports directly to facility management and has the authority to:

- Ensure that all tasks can be accomplished;
- Commit the resources required to ensure that efforts achieve the level of quality expected.

The Emergency Committee should involve personnel from all important departments. These individuals can be used to provide emergency duties in their fields of expertise.

Executive management duties:

- Approve the activation of the plan or the declaration of a disaster.
- Approve recovery expenditures, as required.
- Coordinate and issue all company related news releases to the press and media.
- Monitor all recovery activities with the business recovery team.
- Provide direction and counsel, as required.
- Manage all personnel matters and benefit programs for affected employees.
- Issue information involving employee fatalities and injuries and notifications to employee(s) families and dependents or direct that Human Resources do so. This may also include professional counseling and financial support for employees.
- Involve the legal department as necessary for review of contracts.
- Review recovery progress and status with the Board of Directors.

Engineering department personnel duties:

- Keep the Emergency Committee informed of proposed changes in buildings, processes, and major equipment.
- Maintain up-to-date plans for reconstruction of key equipment and facilities. Critical plans for unique or custom equipment should be kept off-site.
- Maintain spares for parts which are not readily available and which are essential for prompt restoration of equipment that is critical to production.
- Maintain updated drawings and load analyses for the electrical, steam, air and other utility distribution systems.

Maintenance staff duties:

- Help salvage machinery and restore utilities.
- Make immediate repairs to fire protection equipment after an incident to minimize the time any portion of the plant is without proper protection.
- Aid in setting up temporary management, financial, communications, and essential production facilities as necessary.

Production staff duties:

- Quickly report any emergency condition.
- Know the proper use of safety and fire protection equipment.
- Advise management of bottlenecks that might delay prompt resumption of production.
- Prepare work schedules for operations essential to prompt restoration of production.

Purchasing staff duties:

- Advise management of any shortage of critical materials or manufacturing supplies.
- Maintain contact with suppliers who can assist in obtaining materials essential to prompt restoration after an emergency.

- Maintain a database of outside services and resources essential to prompt restoration after an emergency.

Public relations staff duties:

- Maintain a good working relationship with the community.
- Obtain the facts and provide the media with an accurate story should an incident lead to an emergency.

In addition, personnel from the following departments should also be available:

- Human Resources
- Industrial Hygiene and Safety
- Security
- Legal
- Accounting/Finance
- Purchasing
- Information Management
- Employee Training and Development

Prior to an emergency the Emergency Coordinator should organize, staff, and equip both on-site and off-site Emergency Operations Centers.

In addition to implementing pre-emergency planning efforts within the facility, the Emergency Committee must coordinate its efforts with the emergency plans of the community. To ensure that coordination is achieved, the committee should interact with appropriate authorities such as:

- Municipal emergency planning committees
- Elected officials
- Civil preparedness/emergency management officials
- Fire and rescue services
- Emergency medical services (EMS)
- Law enforcement
- Utility suppliers
- Hazardous materials response agencies
- AXA XL Risk Consulting
- Insurance carrier representatives
- Insurance broker/agent
- Key suppliers and vendors
- Other organizations that may be involved in a facility emergency

The Emergency Coordinator ensures that all perspectives are incorporated in the emergency plan. Figure 2 shows a typical incident management system incorporating an Emergency Coordinator.

During an emergency the Emergency Coordinator is expected to:

- Keep management informed about the incident.
- Declare if an emergency exists and how serious it is.
- Mobilize initial emergency response as required by the incident.
- Continuously assess and evaluate the emergency and coordinate effort accordingly.
- Document the results of the emergency assessment(s) and evaluation(s).
- Obtain reports of personnel injury and send them to management.

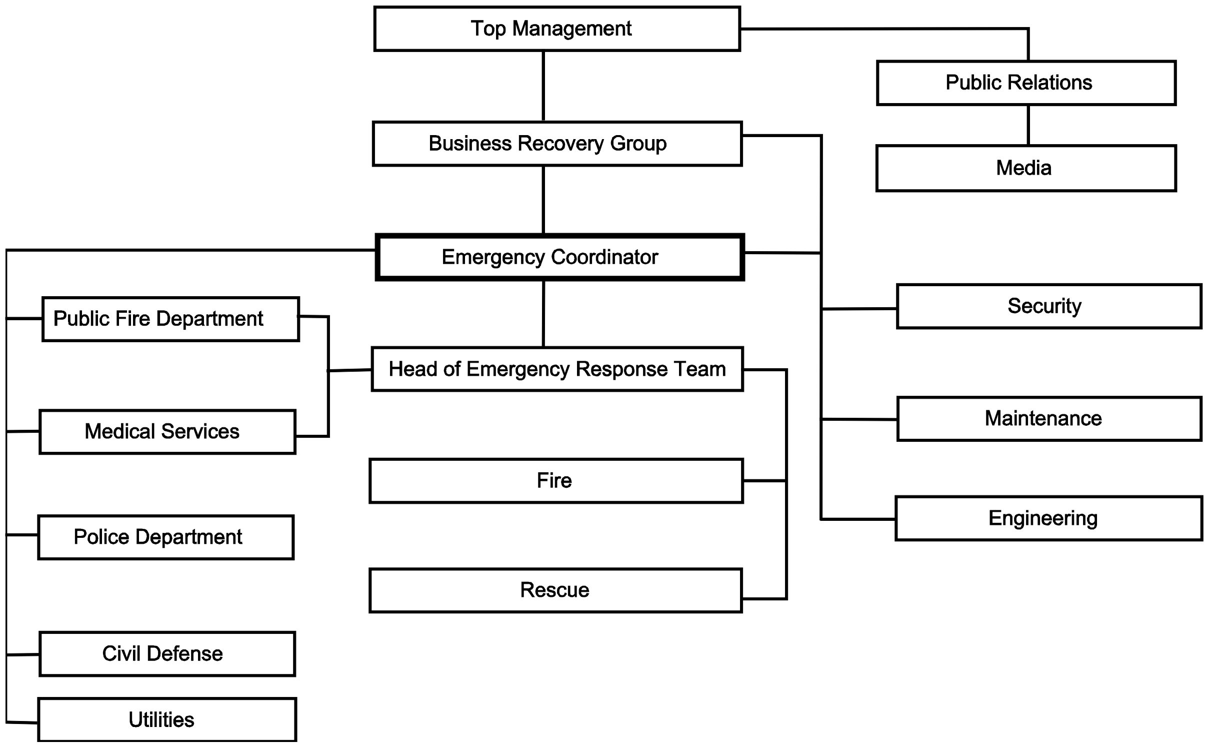


Figure 2. Typical Incident Management System Incorporating Emergency Coordinator.

If the emergency involves business operations the Emergency Coordinator is expected to:

- Establish and organize a business resumption headquarters, at an alternate site.
- Control the activation of the business resumption procedures during an emergency.
- Direct emergency response efforts.
- Alert recovery personnel and have them to report to the Emergency Operations Center.
- Provide for appropriate clerical support.
- Advise business/department managers that the plan has been activated and request that they alert their staff members and have them report to the appropriate off-site locations where they can begin the recovery process.
- Coordinate the recovery of all business functions.
- Manage all administrative activities associated with the recovery operation.
- Terminate or expand/extend the recovery operation, as directed by management.
- Ensure a complete assessment of damages and salvage operations is conducted.
- Report recovery progress and status to management.
- Coordinate the eventual restoration/relocation of the primary site.

Performing An Emergency Assessment

The Emergency Committee conducts an emergency assessment to:

- Identify each type of event that could cause an emergency within the facility;
- Assess the risk each potential event represents.

Three basic categories of events that can lead to emergency situations are:

- **Natural**. Events due to natural occurrences. They are usually a function of:
    - Geographic location;
    - Geologic and atmospheric conditions within that particular geographic region.

- **Technological**. Events due to technology events.
- **Social/Political**. Events due to the social and/or political attitudes of people.

The assessment involves answering questions like these:

- Could an incident of this type occur at the facility?
- What conditions would have to be present for this incident to occur?
- When could this incident occur?
- How frequently could this incident occur?
- How significant would the incident’s impact be on:
  - Personnel in the affected area at the time of the incident?
  - Personnel who respond to the incident?
  - Property damage to the facility?
  - Business operations of the facility?
  - The economic well-being of the company?
  - The community?
  - The environment?

Use an emergency assessment worksheet like the one shown in PRC.1.7.0.A to evaluate each event that could occur at the facility and to assign a probability rating and a consequence rating of its occurrence.

The following terms or numerical ratings could express the probability:

- Cannot happen (1)
- Occurs very rarely (2)
- Likely to occur (3)
- Occasionally occurs (4)
- Frequently occurs (5)

The consequence could be expressed by the following terms or numerical ratings, along with a brief description of the event’s effect on business:

- None (1)
- Negligible (2)
- Moderate (3)
- High (4)
- Catastrophic (5)

Prioritize the events. Planning efforts should start with events that would have the most serious consequences. One method of prioritizing the events is to multiply the probability by the consequence. The events with the highest numbers might have the highest priority.

In addition to the events that have been previously identified, the Emergency Committee should identify areas that present specific problems in recovery operations.

Assess Emergency Response Capabilities

The minimum emergency response by the ERTs dealing with hazardous materials and fire events should include:

- Hazardous Materials — Personnel perform defensive operations from outside of the zone of greatest risk.
- Fire suppression — Personnel fight fires that can be extinguished with portable extinguishers and inside hose connections.

Many industrial/business facilities need to respond at higher levels than identified above. In such cases, base the response level on the emergency assessment and the performance level requirements and limitations.

Facilities that require an ERT to provide hazardous material response must be trained to the hazardous materials technician level. This is usually necessary when:

- No public agency provides these services;
- The response time of the community's Haz-Mat response agency is longer than 10 min;
- The public Haz-Mat response agency cannot guarantee the presence of at least four Haz-Mat technicians, an incident commander, and proper support people at any time of day or night;
- The hazardous materials in the facility are such that the public Haz-Mat response agency cannot respond fast enough to control an incident before it reaches major proportions;
- The facility relies heavily on manual fire suppression;
- The public response agency does not have the expertise required to deal with the hazards and the materials used in the facility;
- The public response agency is not adequately equipped to deal with a major Haz-Mat incident in the facility;
- The community's Haz-Mat response agency cannot guarantee that a response to the facility will take precedence over other responses in the community.

Facilities that require an ERT to provide fire suppression at an advanced level of capability are those where:

- The facility has established an on-site hazardous materials response team trained to the Haz-Mat technician level;
- There are no municipal fire department services in the area;
- The facility's fire protection relies heavily on manual fire suppression;
- The fire department cannot arrive soon enough to control the fire in the hazards at the facility;
- The fire department is not adequately equipped to deal with an advanced fire at the facility;
- The fire department cannot guarantee a minimum response at all times of at least two engines, six firefighters, and a command officer;
- The fire department does not have the expertise or specialized equipment required to deal with the hazards at the facility;
- The fire department does not maintain up-to-date pre-fire plans or standard operating procedures for dealing with fires at the facility.

Establishing Levels Of Emergencies

While all emergencies require prompt response and action, not all emergencies represent the same level of potential consequences. A comprehensive emergency plan should establish categories or levels of emergencies to ensure that the response is sufficient to deal with each level of emergency. The plan should provide for upgrading each response if the emergency escalates.

There are no standard methods for establishing levels of emergencies. Each facility must determine a method that best suits its own needs. The following is one suggested:

Level 1 Emergencies. This is the lowest category of emergencies. And is usually confined to the point of origin. Because of their nature, Level 1 emergencies require a limited level of on-site emergency response.

Level 2 Emergencies. This level of emergency is more serious than Level 1 and results in an emergency that affects a portion of the facility.

Level 3 Emergencies. This level is more serious than Level 3 and affects the entire facility.

Level 4 Emergencies. This is the most serious level of emergency. Level 4 emergencies affect not only the facility, but also the community in which the facility is located.

Creating Emergency Response Teams

The head of the ERT in concert with the Emergency Committee is responsible for maximizing the safety of personnel while ensuring that emergency incidents are managed effectively and efficiently. This is accomplished by creating the necessary ERTs. For additional information on ERT structure, personnel roles, staffing and performance see PRC.1.7.0.2.

The head of the ERTs in concert with the Emergency Committee must determine how employees are to respond to emergencies when they occur in the facility. To accomplish this, they must:

- Conduct an emergency response needs assessment of the facility based on the site-specific hazards and conditions.
- Identify the emergency response functions needed to deal with anticipated emergencies.
- Evaluate the emergency response functions available from public agencies.
- Establish which emergency response functions the facility must provide and maintain to deal with site-specific emergencies.
- Establish the performance levels required for each of the emergency response functions identified.
- Organize, train and equip ERTs to perform their functions as planned.

The head of the ERT should:

- Ensure that the organization of each ERT is based on the site-specific needs of the facility.
- Determine if the ERT is to respond to:
  - Site-specific emergencies on-site only;
  - Site-specific emergencies both on-site and off-site.
- Develop a written ERT organizational statement that includes:
  - The basic organizational structure of the ERT;
  - The expected number of members on the ERT;
  - The emergency response functions and the levels at which the team members are expected to perform;
  - The type, amount, and frequency of training provided to team members;
  - The shifts during which the ERT is expected to be available;
  - Other factors that define limits of the activities of the ERT.
- Define the duties and responsibilities of:
  - ERT Leaders
  - Team specialists
  - Team members
  - Support members
- Establish the job-related medical and physical requirements for ERT members.
- Establish the use of control zones - hot, warm, and cold - to define the operational limits of ERT members. Operations in each zone are to be based on:
  - The medical and physical capability of ERT members;
  - The skills and knowledge levels of ERT members;
  - The personal protective equipment available to ERT members.
- Assign the site-specific duties to ERT members based on:
  - The emergency response function;

    - The performance level.
- Adopt the incident management system to be used by the ERT. For additional information on incident management systems requirements for ERTs and public agencies see PRC.1.7.0.2.
- Establish lines of authority and assign responsibilities to ensure compliance with the ERT organizational statement.
- Adopt performance standards for the training and education of ERT members.
- Develop written emergency action plans for all anticipated events.
- Ensure that all ERT personnel are proficient in their duties.
- Appoint an ERT training coordinator.
    - Conduct training frequently enough to maintain the skills and knowledge of ERT members.
    - Maintain individual training records for each member.
    - Conduct drills to evaluate ERT performance at least annually.
- Appoint an ERT Safety Coordinator.
- Provide ERT communications to:
    - Alert ERT members to respond to an emergency.
    - Provide communication between members during emergency.
- Select and provide ERT members with the appropriate personal protective equipment:
    - Thermal protective clothing for advanced fire suppression team;
    - Chemical protective clothing for Haz-Mat Response Team;
    - Liquid splash-protective clothing;
    - Vapor-protective clothing;
    - High temperature-protective clothing;
    - Self-contained breathing apparatus;
    - Other equipment needed to perform the emergency response function(s) at the specified performance level(s).

The Emergency Committee in concert with the head of the ERT should determine what standard operating procedures (SOPs) are needed by the responding ERT personnel. SOPs are written directives that explain standard courses of action that are to be taken under certain sets of circumstances. They also define the responsibilities and limitations of people with regard to the procedures.

Based on the current ERT standards and regulations the ERT:

- Uses the pre-emergency plan on all incidents and drills. The plan should:
    - Define the roles and responsibilities of ERT personnel;
    - Define roles and responsibilities of off-site emergency response personnel;
    - Utilize an ERT member accountability system;
    - Utilize a risk management policy to define ERT limitations;
- Develops SOPs defining the site-specific functions and limitations of ERT members;
- Bases the a risk management policy on the following:
    - Some risk to the safety of ERT members is acceptable when there is a potential to save human lives;
    - Minimal risk to the safety of ERT members is acceptable where there is a potential to save endangered property;
    - No risk to the safety of ERT members is acceptable where there is no possibility of saving lives or property.

- Follows operational safety requirements:
    - ERT members must use personal protective equipment and respiratory protection required by the control zone in which they are to perform assigned duties.
    - A team must use control zones for all emergency operations.
    - Members must operate in teams of 2 or more when operating in the hot zone.
    - When a team is operating in the hot zone, a rapid intervention or safety team trained and equipped to the same performance level must standby in the warm zone to assist the team in the hot zone if needed.
    - Experienced members should oversee the activities of less experienced members.
- Does not assign duties to any member not qualified for them.

Specialized ERT member functions include the following:

Personnel Evacuation. This specialized member is responsible for:

- Assisting in the orderly evacuation of personnel from the incident area;
- Conducting a primary search to ensure that all personnel have evacuated the area.

Electrical Power Control. This specialized member is responsible for:

- Controlling the electrical power in the incident area or the facility;
- Ensuring that vital fire protection equipment remains in service during the incident;
- Controlling emergency lighting;
- Ensuring that powered smoke control systems remain in service;
- Shutting down fans or operating ventilation equipment in accord with standard operating procedures or as required by the incident commander.

Utility Control. This specialized member is responsible for:

- Controlling facility utilities such as steam, water, natural gas, and other utilities in the incident area.
- Being a valuable resource to on-site and off-site emergency personnel.

Security/Surveillance/Communications System Control. This specialized member is responsible for:

- Maintaining control of the alarm system.
- Responding to alarm signals.
- Communicating alarm system status changes to ERT members.

Sprinkler System Control. This specialized member is responsible for:

- Operating sprinkler system control valves during the incident;
- Maintain control of the sprinkler system(s) in the incident area;
- Ensure that all sprinkler systems are restored promptly after an emergency.

Fire Pump Control. This specialized member is responsible for:

- Ensuring that any automatic pumps have started and are operating properly;
- Starting any manual fire pumps;
- Opening the fill lines to refill the fire pump reservoirs or suction tanks;
- Monitoring the operation of fire pumps until the incident commander decides they can be shut down;
- Standing by to restart the fire pumps if needed until the incident is terminated;
- Monitoring the fuel levels in the fire pump driver fuel tanks and arranging for emergency refilling if necessary during the incident;

- Returning the fire pumps to automatic mode and having the fuel tanks refilled after the incident.

Coordination with Public Fire Department

The head of the ERT should invite the public response agencies to visit the facility to ensure that facility efforts are coordinated with public emergency response agency efforts. These agencies include the local Fire Department, Emergency Medical Services, Haz-Mat Response Team, and Rescue Services.

The head of the ERT should ensure that at least on an annual basis personnel from the first responding fire departments or first responding fire companies visit the facility to coordinate their pre-fire plans and standard operating procedures with the facility's emergency response plan. In areas protected by career or full-time fire departments, visits should include personnel from all shifts. In areas protected by volunteer fire departments, make visits when the volunteers are available.

The objectives of fire department visits are to:

- Establish a solid working relationship and a level of trust between fire department personnel and facility personnel;
- Ensure that in the event of an emergency within the facility, a unified incident command structure will be used;
- Familiarize firefighters with the following characteristics of the facility:
    - Layout;
    - Construction;
    - Occupancy;
    - Location and operation of fire protection equipment;
    - Location of fire protection control valves;
    - Utility shutoffs;
    - Other protective features of the facility.
- Point out site-specific conditions that may affect firefighting operations;
- Review the response route the fire department will take to the property;
- Determine which entrance the fire department will use to enter the facility and where apparatus staging areas are to be set-up;
- Ensure that the firefighters understand the facility's emergency response plan and the roles and responsibilities of facility personnel during an emergency.

Of particular importance is making sure that the fire department's pre-fire plan for the facility and the department's procedures require that:

- One of the first arriving engines connects to the proper fire department connection(s) to maintain at least 150 psi (10.3 bar) to operating sprinkler systems.
- Operating automatic sprinkler systems are not to be shut off until the person in command of the incident is sure the fire is completely extinguished. Fear of excessive water damage should not prompt premature closing of sprinkler control valves.
- If the fire department is to assume the role of incident command once it arrives at the facility, develop procedures to ensure a proper transfer of command.
- Make arrangements for joint training of the facility emergency response team and fire department personnel. These sessions should consist of mock emergencies to help develop patterns of cooperation between the groups.

Develop Emergency Action Plans

A key component of the Emergency Committee is preparing the emergency action plans for various emergency events. While most emergencies have to be addressed during or after an event, some emergencies allow time for precautions to be put in place before an incident, such as a predicted storm. In those cases the emergency action plans should outline the precautions to be taken before the emergency.

Examples of emergency action plans for many events are detailed in PRC.1.7.0.1. These include the following procedures:

- General emergency
    - Emergency reporting
    - Property conservation (salvage)
- Fire protection equipment
    - Impairment
    - Fire protection equipment restoration
    - Sprinkler leakage
- Fire
    - Response
    - Recovery
- Hazardous materials
    - On-site incident
    - Transportation-related incident
- Natural event (flooding, winter storm, hurricane, earthquake, etc.)
    - Preparation
    - Response
    - Recovery
- Utility outage
    - Preparation
    - Response
    - Recovery
- Terrorism/bomb threat
- Civil disturbances
- Labor unrest

The Emergency Communications System

A vital part of managing emergencies is being able to communicate with all necessary parties, both on-site and off-site. Emergency communications systems include automatic fire alarm systems, internal public address systems, paging systems, stationary and cellular telephones and two-way radio systems. Regardless of the system used at a facility, the emergency communications system:

- Permits rapid communication to all employees during an emergency;
- Alerts the on-site emergency response team(s) to respond;
- Alerts employees to evacuate;
- Notifies appropriate outside emergency response agencies.

To be effective, emergency communications systems should:

- Use a paging or public address system if available.
- Keep emergency signals distinct from other types of signals.
- Use coded signals if emergency signals are audible only.
- Confirm that the appropriate public agency has been notified of the emergency, even if the signals are automatically transmitted.

Emergency Resource Database

Regardless of the facility or its location, the telephone is a major component of the emergency communication system. The Emergency Committee should develop and maintain a current emergency resource database of employees, contractor and services with the following information:

- Name
- Address
- Telephone number (business and emergency)
- Fax number
- Email address
- Function
- Billing procedure
- Type of emergency to be notified for
- At what level of the emergency to notify
- Alternate sources of assistance (backups)

Table 2 in PRC.1.7.0.A can be used to develop this list. In addition, key facility personnel should be added to the database. Establish the priority with which they are to be notified, depending on the type and level of emergency.

Special attention must be given to ensure that key personnel from departments that are expected to respond to emergencies can be reached at all times, including holidays or facility shutdown periods.

Loss Accounting, Adjustment And Restoration

When an emergency resulting in property damage or business interruption occurs, procedures should be in place for loss accounting and adjustment. The Finance or Accounting representatives should:

- Immediately notify AXA AXL Risk Consulting and any insurance carrier involved.
- Appoint an individual to maintain all records of information relative to the loss. This individual should:
    - Develop and maintain comprehensive accounting records of costs associated with the loss such as labor, materials, and outside contractors' charges.
    - Find out what the claims adjuster and the loss investigators need to know to thoroughly assess the loss.
    - Help the adjuster establish the dollar amount of the loss.
- Document all claim-related costs.

Handling Emergencies From An Off-Site Location

In the event of an emergency that jeopardizes the normal operations center, the facility's Emergency Committee should assemble in an off-site emergency operations center (EOC) established by the Pre-Emergency Plan. The EOC may be located permanently in a structure or may be mobile in a vehicle or a trailer.

The Emergency Plan should not only establish an EOC but should also define the criteria under which the EOC is to be activated during an emergency. To be effective, an EOC should:

- Be located outside any potential emergency area.
- Have standby power in the form of an engine-driven generator adequate to meet all of the electrical power needs of the EOC.
- Limit access to those personnel responsible for managing the emergency.
- Be equipped with all of the resources and materials required for the proper management of any anticipated emergency. These should include:
    - Desks, tables and chairs;

  - Communications equipment such as telephones (cellular), two-way radio, fax, computer;
  - A copy of the pre-emergency plan;
  - A copy of all emergency procedures;
  - An emergency resource/phone numbers list;
  - A library of reference materials that may be needed;
  - Facility plans, including all utilities;
  - Local maps;
  - An AM/FM radio, television, and weather radio;
  - A copy of the AXA XL Risk Consulting diagram of the facility;
  - Other resources that may be needed.
- Be equipped with some means of initiating internal alarm signals, a paging system, a radio base station, and portable two-way radios.
- Have up-to-date facility layouts showing:
  - Evacuation routes and exits;
  - Locations of automatic and manual fire extinguishing systems;
  - Locations and functions of fire protection control valves;
  - Fire hydrants and hose connections;
  - Fire walls, fire barriers, and fire doors;
  - Hazardous operations;
  - Utility layouts;
  - Locations of hazardous materials.

Developing A Recovery Plan

Depending on the extent of damage it may be prudent to initiate recovery procedures at the onset of the emergency. Just like the emergency response plan, a recovery plan must be in place to cope with the various emergencies that could occur.

Serious emergencies require that the emergency recovery team assemble to manage the facility while the emergency is being dealt with. Include on this team key decision-makers from each of the major departments of the facility. Their role is to provide staff support to the Emergency Coordinator and to maintain oversight of their particular areas of responsibilities. Personnel on the emergency recovery team should include people with the following functional responsibilities:

Marketing duties:

- Provide continual management of all company marketing programs.
- Complete client notification in a prioritized fashion (telephone, fax, letter, etc.).
- Manage and control all notifications to clients throughout the recovery operation.
- Prepare sample letters for client notification, including requests to resubmit data.

Purchasing duties:

- Coordinate the ordering, shipment and delivery of equipment, forms, and supplies.
- Ensure the retrieval and transfer of information and data files.
- Control the movement of equipment and supplies from primary site to alternate sites.
- Coordinate the transportation of company personnel to/from alternate sites.

Building services duties:

- Manage and support requirements for word processing, desktop publishing, print shop services, mail room, supplies, graphics, and microfilming.

- Contact local telecommunication vendors.
- Replace any damaged telecommunications equipment required.
- Manage restoration of telecommunications at primary site.
- Manage installation of emergency lines and equipment at all alternate backup sites.

Information systems duties:

- Identify and retrieve all software backup files.
- Notify alternate backup sites and/or vendors of disaster declaration.
- Identify and retrieve all backup files from off-site storage, as necessary.
- Go to alternate mainframe site, if necessary.
- Establish data communications with mainframe, if necessary.
- Execute mainframe recovery procedures.
- Manage restoration of mainframe computer operations at primary site.
- Replace any PC/LAN damaged hardware and software.
- Restore PC/LAN communications to end user location.
- Execute PC/LAN network recovery procedures.
- Manage restoration of PC/LAN operations.
- Go to alternate data communications site, if required.
- Execute mainframe data communications recovery procedures.
- Manage restoration of data communications network operations at primary site.
- Replace any damaged WAN hardware and software.
- Restore communications to WAN user locations.

Other Business Recovery Considerations

When planning for recovery from an emergency the following items should also be considered:

- Pertinent records;
- Critical computer software back-ups;
- Critical accounting information;
- Raw materials information;
    - Specifications
    - Anticipated delivery times
    - Minimum quantities required
- Inventories of machinery, jigs, tools and fixtures;
- Specifications for finished products;
- Inventories of stock on order and on hand;
- Requirements for skilled labor in manufacturing operations;
- Procedures and specifications for use and construction of testing equipment;
- Records of design data, production engineering procedures, and change orders;
- Plant engineering data on building and utilities;
- Specifications, drawings, and patterns of custom-made machinery and equipment;
- Memory media for data processing and digitally controlled production equipment;
- Storage methods used to protect records from fire, flood, and windstorm;
- Maintenance of duplicate records at another location;
- Availability of suitable, adequately protected temporary building space for use if needed;

- Custom-built, imported, or complex machinery or equipment;
- Suitability and availability of substitute machinery;
- Availability or stockpiling of critical parts;
- Availability of alternate business facilities for use on a temporary basis;
- An up-to-date analysis of the facility's electrical distribution system, load centers, and private power generators. Consider any large or special equipment that may take a long time to repair or replace;
- Major heating and process units which if lost could represent a critical threat to operations. Investigate the availability of rental boilers;
- Impact presented by loss of vital computer equipment:
  - Explore a contractual agreement for the emergency use of external facilities or computer service bureaus.
  - Explore availability of replacement of equipment.
- Raw materials, parts, or components that are imported, dependent upon seasonal crops, or otherwise not readily available:
  - Explore use of temporary substitutes.
  - Explore availability of goods at premium prices.
- Explore subdivision of storage facilities into separate areas not subject to damage from the same incident.

Training And Education

All training and education efforts related to emergencies at the facility should be based on the emergency action plan and the ERT SOPs. The information contained in these documents identifies the minimum required knowledge and skills to respond to and recover from emergencies at the facility.

The skills and knowledge required by employees depend on their assigned emergency response/recovery duties. Skills are acquired through hands-on training, while knowledge is acquired through education.

To be effective, emergency response or recovery training and education must:

- Be based on the facility's site-specific emergency plan and ERT SOPs.
- Define the duties and responsibilities of personnel with regard to the emergency plan.
- Define lines of authority and assigned responsibilities of all personnel involved in emergency response or recovery operations.
- Be based on the tasks personnel are expected to perform related to emergencies.
- Be based on performance standards of specific competencies that are measurable.
- Explain the use of control zones for emergency response.
- Explain the incident management system (IMS) used within the facility.
- Explain emergency communications within the facility.
- Explain the equipment personnel are expected to use during an emergency within the facility.
- Be frequent enough to maintain the skills/knowledge of employees.
- Be documented for each employee involved in emergency response or recovery.

As a service to our customers, AXA XL Risk Consulting offers in-house, on-site, and web-based training programs.

For additional information on resources for dealing with emergencies, see PRC.1.7.0.3.

Testing The Plan

Once an emergency plan has been developed, it must be tested to ensure that it produces the anticipated results. Pre-emergency planning efforts can be totally wasted unless the plan is tested to verify that the anticipated results are achieved. Emergency plans are tested when an exercise is held to test and the plan is evaluated, or when an emergency occurs. Drills or exercises arranged to thoroughly test every component of the emergency plan under simulated emergency conditions are usually far more forgiving than actual emergencies.

Most regulations and standards related to emergency response planning require that a drill or exercise be conducted at least once per year for the purpose of evaluating the plan. However, exercises to test the various components of the overall plan should be conducted in conjunction with training and education sessions for personnel involved in the plan. Training and education efforts are intended to improve performance. Without a test of the performance of people when confronted with an emergency, there is no method to determine what knowledge or skills need to be covered in current or future training sessions.

To be effective, drills or exercises should:

- Emphasize the safety of personnel involved and spectators.
- Be based on a realistic emergencies that are likely to occur within the facility.
- Involve all on-site and off-site agencies and personnel expected to respond to such emergencies.
- Should not be so complex that the major purpose of the drill is lost.
- Recognize mistakes so they can be corrected with training and education.
- Use evaluators who are familiar with of the facility’s plan and SOPs and who are not responsible for developing either. They should be able to evaluate performance if these documents are clearly written.

Critiquing The Plan

Another major component of the pre-emergency planning process is a critique to evaluate how well the emergency plan works. Critiques must be performed after every emergency incident and drill to evaluate how well the emergency plan worked and to identify any changes or revisions that are needed to improve on the performance of those parties involved.

An organized critique should take place at a scheduled time and place where all parties involved with the emergency or drill can attend. While critiques of minor emergencies may be held as soon as the emergency has been terminated and recovery operations completed, critiques of major emergencies and drills should be held days later when personnel are rested and clear-headed.

Each party involved should report from their perspective as to how well the operations went and whether or not the emergency response or recovery portion of the plan needs revision. Any lessons learned from the incident should be identified and used as the basis for plan revisions.

Questions Related to the Emergency

- What caused the emergency?
- Could this emergency have been prevented? If so, How?
- What contributed to the severity of the emergency?
    - How could the degree of damage been reduced?
    - What could have been done to restore operations better?
- Has the emergency revealed deficiencies in any of the following:
    - Construction
    - Protection
    - Employee performance

  - Coordination with public agencies
  - Restoration of fire and other protection systems
  - Restoration of production
  - Equipment design, application and use
- What actions need to be taken to prevent similar emergencies?

Questions Related to the Emergency Plan

- Did the plan:
  - Properly anticipate the incident?
  - Provide a proper response and recovery to the incident?
  - Are any modifications to the plan needed to improve response or recovery operations?
- Did the plan work as intended?
  - If not, why not?
  - How does the plan need to be changed?
- Did the emergency response/recovery procedures accomplish what was intended?
  - If not, why not?
  - Is there a problem with the procedures or is there a problem with people not following procedures?
  - What needs to be done to correct any identified problem with procedures?
  - Do the procedures need to be revised, or additional procedures developed?
- Did the incident management system work as intended?
  - If not, why not?
  - What was the problem(s) related to the incident management system?
  - What needs to be done to revise the incident management system?

Plan Review And Revisions

The final component of pre-emergency planning is reviewing and revising the plan. At a minimum, any emergency plan must be thoroughly reviewed and revised as needed at least annually to ensure that the plan remains current and adequate to meet the facility's needs. In addition, the emergency plan should be reviewed:

- After each emergency,
- After each pre-emergency planning exercise or drill,
- Before any change that affects pre-emergency planning, response or recovery is made at the facility.
- When the community's local emergency plan is revised.

In cases where a review indicates that revisions to either the emergency plan or the emergency response and recovery procedures are needed, the revisions should be promptly developed and distributed to all parties who hold copies.

EMERGENCY ASSESSMENT AND RESOURCES

TABLE 1
Emergency Assessment Worksheet

EVENT	Probability	Facility/Business Consequence	Priority Ranking
Natural Events:			
Flooding			
Tropical Storms			
Hurricane			
Typhoon			
Cyclone			
Tornado			
Earth Movement			
Earthquake			
Tsunami			
Landslide or mudslide			
Sinkhole			
Land subsidence			
Volcanic Eruption			
Cold Weather Emergencies			
Arctic Freeze			
Winter Storm			
Blizzard			
Snow			
Ice			
Avalanche			
Hot Weather Emergencies			
Extreme Heat			
Drought			
Severe Thunderstorm			
Dust or sand storm			
Hail			
Wildland Fire			
Technological Events:			
Fire Protection Impairments			
Hazardous Materials Incidents			
Within the facility			
Adjacent to the facility			
Structural Fire			
Within Facility			
Exposure from Urban Fire			
Explosion			
Medical Emergency Events			
Single Victim			
Mass Casualty Incident			
Rescue Events			
Confined Space			
High Angle			

TABLE 1 (Cont'd.)
Emergency Assessment Worksheet

EVENT	Probability	Facility/Business Consequence	Priority Ranking
Trench			
Entanglement			
Entrapment			
Vehicle Accidents			
Highway			
Airport/Heliport			
Navigable Waterway			
Flooding (impounded water)			
Utilities Shortages/Outages			
Power			
Fuel			
Water			
Resource shortages			
Raw materials			
Process materials			
Structural Collapse			
Sprinkler Leakage			
Machinery Failure			
Molten material release			
Air Pollution			
Water Pollution			
Business Interruption			
Social/Political Events:			
Domestic Disturbances			
Civil Disobedience - Protests			
Civil Commotion			
Rioting			
Workplace Disturbances			
Labor Disputes			
Strike			
Walkout			
Workplace Violence			
Acts of Aggression			
Terrorism			
Sabotage			
Bomb Threats			
Hostage Situations			
Enemy Attack			

TABLE 2
Emergency Resources

Construction services and supplies:	
	Building demolition
	Emergency lighting suppliers
	Equipment rental
	Lumber yard
	Refrigerated trailer rental
	Snow removal
	Structural engineer
Emergency communications:	
	Citizens' band radio club
	Ham radio club
	Telephone company
Emergency equipment:	
	Breathing apparatus service
	Sump pumps
	Heaters and/or heating boilers
	Cooling towers
	Generators
Fire protection equipment:	
	Alarm service
	Automatic sprinkler contractor
	Guard service
Governmental agencies:	
	Local government officials:
	Airport
	Building inspector
	City Clerk
	City Engineer
	City Manager
	Public Works
	Electrical inspector
	Emergency Management
	Health department
	Highway department
	Mayor
	Medical Examiner
	Police
	Post Office
	Superintendent of Schools
	Transit Authority
	State/Provincial Agencies:
	Civil Air Patrol
	Department of Transportation
	Environmental Protection Agency
	Federal Aviation Administration
	Federal Bureau of Investigation
	Federal Communications Commission

TABLE 2 (Cont'd.)
Emergency Resources

State/Provincial Agencies: (Cont'd.)	
	Nuclear Regulatory Commission
	Occupational Safety and Health Administration
	Small Business Administration
	U.S. Army Corps of Engineers
	U.S. Coast Guard
	U.S. Department of Agriculture
	U.S. Division of Forestry
	U.S. Marine Corps Reserve
	U.S. National Guard
Hazardous Materials:	
	CHEMTREC (transportation accident)
Humanitarian Needs:	
	American Red Cross
	Clergy
	Fire department
	Fire marshal
	Food
	Portable toilet suppliers
	Portable shelters
	Potable water suppliers
	Salvation Army
Insurance:	
	Insurance broker
	Insurance company claims adjuster
Loss Prevention Services:	
	AXA XL Risk Consulting Impairment Hotline – RSVPhone +1 800 243 8222, +49-69-66127-8222, or +1 972-383-7161
Media:	
	TV
	Radio
	Newspapers
Medical:	
	Ambulance service
	Hospital
	Physician
	Poison Control Center
Restoration Services:	
	Salvage companies
	Document restoration
	Electronic media restoration
	Smoke deodorizer companies
	Smoke and water cleanup
Terrorism:	
	Bomb search and disposal squad
Transportation:	
	Automotive rental
	Boat
	Buses

TABLE 2 (Cont'd.)
Emergency Resources

Transportation: (Cont'd.)	
	Dump truck rental
	Four-wheel drive vehicles
	Helicopters
	Refuse haulers
	Snowmobiles
	Tow truck service
Utilities:	
	Air compressor rental
	Boiler rental
	Electric company
	Electric generator rental
	Fuel supply distributors
	Gas company
	Water department
Miscellaneous:	
	Attorney
	Authorized boiler/vessel inspection agency

EMERGENCY ACTION PLANS

INTRODUCTION

The purpose of this section is to give guidance for emergency reporting and property conservation procedures as well as to address the various emergencies that may arise at any facility. It is to be used with the other PRC.1.7.0 manual sections.

To help locate the various emergencies that may have to be addressed, Table 1 notes the pages on which the guidance for the various plan elements for each emergency can be found.

TABLE 1
Plans For Emergency Action During Various Emergencies

General Emergency Plan	
Reporting An Emergency	Page 2
Property Conservation and Salvage	Page 2
Fire Protection Equipment Plan	
Equipment Impairment	Page 4
Fire Protection Equipment Restoration	Page 5
Sprinkler Leakage	Page 5
Fire Response	Page 7
Hazardous Materials Plans	
On-Site Incident	Page 8
Transportation-Related Incident	Page 9
Natural Event Plans	
Flood	Page 11
Arctic Freeze	Page 14
Winter Storm	Page 17
Hurricane	Page 18
Tornado	Page 21
Earthquake	Page 22
Technical And Social/Political Event Plans	
Utility Outage	Page 25
Terrorism/Bomb Threat	Page 28
Civil Disturbance	Page 28
Labor Unrest	Page 29

POSITION

Reporting An Emergency

Every employee within a facility must clearly understand the procedures established within the facility for reporting emergencies. If the reporting of an emergency is delayed, the threat to life, property, the environment and business can be greatly increased.

Historically, one of the major reasons for the severity of fire emergencies has been the delay in reporting of the emergency. To ensure that this does not happen, each facility must develop an emergency reporting procedure that everyone understands.

Emergency plan should include the following:

- Establish an emergency reporting phone number within the facility;
- Post the emergency reporting number throughout the facility and on each phone;
- Ensure that all employees are familiar with the number;
- Ensure that personnel understand who is to alert on-site and off-site emergency response organizations and agencies;
- Ensure that fire notification is transmitted to the appropriate agency:
  - Call the fire emergency number or operate the nearest manual fire alarm station;
  - Follow up any alarm sent from a manual fire alarm station with a telephone call;
  - If a sprinkler system is operating when the emergency is discovered, employees should not assume that the alarm has been transmitted to the fire department;
  - If an automatic fire alarm system is operating when the emergency is discovered, employees should not assume that the alarm has been transmitted to the fire department.
- Provide a means of notification of personnel within the facility for evacuation purposes.

Property Conservation And Salvage

Property conservation is the term applied to procedures taken during or after an incident to stop any further damage to property or to minimize any damage already done to property. Detailed property conservation procedures should be prepared well in advance of any emergency, especially in those cases involving materials highly susceptible to damage or contamination.

Property damage can be caused by the incident or during the mitigation of the incident. Not all damage is immediate. Some damage results from long-term exposure to fire byproducts and extinguishing media. Prompt intervention can reduce this secondary damage.

There is no exact point in time during an emergency when property conservation procedures should begin. Throughout the course of any emergency, the Emergency Coordinator must constantly evaluate the need for property conservation efforts. The characteristics of the incident must be evaluated to determine when property conservation efforts should begin. From a practical standpoint, they should be initiated as soon as conditions permit.

Some concerns with property conservation procedures are:

- Breaches or other unprotected openings in structure caused by the incident;
- Contamination of structures, machinery, stock or other contents caused by:
  - Water,
  - Smoke and heat from a fire, or
  - Corrosives or other hazardous materials that may have been released.
- Damage caused by water contamination can cause:
  - Steel parts and assemblies to rust;
  - Electrical equipment to breakdown;

  - Certain materials to mildew.
- Damage caused by heat from a fire can cause:
  - Insulation in wall or roof assemblies to melt, thereby reducing its effectiveness;
  - Insulation on wiring to deteriorate and delicate electronic circuitry to break down.
- Damage caused by smoke contamination can cause:
  - Wide-spread contamination of structures and contents;
  - Corrosion of certain metal components;
  - Staining of surfaces;
  - Contamination of some materials with odors. Certain materials and products, such as food products, are highly susceptible to smoke contamination.

The property conservation plan should include the following:

- Maintain inventories of materials needed to effectively perform property conservation operations.
- Conduct efforts on a priority basis.
- Temporarily cover, seal or repair any breaches or openings in building walls or roofs to minimize secondary damage to contents from the elements.
- Exercise extreme care in the use of any flame- or heat-producing equipment that could result in a fire.
- Minimize the hazards associated with portable or temporary heat and light sources.
- Clean and dry any electrical devices that have been subject to water damage.
  - Rinse with clear water and dry. Low temperature blow-drying may be useful on fixed installations.
  - Portable equipment may be dried in low temperature ovens.
  - Consult the manufacturer's literature or other appropriate references.
- After cleaning and drying, have qualified personnel check the devices to ensure they operate properly. Before electrical equipment is returned to service, have qualified personnel verify the quality of the insulation and the adequacy of the cleaning.
- Remove stored material from the area involved in the incident and check for contamination. In some cases, materials may be salvageable if repackaged.
- Reduce water damage to steel or other ferrous surfaces by cleaning, wiping dry, and covering with a protective coating of oil.
- Inspect equipment for the presence of water, particularly on bearings or in lubricating oil sumps, and for residues on machined or other sensitive surfaces.
- Some materials, such as baled fibers and rolled paper, are particularly water absorbent. If they are wet, take the piles apart promptly, separating wet from dry to reduce absorption of water by dry stock.
- Examine important records, drawings, and tracings and separate the damaged ones from the undamaged. Items only partly damaged should be dried out to prevent further deterioration and facilitate recovery.
- Segregate contaminated materials from noncontaminated materials.
- Decontaminate those materials as needed.
- Clean, dry, or oil damaged stock or machinery.
- Contact a decontamination or restoration company for special needs.
- Contact a salvage company to determine if damaged goods are salvageable.

Fire Protection Equipment Impairments

A fire protection equipment impairment occurs when a facility loses part or all of a fire protection system. When an impairment occurs unexpectedly, it is considered an emergency impairment. This is a major concern and should be treated as an emergency since it increases the seriousness of the threat of fire within the facility. See PRC.1.1.0 for a full discussion of impairment procedures.

The equipment impairment plan should include the following:

- Shut down any hazardous operations in the area affected in an orderly fashion.
- Remove combustibles from the area.
- Eliminate smoking and any hot work in the unprotected area.
- Begin necessary repairs immediately.
- Contact outside contractors as needed.
- Initiate property conservation procedures if needed.
- Notify the appropriate personnel/ agencies of the extent of the impairment:
  - The Shift ERT leader;
  - The Shift Commander of the public fire department;
  - The alarm company which provides surveillance of the facility;
  - The AXA XL Risk Consulting Impairment Hotline +1 800 243 8222, +49-69-66127-8222, or
    +1 972-383-7161.
- Fill out an AXA XL Risk Consulting RSVP “red” Impairment Tag:
  - Hang the “Shut-Off” portion of the RSVP tag on the impaired equipment.
  - Display the “office reminder” portion of the RSVP tag in the office of the person responsible for supervising the impairment.
- Have responsible individuals make fire patrols of the affected area(s) at least every 30 min.
- Use whatever measures possible to maintain as much of the fire protection in service as possible during the impairment.
- Provide charged handlines and other manual fire suppression within the area affected.
- Have members of the Fire ERT stand by in the area.
- Restore complete protection to the area as soon as possible.
- Work continuously through all shifts, if necessary, until repairs are complete.
- Ensure that contractors follow proper hot work fire precautions and procedures.

Fire Protection Equipment Restoration

Once a fire emergency has been terminated, the restoration of fire protection equipment to its normal operational mode is extremely critical to the well-being of the facility should a fire reignite or a separate fire occur.

The equipment restoration plan should include the following:

- Replace fused or heat-damaged sprinkler heads, and restore the system in those portions of the building where the roof or ceilings are still intact.
- Disconnect portions of the sprinkler systems that are inoperable because of broken piping or building collapse and install caps or plugs at the ends of the serviceable piping. This will allow partial restoration while the remainder of the system is being repaired.
- Devise a temporary means of supplying water to damaged mains or risers feeding sprinkler systems. Such an arrangement may include the connection of hose lines between hydrants and the sprinkler system.

- Make certain that the sprinkler and fire protection water supply control valves are fully open once systems have been restored as completely as possible.
- Refill all fire protection water storage tanks or reservoirs.
- Recharge or replace portable fire extinguishers that have been utilized.
- Restore any special extinguishing systems that have operated.
- Reset protective signaling systems.
- Dry hoselines as required, and return manual fire-fighting equipment to its normal place of storage. Supplies of expended items, such as foam concentrate, should be replenished immediately.
- Make necessary emergency repairs to the heating system. Where necessary, provide safe temporary sources of heat to prevent sprinkler systems and water tanks from freezing.

Sprinkler Leakage

Sprinkler leakage is defined as “the sudden and accidental discharge of water from sprinkler systems or from their water supply pipes.” While sprinkler leakage can technically occur within any facility protected by automatic sprinkler protection, the likelihood of this occurring is dependent on the design, installation, maintenance and testing of automatic sprinkler systems and their water supply piping.

The primary concern with sprinkler leakage is the damage done by the water to the structure and equipment. Depending on the size of the leak, water may accumulate very rapidly in what amounts to a localized flash flood.

Leakage from sprinkler heads and the interior piping supplying them can occur where:

- Sprinklers or piping are exposed to mechanical damage such as that caused by lift trucks or other such material handling equipment.
- The ambient temperature exceeds that for which sprinklers are designed.
- Inadequate heat causes water in the sprinkler system to freeze leading to the rupturing of piping, fittings, or sprinklers.
- Defective sprinklers or piping have been installed:
    - To guard against this, all piping and fittings used in sprinkler systems should be listed or approved by a nationally recognized testing agency for use in sprinkler systems.
    - If the proper equipment is utilized, this should be the least likely cause of sprinkler leakage.

Leakage from underground piping can occur where:

- Structures built over piping settle and cause piping to crack or break.
- Piping has not been buried deep enough to prevent freezing.
- Unprotected ferrous piping has been buried in poor soil conditions that lead to corrosion of the pipe.
- Piping has been improperly laid, resulting in abnormal stress when the earth around it settles.
- Piping laid under railroad tracks or roadways may be susceptible to the frequent “live” loads passing over it. This also makes maintenance on mains difficult to perform.

The sprinkler leakage plan should include the following:

For leakage from interior piping or sprinklers:

- Check to make sure there is no fire. If a fire is discovered, initiate appropriate emergency response procedures.
- If no fire is found, promptly stop the flow of water:

  - If a sprinkler is flowing, insert a plug into the sprinkler to minimize damage and reduce the extent of the impairment, or
  - If a plug cannot be used, shut the valve controlling the leaking system.
- Initiate appropriate impairment procedures. If an extended impairment is unavoidable, arrange a temporary water supply to the impaired system either from another sprinkler system or from a fire hydrant to the system's main drain.
- Disconnect power to any electrical equipment that may get wet.
- Begin repairs to the system immediately.
- Initiate property conservation procedures.

For leakage from underground piping:

- Determine the location of the leak by:
  - Looking for water coming out of the ground;
  - Listening for the sound of water flowing.
- Isolate the leak by shutting the appropriate fire protection system control valves:
  - Isolate the smallest portion of the fire protection piping system as possible to minimize the extent of the impairment.
  - Follow the Impairment Handling Procedures.
- If an extended impairment is unavoidable, arrange temporary cross-connections to impaired systems either from other sprinkler systems, fire hydrants or other water source;
- Proceed as promptly as possible with repairs.
  - If needed parts are not available, make temporary repairs.
  - The goal is to restore as much sprinkler protection as quickly as possible.

Fire Response

The fire response plan should include the following:

When a fire occurs:

- Initiate the appropriate incident reporting.
- Evacuate nonessential personnel from the danger area.
  - Identify the emergency area internally using the intercom or some other audible alarm.
  - Alert employees in the danger area to evacuate to their assigned evacuation area.
  - Account for personnel in each evacuation area.
  - Use all available means of fire extinguishment.
- Ensure that all protective equipment is operating properly.
  - Verify that all fire protection systems are in service, fire protection control valves are open, and fire pumps are running.
  - Assign personnel to stand by at each **exterior** fire protection control valve that may require operation during the emergency. They are to operate the valve only on the direct orders from the Incendent Commender.
- Take whatever actions are necessary to minimize the severity of the fire.
  - Assign someone to meet the public fire department or other emergency response agencies at the facility entrance and direct them to the emergency area.
  - Ensure that emergency response personnel and vehicles have access to the incident scene.
  - Notify insurance conmpany of the incident as soon as possible.

  - Handle any impairment to fire protection equipment in accordance with Fire Protection Impairment Procedures.
  - Secure the building and establish patrols in the emergency area to be on the alert for possible reignition.
  - Expedite property conservation operations in peripheral areas.
  - If incendarism or arson is even remotely suspected, immediately secure the fire scene so no evidence is disturbed. Notify the proper authorities. Restore protection promptly, as the arsonist may strike again. Intensify security, especially in such vulnerable sectors as control rooms, computer facilities, and utility distribution areas.
  - Ensure that all impaired fire protection equipment is promptly restored to service.
  - Provide guard or watch patrols in the affected areas when fire protection equipment cannot be restored.
  - Have fire suppression personnel stand by with charged handlines, until the threat of reignition is eliminated.
  - Provide security forces if conditions are such that unauthorized entry is possible.
  - Initiate property conservation procedures as soon as possible.

On-Site — Haz-Mat Incident

Hazardous materials are any substances that may pose an unreasonable risk to health, safety or the environment. Throughout the past two decades, the world has become increasingly concerned with the accidental releases of materials proven to be detrimental to life and the environment.

The release of a hazardous material during normal facility operations, where the material can be absorbed, neutralized, or otherwise controlled by employees or maintenance personnel, usually does not require an emergency response because there is no potential safety or health hazards, such as fire, explosion, or chemical exposure. However, if a release becomes significantly worse, it may be considered an uncontrolled release and be reclassified as an emergency, requiring assistance from a Haz-Mat Response Team.

The Hazardous Material Response Team is a group organized of employees expected to control actual or potential leaks or spills of hazardous materials. At least some members of this team must be trained to the Haz-Mat Technician level.

On-site Haz-Mat incident plan should include the following:

For personnel discovering a release which requires an emergency response

- Initiate emergency reporting procedures
- Instruct employees to follow safe shut-down procedures in their assigned areas.
- Evacuate personnel in the incident area to a safe location.
- Deny personnel entry to the incident area.
- Assess the presence of hazardous materials from a safe distance, if possible, including:
  - Container type, size and shape;
  - Presence of placards or labels;
  - Any signs of materials release.

For first-responder-operations emergency response personnel

- Establish command of the incident.
- Assess the presence of hazardous materials from a safe distance:
  - Container type, size and shape;
  - Presence of placards or labels;
  - Any signs of materials release.

- Initiate the facility Haz-Mat emergency response plan.
- Initiate defensive procedures to limit damage from the release.
- Eliminate ignition sources located downwind, if the material is a flammable liquid or gas.
- Initiate property conservation procedures if possible.

For Haz-Mat ERT response

- Assume command from incident commander.
- Establish control zones.
- Identify the problem.
- Evaluate the risk presented by the incident.
- Determine actions required to mitigate incident.
- Select the level of personnel protective equipment required.
- Initiate mitigation procedures.
- Initiate decontamination procedures.
- Initiate property conservation procedures.
- Initiate recovery from the incident.

Transportation-Related — Haz-Mat Incident

Incidents involving hazardous materials that are foreign to a facility may occur due to transportation incidents either adjacent to the facility or in some cases on the facility property. This procedure is intended to provide guidance for such emergencies.

In the event of such an incident, identification and recognition of the hazardous materials involved and information with regard to initial actions required to deal with the material(s) is critical. CHEMTREC provides emergency responders with information related to hazardous materials emergencies in transportation.

CHEMTREC operates in two stages:

- Provides immediate advice on the nature of the material and steps to be taken in handling the early stages of a problem;
- Contacts the shipper of the material involved for more detailed information and appropriate follow-up, including on-scene assistance when feasible.

The transportation-related Haz-Mat incident plan should include the following:

For personnel discovering a release requiring an emergency response:

- Initiate facility emergency reporting procedures.
- Initiate community emergency response plan.
- Instruct employees to follow safe shut-down procedures in their assigned areas.
- Evacuate nonessential facility personnel within the area to a safe location;
- Deny personnel entry to the incident area;
- Assess the presence of hazardous materials from a safe distance if possible;
    - Mode of transport;
    - Container type, size and shape;
    - Presence of placards or labels;
    - Any signs of materials release.

For first-responder-operations emergency response personnel:

- Establish command of the incident;
- Assess the presence of hazardous materials from a safe distance.

  - Mode of transport;
  - Container type, size and shape;
  - Presence of placards or labels;
  - Any signs of materials release.
- Initiate the facility Haz-Mat emergency response plan;
- Initiate defensive procedures from within the cold zone to limit damage if possible;
- Eliminate ignition sources located downwind if the material is a flammable liquid or gas.

For Haz-Mat ERT:

- Assist community response;
- If material is foreign to the facility, follow initial guidelines in DOT's North American Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Hazardous Materials/Dangerous Goods Incident.
- If no public response is available, assume command of the incident;
- Institute procedures to limit damage within facility;
- Contact CHEMTREC (the Chemical Transportation Emergency Center) for assistance at 800-424-9300 (toll free in U.S.), in Washington, DC 483-7616, or 202-483-7616 (call collect). Information needed:
  - Name of product;
  - Nature of problem;
  - Name and number of caller;
  - Location of problem;
  - Shipper or manufacturer;
  - Container type;
  - Rail car or truck number;
  - Carrier name;
  - Consignee;
  - Local conditions.

An emergency action plan form for transportation-related accidents can be found in PRC.1.7.0.1.A.

Floods

Flooding can occur whenever water rises and overflows the land that normally confines it. See PRC.15.4 for a full discussion of floods. Flooding can be:

- Sudden in the form of flash floods which occur because of extraordinarily heavy localized rain;
- Slow developing as rivers and streams swell and spill over their banks;
- Caused by the a failure of a man-made containment such as a dam or a levee;
- Due to storm surges associated with hurricanes and tropical storms.

The potential for flooding to occur at any given facility must be evaluated by using special flood maps. In the United States these are maintained by the Federal Emergency Management Agency (FEMA). These maps indicate flood plains and show the expected susceptibility of specific areas to flooding.

In the United States, the National Weather Service issues advisories in the form of flood watches and flood warnings.

A **flood watch** implies that flood conditions are a real possibility but are not imminent.

A **flood warning** for a river implies that a flood is imminent or in progress upstream and that immediate precautions should be taken in your area.

Some basic concerns are:

- Undermining of foundations;
- Structural damage;
- Water damage to machinery and contents;
- Disruption of utilities;
- Increased potential for fire.

To prepare for flooding, develop a detailed flood checklist. A sample checklist may be found in PRC.1.7.0.1.A.

The flood plan should include the following:

When a Flood Watch has been issued:

- Activate the emergency operations center.
- Maintain communications with local emergency management authorities.
- Monitor the Emergency Broadcast System and weather reports issued by the National Weather Service.
- Determine if the conditions warrant a partial or total facility shutdown.
- Determine the order to shut down processes and secure the facility.
- Ensure that the time allotted to accomplish pre-flood tasks is sufficient to allow them to be completed before flood waters approach.
- Provide alternate power or nonelectric drives for vital equipment so that the electrical distribution system can be shut down before hazardous conditions develop.
- Initiate emergency process shut-down procedures, as necessary.
- Move important machinery, stock and records to higher, safe elevations as determined by past flood history.
- Coat machinery that cannot be moved with oil or grease.
- Drain open tanks of flammable or combustible liquids.
- Fill the fuel tanks of emergency equipment such as back-up generators and diesel-driven fire pumps.
- Check travel brakes on movable cranes and bridges and anchor them in accordance with the manufacturers' instructions.
- Clean yard drains and catch basins.
- Move vital records to a safe location.
- Brace unsupported structural members at construction sites.
- Anchor any yard items that could be moved by flood waters, such as trailers, lumber, or loose yard storage.
- Barricade critical outdoor equipment with sandbags to provide protection against floating debris.
- Ensure that all fire protection equipment is in service.
- Barricade vulnerable building openings with sandbags.
- Shut off all lines carrying flammable or combustible liquids or gases at their sources.
- Properly support any exposed piping.
- Make sure above- and belowground tanks are properly anchored to prevent flotation.
    - Fill empty tanks with product or water.
    - Extend vent lines on active tanks above the anticipated maximum water level.
- Shut down boiler and other fuel fired equipment.

- Maintain emergency supplies of the following in a secure location;
    - Emergency medical equipment;
    - Emergency lighting equipment;
    - Nonperishable food;
    - Bottled drinking water;
    - Emergency communications equipment.
- Assemble emergency supplies at a secure location:
    - Emergency lighting equipment;
    - Lumber and nails;
    - Sand bags;
    - Roofing paper;
    - Portable pumps and hose;
    - Mops and squeegees;
    - Power and hand tools;
    - Shovels and axes;
    - Chain saws;
    - Tarpaulins.
- Shut off electrical power at the main building disconnect when building flooding is imminent.

After Flood Waters Recede:

- Conduct a damage assessment, paying particular attention to undermining or other damage to foundations.
- Initiate property conservation procedures.
- Begin temporary repairs to prevent further damage.
- Repair damaged fire protection equipment immediately.
- Make temporary repairs to any openings caused by debris.
- Exercise care around damaged or submerged power lines. Advise the utility company of necessary repairs;
- Clear drains of any debris.
- Forbid the use of any flame or heat-producing equipment in any area where flammable liquids or gases could be present.
- Inspect and test electrical power systems for ground faults before turning them on.
- Inspect motors, switchgear and cables for damage.
- Clean and dry electric motors, switchgear and cables before allowing them to be energized. Even if electrical equipment has not been immersed, it may have absorbed sufficient moisture to reduce its insulation resistance to a dangerously low level.
- Examine steam and process lines and any refractory-containing equipment for wet insulation. If insulation is contaminated, it may require removal rather than being allowed to dry in place.
- Test sources of boiler and process feed and cooling water, and any materials in underground storage tanks for contamination before use.
- Clean mechanical equipment and open its casings to inspect for any hidden damage.
- Check mechanical equipment shafts for proper alignment.
- Flush mechanical equipment lubricating systems.
- Service and slowly dry boilers before firing them.
- Remove and replace wet insulation or carefully dry it.

- Clean and dry all test equipment, motors, and transformers before energizing them.
- Clean, inspect and test safety, relief and other types of valves before placing systems in service.
- Initiate boiler start-up procedures.
- Clean and purge gas lines.
- Change fuel filters, drip legs and strainers on fuel trains.
- Clean, dry and lubricate burners.
- Flush and preserve machined surfaces and other equipment, until they can be properly serviced.

A sample checklist for floods may be found in PRC.1.7.0.1.A.

Arctic Freeze And Cold Weather

Cold weather and associated winter storms are normal occurrences each year for much of the world. In some areas, cold weather is not usually considered a matter of concern. This lack of concern is becoming less justifiable. AXA AL Risk Consulting loss experience indicates that shifts in the jet stream can cause bitterly cold Arctic air masses to press deeply into the warmer climes, sustaining freezing temperatures for periods of a week or more. At the same time, these unusual Arctic air masses cause temperatures in those areas which are normally cold to drop well below freezing. This phenomenon has been labeled “Arctic freeze.”

An Arctic freeze is an unusual mass of Arctic air which creates a sustained period of subfreezing temperatures. The air mass extends into areas which do not usually have long periods of freezing temperatures. An Arctic freeze is not associated with a winter storm.

Facilities located in all but tropical areas must give careful consideration to precautions against Arctic freeze that must be taken each year before the cold weather season. In addition to routine precautions, these facilities should determine what steps must be taken or what special facilities must be made available if the temperature drops 15°F – 20°F (8°C – 11°C) below what is considered the normal cold temperature and stays there for one or more weeks. See PRC.15.5 and PRC.15.5.1 for a full discussion of freezing hazards.

Freezing weather/Arctic Freeze creates several concerns, which include:

- Freezing of automatic sprinkler protection and fire protection water supplies, leaving the facility without proper protection.
- Freezing of process piping.
- An increase in the likelihood of a fire due to the use of portable heating appliances or over-worked heating systems.
- Possible overload of heating and freeze protection systems.
- Reduced natural gas pressure due to heavy demand or freezing of liquids in lines.
- Freezing of public water lines and sewers.

The most important way to deal with freezing weather/Arctic Freeze emergencies is with detailed planning in advance. A sample checklist for Arctic Freeze may be found in PRC.1.7.0.1.A.

The arctic freeze plan should include the following:

For general freezing weather/arctic freeze preparedness

- Ensure that all doors, windows, skylights, ventilators, and other openings are weather-tight.
- Heat areas subject to freezing, if cold conditions could cause damage.
    - Maintain at least 40°F (4°C) in areas protected by wet-pipe sprinkler systems.
    - Maintain at least 40°F (4°C) in fire pump houses, and all dry pipe, deluge and pre-action valve closets.

    - Check boiler rooms, areas housing water-cooled engines, and compressor stations for proper heat.
- Check the entire heating system(s) and correct any problems.
    - Clean burners, boilers, and flues.
    - Remove any obstructions from pipes, radiators, and unit heaters.
    - Ensure that all heating equipment controls are operating properly by testing them and repairing as needed.
- Ensure that fuel supplies for heating systems are adequate.
- Make sure heating systems operate properly.
- Maintain safe clearances between heating system components and combustible floors, walls, partitions, platforms, and contents.
- Drain air conditioning systems as needed.
- Install heat tracing tape on piping that is expected to freeze.

For fire protection equipment — freezing weather/arctic freeze preparedness:

- Check outside control valves to ensure they turn freely and do not leak.
- Check tank heating systems, thermometers and temperature controls for proper operation.
- Check fire pump room/house heating systems for proper operation.
- Check concealed spaces and other voids that contain piping for heat sufficient to prevent freezing.
- Convert wet-pipe sprinkler systems in areas that are inadequately heated to dry-pipe or pre-action systems. See PRC.12.1.1.4.
- Drain low points and auxiliary drains of dry pipe sprinkler systems. Drain excess priming water from dry pipe valves.
- Test solutions in anti-freeze systems and add anti-freeze if needed.
- Drain wet standpipe systems in unheated areas.
- Ensure that connections to water motor gongs and fire department connections are drained.
- Check all fire protection water storage tanks for leakage.
- Ensure that all fire protection water storage tanks are properly heated.
- Ensure that all fire hydrants and pump test headers are drained.
- Check all fire protection control valves for leaks.
- Ensure that all valve and meter pits are dry and frostproof.
- Ensure that portable fire extinguishers located in cold areas are suitable for such locations or are in heated cabinets.
- Ensure that motorized fire apparatus has been prepared for winter operations.

For fire protection equipment when freezing weather is predicted:

- Restore heat where it has been reduced or eliminated. Provide additional heat for normally cold areas.
- Expedite any needed repairs to the heating system.
- Forgo any scheduled heating system or boiler inspections until the danger of the severe cold has passed.
- Add heat-trace tape to protective system and process piping that might freeze.
- Check insulation on piping and structures to be certain it will protect them against the extreme cold temperatures.
- Where processes are shut down, drain piping and tanks to prevent freezing.
- Establish tours of the facility to check.

  - Outside air dampers and other possible sources of outside air leakage that could result in freezing.
  - Steam tracing and electric heating systems for outside vessels and piping.
  - Heating systems in remote areas.
- Arrange for a reliable source of portable heaters, heating blankets or other auxiliary or emergency anti-freezing devices.
- Arrange for emergency generators and other equipment as may be needed to assure continued functioning of heating systems, realizing that electric utility lines are frequent casualties of winter storms.
- Anticipate utility outages.
- Ensure that energy conservation measures do not increase the likelihood of storm or freeze-related damage.
- Ensure that circulating hot water in boilers is not allowed to cool excessively because it can cause cracking or other damage to the boilers when they are started.
- Drain tanks and lines to prevent freezing where processes are shut down.

For fire protection equipment during the freezing weather or arctic freeze:

- Check all areas of the facility to be certain that sufficient heat is being maintained to prevent freezing of sprinkler systems, process equipment and piping and utility systems. Pay particular attention to:
  - Concealed spaces above suspended ceilings;
  - Sprinkler-protected entry ways and remote stair towers;
  - Cooling jackets on engines and compressors in remote locations;
  - Check less obvious sources of freeze damage such as water in air system drains and gas drip legs.
- Eliminate any unusual drafts created by winter storm winds.
- Ensure that heat to vital areas is not compromised.

For fire protection equipment after the freezing weather or arctic freeze:

- Once the temperatures begin to rise, inspect areas within the facility that were most likely to have suffered freeze damage.
- Look for any cracks or leaks in piping to prevent major damage when liquids are released from thawed and damaged pipes.

Winter Storm Or Blizzard

Cold weather associated with freezing weather can be further complicated by the presence of the snow and ice that comes with winter storms.

Winter storms are strong low pressure weather disturbances which occur during late fall, winter or early spring and have strong (gale force) winds. In coastal areas, storm surges may cause coastal flooding and the low temperatures bring the additional perils of freezing and snow.

A **blizzard** is a very severe winter storm that brings heavy snow, high winds, and low temperatures. Outside activity during a blizzard may be very dangerous.

A **winter storm warning** implies that strong winds, heavy snow and/or icing is imminent.

Basic Concerns. Winter storms create many concerns, which include:

- Freezing of automatic sprinkler protection and fire protection water supplies, leaving the facility without proper protection;
- Freezing of process piping;
- Hazardous road conditions, which hamper emergency response and evacuations;

- Decreased accessibility to fire protection valves, hydrants, hose houses and fire pumps;
- Increased likelihood of a fire;
- Increased roof loading due to snow and ice build-up that may lead to structural collapse; (see PRC.2.0.3 for a discussion of snow loading);
- Possible overload of heating and freeze protection systems;
- Power failure due to ice build-up on power lines;
- Reduced natural gas pressure due to heavy demand or freezing of liquids in lines.

The winter storm plan should include the following:

For winter storm preparedness:

- Initiate freezing weather/arctic freeze preparedness procedures;
- Plan for snow removal services.

When a winter storm warning is issued:

- Arrange for constant surveillance in the facility to monitor all areas of the facility for signs of impending trouble.
- Provide personnel with an up-to-date list of emergency numbers to call in the event of trouble.
- Activate the emergency operations center.
- Monitor storm advisories issued by the Emergency Broadcast System. Assign snow plowing and shoveling personnel.
- Install snow fences and marker poles at fire hydrants and fire protection control valves.
- Establish tours of the facility to check for dangerous snow accumulations.
- Call in outside plowing contractors and other assistance as needed.
- Arrange for emergency generators and other equipment as may be needed to assure continued functioning of heating systems, realizing that electric utility lines are frequent casualties of winter storms.
- Anticipate utility outages.

During the storm:

- Assess the need for early closing or delayed opening of the facility.
- Request outside plowing assistance as needed.
- Establish communication with employees on the premises, snow plow operators and emergency crews.
- Continue to monitor weather advisories.
- Clear snow from exits, fire protection equipment, and utilities.
- Remove snow from roofs in areas subject to drifting, especially at the junctions of buildings with different roof heights.
- Inspect roof drains and roof-mounted cooling equipment to be sure there is no ice buildup.

After the storm:

- Assess the damage;
- Initiate property conservation procedures;
- Make temporary repairs;
- Remove remaining snow, with priority given to fire protection valves, hydrants, fire pump houses, and emergency response access routes.

Hurricanes, Cyclones and Typhoons

The terms hurricane, cyclone and typhoon are used in certain parts of the world to refer to weather systems that involve cyclonic circulation over tropical waters. See PRC.15.1.1. These weather systems are known as:

- **Hurricanes** when they occur in the Atlantic Ocean and eastern Pacific Ocean.
- **Cyclones** when they occur in the Indian Ocean.
- **Typhoons** when they occur in the Western Pacific Ocean.

For the purpose of this section the term hurricane will be used.

The primary threats these weather systems represent are:

- Winds in excess of 74 mph (119 km/h) or 64 knots;
- Coastal flooding due to the storm surge;
- Inland flooding resulting from heavy rains that are usually part of the weather system;
- Weather conditions that can lead to tornadoes.

TABLE 2
Hurricane Categories

Category	Sustained Winds	Storm Surge	Damage
1	74-95 mph	4-5 ft above normal	Minor
2	96-110 mph	6-8 ft above normal	Moderate
3	111-130 mph	9-12 ft above normal	Major
4	131-155 mph	13-18 ft above normal	Severe
5	above 155 mph	>18 ft above normal	Catastrophic

SI Units: 1 ft = 0.305 m; 1 mph = 0.45 m/s

Weather systems of this type usually occur during the warmest months of the year, and are expected from June to November in the northern hemisphere and from December to April in the southern hemisphere. In the United States, hurricane advisories in the form of hurricane watches and hurricane warnings are issued by the National Weather Service's National Hurricane Center in Miami, Florida. In other countries, weather services issue advisories for their respective territories.

A hurricane **watch** is an advisory that hurricane conditions pose a possible threat to a specified area within 36 h.

A hurricane **warning** is a an advisory that sustained winds of 74 mph (119 km/h) or 64 knots or higher are expected in a specified area within 24 h. See Table 2 for hurricane categories and their effects.

The basic concerns related to weather systems of this type are:

- Winds in excess of 74 mph (119 km/h) or 64 knots;
- Heavy rain;
- Flash flooding of inland facilities;
- Tidal surge along coastal areas;
- These storms may spawn tornadoes;
- Once the "eye" of the storm passes, winds will rise rapidly from the opposite direction.

Preparedness. While these types of weather systems can cause great damage, they can be predicted and monitored usually hours and possibly days in advance. Use a detailed checklist to plan for these weather systems. A sample Hurricane checklist and Tracking Chart may be found in PRC.1.7.0.1.A.

The hurricane plan should include the following:

Hurricane preparation once a hurricane watch has been issued:

- Activate the emergency operations center;
- Determine whether a complete or partial shutdown of the facility is required;
- Determine the order in which processes are to be shut down and the facility secured;
- Initiate process emergency shut down procedures;
- Inspect roofs:
  - flashings
  - coverings
  - drains
  - gutters
  - edge strips
- Clear debris and unrestrained materials from roofs;
- Inspect and repair sign and stack supports, guy wires and anchors;
- Inspect and repair weak door or window latches or hardware and insecure wall panel fastenings;
- Protect windows from flying debris;
- Brace unsupported structural members at construction sites;
- Move important records to locations protected from wind, debris, and rain;
- Fill all aboveground tanks to capacity with product or water;
- Anchor structures, such as cranes, that may move in high winds;
- Fill the fuel tanks of emergency equipment such as back-up generators and diesel-driven fire pumps;
- Ensure that all fire protection equipment is in service;
- Anchor structures in the yard that can be moved by high winds, such as trailers, cranes, lumber, or any loose yard storage;
- Take extraordinary measures to secure outdoor traveling cranes and bridges in accordance with manufacturers' instructions. In addition to setting rail clamps, secure with wedges and cable anchors. Clean yard drains and catch basins.
- Assemble emergency supplies at a secure location:
  - Emergency lighting equipment
  - Lumber and nails
  - Sand bags
  - Roofing paper
  - Tape for windows
  - Caulking compound
  - Power and hand tools
  - Shovels and axes
  - Chain saws
  - Tarpaulins
- Maintain emergency supplies of the following in a secure location:
  - Emergency medical equipment
  - Emergency lighting equipment
  - Nonperishable food
  - Bottled drinking water
  - Emergency communications equipment

After the hurricane:

- Initiate search and rescue procedures.
- Assess the damage from fire, flooding, and impairments to fire protection equipment immediately.
- Initiate property conservation procedures.
    - Protect building contents from rain damage.
    - Temporarily repair openings in roofs and walls.
    - Cover building contents with tarpaulins to minimize rain damage.
- Be alert for downed or damaged power lines. Notify the electric utility company of needed repairs.
- If roofs are safe to stand on, clear debris from roof drains to prevent ponding of water.
- Prohibit the use of any flame or heat-producing equipment in any area where the presence of any flammable liquids or gases is suspected.

A checklist and tracking information for hurricanes can be found in PRC.1.7.0.1.A.

Tornado

A tornado is defined as a wind spout spawned by severe thunderstorms or hurricanes. Winds within the spout may approach 300 mph (483 km/h). In the United States, tornadoes usually travel from the southwest to the northeast at an average ground speed of 35 mph (56 km/h), although speeds as high as 70 mph (113 km/h) have been recorded. In the spring when strong cold fronts collide with humid warm fronts conditions are favorable for severe thunder storms and tornadoes. Preparation for a tornado must be done far in advance since there is usually little time to prepare for an approaching tornado.

A **tornado watch** implies that conditions are favorable for tornadoes to develop.

A **tornado warning** means that tornadoes have been sighted in the area.

The tornado plan should include the following:

When a tornado watch has been issued:

- Alert all employees that a tornado watch has been issued.
- Activate the emergency operations center.
- Assign personnel equipped with two-way radios to watch for funnel cloud formation, to alert the emergency operations center of its characteristics and travel.

When a tornado warning has been issued, or a funnel-cloud sighted, alert all employees to immediately move to designated tornado shelters.

Once the tornado has passed:

- Begin primary search and rescue operations immediately.
- Conduct a damage assessment.
- Begin temporary repairs to prevent further damage.
- Pay special attention to possible fire, flooding, or impairment of fire protection equipment.
- Temporarily cover openings in the building or cover the contents of the building with tarpaulins to minimize rain damage.
- Initiate property conservation procedures.
- Exercise care around damaged power lines. Advise the utility company of necessary repairs.
- Clear roof drains of debris to prevent water from ponding on the roofs, which could lead to roof collapse.

- Forbid the use of any flame- or heat-producing equipment in any area where the presence of any flammable liquids or gases is suspected.

Earthquakes

History has proven time and time again that earthquakes can be the one of the most disastrous emergencies that can occur in certain geographic parts of the world. Coupled with their consequences is their unpredictability. Unlike hurricanes and other natural events which can be predicted hours or days before they occur, earthquakes occur without warning. The key to surviving an earthquake is anticipation and preparedness.

Most damaging earthquakes are caused by the movement of the earth's crust as the rock structures adjust to tectonic forces. Many parts of the world are susceptible to earthquakes. The earthquake potential of any area is evaluated on the basis of its proximity to known earthquake activity. Earthquakes that occur on the ocean floor may result in tidal waves called "tsunami." Additional discussion of earthquakes can be found in PRC.15.2.

Because earthquakes provide little or no warning prior to their occurrence, the key to surviving them lies in a facility's preparedness efforts. An earthquake checklist may be found in PRC.1.7.0.1.A.

Unlike some natural events, earthquakes occur with virtually no warning. The basic concerns are:

- General panic and confusion;
- Structural damage or collapse;
- Entrapment of people;
- Disruption of utilities;
- Loss of public fire protection water supplies;
- Reduction or total loss of outside emergency response services;
- A high likelihood of fire caused by the quaking;
- A high likelihood that the facility will have to survive on its own emergency resources for what may be an extended period of time;
- A likelihood that an earthquake will result in extensive property damage, physical destruction, disruptions of utilities, entrapment of personnel, and potential mass casualties.

The earthquake plan should include the following:

Structural considerations:

- Conduct a seismic hazard appraisal of all buildings and structures within the facility. If any question arises as to the seismic health of the facility, have a structural engineer conduct an appraisal.
- Inspect signs, tanks, stacks and chimneys for proper support.
- Upgrade structural strengthening where necessary.
- Identify or design safe employee shelter and assembly areas. Designate both primary and secondary shelter and assembly areas as well as "duck," "cover," and "hold" locations along evacuation routes.
- Designate at least two safe evacuation routes from each area of the facility to shelters and assembly areas.

Nonstructural considerations:

- Conduct an earthquake hazard/safety appraisal of buildings and operations.
- Brace tall cabinets, shelves, tall machinery and equipment or other top-heavy objects which could topple.
- Brace and adequately support overhead fixtures, drop ceilings, piping, heaters or other overhead devices.
- Protect fuel-fired appliances from rupturing fuel lines.

  - Bolt down and restrain appliances.
  - Provide flexible connections to fuel supplies.
- Ensure that isolation valving for piping systems is easily accessible under emergency conditions.
- Ensure the reliability of vital equipment and services, such as communications and lighting.
  - Provide safe, independent, alternate energy sources.
  - Provide auxiliary and backup equipment.
- Restrain and adequately support mainframe computers.
- Safeguard records vital to restoring business operations to normal.
- Provide earthquake survival training to all employees.
- Ensure that one person in each department on each shift is trained and capable of taking charge of their work groups immediately when an earthquake occurs.
- Ensure that all plant personnel are involved in all facets of earthquake response and are drilled in properly reacting when an event occurs.
- Ensure the continuation of plant security.
- Maintain emergency supplies of the following in a secure location:
  - Emergency medical equipment;
  - Emergency lighting equipment;
  - Nonperishable food;
  - Bottled drinking water;
  - Emergency communications equipment.
- Assemble emergency supplies at a secure location:
  - Emergency lighting equipment;
  - Lumber and nails;
  - Sand bags;
  - Roofing paper;
  - Portable pumps and hose;
  - Mops and squeegees;
  - Power and hand tools;
  - Shovels and axes;
  - Chain saws;
  - Tarpaulins.
- Plan for customer/client/supplier awareness and develop contingency plans for continued business operations. Include plans for:
  - Alternate office facilities;
  - Financial procedures;
  - Data processing;
  - Communications;
  - Transportation.
- Establish an earthquake preparedness program as a section of the pre-emergency plan. Base this program on the premise that an earthquake will eventually occur without warning.
- Assign specific duties and responsibilities for:
  - Accounting for personnel;
  - Checking for injuries;

  - Building damage assessment;
  - Checking for fire and fire hazards;
  - Checking for leaking gas or flammable/hazardous materials;
  - Safe equipment shutdown;
  - Shutting off fuel lines;
  - Disconnecting power;
  - Dealing with hazardous materials;
  - Evacuating the premises.
- Provide an emergency communications system of portable two-way radios for use in communicating with the emergency operations center following an earthquake.

When an earthquake occurs:

- Have employees evacuate the facility, shutting down hazardous operations as they evacuate.
- Have employees report to their pre-assigned areas to ensure all personnel are accounted for.

After the earthquake:

- Establish control of the situation and demonstrate authority and organization;
- Anticipate aftershocks - they are frequently as dangerous as the initial earthquake;
- Assign a reconnaissance team(s) to conduct a primary search of the facility;
- Shut off all power and isolate hazardous liquids and gases;
- Attempt to control or extinguish any fires;
- Establish a communications link with local emergency management authorities;
  - Advise them of conditions at the facility.
  - Alert them to the need for emergency assistance.
- Establish communications with neighboring businesses.
- Determine the extent and severity of the damage. Be especially alert for the potential for fire.
- Assess the damage sustained to utilities in order to formulate and initiate a recovery plan.
- Initiate property conservation procedures.
- Keep nonemergency personnel out of structures until the extent of the damage has been thoroughly assessed.
- Secure the property from looting and vandalism. Get outside assistance as needed.
- Establish an emergency transportation pool. Do not attempt transportation beyond the local premises until accessibility is known.

Forms for earthquake preparedness and an earthquake inventory can be found in PRC.1.7.0.1.A.

Utility Outages

Planned or emergency interruption of utilities can create emergency conditions at facilities. Of primary concerns are:

- Public Water Supplies
  - Impairment or loss of fire protection water;
  - Partial or complete curtailment of operations due to loss of service water.
- Electric Power
  - Exposure to the dangers of a crash shutdown;
  - Loss of control power to processes that can result in dangerous conditions;
  - Impairment or loss of fire protection equipment;
  - Partial or complete curtailment of operations;

  - Brownout causing reduced power consumption.
- Fuel Supply
  - Loss of fuel to processes that can result in freezing of molten processes, such as chemical solutions, metals, glass and ceramics;
  - Partial or complete curtailment of operations;
  - Potential freezing of fire protection equipment;
  - Impairment or loss of fire protection equipment.

The utility outage plan should include the following:

Public water supply outage:

- Contact officials of the water authority to determine:
  - The estimated extent and duration of the outage;
  - What is being done and what the facility can do to expedite repairs.
- Notify the facility's emergency response team(s) and the Shift Commander of the public fire department so they can alter their pre-fire plans accordingly.
- Increase guard patrols to provide additional fire protection surveillance.
- Ensure the safe shutdown, provide a backup, or closely monitor the operation of equipment that uses the public water supply for primary or emergency cooling.
- Verify sufficient boiler feedwater or arrange boiler load reduction or shutdown. If there is danger of freezing, promptly obtain another source of properly treated water.
- Develop a priority list for water usage should conservation of available supplies become necessary.
- Reserve all private fire protection water supplies for fire use only.
- Defer normal sprinkler and fire protection system testing and maintenance until the water supply is restored.
- Initiate Fire Protection Impairment Procedures if a fire protection impairment results.

Electric Power Outage

Widespread Outage

- Determine the magnitude of the outage and its estimated duration.
- Monitor the operation of fire pumps or emergency generators.
- Secure and patrol all potential points of entry.
- See that increased guard patrols are provided for security and fire protection surveillance.
- Have as many circuits as possible disconnected so that the system will not overload when power is restored.

Local Outage

- Determine the magnitude of the outage and its estimated duration.
- Make sure that affected circuits are properly isolated and that repairs are underway.
- Determine that all "critical" equipment and systems (see PRC.1.13.0), protective signaling systems, fire pumps, and key process equipment receive priority treatment when planning restoration.
- Make sure that the operation of diesel-engine driven fire pumps is monitored if they are arranged to start when the power fails. Emergency generators also should be monitored.
- Insure smooth transfer to back-up (turbine or engine) equipment where provided.
- Verify that process valves and controllers that will fail on loss of power have done so in the safe position.

- Close doors and otherwise reduce load on refrigeration systems.
- If possible, isolate boilers to minimize cooling and therefore minimize both the time to return the boiler to service and the likelihood of damaging it by overheating in the process.
- Check to be sure that all circuits are properly repaired, including a test for correct phase relationship, before they are restored to service.
- Have the power load reduced to a minimum before power is restored. Also be certain that large motors are isolated to prevent damage due to possible under-voltage starting.

Brownout

- Determine the magnitude of the brownout and its estimated duration.
- Reduce electrical consumption as much as possible.
- Identify equipment which may be sensitive to low voltage, and take positive steps to prevent its damage.
- Be alert to the possibility of a “single-phase condition.” If this condition exists, shut down all three-phase electrical equipment until a balanced supply can be restored.

Fuel Supply Outage

- Establish the minimum quantities of the various fuels required for maintaining proper fire protection.
    - Maintain at least the minimum quantities of fuels in reserve;
    - The reserve should contain sufficient fuel to prevent freezing of water systems.
- Thoroughly evaluate any proposed arrangements for using alternate fuels to ensure that the storage, transfer, and actual use conform to applicable codes and standards.
- Thoroughly evaluate any proposal for increasing the quantity of fuels stored on site to ensure that the storage facilities conform to applicable codes and standards.
- Reduce building temperatures as needed, taking precautions to:
    - Establish controls to prohibit the use of unauthorized portable heating appliances on the premises;
    - Make sure that there is sufficient heat to prevent sprinkler systems from freezing. Areas such as attics, concealed spaces, or those near frequently opened outside doors should be closely monitored during cold weather. (See PRC.15.5.1.)
- Operate production equipment intermittently rather than continuously.
    - Evaluate equipment start-up and shut-down procedures to be sure they are safe.
    - Ensure that the allowable number of start/stop cycles is not exceeded for large motors.
    - Consider changes in the amount of heat generated by operation of such equipment when evaluating the amount of heat required to maintain safe building temperatures.
- Reduce operating hours in selected areas.
- Extend the guard or protective signaling service to ensure proper surveillance is maintained in these areas during the idle periods.

Bomb Threats

Although history shows that most bomb threats turn out to be hoaxes, all bomb threats must be taken seriously.

The bomb threat plan should include the following:

Dealing with a bomb threat:

- Ensure telephone operators understand how to properly handle bomb threats and to:
    - Obtain as much information as possible from the caller.
    - Complete a Bomb Threat Checklist. See PRC.1.7.0.1.A.

  - Attempt to find out how many devices are involved and when they are due to detonate.
  - Immediately notify the appropriate personnel within the facility.
- Activate the emergency operations center.
- Instruct employees to report any suspicious package, action, or condition that would lead them to suspect a bomb's presence.
- Evacuate personnel from the affected area.
- Alert the appropriate law enforcement agencies. If no agencies are available, alert the appropriate Bomb Squad.
- Determine who will look for the bomb. Many public fire departments feel that their responsibility is to stand by should their services be needed and do not join the search;
- Identify likely places in which to hide a bomb. Bombs may be placed in areas where they will cause the most disruption, such as boiler rooms, electrical substations, control rooms, and computer rooms.
- Alert local fire and emergency medical response agencies.

If a suspected bomb is discovered:

- Activate the Emergency Operations Center;
- Evacuate personnel;
- Alert the appropriate law enforcement agencies. If no law enforcement agencies are available, alert the appropriate Bomb Squad;
- Alert local fire and emergency medical response agencies;
- Have facility emergency response team(s) stand by in a safe location and prepare for emergency duties.

Emergency action plan forms for a bomb threat check list and list of military ordnance disposal centers can be found in PRC.1.7.0.1.A.

Civil Disturbances

Civil disturbances in the community where a facility is located can result in emergency conditions at the facility. They may include looting, rock throwing, localized vandalism, acts of pranksters, and actual acts of aggression.

The civil disturbances plan should include the following:

Minor disturbances:

- Alert facility security personnel.
- Alert the local law enforcement personnel.
- Request special exterior patrols from local law enforcement officials.
- Encourage employees and neighbors to alert security personnel promptly of any suspicious persons in the area.
- If any building damage is done:
  - Repair any building damage promptly, since unrepaired damage could invite further vandalism;
  - Initiate property conservation procedures.

Major disturbances:

- Activate the Emergency Operations Center.
- Alert local law enforcement agencies.
- Shut down the facility if required. Be certain employees:
  - Lock up vital information;

  - Secure their work areas as they would for an extended holiday;
  - Draw curtains on windows;
  - Lock their desks and doors.
- Escort employees to their cars as necessary.
  - Vehicles should be kept within the facility gates, if possible.
  - Maintain accessibility for emergency vehicle response.
- Summon necessary security personnel from off site, if necessary, to maintain facility security.
- Secure utilities and fire protection equipment.
- Request special exterior patrols from local law enforcement officials.
- Secure and patrol all potential points of entry.
- Increase guard patrols to provide for security and fire protection surveillance.
- Inspect all fire protection valves and equipment to ensure they have not been sabotaged or intentionally impaired.
- Institute daily inspections of utility and fire protection equipment to reduce the possibility of sabotage.

Labor Unrest

A strike or other job action brought about because of labor unrest can present unique challenges to a facility and its ability to deal with emergencies. Not only may those involved in the labor unrest not be available to respond to or deal with emergencies, but they may also take actions that increase the likelihood of an emergency at the facility. An incident of this type can leave a facility critically short of staff and totally unable to deal with any emergency.

The labor unrest plan should include the following:

Labor dispute is expected/occurs:

- Activate the Emergency Operations Center;
- Assess the need to stabilize or shut down the facility. The safest course of action may be to shut down the facility as soon as this can be accomplished safely.
- Alert local law enforcement agencies.
- Request special exterior patrols from local law enforcement officials.
- Summon necessary security personnel from off site, if necessary, to maintain facility security.
- Secure and patrol all potential points of entry.
- Tour the facility to look for any evidence of sabotage that may have been created by employees.
- Inspect all fire protection valves and equipment to ensure they have not been sabotaged or intentionally impaired.
- Secure utilities and fire protection equipment as much as possible.
- Increase guard patrols to provide for security and fire protection surveillance.

Institute daily inspections of utility and fire protection equipment to reduce the possibility of sabotage.

EMERGENCY ACTION PLAN FORMS

OVERVIEW FORMS PACKET
(See PRC.1.7.0.1 in the OVERVIEW Manual)
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SUGGESTED ARCTIC FREEZE CHECKLIST WITH COLD WEATHER PRECAUTIONS

When preparing for an Arctic Freeze, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed - expressed in hours or days - to accomplish these tasks should be determined in advance so that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a winter watch or storm warning, check it off and move on to the next one.

	ACTION	TIME NEEDED	DONE
1.	Restore any cutback of heat to buildings or processes.	______	☐
2.	Provide additional heat for normally cold areas.	______	☐
3.	Make certain there is an adequate supply of fuel for the heating systems.	______	☐
4.	Expedite the completion of any postponed repairs to the heating system.	______	☐
5.	Forgo any planned heating plant or boiler inspections until the danger of the severe cold has passed.	______	☐
6.	Keep someone on the premises who will continually monitor all areas of the premises for signs of impending trouble, and provide that person with an up-to-date list of emergency numbers to call should trouble be detected.	______	☐
7.	Add heat tracing to process and protective system piping that might freeze.	______	☐
8.	Check insulation on piping and structures to be certain it will protect them against the extreme cold temperatures.	______	☐
9.	Where processes are shut down, drain piping and tanks to prevent freezing damage.	______	☐
10.	Recheck the *Cold Weather* Precautions listed on this form.	______	☐

Add other items unique to your facility.

COLD WEATHER PRECAUTIONS

Unless proper precautions are taken, cold weather can cause problems. Buildings may be loaded beyond their design by accumulations of snow and ice. Fire protection equipment may freeze, leaving a major portion of the facility without protection.

Prior to and during cold weather, the following precautions should be taken.

A. General
   1. Plans should be made to remove snow from flat roofs or other structures which might collapse.
   2. All doors, windows, skylights, ventilators, and other openings should be weather-tight so they will not admit cold air that could cause sprinkler systems to freeze.

B. Heating Systems
   1. To determine that the entire system is in proper operating condition, it should be examined and deficiencies corrected. Burners, boilers, and flues should be clean. Obstructions should be removed from all pipes, radiators, and unit heaters. Controls of heating equipment should be tested for proper operation.
   2. Where possible, an adequate reserve supply of fuel should be on hand at all times. Safe alternate energy sources should be investigated.
   3. Temperatures about 40°F (5°C) must be maintained at all times in buildings equipped with wet pipe sprinkler systems; in all dry pipe, pre-action, and deluge valve closets; and in all pump houses.
   4. Clearances should be maintained between heating system components and combustible floors, walls, partitions, platforms and stock.

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COLD WEATHER PRECAUTIONS (continued):

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C. Protective Systems

Some of the following maintenance procedures involve valve operation or other impairments to protective systems. Proper procedures should be followed in all such cases (see OVERVIEW Section 1, Impairments To Protective Systems).

1. Plans should be made to promptly clear snow from access ways, control valves, hydrants, hose cabinets, smoke and heat vents, explosion relief vents, and other essential equipment to permit effective operations in the event of an emergency.
2. Wet pipe sprinkler systems in areas which are inadequately heated should be converted to dry pipe or pre-action systems.
3. Dry pipe sprinkler systems and preaction or deluge systems dry pilot lines should be inspected carefully to make sure that the piping is properly pitched for drainage. Any condensation that collects in low points in the piping should be removed. Excessive priming water should also be removed.
4. Sprinkler heads in the immediate vicinity of steam pipes, unit heaters, or other heat-producing appliances should be of the correct temperature rating.
5. Solutions in all anti-freeze sprinkler systems should be tested and anti-freeze added as necessary.
6. Any "shut-in-winter" valves controlling small unheated areas should be closed, tagged with Global Asset Protection Services cold weather shut-off tags, and properly drained. Consideration should be given to converting such systems to either a dry pipe or a pre-action system.
7. All wet standpipe systems with piping located in areas subject to freezing should be shut off, drained and tagged.
8. Connections to water motor gongs and fire department connections should be properly drained.

D. Fire Protection Water Tanks

1. Gravity tanks must not leak, since an accumulation of ice on trestles can cause the tank structure to collapse. The expansion joint and riser boxing should be in good condition.
2. The water temperature in the gravity tank should be checked frequently during cold weather and maintained at no less than 42T.
3. The tank heating system should be flushed and put in good working order.
4. The tank roof-hatch cover should fit tightly and be fastened.

E. Hydrants and Underground Piping

1. Hydrants and fire pump hose headers should be drained. Outlet hose valves must be left half open to prevent damage from freezing.
2. Hose should be properly drained and dried.
3. Packing on post indicator valves should not be leaking.
4. Sections of exposed piping should be drained or otherwise protected against freezing.
5. Valve and meter pits should be dry and frost-proof.

F. Portable and Wheeled Fire Extinguishers located in cold areas should be suitable for such locations or installed in heated cabinets.

G. Automotive Fire Apparatus should be properly serviced for cold weather.

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(See PRC.1.7.0.1 in the OVERVIEW Manual)
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EARTHQUAKE
BUILDING INVENTORY

Bldg. Name/No. __________ Inventory By __________ Date __________

Date of Construction __________ Design Bldg. Code __________ (Local. State. Nat'l) Code Adopted __________ (Date)

Bldg. Use __________

Drawings Available (Y/N) __________

Number of Stories __________ Height __________ Size __________ Footprint

Shape __________ (Comment horizontal and vertical shape — Regular vs irregular)

Provide freehand sketch and section on back of form. (Note adjacent buildings.)

Construction

- Structural System __________ (Describe or classify)
- Roof Construction __________ (Describe or classify)
- Exterior Walls __________ (Construction) Floors __________ (Construction)
- Connections __________ (Describe anchors for roof to wall, wall to floors or foundation)
- Condition __________ (Evaluate general condition of structure - Note prominent weakness)

Is bldg. on: ☐ Level Ground ☐ Sloping Ground ☐ Adj to earthen Bank

Is bldg. constructed on: ☐ Rock ☐ Natural Soils ☐ Fill ☐ Unknown

Nonstructural

- Partitions __________ (Type and Construction) Ceilings __________ (Type and Construction)
- Windows __________ (Fixed or Movable - Wood or Metal Frame)
- Light Fixtures __________ (Hanging - Am they secure)
- Mechanical Equipment __________ (Floor, wall or ceiling mounted - secure mount or anchor)

Professional structural and hazard analysis needed? (Y/N)

Comments __________

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EARTHQUAKE PREPAREDNESS

The establishment of an Earthquake Preparedness program must accept the premise that earthquakes occur without warning. There will be no "watch" or "warning" period as issued for other natural hazards such as hurricane, flood, winter storm or arctic freeze. Current technology does not allow for precise time and location forecasting of a damaging earthquake. Efforts for loss mitigation must entail a continuing program consisting of preparations subject to repetitive review, reevaluation and upgrading. Drills and practice must contemplate after the fact response to property damage, physical destruction, interruption of utility services, personal injury and possibly loss of life. AND: you will be left to your own resources for a nominal period of time.

The following checklist notes items which, if appropriately addressed, will enhance the potential for your business to fully recover from the effects of an earthquake.

STRUCTURAL CONSIDERATIONS:

ACTION	IMPLEMENTED	REVIEWED
1. Make a seismic hazard appraisal of buildings and structures. If in doubt of the seismic health of the facility consult a structural engineer.	________	________
2. Inspect signs, tanks, stacks and chimneys for deterioration and proper support.	________	________
3. Plan upgrade strengthening where necessary for 1. and 2. above.	________	________
4. Designate –"safe" shelter or assembly areas.	________	________
5. Designate –"safe" evacuation routes from all areas to assembly areas.	________	________

(Note: A minimum of two safe assembly areas and two evacuation routes should be established in case the primary area or route is inaccessible.)

NON-STRUCTURAL BUILDING RELATED CONSIDERATIONS:

ACTION	IMPLEMENTED	REVIEWED
1. Make an earthquake hazard/safety appraisal of buildings and operations. (Also identify or develop - Duck, Cover and Hold - locations along evacuation routes.)	________	________
2. Brace tall cabinets, shelves, tall machinery and equipment or other top heavy objects which could topple.	________	________
3. Brace and adequately support overhead mounted fixtures, drop ceilings, piping, heaters or other overhead devices.	________	________
4. Bolt down and restrain flammable fuel fired appliances and provide flexible connectors for fuel supply.	________	________
5. Provide frequent isolation valving for piping systems.	________	________
6. Provide safe independent alternate energy sources for vital equipment and services.	________	________
7. Provide auxiliary and backup equipment and energy sources for critical services such as communications and lighting.	________	________
8. Restrain and adequately support mainframe computers.	________	________
9. Safeguard vital records. (Include both physical and machine processing for update. storage and retrieval.)	________	________
10. Plan for continuation of Plant Security.	________	________
11. Consider that employees may remain on premises for up to 72 hours. Provide reasonable and adequate supplies of necessities.	________	________
12. Plan for Customer/Client/Supplier awareness and develop contingency plans for continued business operations. (include plans for alternate office facilities, financial procedures, data processing, communications and transportation.)	________	________

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RESPONSE CONSIDERATIONS:

ACTION	IMPLEMENTED	REVIEWED
1. MAKE A PLAN AND REVIEW IT ANNUALLY. **NOTE**: Earthquake aftershocks may occur-expect them -include the probability in your planning.	________	________
2. Acquire necessary up-to-date educational and emergency information materials.	________	________
3. Involve all level of personnel in information discussions and repetitive meetings, drills and practice sessions. Allow for the contingency of on-site customers, vendors or visitors.	________	________
4. Assign two responsible people in each department, each shift, who can "TAKE CHARGE" of their group immediately. This will reassure all employees that the situation is under control and enhance prompt response actions.	________	________
5. Assign specific duties and responsibilities such as accounting for personnel, checking for injuries, building damage assessment, checking for fire and fire hazards, leaking gas or flammable/hazardous liquids, safe equipment shutdown, shutting off fuel lines, disconnecting power, containing hazardous materials and evacuating the premises, as much as practical.	________	________
6. Suitable prearrangements will be necessary for the care and handling of injured and handicapped persons.	________	________
7. Establish a communications network employing self contained devices such as radio transceivers. Include reporting of conditions from on premises locations and off premises sites as practical to a central on site control point such as the designated 'safe shelter assembly area." A bulletin board can be used to post situation reports of general interest regarding employee residence, specific landmarks, personal inquiries and general status notices.	________	________
8. Establish an emergency transportation pool. Transportation beyond the immediate premises should not be attempted until accessibility is known. An inspection of the company properties will be necessary and mobile material handling equipment may need to be utilized on site.	________	________
9. Establish contact with neighbors or other industrial mutual aid agreement participants.	________	________
10. Establish contact with civil authorities such as police, fire, medical and emergency agencies to advise them of your situation and request or offer assistance as needed or available.	________	________

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SUGGESTED FLOOD CHECKLIST

When preparing for a flood, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed - expressed in hours or days - to accomplish these tasks should be determined in *advance so* that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a *flood watch* or flood *warning,* check it off and move on to the next one.

	ACTION	TIME NEEDED	DONE
1.	Shut down processes safely, and drain open tanks of flammable or combustible liquids.	________	☐
2.	Brace unsupported structural members at construction sites.	________	☐
3.	Up-date important backup records, and move them to a location not vulnerable to flooding.	________	☐
4.	Anchor yard items that can be moved by flood waters, such as trailers, lumber, or loose yard storage. Move stored materials inside if practical. Barricade critical outdoor equipment with sandbags to provide protection against floating debris.	________	☐
5.	Assemble the following supplies and equipment at a central, secure location: _____ Portable pumps and hose _____ Emergency lighting _____ Lumber and nails _____ Sandbags _____ Mops and squeegees _____ Tarpaulins _____ Power and manual tools Shovels and axes		☐
6.	Ensure that the emergency crew remaining on the premises has the following: _____ Nonperishable food _____ First aid equipment _____ Lighting _____ Two-way radios _____ Stored drinking water	________	☐
7.	Fill emergency generator and fire pump fuel tanks	________	☐
8.	Inspect all fire protection equipment to be sure it is in service.	________	☐
9.	Check travel brakes on movable cranes and bridges. Anchor them in accordance with the manufacturer's out-of-service instructions.	________	☐
10.	Place sandbags at vulnerable building openings and around critical outdoor equipment. Divert water from critical areas such as holes in foundations, doorways, and sills.	________	☐
11.	Move important machinery, stock, and reports to higher elevations. By knowing the past flooding history of the area, reasonably safe areas can be selected. If major equipment cannot be moved, coat vulnerable metal surfaces with grease.	________	☐
12.	Shut off all flammable and combustible liquids and gases lines at their source to prevent the discharge of such liquids and gases from piping broken by floating debris. Support exposed piping properly.	________	☐
13.	Make sure above and below ground tanks are properly anchored to prevent flotation. Fill empty tanks with water or product, and extend vent lines on active tanks above the anticipated maximum water level.	________	☐
14.	Lash down portable containers of flammable or combustible liquids.	________	☐
15.	Shut off electrical power at the main building disconnect when that building is in imminent danger of flooding.	________	☐

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OVERVIEW FORMS PACKET
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TYPICAL BOMB THREAT CHECKLIST WITH MILITARY ORDNANCE DISPOSAL CONTROL CENTERS

INSTRUCTIONS: LISTEN, DO NOT INTERRUPT THE CALLER!

Name of Operator ______________________ Time ________ Date ________

Caller's Identity

Sex: Male ______ Female ______ Approximate Age Years ______

Origin of Call

_____Local _____Long Distance _____Booth _____Internal (from within Bldg.?) If internal, leave plug in board.

VOICE CHARACTERISTICS	SPEECH	LANGUAGE	ACCENT	MANNER	BACKGROUND NOISES
___ Loud	___ Fast	___ Excellent	___ Local	___ Calm	___ Office Mach.
___ High Pitch	___ Distinct	___ Fair	___ Foreign	___ Rational	___ Factory Mach.
___ Raspy	___ Stutter	___ Foul	___ Race	___ Coherent	___ Bedlam
___ Intoxicated	___ Slurred	___ Good	___ Not Local	___ Deliberate	___ Animals
___ Soft	___ Slow	___ Poor	___ Caucasian	___ Righteous	___ Quiet
___ Deep	___ Distorted	___ Other	___ Region	___ Angry	___ Mixed
___ Pleasant	___ Nasal		___ Other	___ Irrational	___ Street Traffic
___ Other	___ Other			___ Incoherent	___ Airplanes
				___ Emotional	___ Party Atmos.
				___ Laughing	___ Trains
				___ Other	___ Music
					___ Voices

BOMB FACTS

If caller seems agreeable to further conversation, ask questions like:

KEEP CALLER TALKING

WHEN WILL IT GO OFF? Certain Hour ______ Time Remaining ______

WHERE IS IT PLANTED? Building ______ Area ______

WHAT KIND OF BOMB? WHERE ARE YOU NOW? HOW DO YOU KNOW SO MUCH ABOUT THE BOMB? WHAT IS YOUR NAME AND ADDRESS? HOLD ON LINE WHILE YOU NOTIFY SUPERVISOR LISTED BELOW:

Did caller appear familiar with plant or building by his description of the bomb location?

Write out the message in its entirety and any other comments on reverse side.

ACTION TO TAKE IMMEDIATELY AFTER CALL

Notify following persons in order given:

NAME ______________________ PHONE NO. ______

NAME ______________________ PHONE NO. ______

NAME ______________________ PHONE NO. ______

NAME ______________________ PHONE NO. ______

(over)

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Military Ordnance Disposal Control Centers

FIRST U.S. ARMY
Control Center
542nd/549th ORD DET
Fort Meade, MD 20755
Telephone: (301) 677-5182 or 677-5183

Area of Responsibility:
Maine, New Hampshire, Vermont, New York, Massachusetts
Connecticut, New Jersey, Pennsylvania, Delaware
Maryland, Ohio, Virginia, West Virginia, Kentucky
Rhode Island, and District of Columbia

THIRD U.S. ARMY
Control Center
547th ORD DET
Fort McPherson, GA 30330

Telephone:
Duty Hours: (404) 752-3004 or 752-3055
Non Duty Hours: (404) 752-3113

Area of Responsibility:
North Carolina, South Carolina, Georgia, Florida
Alabama, Mississippi and Tennessee

FOURTH U.S. ARMY
Control Center
546th ORD DET
Fort Sam Houston, Texas 78234

Telephone:
Duty Hours: (512) 221-4646 or 221-5308
Non Duty Hours: (512) 221-5500 or 221-2907

Area of Responsibility:
Texas, Louisiana, Arkansas, Oklahoma, New Mexico

FIFTH U.S. ARMY
Control Center
543rd ORD DET
Fort Leonard Wood, Missouri 65473

Telephone: (314) 368-3814 or 368-4313

Area of Responsibility:
North Dakota, South Dakota, Wyoming, Colorado
Kansas, Missouri, Iowa, Wisconsin, Michigan, Illinois
Indiana, Minnesota, and Nebraska

SIXTH U.S. ARMY
Control Center
548th ORD DET
Presidio of San Francisco, California 94129

Telephone: (415) 561-4203 or 561-4312

Area of Responsibility:
California, Washington, Oregon, Arizona, Nevada,
Idaho, Montana, Utah

OVERVIEW FORMS PACKET
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SUGGESTED HURRICANE CHECKLIST

When planning for hurricanes, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed — expressed in hours or days — to accomplish these tasks should be determined in advance so that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a *hurricane watch* or *hurricane warning*, check it off and move on to the next one.

	ACTION	TIME NEEDED	DONE
1.	Shut down processes safely.	________	☐
2.	Inspect roof edging strips, gutters, flashing, covering, and drains.	________	☐
3.	Inspect sign and stack supports, guy wires, and anchorages.	________	☐
4.	Check for weak door and window latches or hardware or for insecure panel fastenings. Expedite repairs.	________	☐
5.	Protect vulnerable windows from flying debris.	________	☐
6.	Brace unsupported structural members at construction sites.	________	☐
7.	Protect important records from wind, debris, and rain.	________	☐
8.	Up-date important backup records and move them to a location not vulnerable to the same incident.	________	☐
9.	Fill aboveground tanks to capacity with product or water to minimize wind damage (see Flood Checklist for underground tanks).	________	☐
10.	Anchor structures in the yard that can be moved by high winds, such as trailers, lumber, or any loose yard storage. Move stored materials inside where practical.	________	☐
11.	Assemble the following supplies and equipment at a central, secure location: ________ Emergency lighting ________ Lumber and nails ________ Tape for windows ________ Sandbags ________ Roofing paper ________ Caulking compound ________ Tarpaulins ________ Power and manual tools ________ Shovels and axes ________ Chain saws	________	☐
12.	Ensure that the emergency crew remaining on the premises has the following: ________ Nonperishable food ________ First aid equipment ________ Lighting ________ Two-way radios ________ Stored drinking water	________	☐
13.	Fill emergency generator and fire pump fuel tanks.	________	☐
14.	Inspect all fire protection equipment to be sure it is in service.	________	☐
15.	Take extraordinary measures to secure outdoor traveling cranes and bridges in accordance with manufacturers' instructions. Besides setting rail clamps, secure with wedges and cable anchors.	________	☐
16.	Clean out drains and catch basins.	________	☐
17.	Be sure to prepare the Flood Checklist as well as the Hurricane Checklist.		☐

Add other items unique to your facility.

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HURRICANE TRACKING DATA WITH MAP

STORE NAME ________________________________					MAXIUMU WIND (MPH)	CENTRAL PRESSURE (INCHES HG.)	FORWARD SPEED (MPH)	DIRECTION
DATE	TIME	LATITUDE (DEG. N)	LONGITUDE (DEG. W)	MILES – – – FROM				

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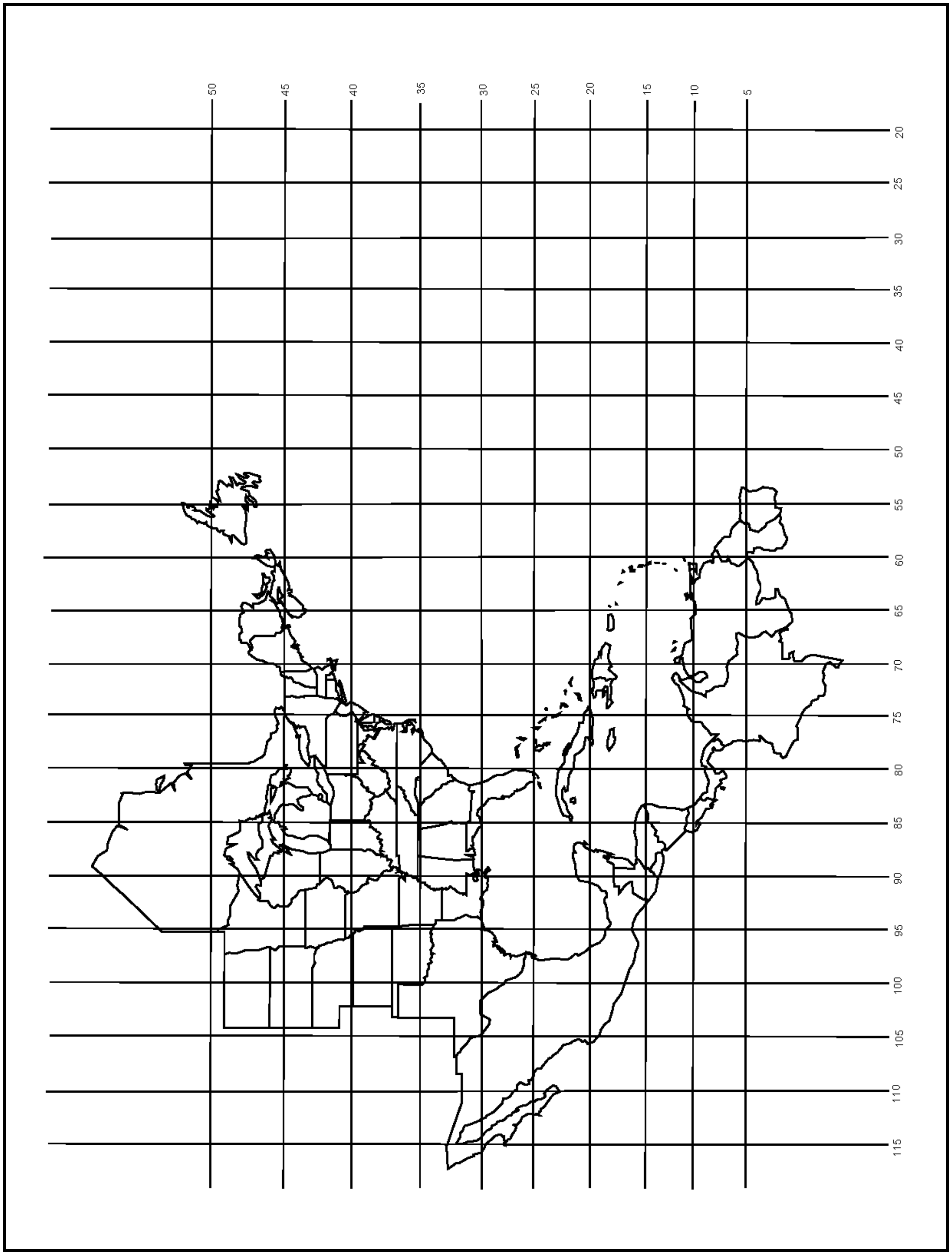
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TYPHOON TRACKING DATA WITH MAP

STORM NAME: ____________________

DATE	TIME	LATITUDE (DEG. N)	LONGITUDE (DEG. W)	KILOMETERS – – – FROM	MAXIUMU WIND (MPH)	CENTRAL PRESSURE (INCHES HG.)	FORWARD SPEED (MPH)	DIRECTION

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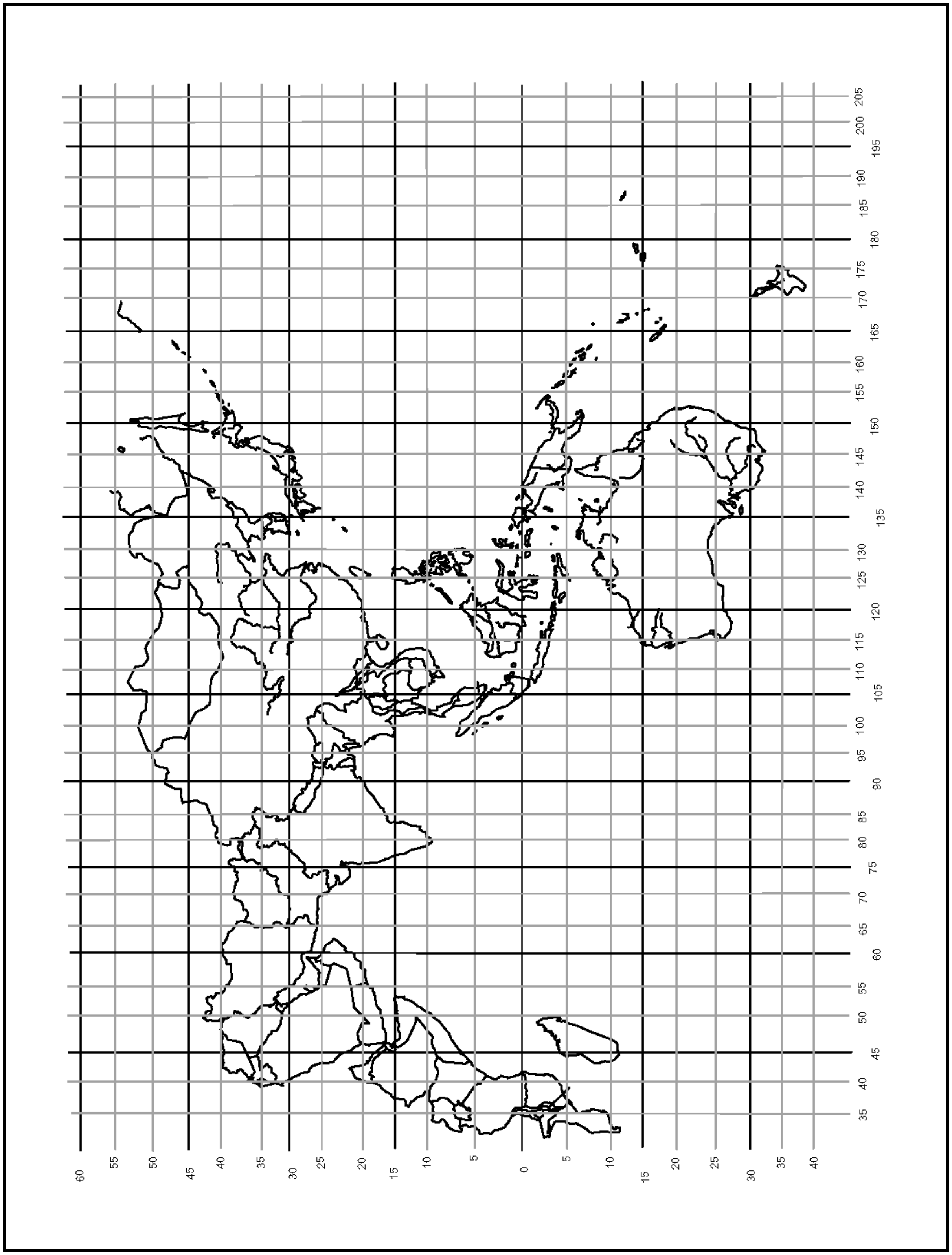
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OVERVIEW FORMS PACKET
(See PRC.1.7.0.1 in the OVERVIEW Manual)
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CHEMTREC GUIDELINES FOR RESPONDING TO CHEMICAL OR HAZARDOUS MATERIAL EMERGENCIES

FOR CHEMICAL EMERGENCY
Spill, Leak, Fire, Exposure, or Accident
CALL CHEMTREC — DAY OR NIGHT
***800–424–9300**
Toll-free in the continental U.S.
*Add long distance access number if required

483-7616 in District of Columbia

For calls originating outside the
Continental U.S.:
202–483–7616 –Washington, D.C., Collect
ALL CALLS ARE RECORDED

USER GUIDANCE

CHEMTREC can usually provide hazard information warnings and guidance when given only the NAME OF THE PRODUCT and the NATURE OF THE PROBLEM. For more detailed information and/or assistance, or if product is unknown, attempt to provide as much of the following additional information as possible:

- Name of caller and call back number
- Location of problem
- Shipper or manufacturer
- Container type
- Rail car or truck number
- Carrier name
- Consignee
- Local conditions

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CHEMTREC Information

What It Is

CHEMTREC, the Chemical Transportation Emergency Center provides information and/or assistance to those involved in or responding to chemical or hazardous material emergencies. Established in 1971, it is a public service of the Chemical Manufacturers Association (formerly Manufacturing Chemists Association) in Washington, D.C.

CHEMTREC operates in two stages: First, on receipt of information regarding the name of a chemical, it provides immediate advice on the nature of the product and steps to be taken in handling the early stages of a problem. Second, CHEMTREC promptly contacts the shipper of the material involved for more detailed information and appropriate follow-up, including on-scene assistance when feasible.

While the Center's primary mission is to help in transportation incidents, it also provides support in chemical and hazardous materials emergencies in non-transportation situations.

CHEMTREC operates 24 hours a day, seven days a week to receive calls on phone numbers shown on the front panel of this folder. The number is widely circulated in professional literature distributed to emergency service personnel, carriers, the chemical industry, bulletins of government agencies, trade associations and others who may have need. It is *not* circulated in the public press. The public need is best served through the emergency services.

CHEMTREC is not a reporting center. The Department of Transportation handles this function. CHEMTREC should be called only in those cases where assistance is needed.

CHEMTREC, in its years of operation, unfortunately has received many calls that were not pertinent to emergencies. These calls often interfere with the handling of legitimate emergencies. It is vital that callers understand CHEMTREC is neither intended nor equipped to function as a general information source.

Mode of Operation

Participating companies are requested to include the following on their shipping documents: "For Chemical Emergency — Spill, Leak, Fire, Exposure, or Accident, Call CHEMTREC 800-424-9300 day or night."

An emergency reported to CHEMTREC is received by the Communicator on duty. Recording details in writing, or on a video-screen, and by tape recorder, they question the caller to determine as much essential information on the problem as possible. This enables them as a first step, to provide the best available information on the chemical(s) reported to be involved, thereby giving specific indication of hazards, what to do, or what not to do in case of spills, fire or exposure.

Having advised the caller, the Communicator proceeds immediately to notify the shipper by phone or via electronic transmission. The known particulars of the emergency are relayed, and responsibility for further guidance — including dispatching personnel to the scene, or whatever seems warranted — passes to the shipper.

CHEMTREC Communicators are chosen for their ability to remain calm under emergency situations. To preclude unfounded personal speculation regarding a reported emergency, they are under instructions to abide strictly by the information provided for their use by technical experts employed by the industry.

The second stage of assistance becomes more difficult where the shipper is unknown. However, the Communicator has other resources. For example, on problems involving radioactive materials, CHEMTREC can call on the U.S. Department of Energy.

Mutual aid programs exist for some products. Here one producer will service the field emergencies involving another producer's product. Initial referral may be in accordance with the applicable mutual aid plan, rather than directly to the shipper. Arrangements of this sort are established on chlorine through the Chlorine Institute and on pesticides through the National Agricultural Chemicals Association.

The former has CHLOREP, the Chlorine Emergency Plan, in which the nearest producer responds to a problem. NACA has a Pesticide Safety Team Network (PSTN) of some 40 emergency teams distributed throughout the country. In addition, there are mutual assistance programs for other products, including vinyl chloride and hydrogen cyanide. CHEMTREC serves as the communication link for these programs.

CHEMTREC truly serves as the communication point for the entire emergency response system of the private sector and helps support that of the public sector. Many companies in the chemical and other industries have their own well-organized national response capabilities. The chemical industry is constantly working to expand this capability to assist others in planning such capabilities.

Identification of product and shipper is important to minimize time needed to provide necessary information and assistance. Shipping papers are carried by truck drivers and in the engine or caboose of trains. Car and truck numbers and carrier names can be useful in tracing unknown cargoes.

Relationship to Government

While CHEMTREC is in the private sector, its capabilities have been recognized for many years by the Department of Transportation, and a close and continuing relationship is maintained between CHEMTREC and the Department. More recently, formal acknowledgement of this arrangement was signed by DOT and CMA. Through the U.S. Coast Guard's National Response Center, the DOT is notified of significant incidents affecting personnel or the environment. The usual day-to-day incidents are not reported. Working closely together, the capabilities of each system will be enhanced.

Background

CMA is a trade association of chemical manufacturers, large and small, representing more than 90 percent of the production capacity for basic industrial chemicals in the United States and Canada. It has long been active in programs to improve the safety of chemical shipping containers, both package and bulk units, thereby minimizing failures and leakage of contents under extraordinary stress. Such efforts continued unabated.

Nevertheless, despite precautions taken, train derailments, truck upsets and collisions and barge accidents do happen. Such emergencies deserve to be handled as well as possible to minimize harmful effects on life and property.

Emergency services — fire and police — normally are well-prepared to cope with common materials. including certain flammables such as fuel oil and gasoline. Too often they are at a disadvantage when chemicals are involved, especially since "what should be done" and "what should not be done" in the early stages may bear heavily on the seriousness of the incident. They need accurate, clearly understandable information to help them act with proper precautions.

The concept of CHEMTREC was first explored by the Chemical Manufacturers Association in the mid 1960s following some major derailments. Officials of concerned federal departments approached CMA to determine what the industry could do to provide information to emergency services and carriers. After thorough consideration, the CHEMTREC concept was recommended and approved by CMA's Board of Directors in June 1970. The continuous and expanding operations since that time have confirmed the validity of the concept.

Other Associations

CMA and CHEMTREC coordinate their programs with many other trade associations and professional groups. The Bureau of Explosives of the Association of American Railroads is involved in many rail incidents. Members of the American Trucking Associations and National Tank Truck Carriers are also major users of CHEMTREC. Groups representing manufacturers of other hazardous materials work with CHEMTREC in providing information in emergencies. This, and cooperation with emergency services, is essential in maintaining an effective program.

For More Information

Questions regarding CHEMTREC should be sent to: Director, CHEMTREC.
c/o CMA, 2501 M Street, N.W., Washington, D.C. 20037. Telephone 202-887-1255.

EMERGENCY RESPONSE TEAMS AND INCIDENT MANAGEMENT SYSTEMS

INTRODUCTION

A key part of an emergency response system is to create the necessary emergency organization that can react to emergencies that may arise at the facility. In addition, this section also addresses incident management systems and how they impact the pre-emergency planning. For details on pre-emergency planning see PRC.1.7.0.

POSITION

Emergency Response

A facility may elect to organize emergency response teams (ERT) that perform the following emergency response functions:

- Fire response;
- Medical emergency response;
- Haz-Mat response;
- Confined space rescue response.
- If more than one function has to be performed, there are four possible choices:
- Multiple ERTS, perform a single emergency response function. (See Figure 1)
- A single ERT composed of personnel who are trained and equipped to provide multiple emergency response functions. (See Figure 2)
- A single ERT composed of sub teams who each specialize in a single emergency response function. (See Figure 3)
- A combination or variation of the above.

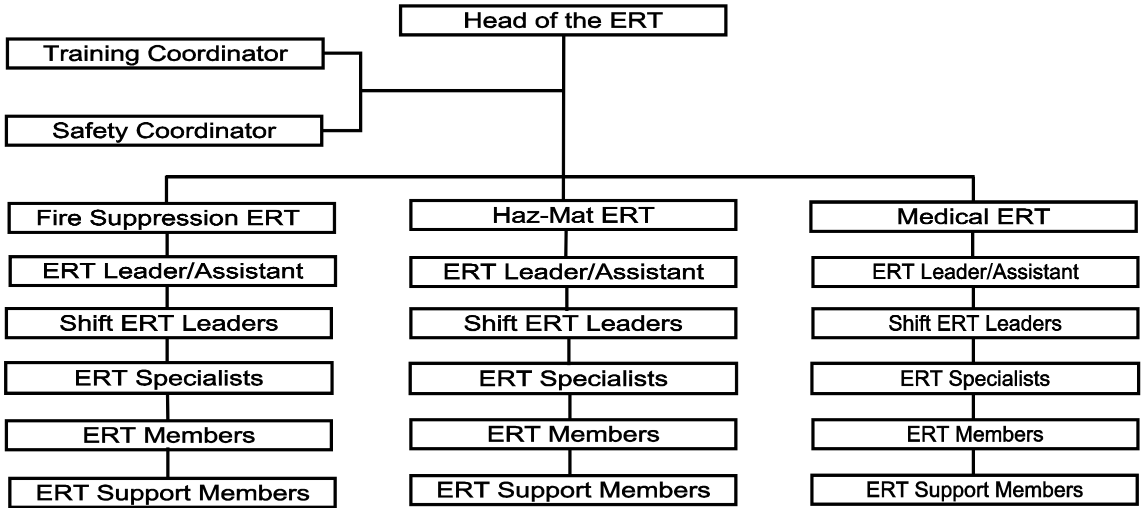

Figure 1. Flowchart For Multiple ERTs.

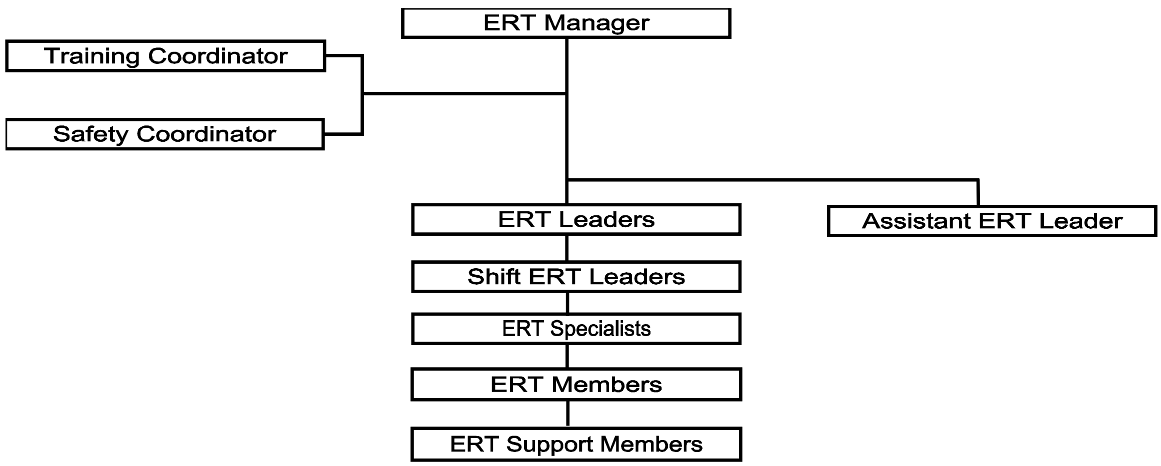

Figure 2. Flowchart For Single Team.

ERT Personnel Roles and Responsibilities

Regardless of how the facility chooses to organize its emergency response team(s), certain basic roles and responsibilities must be assigned to individuals to ensure that the emergency response team performs as intended.

Head of the ERT. This is the individual who has the ultimate responsibility for the emergency response team. He/she has the responsibility for ensuring that the team is organized in accord with organizational guidelines and standard operating procedures. While this person is not expected to be involved in the day-to-day activities of the ERT, he/she is to serve as the interface between facility management and the ERT.

ERT Safety Coordinator. This individual is responsible for overseeing and coordinating the ERT safety program and ensuring that the safety needs of ERT members are being met.

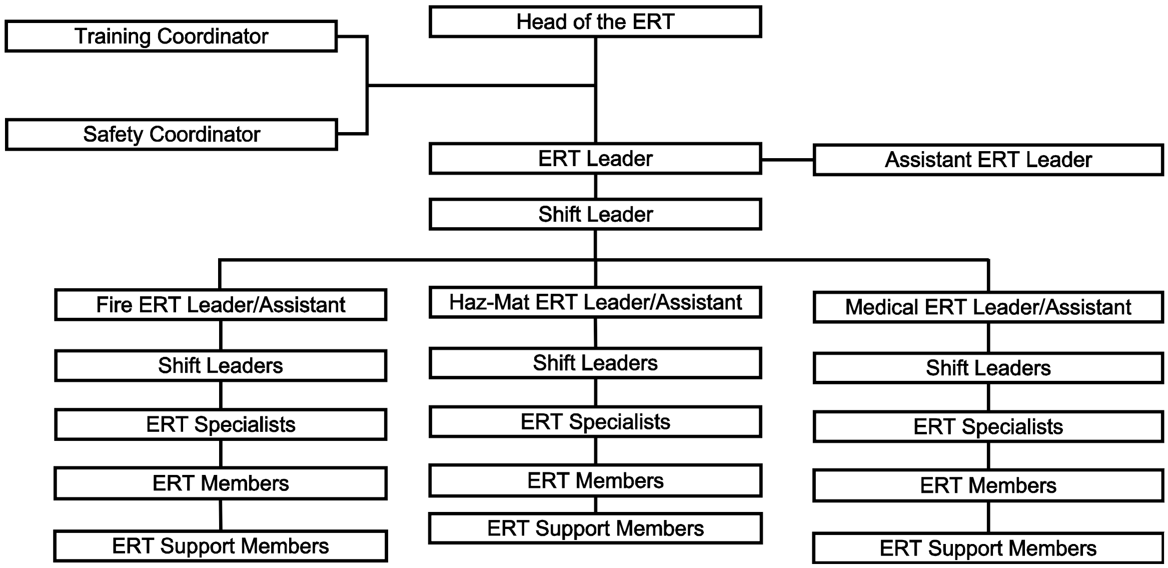

Figure 3. ERT For Single Team Made Up Of Sub-Teams**.**

ERT Training Coordinator. This individual is responsible for overseeing and coordinating the training program and ensuring that the training needs of members are being met.

ERT Leader. The ERT Leader is responsible for the day-to-day administration of the ERT and is responsible for ensuring that the basic needs and requirements of the ERT are met.

ERT Shift Leader. This individual is responsible for the operation and activities of the ERT during the specific shift to which he/she is assigned.

ERT Specialists. These individuals are designated as specialists to function as sector commanders or supervisors for specific emergency response functions to direct ERT members who have less experience or training.

ERT Members. These individuals have the responsibility for performing assigned emergency response duties at the performance level required.

ERT Support Members. These individuals are not expected to enter the warm or hot zones at the emergency scene, but are expected to perform a variety of specialized or support services from the cold zone to assist members operating in the warm and/or hot zones. ERT support members may be responsible for:

- Instituting property conservation procedures to minimize primary and secondary damage caused by the incident.
- Maintaining control of nonemergency personnel and equipment to keep access to the incident area open to emergency response personnel and equipment.
- Staging spare breathing apparatus cylinders, assisting members in replacing empty cylinders, and in some cases recharging cylinders.

Figure 4 shows a sample organizational chart for a three-shift response team.

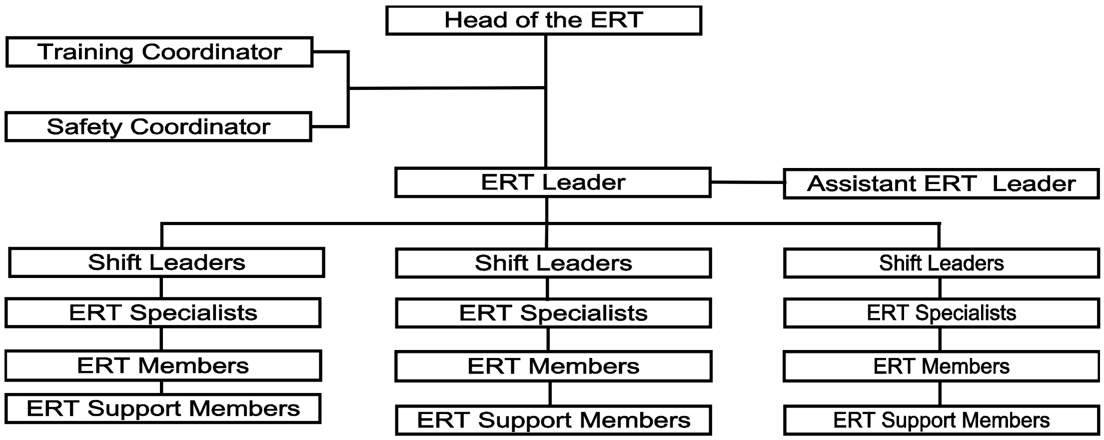

Figure 4. Three-Shift Organization.

ERT Staffing

If an emergency response team is to be effective, staffing must ensure that a sufficient number of personnel are available on each shift to allow the ERT to safely perform their tasks as intended. Tables 1 and 2 show performance requirements for Fire Brigade and Haz-Mat ERTs.

Staffing For An Incipient III Level Fire Suppression ERT

Functions and minimum personnel required:

- Fire Attack
  - Portable extinguishers: 1 member for fire attack and 1 member for back-up with charged extinguisher;
  - Low-volume handline: 2 members for fire attack and 2 members for back-up with second charged low-volume handline;
  - High-volume handline: 3 members for fire attack.
- Fire Attack Support 2 members
- Incident Command 1 member
- Support Functions:
  - Personnel Evacuation: number as needed;
  - Electrical Power Control: 1 member;
  - Utility Control: 1 member;
  - Sprinkler System Control: 1 member;
  - Fire Pump Control: 1 member or as needed;
  - Property Conservation: 4 members;
  - Incident Scene Control: as needed.

TABLE 1
Fire Brigade Performance

Level	Incipient I	Incipient II	Incipient III	Advanced Exterior	Advanced Interior	Advanced Interior /Exterior
Duties and Limitations	• Offensive and defensive action limited to only incipient interior and exterior fires	• Offensive and defensive action limited to only incipient interior and exterior fires	• Offensive and defensive action on incipient interior and exterior fires • Defensive action only from cold zone on advanced exterior fires	• Offensive and defensive action on incipient interior and exterior fires • Offensive and defensive actions on advanced exterior fires only • Defensive action on advanced interior fires	• Offensive and defensive action on incipient interior and exterior fires • Offensive and defensive actions on advanced interior fires only • Defensive action on advanced exterior fires	• Offensive and defensive action on incipient interior and exterior fires • Offensive and defensive actions on advanced interior fires • Offensive and defensive action on advanced exterior fires
Equipment Used	• Portable extinguishers	• Portable extinguishers • Low-volume handlines	• Portable extinguishers • Low-volume handlines • High-volume handlines • Master stream devices	• Portable extinguishers • Low-volume handlines • High-volume handlines • Master stream devices	• Portable extinguishers • Low-volume handlines • High-volume handlines • Master stream devices	• Portable extinguishers • Low-volume handlines • High-volume handlines • Master stream devices
Primary Function	• Incipient fires only	• Incipient fires only	• Incipient fires • Control advanced exterior fires	• Incipient fires • Advanced exterior fires	• Incipient fires • Advanced interior fires	• All fires
Actions: Offensive Defensive	• Incipient: offensive & defensive	• Incipient: offensive & defensive	• Incipient: offensive & defensive • Advanced Exterior: defensive	• Incipient - offensive & defensive • Advanced Exterior – offensive & defensive- Advanced Interior – defensive	• Incipient - offensive & defensive • Advanced Interior - offensive & defensive • Advanced Exterior - defensive	• Incipient - offensive & defensive • Advanced Interior - offensive & defensive • Advanced Exterior - offensive & defensive
Control Zones Permitted	• Cold, warm	• Cold, warm	• Incipient: cold, warm • Advanced Exterior: cold	• Incipient: cold, warm, hot • Advanced Exterior: cold, warm, hot • Advanced Interior: cold, warm	• Incipient: cold, warm, hot • Advanced Interior: cold, warm, hot • Advanced Exterior: cold, warm	• Incipient: cold, warm, hot • Advanced Interior: cold, warm, hot • Advanced Exterior: cold, warm, hot
Protective Equipment Required	• None • Normal work clothing	• None • Normal work clothing	• None • Normal work clothing	• Thermal protective clothing • SCBA	• Thermal protective clothing • SCBA	• Thermal protective clothing • SCBA
Physical Capabilities	• Normal job requirements	• Normal job requirements	• For use of high-volume handlines	• For advanced fire suppression • Use of SCBA	• For advanced fire suppression • Use of SCBA	• For advanced fire suppression • Use of SCBA
Knowledge and Skills	• Site-specific Incipient I	• Site-specific Incipient II	• Site-specific Incipient III	• Site-specific Advanced Exterior	• Site-specific Advanced Interior	• Site-specific Advanced Interior/Exterior

TABLE 2
Haz-Mat Performance

Level	First Responder – Awareness	First Responder - Operations	Haz-Mat Technician	Haz-Mat Specialist	On-Scene Incident Commander
Duties and Limitations	• May discover release or potential release • Recognize presence of Haz-Mat • Initiate emergency response • Avoid release area • Alert others to avoid release area	• Member of initial response team • Responds to release or potential release • Protect nearby persons, property, or environment from effects of release • Perform defensive operations to contain release from a safe distance to keep it from spreading and prevent exposures	• May be member of initial response team or Haz-Mat Response Team • Responds to release or potential release • Approaches point of release • Plug, patch or otherwise stop release	• May respond as member of HazMat Response Team; may be specially called • Provides support to Haz-Mat Technician • Has more focused knowledge of the material involved • Site liaison with government authorities	• Member of initial response • Responds to release or potential release • Assumes command of the incident
Primary Function	• Recognize Haz-Mat release • Initiate emergency response	• Assess incident • Protect exposures	• Stop or mitigate release	• Advise Haz-Mat Technicians	• Manage incident
Actions: Offensive/ Defensive	• Defensive only	• Defensive only	• Offensive and defensive	• Technical support • May be offensive or defensive	• Incident command
Control Zones Permitted	• Cold	• Cold, warm	• Cold, warm, hot	• Cold, warm • May be hot, if qualified	• Cold, warm • Should not be in hot zone
Protective Equipment Required	• None • Normal work clothing	• Minimum level • May be thermal protective clothing (fire brigade) • SCBA not required	• Highest level of chemical protective clothing • Level A or B with SCBA	• May be normal work clothing • May be highest level (Level A or B with SCBA)	• Minimal • May be normal work clothing
Medical & Physical Capabilities	• Normal job requirements	• Normal requirements for emergency response team	• Highest level • Work in hot zone with protective equipment	• May be normal job requirements or same as Haz-Mat Technician	• May be normal job requirements or same as for emergency response team
Knowledge and Skills Required	• Understand Haz-Mat • Recognize Haz-Mat labels and containers • Realize when emergency response is required • Initiate emergency response	First Responder-Awareness plus: • Hazard and risk assessment • Basic control, containment and/or confinement • Basic decontamination	First Responder- Operations plus: • Implementation of emergency plan • Select and use proper chemical protective clothing • Advanced control, containment, and/or confinement operations • Basic chemical terminology and behavior	• In-depth hazard and risk assessment • Select and use proper chemical protective clothing • Advanced control, containment, and/or confinement operations • Determine and implement decontamination procedures • Chemical, radiological and toxicological terminology and behavior	At least First Responder-Operations plus: • Implementing in-house incident management system • Implementing employer's emergency response plan • Implementing local emergency response plan • Safety of incident scene • Decontamination procedures

NOTES: Terminology used in Tables 1 and 2.

Advanced Exterior Fire. A fire beyond the incipient stage located outside of a structure or building.
Advanced Interior Fire. A fire beyond the incipient stage located inside a structure or building.
Control Zones. Zones established to delineate risk and limitations to personnel performing operations.
- **Hot Zone**. The control zone that surrounds the actual emergency incident. This zone represents the greatest risk to personnel.
- **Warm Zone**. The control zone surrounding the hot zone. The warm zone represents less risk to personnel than the hot zone.
- **Cold Zone**. The control zone surrounding the warm zone. Personnel in the cold zone are safe from the effects of fire.

Defensive Actions. Actions taken to keep a fire from extending to another area.
High-Volume Handline. A hoseline with nozzle attached which can flow up to 300 gpm (1140 L/min).
Incipient Fire. A fire that has not progressed beyond the point at which it can be extinguished with portable extinguishers or low-volume handlines.
Low-Volume Handline. A hoseline with nozzle attached which can flow up to 125 gpm (473 L/min).
Master Stream Device. A portable or fixed fire-fighting appliance supplied by hoselines or piping that flows in excess of 300 gpm (1140 L/min).
Offensive Actions. Actions taken to reduce the size of the fire.
SCBA. Self-contained breathing apparatus.
Thermal Protective Clothing. Helmet, boots, gloves, hood, trousers, and coats designed to protect fire brigade members in fire suppression operations.

Staffing for an Operations level Haz-Mat ERT

Functions and minimum personnel required:

- Confinement/defensive team - 2 members;
- Team Support - 4 members;
- Incident Command - 1 member;
- Support Functions:
  - Personnel Evacuation: number as needed;
  - Electrical Power Control: 1 member;
  - Utility Control: 1 member;
  - Property Conservation: 4 members;
  - Incident Scene Control: as needed.

Staffing for an advanced level Fire Suppression ERT

Functions and minimum personnel required:

- Fire Attack
  - Two low-volume handline teams: 4 members for fire attack;
  - Back-up team: 2 members with charged low-volume handline.
- Fire Attack Support 4 members;
- Incident Command 1 member;
- Support Functions:
  - Personnel Evacuation: number as needed;
  - Electrical Power Control: 1 member;
  - Utility Control: 1 member;
  - Sprinkler System Control: 1 member;
  - Fire Pump Control: 1 member or as needed;
  - Property Conservation: 4 members;
  - Incident Scene Control: as needed;
  - Breathing Apparatus Support: 1 member.

Staffing for a Hazardous Material Response Team

Functions and minimum personnel required:

- Entry Team: 2 members;
- Back-up team: 2 members;
- Secondary Entry Team: 2 members;
- Entry Team Support: 2 members;
- General Support Personnel: 4 members;
- Incident Command: 1 member;
- Decontamination: 4 members;
- Support Functions:
  - Breathing Apparatus Support: 1 member;
  - Personnel Evacuation: number as needed;
  - Electrical Power Control: 1 member;
  - Utility Control: 1 member;
  - Sprinkler System Control: 1 member;
  - Fire Pump Control: 1 member or as needed;
  - Property Conservation: 4 members;
  - Incident Scene Control: as needed;

Emergency response team forms for keeping records of drills, individual training, and annual training may be found in PRC.1.7.0.2.A.

Incident Management Systems

An incident management system is the management system or command structure used during emergency operations to clearly identify who is in command of the incident and what roles and responsibilities are assigned to various personnel. The purpose of using an incident management system is to provide structure and coordination to the management of emergency operations to effectively and efficiently manage the incident and to provide for the safety and health of personnel involved in these operations.

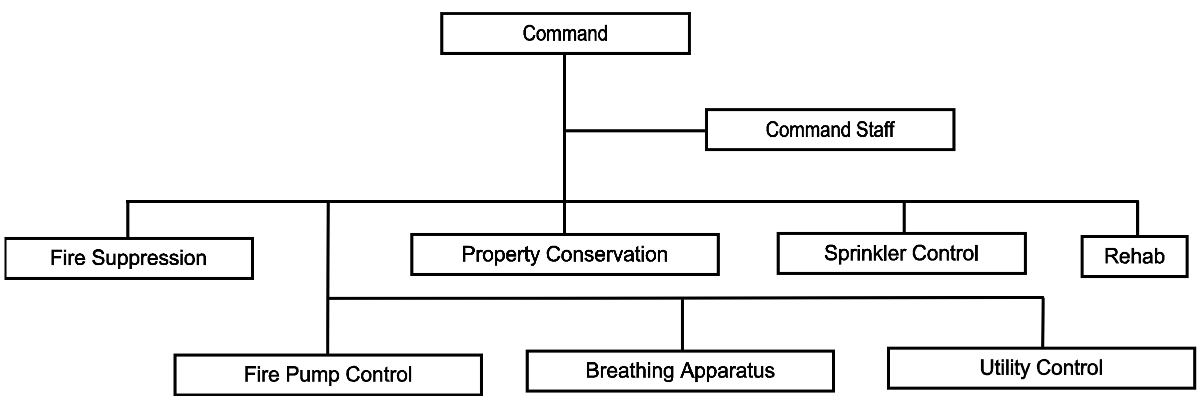

Figure 5. Sample Incident Command Model For A Fire Incident.

One of the most popular incident management systems is the Incident Command System (ICS). See Figure 5. This model and various community-specific adaptations of it have been adopted by most emergency response organizations in the United States. In the ICS, the first emergency responder at the scene establishes command of the incident. This person becomes known as the Incident Commander and is charged with the responsibility of managing all operations at the scene of the emergency.

Initially, the Incident Commander defines the control zones and establishes a command post located in the cold zone. As additional personnel arrive, the Incident Commander establishes the sectors needed to manage the incident. Command of the incident can be transferred by the Incident Commander once he/she has briefed the individual who is to assume command.

The incident management system allows for the escalation of the incident management process without requiring any major change in what is already being done. In the event of needed escalation because of the complexity of the emergency management operations, the command post and/or Incident Command may be relocated to a command vehicle or an emergency operations center that is staffed by the key staff members required for advising the Incident Commander. When this occurs, the original command post may be designated “Operations” or some other functional name.

Intermediate levels of command report to the Incident Command and are responsible for managing sectors, branches or sections. Sector commanders are assigned responsibility for supervising certain geographical portions of the operations or for supervising specific functions. They are identified, not by their title or by their normal radio call signs, but rather are identified by their sector identifiers. Once at the scene of the emergency, people assume titles that are descriptive of their location or incident command role with regard to the specific incident.

The in-house emergency plan allows the Head of the ERT to be acting incident commander until relieved by the responsible individual from the public sector. In some rare cases the Head of the ERT may continue to serve as incident commander. These transition of authority is a vital part of the pre-emergency planning effort.

Objectives of an incident management system

An incident management system is intended to achieve a number objectives. A properly structured IMS:

- Assigns overall command authority and responsibility to the individual designed as the Incident Commander;
- Provides structured authority and responsibilities for the various command levels and positions;
- Provides a structured hierarchical reporting system with a manageable span of control at each level;
- Is used to coordinate all incident scene operations;
- Ensures that everyone involved in operations at the incident scene has a relationship to the incident management system that includes reporting and receiving assignments in a standard manner;
- Is documented in written standard operating procedures;
- Is simple and familiar and is used routinely at all incidents;
- Bases supervisory assignments on functions, locations, or both;
- Establishes communications protocols to match the IMS;
- Provides for a structured system for the response of resources and for summoning additional resources;
- Provides for expansion, escalation, transfer, and transition of command roles and responsibilities;
- Requires safety and health of emergency response personnel to be managed as major strategic and operational priorities in all cases;
- Employs standard tactical approaches that are applied to different situations and circumstances;
- Leads to the eventual termination of the incident.

Guidelines for an incident management system

The following guidelines are intended to provide a foundation for the development or adoption of an incident management system.

An effective incident management system should:

- Define how incident command is established. An individual is in charge from arrival until termination of the incident.
- Define circumstances and procedures for transferring incident command.
- Define the risk management policy.
- Be used on all emergencies, training activities, and drills.
- Be based on written procedures to define IMS duties.
- Include written procedures for communications that:
    - Utilize standard terms.
    - Utilize easily understood text.
    - Establish a procedure to assign priority to emergency (mayday) messages.
- Identify standard emergency response supervisory functions.
- Support escalation of any incident from small to large or routine to unusual without necessitating major changes in what is being done.
- Encompass interagency coordination:
    - Integrated IMS - with other agencies;
    - Establish a “unified command” where multiple agencies are involved;
    - Coordinate operations with other agencies.
- Include procedures for staging - where resources are assembled.
- Establish a command structure for use in all incidents.
    - Identify a series of supervisory levels. These levels depend on scale and complexity of the incident.
    - Establish modular elements should be - use only those elements needed for the incident.
    - Establish a routine process for escalation or downsizing command structure.
    - Incident Commander decides what is needed for each incident.
- Define standard supervisory assignments such as role, authority and responsibilities by function or by location.
- Establish a personnel accountability system.
    - Account for all personnel who respond to the incident.
    - Account for all personnel who enter the hot and warm zones.
    - Make all supervisors responsible for accounting for their team members.
    - Account for location and function of all teams at all times.
    - Provide a control point to warm and hot zone entry.
    - Control and record entry of personnel.
- Establish a procedure for the emergency retreat/evacuation of the hot zone or incident scene when personnel may be in imminent danger.
- Establish a method for alerting personnel in danger area to retreat.
- Establish a procedure for setting up a rehabilitation sector (Rehab) for personnel at each emergency to provide:
    - Medical evaluation and treatment;
    - Food and fluid replenishment;

- Relief from extreme weather conditions.

EMERGENCY RESPONSE TEAM FORMS

OVERVIEW FORMS PACKET
(See PRC.1.7.0.2 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

INDIVIDUAL TRAINING RECORD

NAME ______________________ POSITION ____________ SHIFT __________

DATE	SUBJECT	HOURS		INSTRUCTING AGENCY	EXAMS			COMMENTS
		ACADEMIC	PRACTICAL		WRITTEN	ORAL	PRACTICAL	

Printed in USA
PRC.1.7.0.2

OVERVIEW FORMS PACKET
(See PRC.1.7.0.2 in the OVERVIEW Manual)
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REPORT OF FIRE BRIGADE DRILL

DEPARTMENT: ______________________________

SHIFT: ______________________________

TRAINER: ______________________________

FIRE BRIGADE MET ON: ______________________________

FIRE BRIGADE MEMBERS PRESENT:

______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________

FIRE BRIGADE MEMBERS PRESENT:

____
____
____
____
____
____

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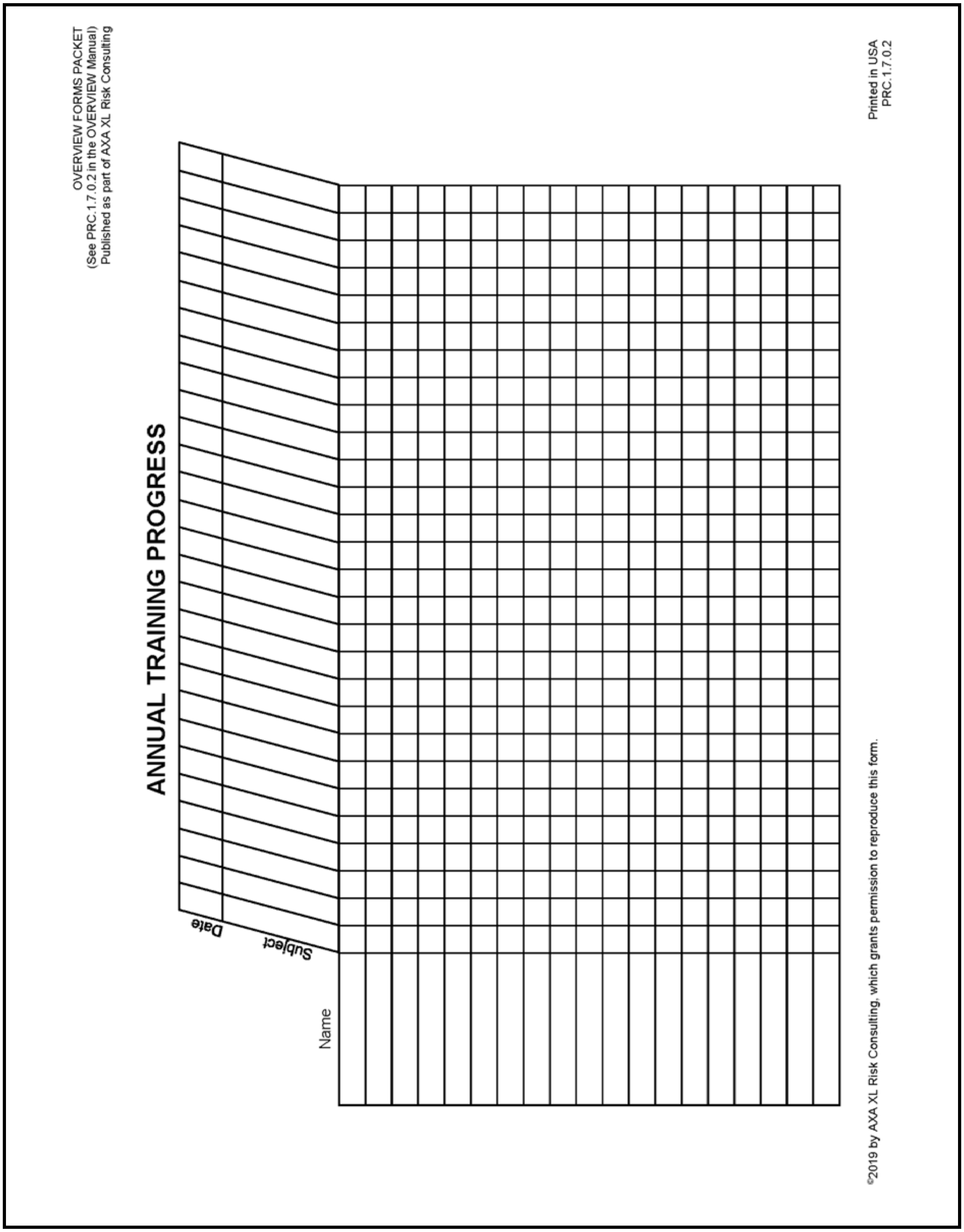
PRC.1.7.0.2



OVERVIEW FORMS PACKET
(See PRC.1.7.0.2 in the OVERVIEW Manual)
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ANNUAL TRAINING PROGRESS

Date

Subject

Name

PRE-EMERGENCY PLANNING RESOURCES

INTRODUCTION

Throughout the world, various governmental bodies as well as consensus standards-making organizations and trade associations have promulgated numerous laws, regulations, standards and recommended practices related to pre-emergency planning. A list of nongovernmental organizations that provide pre-emergency planning resources can be found in Table 1.

TABLE 1
Organizations That Provide Training Resources

	TEXT BOOKS	PERIODICALS	VIDEOS/DVDs	ON-SITE TRAINING	ON-LINE TRAINING
IFSTA	X	X	X		X
AXA XL Risk Consulting		X		X	
ISFSI	X	X	X		X
NAFED	X	X	X		X
NFPA	X	X	X	X	X

IFSTA 930 N. Willis, Stillwater, Oklahoma 74074
AXA XL Risk Consulting 100 Constitution Plaza, Hartford, CT 06103
ISFSI 14001C Saint Germain Dr. Suite 128, Centreville, Virginia 20121
NAFED 180 N. Wabash Avenue, Suite 401, Chicago, IL 60601
NFPA 1 Batterymarch Park, Quincy, MA 02269

PRE-EMERGENCY PLANNING RESOURCES

In the United States, the most commonly referenced documents related to pre-emergency planning are:

Title 29 *Code of Federal Regulations,* Part 1910, Section 38 (29 CFR 1910.38) This part of the Occupational Health and Safety Administration's (OSHA) regulations requires businesses with more than 10 employees to develop and maintain: 1) an Emergency Action Plan and 2) a Fire Prevention Plan.

The Emergency Action Plan must address:

- Emergency escape procedures and routes;
- Procedures for employees who remain behind to operate critical equipment;
- Procedures to account for employees after evacuation;
- Rescue and medical duties;
- Procedures for reporting fires and other emergencies;
- Names or titles of people who can be contacted for further explanation of the plan.

The Fire Prevention Plan must address:

- Major fire hazards in the workplace;
- Educating employees about the hazards in the workplace;
- Methods of controlling fire hazards;
- Names or titles of people responsible for maintaining protective systems;
- Names or titles of people responsible for controlling fuels that could be a hazard.

Title III of The Superfund Amendments and Reauthorization Act 1986 (SARA Title III). This law mandates appointment of a Local Emergency Response Committee and the development of a comprehensive, Local Emergency Response Plan. The plan must be reviewed and revised annually, and must include:

- The identification of specific sites and transportation corridors in which extremely hazardous materials are stored, used or transported;
- Emergency-response procedures;
- Designation of a community coordinator and facility coordinator to implement the emergency plan;
- Emergency notification procedures;
- Procedures for determining the occurrence of a chemical release and the probable area and population that will be affected;
- Description of community and industrial emergency-response equipment ad resources, and the identity of personnel responsible for them;
- Evacuation plans;
- Method and schedule for conducting emergency-response plan exercises.

NFPA 1600, *Recommended Practice for Disaster Management*. This document recommends minimum criteria for disaster management for the private and public sectors in the development of a program for effective disaster preparedness, response, mitigation and recovery.

NFPA 1620, *Recommended Practice for Pre-Incident Planning*. This consensus document spells out the recommended practices for pre-incident planning relative to fire and like emergencies in all occupancies.

EMERGENCY RESPONSE RESOURCES

The on-site emergency response functions needed in most industrial/business facilities generally fall into four basic areas:

- Fire Suppression
- Hazardous Materials
- Medical Emergencies
- Confined Space or other Specialized Rescue

In evaluating a facility's need for these functions, relevant standards and regulations should be reviewed. The following is a brief list of pertinent standards and regulations related to emergency response.

Title 29 of the *Code of Federal Regulations,* Part 1910, Section 156 (Fire Brigades). This part of the OSHA regulations was promulgated in 1980 and specifies OSHA's requirements for industrial fire brigades.

NFPA 600, *Standard on Industrial Fire Brigades*. This document closely parallels OSHA's requirements and actually expands and clarifies the work done by OSHA in 1910.156 with regard to industrial fire brigades.

Title 29 of the *Code of Federal Regulations,* Part 1910, Section 120, [HAZWOPER]. OSHA requires that personnel who function as emergency responders to incidents involving hazardous materials (HazMat) have minimum levels of training. The levels identified are:

- First Responder - Awareness
- First Responder - Operations
- Hazardous Materials Technician
- Hazardous Materials Specialist
- On Scene Incident Commander

NFPA 472*, Professional Competence of Responders to Hazardous Materials Incidents*. The performance requirements of this consensus standard closely parallel and further clarify those requirements in OSHA 1910.120.

Title 29 of the *Code of' Federal Regulations,* Part 1910, Section 151, (Medical Services and First Aid). OSHA states: "If a medical facility is not located in proximity to the workplace, there shall be a person or persons on-site with adequate first-aid training. First aid supplies approved by a consulting physician shall be available on-site. If there is a potential of corrosive materials on-site, suitable facilities shall be available for drenching of eyes and skin."

Title 29 of the *Code of Federal Regulations,* Part 1910, Section 146,(d)(9) (29 CFR 1910.146 (d)(9)). OSHA explains its requirements regarding rescue from permit-required confined spaces. This requires employers to "develop and implement procedures for summoning rescue and emergency services, for rescuing entrants from permit-required confined spaces, for providing necessary emergency services to rescue employees, and for preventing unauthorized personnel from attempting a rescue."

OSHA requires that each employer who requires employees to enter permit required confined spaces to perform rescue services to ensure that each member of the rescue service:

- Is provided with, and is trained to use the personal protective equipment and rescue equipment necessary for making rescues from permit-required spaces;
- Is trained to perform assigned rescue duties in addition to the training required for confined space entrants;
- Practices a simulated rescue of a simulated victim from a confined space at least once per year;

- Is trained in basic first-aid and in cardiopulmonary resuscitation (CPR).

When an employer elects to have outside rescue services perform confined space rescue, OSHA requires the host employer to:

- Inform the rescue service of the hazards they may confront;
- Provide the rescue service with access to all permit-required confined spaces from which rescue may be necessary, so that the rescue service can develop appropriate rescue plans and practice rescue operations.

The Emergency Team must remember that regardless of whether the employer's personnel or outside rescue services are to perform confined space rescue, OSHA places all responsibility for the rescue operations on the employer.

INCIDENT MANAGEMENT SYSTEMS RESOURCES

The following documents require that can be utilized for managing emergencies:

- NFPA 1600, Recommended Practice on Disaster Management
- OSHA 1910.120(q)(3) HAZWOPER
- NFPA 600, Standard on Industrial Fire Brigades
- NFPA 471, Recommended Practice for Responding to Hazardous Materials Incidents.

Aids In Preparing The Written Document

Put The Plan On Paper

The final product of the Pre-Emergency Planning efforts is the written plan. See PRC.1.7.0. This is the document that takes all of the results of the planning work and puts it in a format that allows it to be easily used on a day-to-day basis by anyone involved in emergency response and recovery operations.

To be effective, emergency plans must be "user friendly" and written for ease of use and understanding by end users. To achieve this, we offer the following tips:

Write For Understanding

- Write for the reader, not the writer.
- Keep it simple.
- Understanding and clarity is critical.
- Use easily understood text and avoid technical jargon.
  - Avoid abbreviations and acronyms unless they are clearly defined.
  - Long words and long sentences reduce clarity and increase the likelihood of misinterpretation by the reader.
- Use drawings and charts wherever possible.
- Provide a glossary of terms used within the plan.

Format The Plan

- Use a binding system, such as a loose leaf binder, that allows for ease of revisions and/or additions.
- Divide the plan into sections.
- Number each section.
- Number each page with a section and page number so that any page can be updated without having to revise the entire section.

- Date each page, and show the “effective date,” the “date of revision” and the “date which the revision replaces.”
- Select a format that is functional and easy to navigate.
- Remember that a emergency plan:
    - Is a dynamic working document;
    - Will never be complete - it will always be in a state the revision.

RENTED EQUIPMENT

INTRODUCTION

Facilities rent boilers, compressors, refrigeration units or other pressure vessels for various reasons. A standby or emergency source of steam, compressed air or refrigeration may be needed to:

- Restore production if the equipment fails that normally supplies the services.
- Maintain a controlled environment during an emergency for goods in storage or process.
- Prevent water or water-based fluid systems from freezing during abnormally cold conditions or service outages.
- Supplement steam or compressed air supplies when seasonal or other conditions place abnormally high demands on the supplies.
- Replace steam or compressed air systems during scheduled maintenance of the equipment that normally supplies the steam or compressed air.
- Provide temporary services during construction or new process installation.

Personnel at a facility often have no information concerning how rental equipment was previously used. They certainly have no control over its maintenance history. Rental boilers sometimes arrive at job sites heavily scaled from being operated with unsatisfactory feed water. Air tanks have arrived half filled with water. Safety and relief valves are occasionally wired shut. It does no good to bring in rental equipment to mitigate a production loss if the rental equipment is going to promptly fail or cause more problems. Therefore, the equipment must be thoroughly inspected before it is installed, if possible, and certainly before it is placed into service.

Concerns that may apply to rented equipment are:

- Past equipment maintenance may not meet established standards.
- Loss control systems may be challenged by temporary connections.
- Jurisdictional regulations must receive attention.

POSITION

Facilities which may use rental equipment should include appropriate procedures in their pre-emergency plans. Pre-emergency plans are described in Section 7 of *OVERVIEW*.

Even when a pre-emergency plan is in place, rental equipment often must be installed and used under adverse circumstances. Although all parties concerned may be focused on restoring production or preventing further product or equipment deterioration, loss prevention and control must not be compromised.

Electrical installation of any piece of equipment should comply with NFPA 70 or equivalent electrical code. Most rental boilers are oil or gas fired; most rental air compressors are diesel or gasoline engine driven. Fuel handling and burner arrangements should include precautions to prevent fire and explosion hazards. Install the fuel supply for the equipment in accordance with NFPA 31 or NFPA 54 as applicable. The authority having jurisdiction should be consulted.

The following recommendations also apply to any rental equipment installation:

- Locate the equipment where it will not block personnel or emergency vehicle access to any part of the facility or to fire protection equipment or utility service disconnects.
- If temporary shelter is used, ensure that the shelter can withstand anticipated wind or snow loadings.
- Provide fire extinguishers, hose connections and other equipment needed to protect rental equipment and combustible temporary shelters from fire.
- Monitor and maintain rental equipment to the same standard as the equipment being replaced.

When a rental boiler is to be installed, the following recommendations apply:

- Arrange for an internal and external inspection of any rental boiler before placing it in service. The inspection should be performed by an authorized inspector in accordance with the rules of the jurisdiction.
- Install in advance the necessary valves and piping for connecting steam, feedwater, fuel and electricity to the boiler. This will speed and simplify connecting a rental boiler. Steam connections are particularly difficult to install quickly.
- Ensure fuel supply arrangements do not present a fire hazard. Review the situation with the fire brigade chief, the local fire department and the authority having jurisdiction as appropriate.
- Ensure all steam, feedwater, electrical, and other connections are made safely and in accordance with local codes and jurisdictional rules. Test flame failure, low water and other control circuits before firing the boiler.
- Do not operate any boiler having deficient safety controls or protective devices.
- Obtain a certificate of operation from the jurisdiction. Most jurisdictional certificates only cover a boiler at a specific location. A boiler with a new owner or location must be recertified. Some jurisdictions require an installation certificate, particularly if the boiler is brought in from another jurisdiction.
- Ensure the boiler will be operated by properly qualified and, if necessary, licensed operators, whether or not they are employees of the insured, the rental organization or a third party.
- Test safety valves before placing the boiler in service and test the valves periodically as necessary.
- Test the low water protective devices.
- Operate and maintain the boiler in accordance with PRC.7.1.0.5.

Consult the local AXA XL Risk Consulting's representative for assistance if necessary.

Rented pressure vessels are usually associated with air compressing and refrigeration equipment. When such equipment is installed, the following recommendations apply:

- Install in advance the piping for connecting refrigerant, brine, chilled water and condenser water to a rented refrigeration machine. In most cases, rented air compressors only require a flexible hose connection to the air system.
- Inspect pressure vessels before placing them in service. If there are signs of corrosion, weakness, or any other adverse condition, conduct an ultrasonic test and, if possible, an internal inspection.
- Ensure all compressed air, electrical, and other connections are made safely and in accordance with local codes and jurisdictional regulations.

- Ensure fuel supply arrangements do not present a fire hazard. Review the situation with the fire brigade chief, the local fire department and the authority having jurisdiction as appropriate.
- Obtain a certificate of operation from the jurisdiction. Most jurisdictional certificates only cover a vessel at a specific location. A vessel with a new owner or location must be recertified. Some jurisdictions require an installation certificate, particularly if the vessel is brought in from another jurisdiction.
- Ensure the equipment will be operated by properly qualified and, if necessary, licensed operators, whether or not they are employees of the insured, the rental organization or a third party.
- Test safety valves before placing vessels in service and test periodically as necessary.

Consult the local AXA XL Risk Consulting representative for assistance if necessary.

DISCUSSION

Rental equipment may be put in service immediately or connected for standby in case other equipment fails. Rented boilers and pressure vessels present the same hazards as permanently installed equipment. These include:

- Overpressure and rupture.
- Overheating and igniting flammable surroundings.
- Uncontrolled combustion or fuel explosion inside or outside the object.
- Business interruption and consequential damage in case of failure.

Since use of rented equipment may involve temporary connections and less than ideal equipment, careful attention to inspection and operation of the equipment is necessary.

Boilers in most parts of the country require a certificate of operation. Many states require similar certificates for pressure vessels and a few require certificates for refrigeration systems. An authorized inspector must inspect equipment before a certificate can be issued. Also, in many jurisdictions, the authorized inspector must approve, and possibly witness, the installation of pressure piping. An authorized inspector can advise about safe equipment installation and operation.

Jurisdictional certification, when required, of vessels on rented air compressors or refrigeration systems involve procedures similar to those outlined above for boilers, except internal inspections are not usually required.

HAZARDOUS MATERIALS EVALUATION

INTRODUCTION

Most facilities handle some hazardous chemical substances. Even offices have materials like duplicating fluids or powders and cleaning supplies that have not traditionally been considered hazardous materials. It is important to have a program for identifying all hazardous materials, both common and exotic, and making employees aware of the hazards and the necessary precautions.

Chemical substances have various hazardous properties, such as flammability, radioactivity, toxicity and reactivity. The properties of a particular substance must be determined and evaluated before proper precautions can be established. In addition, government regulations at both the federal and state level affect the handling of many substances.

POSITION

Establish a hazardous materials evaluation program that incorporates:

- Assigning responsibility for determining the physical properties of each chemical substance handled at the facility.
- Evaluating the hazardous properties and determination of the relative hazard levels of each substance and any necessary handling precautions.
- Distributing hazard information and material handling precautions to the employees, the emergency response organization, the local fire department and others who may respond to an emergency.
- Establishing methods for developing process hazards evaluations. (See *OVERVIEW*, Section 13, Hazard Identification and Evaluation [PRC.1.13.0].)
- Determining what state and federal regulations affect the handling, storage, use and disposal of materials handled.

DISCUSSION

Traditionally, materials that were highly flammable, reactive or toxic have been recognized as hazardous materials. However, many materials that were not previously recognized as hazardous are now considered hazardous due to their long-term effects on health or the environment. The treatment of asbestos as a hazardous material is a prime example of this trend.

Public awareness of material properties has also increased. As a result, hazardous material evaluation has become important in all facilities. Government authorities in the U.S. have determined that the public and workers have a right to know about and be protected from hazardous materials.

Hazardous materials evaluation programs will vary widely in scope. All such programs must evaluate materials presently used or stored on site. The programs must also evaluate all new materials. This makes Management of Change (MOC) essential to good hazardous materials evaluation programs. See the second chapter of *OVERVIEW* (PRC.1.0.2) for further details. Facilities should be able to obtain necessary data about a substance from chemical manufacturers' safety data sheets or from other published sources.

Hazard information and physical property data for new materials or chemical substances generated by processes at a facility may not be available. In such cases, tests may have to be performed to measure the properties which are necessary for proper materials evaluation. Standardized test procedures should be followed so that results may be compared with materials whose properties are known.

When assembling hazardous materials information for a facility, start by reviewing purchasing records. This review will generally identify most of the materials brought into the facility. There may be some items, however, that were acquired without going through the purchasing department. A discussion with supervisors about the materials they handle is needed, and should include a review of the substances generated by the processes.

In addition, the person responsible for the program should review the sales department's records. This will provide a list of the finished goods the facility produces. Items in the purchasing and sales records form the basis of a literature search for materials' properties. It is important that this information be assembled and organized for rapid retrieval under emergency conditions because an accident may create an immediate need for facts. One way to record such data is on a Safety Data Sheet (often referred to as an "SDS"). Several versions of Safety Data Sheets have been developed for various purposes. In the U.S. the Occupational Safety and Health Administration (OSHA) requires SDS for all materials used at a facility. OSHA specifies the information that must be included in an SDS but not the exact format. Much of the data required is similar to and available from the manufacturers' safety data sheets mentioned above. The Safety Data Sheets can be readily filed, duplicated and disseminated to those persons requiring the information. However, if the facility involved is a chemical manufacturing facility or is operating complex chemical processes, more detailed technical information may be required than is normally included on a Safety Data Sheet.

It is also important to include outside contractors in hazardous materials evaluation programs, as it would otherwise be impossible to identify, evaluate or respond to hazardous materials brought on site by them.

When evaluating substances, one must decide which properties should be investigated. Testing to determine the properties of a material falls into five major categories: general information; flammability; radioactivity; toxicity; and reactivity.

Appendix A lists properties and tests. This list is not all-inclusive since special testing for unusual properties may be needed.

Once properties have been determined, evaluation may be relatively simple or complex. In some cases, the material is an article of commerce for which the relative hazard as determined by one of several systems has been published.

In addition to providing the information for use in process hazard evaluation, the information can be disseminated to other employees in several ways. One is to post identifying signs wherever the material is present using a system such as that described in NFPA 704.

Piping in the facility may be color-coded to identify the contents or the contents' hazards. Color coding will also reduce the potential for operations and maintenance errors. Color schemes can be found in ANSI A13.1, CFR29 Section 1910.144, and ISO R508.

Shipping containers and cylinders carrying hazardous materials will be marked with symbols mandated by the Department of Transportation or other government agencies. The meaning and limitations of these symbols should be explained to, and understood by, employees.

Because labels and signs are reminders of hazards and proper procedures, they must be regularly reviewed as a part of the employee training program. (See *OVERVIEW*, Section 4, Employee Training [PRC.1.4.0].)

LIST OF PROPERTIES OF MATERIALS AND TESTS

The following are properties and tests that are commonly used when evaluating the degree of hazard posed by a material. This list is not all-inclusive as special tests will be needed to determine unusual properties.

General Information

Corrosivity
Purity
Formula
Quantity of Material
Color
Hygroscopicity
Molecular Weight
Appearance
Odor
Physical State
Solubility
Viscosity

Flammability

Flash Point
Fire Point
Flammable Limits
Specific Gravity
Vapor Density
Vapor Pressure
Heat of Vaporization
Boiling Point
Ignition Temperature
Autoignition Temperature
Spontaneous Heating
Dielectric Constant
Melting Point
Flow Point
Percent Volatiles
Decomposition Products
Heat of Fusion

Radioactivity

Alpha Exposures
Beta Exposures
Gamma Exposures
Neutron Exposures

Reactivity

Differential Thermal Analysis
Impact Test
Thermal Stability
Detonation with Blasting Cap
Drop Weight Test
Thermal Decomposition Test
Lead Block Test
Influence Test
Self-Acceleration Decomposition Temperature
Card Gap Test
Thermal Stability
Critical Diameter
Limiting Oxygen Value
Hazardous Decomposition Products
Incompatibility
Self-Reactivity
Instability
Shock/Friction Sensitivity
Decomposition Temperature
Specific Heat
Gas Evolution
Adiabatic Temperature Rise
Heat of Reaction

Toxicity

Threshold Limit Values (TLV)
Time Weighted Average Exposures (TWA)
Lethal Concentration (LC_{50} Values)
Lethal Dose (LD_{50} Values)
Lowest Published Lethal Concentration (LCLo)
Lowest Published Lethal Dose (LDLo)
Lowest Published Toxic Concentration (TCLo)
Lowest Published Toxic Dose (TDLo)
Chronic Effects
Acute Effects
Cumulative Effects
Carcinogenicity
Mutagenicity
Teratogenicity
Neoplastic Effects

CUTTING, WELDING AND OTHER HOT WORK

INTRODUCTION

Welding, brazing, flame or plasma cutting, hot riveting, grinding, chipping, sweating, soldering and other activities that produce sparks or use flame are important tools of modern industry. The portability of some of the equipment and its careless use outside of areas specifically designed for its safe use, such as maintenance shops or manufacturing areas designated as hot work areas, can increase the likelihood of fire that will destroy facilities and interrupt production. To make sure portable cutting, welding and other hot work for maintenance, construction or modifications is done safely, a permit system should be used.

POSITION

Design production areas and specifically designated sections of the maintenance shop where hot work is routinely done to minimize the hazards hot work operations present. (See PRC.1.13.0.)

To properly control the hazards of portable hot work equipment, establish a comprehensive hot work control program that includes the following elements:

- Assigning responsibility for the program;
- Establishing and implementing a permit system;
- Providing the necessary safety equipment;
- Providing the personnel necessary to implement the safety regulations.

DISCUSSION

While industrial cutting, welding and other hot work are common and useful production, construction, modification and maintenance methods, they introduce hazards that must be controlled.

The principal hazard associated with portable hot work equipment is the introduction of unauthorized ignition sources into random areas of the facility. Temperatures sufficient to start fires or ignite explosive materials may come from a number of sources including:

- The open flame of a torch;
- Metals being cut or welded;
- Molten slag or metal that flows from the work;
- Sparks that fly from the work;
- An improperly handled soldering iron or propane torch;

- Dropped hot rivets;
- Improperly applied electric arc welding grounding clamps.

In 1953, improper cutting or welding resulted in a fire and subsequent property damage in excess of $325 million (2015 values). The fire began when sparks from cutting ignited residue in an uncovered portion of a very long drip pan located approximately 11 ft (3.35 m) above the floor in an unsprinklered area. Until then, workmen had covered the portion of the drip pan where they were working with a tarpaulin which they repositioned as they moved. In this case, they neglected to move the tarpaulin and sparks ignited the uncovered residue. The fire was spotted by the fire watch, who tried unsuccessfully to extinguish it from floor level with a portable extinguisher. Other employees also used portable extinguishers, but no single extinguisher was adequate to put out the fire.

During the next 10 min, the fire intensified and molten asphalt began to seep through the roof deck joints into the building below.

After the public fire department arrived, firefighters discovered that their hose streams were inadequate to reach and extinguish the blaze. The fire developed so rapidly that it traveled the entire 1800 ft (549 m) length of the building in an hour and a quarter. The 1,575,000 ft² (146,475 m²) plant was almost totally destroyed.

To prevent losses like this, management should appoint a responsible person to closely supervise the use of all cutting, welding and other hot work equipment. Employees and outside contractors should secure a written permit from this supervisor before beginning hot work. Such a permit system will help impress upon the persons doing and overseeing the work that proper procedures and controls are very important.

To aid its clients, AXA XL Risk Consulting has developed a permit program. (See PRC.1.9.0.A.) A cutting, welding or hot work permit should be filled out each time hot work is conducted and should be kept available at the job site.

LOSS PREVENTION AND CONTROL FOR CUTTING, WELDING, HOT WORK OPERATIONS

INTRODUCTION

The essence of a good hot work permit program is as follows:

- The program should be supervised by a qualified individual such as a welding superintendent, maintenance foreman, fire chief, plant engineer or master mechanic.
- This individual should examine the location of any proposed work, insist on other methods if conditions cannot be made safe and make sure that the precautions listed on the permit are taken.
- The individual should then sign a permit (see illustration) and give it to the welder. No work should be allowed without a properly signed permit at the job site.
- If work at a location continues for more than one shift, a new permit should be issued for each shift.

Welders and other personnel who might be using hot work equipment should be instructed in precautions to be taken and a list of these precautions should be posted in the maintenance shop, on the equipment and on the permit. These precautions should include:

- Performing hot work in a properly arranged maintenance shop except when the job cannot be moved to it.
- Using only equipment that is in good condition. Valves, regulators, hoses and torches should be thoroughly checked.
- Refraining from using welding, cutting or other hot work equipment in a building where sprinklers are out of service.
- Moving combustibles at least 35 ft (11 m) from hot work operations. If combustibles cannot be moved, they must be protected by metal guards or by flameproofed curtains or covers rather than ordinary tarpaulins.
- Prohibiting hot work in or on vessels containing flammable or combustible materials, including residues, until they have been completely cleaned and purged or inerted.
- Checking the atmosphere for combustible gases or vapors where necessary, using reliable detection equipment. If there is a chance of a gas vapor release during hot work operations, continuous-duty portable combustible gas detectors should be used to constantly monitor the area.
- Prohibiting hot work until surrounding floors have been swept clean and, if combustible, wet down.
- Prohibiting hot work until all wall and floor openings within 35 ft (11 m) of the operations have been tightly covered or otherwise protected with metal guards or flameproofed tarpaulins.
- Prohibiting hot work until responsible persons have been assigned to watch for dangerous sparks in the area and on floors above and below.
- Securing gas cutting and welding cylinders so they will not be upset or damaged and replacing protective caps on all cylinders not actually in use.
- Carefully connecting the ground clamp when using electrical arc welding equipment. Since an improperly made ground can be a source of ignition, the ground clamp should be connected as close to the work as possible so that it may be easily observed.

- Arranging for a continuous fire watch to patrol of the area, including floors above and below, during work, any break in the work such as lunch or rest periods, and for at least one (1) hour after the work has been completed. Provide three (3) hours of periodic random patrols (not more that 15 minutes apart) through the work area after the fire watch has been released, for a total of 4 hours after work has been completed. If the hot work ends near the time of a shift change, make arrangements for the patrols to continue into the next shift.
- Using portable stands to elevate welding hose or cable off floor areas where it can be easily damaged.

The cutting, welding and hot work permit and the warning tag are both printed on canary stock.

LOSS PREVENTION AUDIT

INTRODUCTION

Even though employees can provide informal feedback on management programs for loss prevention and control, management should have a formal mechanism to evaluate the effectiveness of the other *OVERVIEW* programs. The loss prevention audit provides this mechanism.

AXA XL Risk Consulting's representatives consult with management by means of periodic surveys of customers facilities, but they are obviously not in a position to provide the constant monitoring that an on-site inspector can provide. However, with assistance from AXA XL Risk Consulting, management can train selected employees as in-house inspectors to monitor the necessary programs for the safe operation of a facility.

The best defense against loss is a series of interdependent programs created by management to identify and control fire, explosion, mechanical and electrical breakdown, and other perils, and to deal with the resulting emergency or contingency. Yet without feedback, it is impossible to tell whether programs have been implemented as management intended. The effectiveness of these programs must be continuously monitored because the failure of one or more of them significantly increases the potential for loss. Loss prevention audits provide management with a feedback mechanism that allows prompt detection of unsatisfactory conditions and initiation of appropriate corrective actions.

POSITION

Conduct loss prevention audits at least once a month. To set up an effective audit program:

- Appoint a member of management to monitor the program.
- Initiate a complete survey of the facility for the purpose of developing a Loss Prevention Audit Report form and a uniform procedure for making subsequent loss prevention audits.
- Select and train one or more individuals as in-house inspectors to conduct the audits.
- Establish effective procedures for management review of the reports. Copies of these reports should be sent to the Property Risk Manager for distribution and should be filed for subsequent AXA XL Risk Consulting review.
- Initiate a procedure for prompt action to correct any noted deficiencies.
- Demonstrate full support of the loss prevention audit program and encourage all employees to cooperate with the inspectors. The management representative should periodically tour with the inspectors as a show of support for the overall program.

DISCUSSION

The individuals selected to perform as in-house inspectors should be:

- Familiar with the facility.
- Physically capable of performing the audit.
- Personable, with an ability to communicate effectively to ensure proper reporting. If inspectors can communicate well with individual department heads, they can often get minor deficiencies corrected immediately. In addition, the cooperation of first-line supervisors is invaluable. Failure of any such supervisor to cooperate with loss prevention inspectors should be reported.
- Enthusiastic about the task. Enthusiasm generally breeds thoroughness, which results in an accurate audit and report.
- Familiar with maintenance and testing procedures.

Once selected, inspectors must be properly trained. This training must be ongoing. Results to be acquired from this training include:

- Familiarity with the goals of the management programs for loss prevention and control so the inspector is able to judge the effectiveness of each program.
- Familiarity with the hazards and with the protection features installed to protect them.
- Knowledge of fire protection equipment and of the inspection and testing techniques used in making the fire protection equipment inspections.
- Knowledge of process and equipment safeguards and protective features and of the methods used to verify the integrity of the equipment and safety systems.

By observing the techniques used by the AXA XL Risk Consulting loss prevention representative during a Loss Prevention Survey and by asking questions, the inspector has the opportunity to share the experience of AXA XL Risk Consulting's representatives. Attendance at appropriate schools or seminars may assist the inspector in keeping up with technology by the course content and by contact with peers.

After completing the audit, the inspector should fill out, date and sign the form, and forward it to management for review. Any noted deficiencies should be promptly corrected. A copy of the completed form should be filed for review by AXA XL Risk Consulting's representatives.

Appendix A describes how to conduct a loss prevention audit, and Appendix B shows a suggested Loss Prevention Audit Report form.

CONDUCTING THE LOSS PREVENTION AUDIT

The loss prevention audit is designed to provide management with feedback about how well the other *OVERVIEW* programs are being implemented at a facility.

The in-house inspector must tour the entire facility, including outside areas, roofs and the interiors of all buildings. A report form, such as the one shown in Appendix B, should be completed during each audit. The suggested report form is a brief checklist of all management programs in force. Appropriate comments should be made only where deficiencies or major changes are noted. Most facilities will require a custom-designed form.

The inspector should be familiar with the facility's Management of Change (MOC) program. During the audit, the inspector should determine whether MOC procedures were followed in implementing each change noted as a result of the audit.

Loss and "near miss" reports for incidents occurring since the last audit should be thoroughly reviewed to identify management program failures. Any deficiencies found should be corrected.

Following are specific areas to check for the *OVERVIEW* programs listed on the sample form:

MANAGEMENT OF CHANGE

It is not the inspector's responsibility to evaluate changes but to ascertain the present state of the facility's Management of Change system. The inspector should be familiar with the facility and its processes, procedures and personnel so that any changes will be recognized. Then the concerned personnel and documentation should be consulted to determine if all relevant Management of Change procedures have been followed properly.

IMPAIRMENTS TO FIRE PROTECTION SYSTEMS

In verifying that the impairment handling program at the facility is functioning properly, the inspector should be thoroughly familiar with AXA XL Risk Consulting's RSVP impairment handling program or other equivalent program in use at the facility. At the time of each audit, the shut-off and reminder tags should be reviewed for each impairment that has occurred since the last audit. During this review, evidence of any improper handling should be noted. Any impairment encountered during the tour should be reviewed to be sure proper procedures are followed.

SMOKING REGULATIONS

While touring the facility, the inspector should check for the following:

- Proper posting of "No Smoking" signs;
- Evidence of failure to comply with smoking regulations, such as discarded smoking materials or someone smoking in "No Smoking" areas;
- Occupancy changes requiring revisions of smoking regulations;
- Cleanliness in smoking areas.

MAINTENANCE

The inspector should be alert to indications of deficiencies in the maintenance management program. Work orders and equipment data files should be checked to determine if proper priorities are being followed. If the maintenance information system is computerized, access to it will allow the inspector to audit its general condition. Observation of maintenance jobs in progress should reveal the adequacy of training, as well as the general competence of, and direction given to, maintenance employees.

The inspector should review maintenance records and equipment operating logs, paying particular attention to the possibility of adverse trends developing unnoticed. Any changes made in original devices or materials should be documented in the facility's MOC program.

The inspector should confirm that all components and systems determined to be "critical" or safety-related by the Hazard Identification and Evaluation (see PRC.1.13.0) have been so noted within the maintenance program. A review of the written maintenance notification reports to management should reveal whether any critical components or systems have been out of service and whether any safety-related components or systems remain out of service.

During the plant tour, the inspector should note indications of maintenance deficiencies. These indications include:

- Building Construction
    - Blistered or damaged roof covering;
    - Loose flashings;
    - Improperly sealed penetrations;
    - Overloaded floors;
    - Excessive cracks in masonry walls;
    - Broken windows.
- Electrical Equipment
    - Covers not in place on junction boxes and equipment enclosures;
    - Missing bolts and threaded covers on hazardous location equipment enclosures;
    - Covers, including gaskets, not in place on weathertight equipment enclosures and junction boxes;
    - Use of temporary wiring, including extension cords;
    - Presence of "cheater cords," which allow use of nonapproved devices in hazardous locations;
    - Dust, dirt and residues in and on motors, panels and lighting fixtures and corrosion of enclosures and conduits;
    - Missing or cracked globes on lighting fixtures in hazardous areas;
    - Any evidence of arcing or overheating;
    - Leaking insulating fluids;
    - Wear, chafing or other mechanical damage to cables or enclosures.
- Piping
    - Missing flange or support bolts;
    - Leaking joints and valve packings;
    - Excessive corrosion;
    - Loose, missing or "bottomed out" supports or hangers;
    - Hammering or vibration.
- Machinery
    - Improper lubrication;
    - Excessive or unusual noise or vibration;
    - Missing bolts in cover plates;

- Any hastily erected, temporary equipment;
- Loose or broken foundation bolts.

- Boilers and Pressure Vessels
  - Leaks, cracks, bulges, local overheating or excessive corrosion;
  - Corroded or leaking safety or relief valves;
  - Relief valve discharge piping reduced in size or not properly supported;
  - Loose or missing insulation.

EMPLOYEE TRAINING

During loss prevention audits, the inspector should be alert to unsafe work practices, which may indicate inadequate employee training programs or the need for retraining. The inspector should be familiar with the work methods taught in the training programs to determine whether the work practices observed during the audits are "by the book" or are worker adaptations.

If worker adaptations are observed, the inspector should determine if management tolerated the modification. This would indicate a lack of support for the training program. The inspector should determine if proper Management of Change procedures were followed in instituting the changed work practices.

Loss and "near miss" reports should be reviewed to determine whether employee training needs improvement.

NEW CONSTRUCTION

If any new construction, remodeling or change of occupancy is underway, the inspector should determine whether codes and standards are being observed, protection features are being expedited, combustible materials are being kept out of buildings until sprinklers are in service, and trash is being removed to ensure proper housekeeping.

For major construction projects, the inspector should accompany the construction manager on a tour of the site to determine that the precautions listed are being taken. In any recently completed construction, the inspector should determine whether loss prevention and protection specifications were actually followed.

LOSS PREVENTION RECOMMENDATIONS

The inspector should be familiar with AXA XL Risk Consulting recommendations and should report on the status of any that are being, or have recently been, completed.

PRE-EMERGENCY PLANNING

The inspector should be familiar with the written pre-emergency plan to determine whether it is current and takes into account changes in new construction, occupancy, operations or personnel. The inspector should also check the records to determine whether the Fire Brigade is training regularly and to be sure that the public fire department has visited the facility within the last year. If it was necessary to implement the pre-emergency plan since the last audit, the inspector should determine if the results were properly critiqued and any deficiencies corrected.

HAZARDOUS MATERIALS EVALUATION

During each loss prevention audit, the inspector should check for new materials being used. When a new material is found, the inspector should hold a discussion with the person responsible for hazardous materials evaluation to determine if it has been evaluated and what cautionary signs or markings are required.

New materials are usually encountered where new processes or operations have been installed. However, materials used in an old operation may be changed for a variety of reasons. For example, a more effective material might be found or a less expensive material used in a process. Whenever materials have changed, the inspector should confirm that the change was reviewed under the MOC program.

During the tour, the inspector should also check areas known to contain hazardous materials to see that proper signs and labels are being used and are readable. Random discussion with area supervisors and operators should be held to determine whether they understand the hazards of the materials.

CUTTING, WELDING AND OTHER HOT WORK

During each loss prevention audit, the inspector should observe any hot work in progress. First, the existence of a properly completed and signed permit at the job site should be verified. Then the work practices being followed should be compared to those indicated on the permit. The inspector should also check the condition of hot work equipment and verify that warning tags are in place. The file of permits pertaining to jobs done since the last audit should be reviewed to see that proper procedures were followed.

FIRE PROTECTION AND SECURITY SURVEILLANCE

To verify that the surveillance program at the facility is functioning as intended, the inspector should spot-check guard records to be certain the guards are making tours correctly. If passive programs are in use, the inspector should verify that fire protection signaling systems are in service and have been properly tested as a part of the fire protection equipment inspection and that other protective systems are being maintained as well. The inspector should also check other elements of the passive programs such as barriers, fences and locks to be certain that they continue to perform their intended function. Where identification badges are used, the inspector should record any infractions of this system.

FIRE PROTECTION EQUIPMENT INSPECTION

The inspector should determine if inspections are being made at proper intervals, review the records for each inspection, and ascertain whether corrections are being made promptly. During the loss prevention audit, the inspector should note any deficiencies that would indicate weaknesses in the fire protection equipment inspection program.

HAZARD IDENTIFICATION AND EVALUATION

While it is not the inspector’s responsibility to evaluate hazards, changes noted in the hazard level should be recorded, along with a description of the nature of the change. Hazard level changes may stem from new processes, equipment, or materials. The inspector should determine whether MOC procedures were followed in making the changes.

In addition, increased production rates may raise the hazard level. This may be the result of increases in storage and handling of hazardous materials or the operation of processes or equipment at rates above design capacity.

Some of the more common types of hazard increase include:

- Use of a new flammable solvent in place of a nonhazardous liquid;
- Warehousing or storage higher than normal, storage in aisles, or increased storage of a hazardous material such that quantities exceed protection design parameters;

- Improper types of industrial trucks being operated in hazardous areas;
- Combustible stock stored in an unsprinklered area;
- Safety instrumentation out of service;
- Ineffective operation of dust or vapor control equipment;
- Machine speedup undertaken without consideration of all the stresses involved;
- Unauthorized adjustment of safety valve, overspeed trip, axial position limit or other safety, or disabling of the devices themselves;
- Use of external fans or water spray for additional cooling of electrical equipment.

PROPER HOUSEKEEPING

During each loss prevention audit, the inspector should check that specified levels of housekeeping are being maintained throughout all areas of the facility. This check should include:

- All areas on each floor. Special attention should be given to enclosed, low-traffic areas. Areas such as elevator machinery rooms and electrical transformer/switchgear rooms should be free of storage and debris.
- Outside yard areas. Dried vegetation, debris and combustible yard storage should be kept well away from buildings, utilities and liquefied gas storage containers.
- Exposing properties. While it may not be possible to make internal building inspections, any obvious deficiencies should be noted. The inspector should make appropriate recommendations to protect the exposed part of the facility.

LOSS PREVENTION AUDIT REPORT

OVERVIEW FORMS PACKET
(See PRC.1.10.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

LOSS PREVENTION AUDIT REPORT

Audit to be made at least once a month.

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Identify deficiencies, if any, in the following programs. Make appropriate comments concerning location, specific deficiency, and corrective action taken or required. Major changes in occupancy or construction, as they affect programs, should also be described.

OVERVIEW PROGRAM	Deficiencies None	Deficiencies Noted	COMMENTS
Management of Change	☐	☐	
Impairments to Fire Protection Systems	☐	☐	
Smoking Regulations	☐	☐	
Maintenance	☐	☐	
Employee Training	☐	☐	
New Construction	☐	☐	
Insurance Company Recommendations	☐	☐	
Pre-Emergency Planning	☐	☐	
Hazardous Materials Evaluation	☐	☐	
Cutting, Welding, and Other Hot Work	☐	☐	
Fire Protection and Security Surveillance	☐	☐	
Fire Protection Equipment Inspection	☐	☐	
Hazard Identification and Evaluation	☐	☐	
Proper Housekeeping	☐	☐	

ADDITIONAL COMMENTS (identify by program number): ______________________

Report reviewed by: ______________________ (signed) Position: ______________________

FILE FOR REVIEW BY AXA XL RISK CONSULTING REPRESENTATIVE

(over)
Printed in USA
PRC.1.10.0

FIRE PROTECTION AND SECURITY SURVEILLANCE

INTRODUCTION

Prompt detection of adverse conditions is crucial to effective loss prevention and control. Most catastrophic losses grew from an initiating event that could have been easily controlled with prompt detection, correct diagnosis and an appropriate response. While many factors make it possible to contain a fire to its area of origin, the most important factor is how soon the fire is detected.

During normal business hours, most areas of a facility are occupied. By their presence, the occupants provide protective surveillance because they are able to detect and respond to problems such as fires; ammonia or other hazardous materials leaks; refrigeration or other utility failures; vibrating machinery or overheated electrical conductors.

A carelessly discarded cigarette, for example, may ignite the contents of a wastebasket, and the ensuing fire may spread until the entire building is involved. However, someone who discovers the fire while it is still in its incipient stage may be able to extinguish it with a portable fire extinguisher. In some cases, the occupants can also detect conditions that might lead to a fire, such as a malfunctioning machine. Similarly, most companies realize that increased surveillance is vital in guarding against theft and fires of incendiary origin.

Occupants are not always available to provide surveillance. After workers go home or in areas that are otherwise unoccupied, some alternate means of continuing surveillance must be provided.

In conjunction with fire and explosion protective systems and with other management programs for loss prevention and control, fire protection and security surveillance provides a means of:

- Continuously monitoring the facility for conditions that might lead to a fire, explosion, or other incident;
- Promptly notifying the management representative (Emergency Coordinator) and, if appropriate, the public fire department or private Fire Brigade; and
- Effectively preventing unauthorized access to the facility.

Management must determine how this surveillance is best achieved. See PRC.1.11.0.A, PRC.1.11.0.B and PRC.1.11.0.C.

POSITION

Management should develop a written surveillance plan for both fire protection and security to be certain that the facility is checked regularly during idle periods. To accomplish this, management should:

- Determine which areas of the facility are unoccupied during both working and nonworking hours.
- Consult with AXA XL Risk Consulting when selecting the types of surveillance for the unoccupied areas.
- Designate a management representative to be responsible for overseeing the surveillance program. This representative should review surveillance reports daily. Management control of surveillance is critical to maintaining program integrity.
- Evaluate changes in the facility that might require revising the surveillance plan. Refer to PRC.1.0.2.

DISCUSSION

The ideal type of surveillance is continuous occupancy throughout all portions of a facility by people who are trained to react properly to emergencies. However, this is rarely achieved. Even facilities that operate 24 hours a day often have holiday and vacation shutdowns. These plants may also have offices, storage areas or idle process areas that are only visited occasionally. Thus, even facilities with continuous operations require supplemental surveillance programs.

Surveillance programs fall into one of two broad categories: active programs using guards who limit access and make patrols during idle periods; and passive programs using fences, lights, barriers and electronic devices. In many cases, facilities must combine active and passive programs to achieve adequate surveillance.

Active Programs

An active surveillance program of “standard” guard service has advantages over a strictly passive program in that guards can detect unsafe conditions and correct them before a loss occurs. In addition, guards can use their senses to detect incipient fires. They can then sound an alarm and attempt extinguishment. Standard guard service is defined by AXA XL Risk Consulting as hourly recorded tours during nights and bi-hourly recorded tours during idle days that cover all the unoccupied areas of the facility.

Guard tours must be supervised. This may be done using a system of guard reporting keys or stations permanently installed along the specified route of the tour. Records of the completion of each tour may be kept by means of portable or stationary watchclocks or by means of a central station or proprietary guard patrol tour supervisory system. The watchclock or proprietary system records should be checked daily by management’s representative for omissions, and the reason for any omission should be promptly determined. Similarly, any tour delinquency reports from a supervising central station should be checked upon receipt and the reported interruption investigated.

While making regular tours throughout the facility, guards must be alert for all emergencies, paying special attention to known hazardous areas. Guards are in a position not only to detect and correct unsafe conditions that might lead to a serious fire, but also to discover an incipient fire. Therefore, the guards should be familiar with the fundamentals of fire control and with the proper use of all available extinguishing equipment.

The importance of notifying the fire department before attempting to fight the fire should be stressed in guard training. Guards should report any situation that may endanger the facility, such as an exposing fire in adjacent properties. Any unusual condition that the guards cannot correct without assistance must be reported immediately to the proper official so the situation can be remedied without undue delay. Such situations include the impairment of sprinkler service, the failure of heating equipment, or the abnormally strong odors of refrigerants or materials in process.

In addition to carefully following written pre-emergency plans, guards must be resourceful and capable of applying common sense to any unusual conditions they may encounter, such as “natural” hazard threats. If the facility is experiencing freezing weather, for example, the guard should be alert to those areas of the facility where protective systems or process equipment might be vulnerable to freezing damage. Such areas should be checked frequently to ensure that heating systems are maintaining the temperature necessary to avoid damage. If a thermometer is unavailable, a resourceful guard might set out a small container of water to observe by the condition of the water when the area might be approaching a dangerously low temperature.

Passive Programs

Passive surveillance programs include protective signaling systems, such as central station systems, as well as equipment that contributes to the physical security of the premises, such as fences, lights, barriers, locks, and closed circuit television or other intrusion detection devices. Passive programs can either replace or supplement active programs. At locations where values are lower and hazards are limited, passive programs may replace active programs. At locations with higher values or greater hazards, passive programs may supplement active programs. See NFPA 72, PRC.11.0.1 and PRC.11.1.1.0.

When a protective signaling system is used as the sole means of surveillance, a walk-through tour to detect unsafe conditions should be made by a competent person immediately after the facility becomes unoccupied. Such a tour would be similar to the first tour made by a guard if standard guard service were provided. Further, when unusual conditions prevail at such a facility, a responsible person should remain there or return as quickly as possible to provide additional surveillance. Unusual conditions include, but are not limited to, impairments to fire protection systems or severe weather conditions. Failure of a protective signaling system in conjunction with such unusual conditions might severely increase the facility's susceptibility to loss.

Regardless of the location or size of a facility, one way of increasing security is to physically prevent access by unauthorized persons; e.g., windows may be covered with heavy screening or protective bars or may be permanently sealed. It should be noted, however, that sealed window openings may delay fire detection and may reduce heat, smoke or explosion venting. See PRC.16.3.

Exterior doors should be equipped with security locks. When it is not possible to physically prevent unauthorized entry, intruders may be detected by a protective signaling system. Such a system should be installed only by reputable contractors using equipment listed or approved by a nationally recognized testing laboratory, and the plans should be reviewed in advance by AXA XL Risk Consulting.

To secure a facility's perimeter, chain link fencing may be used. Fences should be inspected at least weekly to be sure they have not been breached.

A physical barrier may be supplemented by perimeter lighting and closed circuit television. The lighting should be checked nightly and the closed circuit television maintained according to specifications provided by the installer. The closed circuit television system should be equipped with motion detection, as well as a means of recording on videotape unusual activities. Any breakdowns should be investigated and repaired immediately.

EVALUATING GUARD SERVICE

Consider the following features when evaluating standard guard service:

TOUR SUPERVISORY SYSTEM RECORDING METHODS

Guard tours should be recorded by one of the following methods:

- Portable watchclock. The clock must be kept locked, and the key must be inaccessible to the guard. The clock records should be removed from the clock and checked daily by management's representative. Guards should never remove their own records from the clock. Even if contract guard service is employed, management's representative should remove the records from the clock and check them rather than relying on a supervisor from that service.
- Central station guard patrol tour supervisory system. With this type of system, the written records of the guards' tours are maintained in the central station. NFPA 72, requires the central station to notify the facility in writing if the guard is late in starting or finishing a tour. A specified grace period of 10 min – 15 min is usually permitted. Upon the expiration of the grace period, the central station attempts to contact the guard by telephone. If unable to reach the guard, the central station immediately notifies the police and dispatches its own armed guard.
- Proprietary guard patrol tour supervisory system and stationary watchclocks. With these systems, the guards' tours are automatically recorded at a central location. Management's representative should review this record daily.

CHECKING TOUR RECORDS

When checking tour records, make sure that:

- All unoccupied areas of the facility are included in each tour.
- All key stations or tour supervisory transmitters in each tour have been recorded clearly in a regular hourly pattern at night and in a bi-hourly pattern during the day.
- Tours last no longer than 45 min, allowing for a rest period of at least 15 min each hour.
- The tours begin within one half-hour of the time the area becomes unoccupied and continue to within one half-hour of the resumption of occupancy.
- The "tell-tale" of a portable or stationary watchclock is recording each time the clock is opened. Look for indications that the clock has been opened more than once a day or at unusual times. This might indicate that surveillance records were tampered with or that unauthorized persons have access to a clock key.

TOUR SUPERVISORY SYSTEM INITIATING DEVICES

Key stations, tour supervisory transmitters, or intermediate stations should be inspected once a month to see that they have not been relocated or removed, and to confirm that they are firmly attached and sealed with a "tamper" seal. Make sure the key has not been damaged. If there is evidence of tampering, the key stations, tour supervisory transmitters, or intermediate stations should be checked more often and suitable action taken.

GUARDS

Consider the following points when evaluating guards. See NFPA 601 for further details.

- The physical and emotional stability of guards should be evaluated. Guards hold positions of trust that require individuals who are physically able, mentally alert, and morally responsible. Pre-employment tests and investigations evaluating these qualifications should be mandatory whether the guards are employees of the company or from a contract service.
- Guards should have sound judgement and should be capable of responding calmly in an emergency. They should be mature enough to have sound judgment and should have the physical stamina required by the job.
- A sufficient number of guards should be provided to maintain proper surveillance. It is not desirable for guards to be assigned part-time duties unrelated to surveillance. If they are so assigned, however, these duties must not interfere with surveillance.
- The guards should receive management's full support in the performance of their duties.
    - When the guards are facility employees, management should provide the necessary training and supervision and establish the scope of the service.
    - If a contract guard service is used, management should not assume that it will be adequate. Rather, management should prepare detailed specifications and investigate the ability of prospective contractors to meet these specifications. When the contract has been let, management should make sure that its intent is being carried out.
- The initial and continued training of guards should be given as a formal, comprehensive written program covering all applicable protection procedures. Each guard must be:
    - Acquainted with the general nature of the facility's operations and possess specific knowledge of those operations which are hazardous.
    - Familiar with the facility's manual and automatic fire protection equipment and protective signaling systems. They should be especially aware of the location of all sprinkler valves and know which area each controls. AXA XL Risk Consulting suggests that guards periodically accompany the person making fire protection equipment inspections in order to gain a working knowledge of facility protection features and hazards (see *OVERVIEW*, Section 12 [PRC.1.12.0]).
    - Familiar with the location and operation of manual fire alarm stations and other means of transmitting fire alarms. Such means should be provided throughout the facility to permit guards to easily report a fire.
    - Taught to notify the fire department before attempting to fight the fire.
    - Taught how to admit public fire apparatus to the property and how to direct fire department officers to the location of the fire.
    - Taught to properly notify company officials when an emergency occurs or when potential trouble is observed.
    - Taught to maintain a shift log and to prepare reports to management of observations made and action taken during tours.
- Guard service should be integrated into the overall pre-emergency planning program (see *OVERVIEW*, Section 7 [PRC.1.7.0]).
- General and special instructions and other data required by the guards should be written down and kept up-to-date (see NFPA 601).

In summary, management should expect, and is entitled to receive, guard service of the highest quality. Guards must be conscientious in the performance of their duties, noting and reporting all infractions of company regulations and closely following the orders given to them.

FIRE ALARM AND INTRUSION DETECTION SYSTEMS

Fire alarm systems use three basic types of signals:

- Alarm, a signal indicating fire. This includes:
  - Manual fire alarms;
  - Discharge of automatic sprinkler or other fixed extinguishing systems;
  - Automatic fire alarms, such as heat, smoke or flame detectors.
- Supervisory, a signal that indicates an “off normal” condition in a fire protection system and its return to normal. This includes:
  - Control valve tamper for automatic sprinkler or other fixed extinguishing systems.
  - High and low air pressure on dry pipe or preaction sprinkler systems.
  - Private water supplies, such as gravity tank level and temperature or electric motor-driven fire pump running and power failure.
  - Public water supplies, such as low public water pressure.
  - Low building temperature for buildings with wet pipe sprinkler systems; for dry pipe, preaction, or deluge valve closets; and for fire pump houses located in areas subject to freezing. Such devices should be located in portions of the facility most likely to become dangerously cold first, such as remote stairwells or spaces above suspended ceilings. They should be set at high enough a temperature that facility personnel will be able to respond to and correct a loss-of-heat condition before damage occurs.

    Supervision of the operating status of a facility’s boiler or furnace may be used to supplement low building temperature supervision, but should never be used in place of specifically located low building temperature detectors, as it is possible for a portion of the heating system to become ineffective while the boiler or furnace continues to operate. In particular, if the boiler has insufficient water, prompt detection may prevent severe boiler damage which might have resulted in a fire.
  - Guard patrol tour delinquency.
- Trouble, a signal indicating the loss of fire alarm system power supply or circuit integrity.

There are five basic types of fire alarm systems. These are protected premises, central station, proprietary supervising station, remote supervising station and auxiliary systems. All five types are addressed in NFPA 72. Also see PRC.11.1.1.0.

Intrusion detection systems use two basic types of signals:

- Intrusion, a signal indicating unauthorized entry.
- Trouble, a signal indicating the loss of intrusion detection system power supply or circuit integrity.

IS YOUR FACILITY SECURE?

The following questions are intended to assist management in determining the security measures needed to adequately protect their facilities from fire and explosion. These fires and explosions may be the result of acts of the facilities' employees, authorized visitors, or intruders. Also see PRC.1.11.1.

ORGANIZATIONAL PLANNING

An appraisal of the following points will give some indication of the likelihood of damage from riot and civil commotion or acts of vandalism or malicious mischief by intruders. The degree of security needed can then be more reasonably determined. To assist in determining if a facility is a potential target, management should consider:

- Nature of Business
  - Is production carried on under military research or procurement contracts?
  - Are the products particularly "attractive" to criminals? The list of attractive materials includes explosives, firearms, ammunition, drugs, electronics, intoxicants and flammable liquids.
- Public Image of Company
  - Is hiring policy considered fair?
  - Are wage policies acceptable?
  - Are employee relations satisfactory?
  - Is the neighborhood satisfied with the facility?
  - Has employment been stable (without cutbacks or layoffs)?
  - Are any employees or ex-employees disgruntled?
  - Has the facility been criticized for environmental pollution?

To evaluate the degree of security provided, management should review the facility's security planning:

- Has a written security plan been developed?
- Does this plan include protection against arson and vandalism?
- Does the plan provide for consultation and liaison with public safety authorities?

EXTERNAL SECURITY

External security precautions should reasonably control access while allowing normal business to continue.

- Control of Access
  - Do topographical features, such as cliffs or rivers, afford a degree of natural protection?
  - Are fences and exterior perimeter alarms adequate?
  - Are gates properly controlled and locked on schedule?
  - Is entrance of individuals and motor vehicles controlled?
  - Are contents of vehicles checked?

  - Is access to keys restricted and controlled?
  - Has provision been made to quickly admit the public fire department during an emergency?
- Other Considerations
  - Does the locale have a history of, or potential for, civil strife?
  - Is the area adequately illuminated?
  - Are adequate external guard patrols provided where needed?
  - Are doors and windows adequately secured and adequately protected against thrown objects?
  - Are other means of access protected?

INTERNAL SECURITY

Internal security precautions include supervising personnel, taking security measures, and making sure fire and explosion protective systems remain in service.

Personnel

To evaluate supervision of personnel, management should consider:

- Employees
  - Are proper pre-employment screenings made?
  - Are identification cards or badges used to restrict employees to specific areas?
  - Are employees instructed to challenge strangers?
- Contract Service Personnel
  - Are their pre-employment screenings reviewed?
  - Are they required to log in and out of the facility, and are their movements supervised by facility personnel?
  - Do they wear identification badges?
  - Are their tool kits or equipment inspected upon entering and leaving the facility?
- Outside Vendors, and Delivery or Repair Personnel
  - Are they regularly assigned?
  - Are they issued identification badges?
  - Are they required to log in and out of the facility, and are they escorted while at the facility?
  - Are they restricted to specific areas?
  - Upon entering and leaving the premises, are their tool kits and equipment inspected?
- Guests and General Public
  - Are they admitted on legitimate business only?
  - Are they identifiable as guests?
  - Are they required to log in and out of the facility, and are they escorted while at the facility?
  - Is access restricted to certain areas?
  - Are their belongings inspected upon entering and leaving the facility?

Security Measures

To evaluate internal security, management should consider:

- Are the buildings adequately patrolled by security personnel?
- Are security alarms used in vital unattened areas?
- Do plans for handling civil disturbances provide for additional security coverage?

Protective Systems

To determine the likelihood that fire and explosion protective systems will function properly in an emergency, management should consider:

- Are critical facilities located in locked or continuously supervised areas or are they otherwise specially protected? These facilities include substations and switchgear, computer equipment, fire pumps and other water supplies, sprinkler controls and special extinguishing systems.
- Are water supplies and sprinkler systems kept in service?
- Are sprinkler control valves either sealed or electrically supervised?
- Do all employees know how to report a fire?
- Has a suitably organized and trained Fire Brigade been provided?
- Has an adequate supply of portable extinguishing equipment been provided, and have employees been instructed in its use?

RIOT AND CIVIL COMMOTION

INTRODUCTION

Riot, riot attending a strike and civil commotion seriously threaten the survival of businesses, especially inner-city locations. Riots can destroy property faster and more violently than ever before. Whether or not a facility survives depends upon the degree of protection provided.

The Los Angeles, California civil disturbance of April 1992 and the Watts, California riot of 1965 illustrate two types of rioting. These incidents should be reviewed to learn what a facility could face during riot and civil commotion and to become aware of the following riot trends:

- Riots tend to break out more frequently in high crime or economically depressed areas.
- Rioters usually attack retailers and often strike liquor stores, pawn shops and gun shops first; then food, drug, appliance, furniture and clothing stores. Looters take anything that can be used or easily sold.
- Rioters also attack nonmanufacturing facilities which are viewed as institutions of authority, such as police and fire stations, school administration buildings, libraries and other government buildings.
- Rioters do not often attack manufacturing facilities. However, those facilities which manufacture consumer products are targets. Highly visible locations, such as military contractors, suppliers, radio and television studios, and station transmitters, are also vulnerable.
- Police and fire protection may not be available or may be seriously delayed during a riot. Widespread rioting forces fire departments to allow some fires to burn so that other fires, which more seriously threaten lives and adjacent properties, can be controlled, or until they have safe escort into the riot area.
- Buildings of noncombustible construction, properly protected with automatic sprinklers, survive better than nonsprinklered buildings. Looters tend not to enter premises where sprinklers are operating. Rioters do not normally target control valves to impair sprinkler systems.
- Closed circuit TV systems do not deter intruders. Although closed circuit systems might improve existing surveillance in large areas outside of buildings, such systems do not protect against riot and civil commotion.

During a riot or civil commotion, a sprinklered facility's chances for survival are impressive. In 1992, according to the Fire Sprinkler Advisory Board of Southern California, "sprinklers prevented at least $187 million in building losses and exceeded design requirements by extinguishing all but two blazes before the fire service responded."[1] In one of those instances, weary fire fighters arrived at a high-rise office building to find an incendiary fire burning under a desk. A single head was controlling the blaze.

They simply overturned the desk to expedite the inevitable effect of sprinkler operation. In another instance, there were 11 separate fires set over 3 days. A total of 22 sprinklers extinguished all of those fires.

"The only fully protected building to burn down during the Los Angeles civil disturbance was a supermarket... Although a single sprinkler head suppressed a fire late on April 19, someone later turned the system off and the next morning looters started a second fire that destroyed the supermarket...[2]"

POSITION

General Guidelines

Use general site preparation guidelines to improve the facility's normal security and to increase the facility's ability to resist rioting acts. The following recommendations apply:

Management Programs

All applicable sections of *OVERVIEW* which contain information on impairments to fire protection systems, pre-emergency planning, and fire protection and security surveillance should be followed.

Security

- Take every precaution to make sure unwanted people do not enter the premises. Instruct security personnel to control people accessing and exiting the facility during daily operations. Ensure 24 hour physical protection.
- Develop good security habits before the incident occurs. Make sure employees strictly follow security procedures daily. Employees should wear photo identification badges at all times. Challenge all persons without badges.
- Have security personnel review written procedures, safeguards, and police and fire department regulations that might affect facility protection.
- Check security personnel equipment. Equipment that might be needed during a commotion should include emergency lights, battery-operated megaphones and two-way radios.
- Lock all inside doors and secure perimeter fencing when closing the facility for the night. Retail stores should secure roll down doors and shutters nightly.
- Provide electronic supervision for sprinkler valves. Lock valves with hard shackle locks to discourage tampering.
- Closely survey entryways and parking lots to help deter "hit and run" attacks.
- Illuminate all yard areas. Under normal conditions light interior areas. If a riot is anticipated, turn off interior lights.
- Contact police and fire departments when any disturbance occurs. Discuss procedures they suggest in case of riot or facility evacuation.
- Evacuation procedures should see that sprinkler valves are open, hard shackle locks are provided, and all automation protection is in service.

Sprinkler Systems

- During a riot, a facility should not shut off any part of the sprinkler system until the facility is permanently secured by civil authority and repairs can be immediately initiated. Strictly follow RSVP procedures. AXA XL Risk Consulting should be contacted if shutdown is necessary.
- If operating heads cannot be replaced immediately, plug the heads with wedges or blocks, and leave the system on. During riots, many facilities have survived because sprinklers doused incendiary fires.
- Have extra sprinkler heads available. Replacements may not be readily available after the riot.

Alarms

- Make sure all alarm and protective systems are in service around the clock. Do not disarm the service for any reason. Advise the alarm company of evacuation.
- Maintain the alarm systems so that authorities will be made aware of all operating protection.
- Alarm egress doors.
- If necessary, provide standard watchmen service to supplement central station supervision.

Physical structures

- For manufacturing facilities and malls, focus site preparation on the facility as a whole rather than on individual buildings. Stores that front the street and other nonmanufacturing facilities should use site preparation techniques for each building.
- Make sure fire doors operate properly. Do not block them with storage. Close doors during nonoperating hours or as part of the evacuation plan.
- Lock all inside and outside doors when the facility is unoccupied. Keep doors to unused areas closed and locked.
- Completely cover door and window openings with protective devices. Essentially, these should be noncombustible roll down doors and shutters that cover shop entrances and windows. Secure the doors with substantial locks that prevent tampering.
- Do not use scissor gates for protection of openings.
- Have plywood available where windows can be broken out.
- Physically secure roof hatches. Secure access to the roof by locking or removing exterior ladders.
- Protect roof openings and install safety glass, Plexiglas,™ or Lexan™ glazing materials in windows.
- Secure skylights, heat smoke vents, ventilator openings, and entrances to sewer or service tunnels.
- Move elevators to upper floors, and lock them.
- Make sure emergency generators or other backup power facilities can handle the load from elevators, escalators, lighting and critical equipment.
- Cash registers should be emptied and the drawers left open to show that they are empty.

New Construction

- Incorporate site preparation techniques in the design phase of a new construction project. For example, construct the building far enough back from the street to create a buffer between the street and building front. Design fire exits so people can easily leave the building, but cannot easily enter through the fire exits.
- Ensure that buildings are made of noncombustible construction.
- Ensure that only necessary wall openings are provided, and locate risers inside the buildings.

Locking devices

- Secure door hinges or pins so pins cannot be pulled and hinges cannot be broken.
- Make sure lock bolts cannot be easily disengaged by a thin instrument pried off or cut.
- Ensure padlock hasps have tamperproof screws.

Yard Areas

- Fence all yard areas.
- Illuminate all yard areas.

- Lock personnel and vehicular gates during nonoperating hours. All gates should be included in security patrols, television surveillance or electronic supervision.
- Yard storage should be avoided. Where unavoidable, move all combustible materials far enough away from the fence to prevent materials from being ignited by a source outside of the fence. Trash bins also make good vehicle barriers if placed at driveway locations.
- Garage all vehicles in a safe place.

Records

- Make duplicates of vital business records. Examples include inventory, receivables, credit information and computer tapes.
- Organize the record keeping system to allow removal of important records to a safe location.

Salvage Supplies

Put supplies of flameproof water-resistant salvage covers in centrally located storerooms. Materials may be needed to temporarily repair broken doors, windows and glass store fronts.

Flammable Liquid Storage

Store flammable liquids in a locked “safe” place cut off from combustible storage.

Riot and Civil Commotion by the General Populous

Plan to evacuate the facility, but leave it as secure as possible. Because today’s riots strike suddenly and more violently, management should evacuate all personnel, secure facilities quickly, and keep all automatic protection systems in service.

Evacuation

- Be ready to secure the facility at a moment’s notice.
- Provide a written evacuation plan, and train personnel how to implement the plan. Discuss the plan with police and fire authorities.
- Determine the evacuation route prior to the riot. Inform the employees of that route.
- Designate shelter areas in case evacuation proves unsafe or personnel become trapped.

Commercial Storage

- Where practical, use secure areas to store high value items during times of potential rioting.
- Store guns and ammunition in protected locations.
- When possible, remove all flammable liquids from the facility.

Utility Services

- If heat is not needed, shut off and lock shut gas supplies to the unoccupied facility.
- Turn off all interior lighting. Leave exterior lighting on. Businesses with interior lights helped looters see inside stores, break in and take what they wanted. Looters were skeptical of their own safety when entering unlit areas.

Riot And Civil Commotion Resulting From Labor Unrest

During labor unrest, management should be concerned about two possible scenarios: (1) employees are inside the premises when a dispute boils over; (2) strikers outside the facility threaten to attack the facility.

Management should maintain strict lines of communication with the Emergency Coordinator and anticipate when to implement the pre-emergency plan, particularly the security portions. If negotiations start to break down, the Emergency Coordinator should implement the pre-emergency plan.

When strikers begin picketing, management may decide to maintain production by bringing in nonunion labor. Nonunion employees or union employees from unrelated unions may refuse to cross the picket lines. Management may need to act quickly to maintain the sprinkler and alarm systems by hiring a contractor to perform this service. Making plans well in advance is critical. All protection features must stay in service. Initiate site preparation precautions.

If it is suspected that angry workers may destroy equipment, management should resolve the negotiations quickly or shut down the facility. The best protection scheme would be to handle negotiations in a manner that will keep the dispute from mounting.

Each facility should evaluate existing conditions and plan appropriate defenses. Industrial relations should look into upcoming events that might lead to labor unrest. Managers should be trained in negotiation skills and have sensitivity training.

DISCUSSION

Many do not understand the need to protect a facility against riot. Very few riots broke out in the United States between the 1965 Watts riot and the 1992 riot in Los Angeles, California. Throughout periods of quiet times, people tend to relax security procedures. Then when civil commotion suddenly strikes, facilities are unprepared.

There is a vast difference between the 1965 Watts riot and the 1992 Los Angeles riot. A comparison study of the two riots showed the following:

- During the Watts riot, rioters targeted any building within the general riot area and secured small neighborhoods to prove to authorities that they, not the government, controlled the area. But in 1992, rioters, motivated by material gain, looted, then burned businesses, mostly the retail facilities. Rioters generally avoided manufacturing facilities, private houses, tenements, and office buildings.
- In 1992, looting, rioting and destruction far exceeded Watts activity. Upheavals spread over 105 square miles (272 square kilometers) compared to 32 square miles (83 square kilometers) in 1965. In 1965, rioters destroyed two hundred buildings and damaged four hundred. In 1992, rioters looted or burned over 10,000 buildings and damaged hundreds of others. The dollar loss in 1992 was four times greater than in 1965.
- Suddenness of rioting in 1992 far exceeded that of Watts, reaching its full height in 4 hours compared to 48 hours in the Watts riot.
- Civilian injuries in 1992 were twice those of 1965.
- 1992 firefighter injuries were half those of 1965.

Lessons learned from past incidents point to these facts:

- Public fire or police protection may not be available.
- Maintaining personnel on the property may not protect the property during a riot. Therefore, management should have four goals when developing the preplan: evacuate, keep protection in service, secure the premises, and recover quickly to resume operations.
- Sprinklers were effective in preventing complete destruction if they were kept in service.
- Over 60% of the businesses that suffered heavy losses never reopened even though insurance paid their losses.

REFERENCES

1. Mangan, Joseph F. "Best's Review." *Best's Underwriting Newsletter*, January 1993, 62.

2. Mangan, Joseph F. "Best's Review." *Best's Underwriting Newsletter*, January 1993, 62.

ARSON AND INCENDIARY FIRES

INTRODUCTION

Arson is the crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion according to NFPA 921 *Guide for Fire and Explosion Investigation*. The reasons for an arsonist to strike are many including:

- concealment of a crime such as robbery, vandalism, or murder
- revenge
- result of riots and civil unrest
- insurance fraud
- intimidation
- extortion
- wanting attention
- thrill seeking

While insurance fraud with AXA XL Risk Consulting clients is not a major issue, other reasons such as concealment of a crime, revenge, riots and civil unrest, and wanting attention can happen at all facilities. The crime of arson can be as small as burning cardboard in a secluded section of the building or property to as large as burning the entire building down.

If the remnant's of a small fire is discovered, and no reason for it to have started or the cause of the fire cannot be determined, suspected arson and call the authorities to have them start to investigate. Catching an arsonist early can help reduce the total damage that can occur. Work with the authorities within legal limits to help the person. This section will assist you with how to prevent and minimize the damage of an arsonist. It will not prevent the damage as a result of riots and civil unrest and concealment of a crime.

Arson as a result of concealment of a crime, riots and civil unrest, are typically unplanned. Arson for revenge, insurance fraud, intimidation, attention getting and thrill seeking typically are thought out prior to the setting of the fire. In one case a security guard, who had to work when he wanted time off, over a few nights wired the sprinklers so they would not operate properly and set a fire that destroyed the business. In another case a fire investigator set a series of fires on his way to conferences. In numerous cases volunteer firefighters were caught set fires so they could be the first to report them and extinguish them.

The arsonist can be anyone, a disgruntled employee, the person who comes in to the facility to service equipment, or someone who wants to protest an issue. The best defense from someone who wants to start a fire is to have good security.

POSITION

Provide security to prevent unauthorized people from entering the facility. Security can be in the form of physical barriers such as fences, walls, and controlled access gates. Provide lighting both inside the building and around the outside of the buildings. If the fencing has uncontrolled access gates, lock all the gates.

Where there is combustible outdoor storage, maintain a 25 ft (7.6 m) clear space between the fence and storage. Where there is noncombustible outdoor storage, maintain at least 8 ft (2.4 m) clear space between the fence and storage. Keep combustible outdoor storage, at least a 50 ft (15.2 m) from buildings. The clear space at the fence will also allow security to monitor the fence. The clear space between the storage and buildings will minimize damage to the buildings.

Provide either recorded guard service, making recorded tours throughout the facility on a periodic basis and documenting any abnormal conditions; complete central station alarm service including burglary; or closed circuit cameras (CCTV) throughout the facility and have them transmitted to a constantly attended location. If guard service is used, patrol the perimeter hourly. Vary the schedule and route so as not to have a routine. If the facility operates 3 shifts a day, 7 days a week, make random periodic tours of idle areas, checking the locks on any uncontrolled gates, and document any abnormal conditions. Install door alarms on all doors that are not being used (exterior doors and doors to idle areas).

Review the recorded guard tours and documentation, alarms from the central station, and documentation of abnormal conditions during continuous operation to see if there is a pattern unlocked or damaged doors or windows.

If unrest is anticipated as a result of labor or civil issues, provide guard services or increase existing guard service to monitor facility. Relocate or reduce combustible material from the perimeter of the yard so the arsonist could not start a fire.

Monitor the fire department response in the area. If they respond to numerous “small” fires, elevate the surveillance of your facility.

Facilities with more than 50 people or operating on multiple shifts, use company identification (ID) badges with a photograph of the employee and if they have any restricted area access. Collect the badges when the employee leaves the company.

Have visitors/contractors sign in and out and have they escorted by employees. Have all visitors/contractors wear a “Visitor” badge while on the property.

Conduct a background check, within legal limits, on new employees. Monitor the employees that show signs of resentment to the company or who are having or have had bad family issues.

Conduct a background check, within legal limits, on contractors. If background checks are not available, escort the contractor to the work site and monitor their actions. If the contractor will be on site multiple times and they have passed the background checks issue them special ID badges.

Keep trash and other combustible debris to a minimum. Keep dumpsters away at least 30 ft (10 m) from the building and from under canopies. If possible lock the dumpsters.

Keep building heat on during the cold months. If it is impractical to maintain the building heat, convert the sprinkler systems to a dry-pipe system per PRC.12.1.1.4. Provide heat in the sprinkler riser room.

Inspect fire protection equipment per PRC.1.12.0. Check exterior doors weekly to make sure the locks work properly and the doors are in good condition. **Do not** chain or bolt doors shut if the doors are used as a means of egress during an emergency. If sprinkler control valves are not electronically supervised, and break-away locks are used, replace the locks with a hard shank lock and make sure security guards have copies of the keys or place a key along with the other keys in a “Knox Box” or fire department access box where only the fire department has access to the box.

Conduct periodic inspections of non-routine entry points such as windows, skylights, gates on fences, etc. to ensure they are still in good condition. Train the employees to notify management if they notice accumulation of combustibles where there should be accumulating. Have them report any unusual situations such as covers of junction boxes loose, equipment connected to electrical system that should not be connected, unusual conditions with the electrical equipment as this is one of the major ignition sources that can go undetected and hard to prove intentional ignition source.

If the facility has an Emergency Response Team (ERT), conduct periodic drills. Have them work with the local fire department/brigade and fire investigation unit to know what to do if they suspect a fire was set.

If the facility is open to the public, such as hotels, stores, hospitals, office buildings, universities, etc. restrict the public from non-public areas such as store rooms, mechanical rooms and basements.

As best as possible, keep valuable documents, contracts, drawings, records, in a fire-proof cabinets, vault or safe. If possible make duplicates and store them off-site.

DISCUSSION

According to www.gov.uk in England there were 4,370 deliberately set fires in 2015. According to the National Fire Protection Association between 2007 and 2011 there were 282,600 deliberately set fires in the United States. According to the Council of Canadian Fire Marshals and Fire Commissioners, in 2007 there were over 7,900 deliberately set fires in other than dwellings. While it appears the trend of deliberately set fires is decreasing, the cost of these fires has increased.

Arson fires are set on purpose, to either destroy evidence, to intimidate someone or a group, or to draw attention. There could be a single fire, or multiple fires. They can cause minor damage or destroy buildings and kill people.

There have been some well know arsonist that have gotten caught. A Fire Investigator with the Glendale (CA) Fire Department was convicted of three accounts of arson as a result of fires he set that caused thousands of dollars in damage to stores. A man, who was thrown out of a Happy Land nightclub in Bronx, New York, was convicted of murder after he set the fire that killed 174 people and destroyed the nightclub. Four teenagers set a fire at the Gothenburg discothèque in Gothenburg Sweden that killed 63 and caused thousands of Swedish krona (kr) in damage when they were denied entry to a party. A group of people called the Earth Liberation Front (ELF) set fire to a part of a ski resort in Colorado causing $18 million in damage, burnt approximately 30 SUVs at a car dealership, burnt down a $27 million, five-story, 206-unit condominium project under construction, set fire to several laboratories and multimillion dollar homes. A security guard for a department store was angry that he had to work on a Super Bowl Sunday. During the following week, while he was on night duty and the store was closed, he disabled numerous sprinklers and set a fire, causing several thousand dollars of damage.

While these cases are known, disgruntled employees and former employees have been known to have set a high number of fires. They know what areas are critical for production or have high values in a small area. Fires have been set at locations where there is labor unrest due to strikes and reduction of the work force. It is critical that if a person is laid off for whatever reason, there is labor unrest, or an employee is known to have a grudge security and awareness needs to be increase.

The arsonist production and storage occupancies will strike where there are a lot of combustibles and they think they can start the fire, escape from it, and not get caught. The area’s most hit are areas where there are very few people work such as a warehouse or at night when the facility is shut-down. In mercantile occupancies they will most of the time use a delay device in a secluded area so they can set the fire and get out without getting caught. Cameras should be positioned to cover areas where employees don’t cover all the time.

Yard storage is another target area. These areas have a large amount of combustibles such as idle pallets, heavy vegetation, very few people working in the area, no fire protection or detection, and the arsonist can escape easily. Security and moving the combustibles away from the building and property line will make it harder for an arsonist to strike.

FIRE PROTECTION EQUIPMENT INSPECTION

INTRODUCTION

Emergencies seldom give warning before they strike. Thus, it is essential that fire protection equipment be inspected, tested, and maintained to be certain it is operable at all times. To accomplish this, management must establish an effective fire protection equipment inspection program.

POSITION

- Perform fire protection equipment inspections at least weekly.
- Appoint a qualified individual as the Fire Brigade Chief or Emergency Response Coordinator to monitor the program and report to management. The qualifications for the Brigade Chief or Emergency Response Coordinator are included in PRC.1.7.0.
- Select and train individuals with appropriate mechanical aptitude to conduct the inspections and tests of fire protection equipment.
- Initiate a complete survey of the fire protection equipment at the facility to determine the scope of the inspection program.
- Make an initial tour with the inspector to identify any problems with procedures and verify the practicability of the reporting system.
- Establish effective procedures for reviewing the inspection results.
- Initiate prompt action to correct any noted deficiencies.
- File the results for subsequent AXA XL Risk Consulting review.
- Sign contracts for periodic testing and emergency maintenance of specialized fire and explosion protective systems.

DISCUSSION

Fire protection equipment, like all other equipment, deteriorates with time. It is also vulnerable to external influences such as corrosive environments, tampering, accidental damages, and careless use. Further, since fire protection equipment is used infrequently, it must be inspected and tested regularly to determine its condition, its operability, and its need for routine maintenance. Detecting an unsatisfactory condition prior to an emergency is far better than discovering it during the emergency.

Once the inspectors are selected, they must be properly trained. Several features this training should include:

- Reviewing of existing protection equipment and its maintenance, operation and testing techniques and familiarization with newly installed fire protection equipment.
- Attending appropriate schools and seminars. AXA XL Risk Consulting offers a one-week course covering the fundamentals of industrial fire protection equipment.
- Making copies of manufacturers' instruction manuals and other data available in a centralized training file.
- Accompanying AXA XL Risk Consulting's representatives during their loss prevention surveys, asking them questions and learning from their experience.

Base the inspection schedule on the requirements in the various NFPA Codes. Consult NFPA 25 and PRC.12.0.2 as a basis for testing water based systems and NFPA 72 and PRC.11.1.1.0 for protective signaling systems.

The inspection recording system must include a variety of data to guide inspectors and enable them to adequately record their results. A computerized inspection procedure should be developed to help track problems with equipment and to minimize overlooking equipment. AXA XL Risk Consulting recommends that each location have a custom-designed inspection recording system for the inspections. Although AXA XL Risk Consulting has available a sample fire protection equipment inspection form (see PRC.1.12.0.A) to use to develop a custom-tailored report form, there are many other sources that could be used. In the appendix of NFPA 25, there are two sample forms for water-based extinguishing systems.

When custom-designing a form or computerized program, include the appropriate sections. For example, PRC.1.12.0.B contains a suggested fire door checklist showing items that should be inspected for all types of fire doors. Forms should be printed with facility identification numbers such as building and valve numbers and may be limited by design to include only the equipment encountered at the facility.

Inspect all fire protection equipment. As a minimum, AXA XL Risk Consulting recommends the inspection frequencies that follow, although under certain circumstances the management of some facilities may feel that more frequent inspections are desirable. An example of a condition requiring more frequent inspection would be a strike by facility employees.

In the course of making the inspection, any unsatisfactory condition relating to fire protection should be reported. Such deficiencies might include stock piled too near the sprinkler heads; bent sprinkler piping; sprinkler heads that are painted, corroded or otherwise obstructed; and blocked fire doors. Any deficiencies should be noted for correction or repair.

The weekly inspection should include, but not necessarily be limited to, verification that:

- All fire protection control valves are open and sealed.
- System air pressure and priming water levels in dry pipe systems are proper and adequate room heat is provided.
- Visually inspect all fire doors and shutters. Look for stock blocking the door, bent rails or shroud, missing fusible links and missing rollers.
- Public and private water supplies are in service.
- Critical components of automotive fire apparatus are checked in accordance with PRC.1.12.0.C. The manufacturer's recommendations should be followed.
- Special extinguishing systems, including carbon dioxide, dry chemical, foam, foam-water, explosion suppression and spark extinguishing systems are in service. Critical components should be examined in accordance with the manufacturer's recommendations.
- Water supply tanks are full, heaters operational and exterior in good condition.

- Fire pumps are operated; checklist completed and pumps controller left in automatic operation. The checklist should be based on the requirements of NFPA 25. The controllers should be tested in accordance with PRC.14.2.1.3.

At least once a month, the following should be inspected:

- Drain dry pipe system low points. Inspect the weights, where provided, of deluge and pre-action valves to be certain there is no corrosion or obstruction that would prevent it from falling freely. Various types of sprinkler systems may require additional inspection of special design features. Certain items such as sprinkler system water supply pressure and dry pipe valve air pressure may require more frequent checking.
- Fire pump checklists completed and pump controllers left in automatic operation. Base the checklist on the requirements of NFPA 25.
- Hand-portable and wheeled fire extinguishers and inside hose connections to be certain they are accessible, properly placed and maintained. Each extinguisher should be properly charged and a tag should be attached indicating that it has been serviced within the last year and hydrostatically tested as required. At each inside hose connection, the nozzle should be properly attached and in the shut position, and the hose should be correctly racked and connected to the supply piping. A checklist or plan showing the location and type of units should be available to aid the inspector in making certain each unit is inspected (see PRC.1.12.0.D).
- Hose houses, hydrants and monitor nozzles to be certain they are well-arranged, properly equipped and maintained and accessible at all times. A list of required equipment should be posted in each hose house. Equipment in the hose houses should be inventoried against this list.
- Fire doors and shutters manually closed to check for proper operation.
- Explosion-relief vents to be certain that nothing will hinder their proper operation.

At least once a quarter, the following should be inspected:

- Sprinkler system static and flowing water pressures to be sure that they are at acceptable levels, that alarm control valves are open and sealed, and that alarms are operating properly. System air pressure and priming water levels in dry pipe systems should be checked and low points should be drained. Supervisory air pressure in deluge and preaction systems should be checked. The weight in some types of deluge and pre-action valves should be inspected to be certain there is no corrosion or obstruction that would prevent it from falling freely. Various types of sprinkler systems may require additional inspection of special design features. Certain items such as sprinkler system water supply pressure and dry pipe valve air pressure may require more frequent checking.
- Protective signaling system components such as waterflow and gate valve supervision have been tested.

Once the entire facility has been inspected and the report form filled out, the inspector should forward the report for appropriate management review. Deficiencies should be promptly corrected. A copy of the report should be filed for review by the AXA XL Risk Consulting representative.

Where more detailed maintenance is required on fire or explosion protection systems, such operations should be included in the maintenance information system (see PRC.1.3.0).

Additional inspections and tests should be conducted at various times during the year. A special inspection of the facility should be made prior to the onset of cold weather (see PRC.1.12.0.E). More complete performance tests of various fire protection equipment may also be necessary (see PRC.1.12.0.F).

SUGGESTIONS FOR CONDUCTING THE FIRE PROTECTION EQUIPMENT INSPECTION

WEEKLY CHECKLIST

The following should be completed weekly.

Water Supply, Sectional and Sprinkler System Control Valves

- Identify each fire protection valve. Where valves are not already identified, establish an identification system such as numbers for sprinkler control valves and letters for all other valves. Use of building or area numbers as prefixes will aid in identifying the area controlled by each valve.
- Visually inspect each valve to make sure it is open and sealed. Mark the form accordingly.
- If a valve is found unsealed, confirm that it is open by turning the valve wrench or wheel to the full open position. The wrench or wheel should then be backed off slightly and the valve resealed. Where possible, a drain test should be performed downstream of the valve to confirm that it is open. See Quarterly Checklist, first paragraph, third bullet, for the specific test procedure. If a valve is locked, it should also be sealed.
- If a valve is found shut, investigate the reason for the closure and promptly have it opened if appropriate. Follow AXA XL Risk Consulting's RSVP (Restore Shut Valves Promptly) Procedures. (See *OVERVIEW* Section 1 [PRC.1.1.0].) Indicate the reason for the closure under the Additional Comments and Recommendations section on the form.

Wet Pipe, Dry Pipe, Deluge and Pre-Action Sprinkler Systems

- Check each dry pipe system for adequate air pressure. This pressure should be 20 psi (1.4 bar) above the trip pressure of the dry pipe valve. The AXA XL Risk Consulting's representative can identify the trip pressure. If the pressure is low, it should be corrected.
- Check each deluge or pre-action system for proper supervisory air pressure.
- Check the temperature in buildings protected by wet pipe sprinkler systems and in enclosures containing dry pipe, deluge and pre-action valves. The temperature in these areas is considered adequate if it is at least 40°F (4.4°C). During periods of extremely cold weather, such as when temperatures remain below freezing for an extended period, temperatures should be checked daily.

Public Water Supply

- Indicate whether the public water supply is in service. Record the static pressure reading of the public water supply. If the reading is below normal, make an appropriate notation on the form. Where private pumps, gravity tanks or pressure tanks supply the same system, take the static pressure reading on the public water supply side of the check valve. If not already provided, a pressure gauge should be installed at that location.
- Confirm that the backflow preventer is in operational condition. For reduced pressure assemblies and reduced pressure detector assemblies, ensure the differential-sensing valve relief port is not continuously discharging.
- Manually check the fire department connections for conditions noted on the inspection form. If caps are missing from the inlets, confirm that there is no debris in the piping up to the check valve before reinstalling the caps.

Fire Pumps

- Suitably identify each fire pump at the facility.
- Complete a fire pump checklist for each pump.

Water Supply Tanks

- Identify the tanks by number or other suitable means.
- Visually examine each tank for leaks or structural problems, such as external corrosion, broken ladders and broken tie rods.
- Check the water level of each tank to verify that it is full. Gravity and suction tanks should be overflowed when weather permits.
- During cold weather, verify on a daily basis that the heater is operational and record the water temperature. Tank water temperature should be at least 42°F (5.5°C) at all times.

Automotive Fire Apparatus

- Determine that each piece of apparatus is ready for immediate use, making an appropriate notation on the inspection form.
- Prepare an Automotive Fire Apparatus Checklist for each unit. PRC.1.12.0.C contains a suggested checklist. This checklist should be customized for each piece of apparatus.

Special Extinguishing Systems

- Identify all special extinguishing systems by the hazard protected or other suitable means.
- Indicate the type of system. Types include carbon dioxide, dry chemical, foam, foam-water, halon or other clean agent systems, explosion suppression and spark extinguishing systems.
- Inspect each system to be sure it is in service.
- Indicate the date the system was last serviced.
- Indicate the date the system was last tested.

Fire Doors

- Ascertain that all fire doors and shutters are in good condition. Test the action of automatic sliding and counter-balanced doors by manually raising the counterweight to see if the door closes. The metal cladding on the doors should be inspected to make sure it has not been damaged. All necessary hardware, including latches, guides and thresholds where provided, should be inspected.
- Complete a fire door checklist.

MONTHLY CHECKLIST

The following should be completed monthly.

Wet Pipe, Dry Pipe, Deluge and Pre-Action Sprinkler Systems

- Visually spot check the condition of pipe hangers, piping and fittings. Look for corrosion, stock too close, missing hangers and material hanging from sprinkler piping.

Fire Pumps

- Complete the fire pump checklist for each pump.

Fire Extinguishers, Inside Hose Connections and Standpipes

- Inspect each fire extinguisher, inside hose connection and standpipe to determine that the unit is in service and accessible.

- Complete a Fire Extinguisher and Inside Hose Connection Report form. PRC.1.12.0.D contains a suggested form. This form may be customized as necessary.

Hydrants, Hose Houses, and Monitor Nozzles

- Identify each hydrant, hose house and monitor nozzle at the facility.
- Check each monitor nozzle and hydrant to be sure that it is accessible and properly drained. Hydrant caps should be easily removable and hose gate valves should be free to turn. In cold weather, the hose gate valves should be left half-open to prevent damage from freezing.
- One way to determine if the hydrant is drained is to remove a hydrant cap and strike the opening smartly with the palm of the hand. A deep, hollow sound indicates a drained barrel.
- Make sure that the locking mechanism for each monitor nozzle operates freely. Nozzle tips should turn freely. Where monitor nozzles are pre-aimed and pre-adjusted, the settings should be visually checked to verify that they are proper.
- Check the equipment in each hose house to be certain that it is adequate and in good condition. A list of the equipment that should be present should be posted inside each hose house.

Fire Doors

- Ascertain that all fire doors and shutters are in good condition. Test the action of automatic sliding and counter-balanced doors by manually raising the counterweight to see if the door closes. Operate the fire doors occasionally by disconnecting the fusible links. The metal cladding on the doors should be inspected to make sure it has not been damaged. All necessary hardware, including latches, guides and thresholds where provided, should be inspected. The checklist should be completed.
- Make certain that automatic closing mechanisms are operable. Fusible links should be checked to be sure that they are free of paint and other foreign material. Other releasing devices should be tested to verify their operability.
- Inspect the area around vents to be sure that clearance is available to allow full operation. Explosion vents should be unobstructed and the path of the vents is clear of material that could become missiles.

Protective Signaling Systems

- Test the systems in accordance with the instructions contained in the NFPA 72 and PRC.11.1.1.0. Such tests will verify the proper operation of alarm, supervisory and trouble signals.
- When possible accompany the protective signaling system contractors when they examine equipment and perform tests.

QUARTERLY CHECKLIST

The following should be completed quarterly.

Wet Pipe, Dry Pipe, Deluge and Pre-Action Sprinkler Systems

- Identify all sprinkler systems by number, area protected or other suitable means.
- Test all sprinkler system alarms using proper test connections and procedures.

CAUTION*: Before starting the test, notify the fire department and the central, remote or proprietary station alarm service as necessary*.

Test wet pipe sprinkler system alarms using the inspector's test connection to simulate the operation of a single sprinkler head. This connection is normally located near the end of the system. In a multi-story building, the connection is usually found on the top floor. Dry pipe, deluge and pre-action sprinkler system alarms are tested by opening the alarm test bypass valve. When testing the alarm for a dry pipe system, hold in the plunger on the automatic drain from the dry pipe valve as the bypass valve is slowly opened.

***CAUTION**: While a trickle of water from the automatic drain is normal, a heavy flow could result in the accidental tripping of the dry pipe valve. When a heavy flow is noted, the bypass valve should be shut immediately*.

- Conduct a "drain test" on each system to determine if the valves controlling the sprinkler systems are open.

***CAUTION**: Before opening the drain valve, make certain that the fire department and appropriate alarm service have been notified and that the drain is clear and discharges to a safe location*.

To conduct this test, read "static" and "flowing" pressures on the gauge connected below each wet pipe, dry pipe, deluge or pre-action valve. Open the system drain valve fully and flow water until the pressure stabilizes. Record this flowing pressure.

Close the drain valve slowly to avoid creating an artificially high pressure due to water hammer. Then record the static pressure. Static pressure taken during this test may vary slightly from the pressure of previous tests due to normal variations in water supply usage.

The difference between the static and flowing pressures represents the pressure loss between the supply and the riser gauge connection with water discharging through the fully open drain valve. This differential is important and should approximate the differential recorded on the RSVP riser label. If the differential increases materially from that shown on the label, the cause should be investigated. If the static pressure does not return promptly to normal, the reason should be determined and corrective action taken as necessary.

Fire pumps should be left on during drain tests. This will ensure the integrity of vital water supplies should a fire occur during these tests.

Fire Pumps

- Complete the fire pump checklist for each pump.

Protective Signaling Systems

- The systems should be tested in accordance with the instructions contained in the NFPA 72. Such tests will verify the proper operation of alarm, supervisory and trouble signals.

Other Protection Deficiencies

- Check for deficiencies in the items listed.
- Note the location of the deficiencies.

Record the deficiencies or recommendations, which should be called to the attention of the reviewer.

SUGGESTED CHECKLIST FOR FIRE PROTECTION EQUIPMENT

OVERVIEW FORMS PACKET
(See PRC.1.12.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

FIRE PROTECTION EQUIPMENT INSPECTION REPORT

Facility: ____________________ Conducted By: ____________________

Location: ____________________ Date: ____________________

The Following Items Should Be Checked At Least Weekly.

Any "No" response should be explained.

WATER SUPPLY, SECTIONAL, AND SPRINKLER SYSTEM CONTROL VALVES

Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed

PUBLIC WATER

Public water supply in service? ☐ Yes ☐ No ____________________ Pressure: ________psi

Fire department connection accessible, caps in place, couplings free to rotate? ☐ Yes ☐ No ____________________

FIRE PUMPS

Pump ID	Type	Set For Auto.?		Operated Today?		Checklist Completed?		Comments
		Yes	No	Yes	No	Yes	No	

WATER SUPPLY TANKS

Tank ID	Tank Full?		Heater Working?		Water Temp.		Comments
	Yes	No	Yes	No			

AUTOMOTIVE FIRE APPARATUS

Each fully in service? ☐ Yes ☐ No ____________________

Checklist completed? ☐ Yes ☐ No ____________________

SPECIAL EXTINGUISHING SYSTEMS

System ID	Type	In Service?		Date Last Serviced	Date Last Tested	Comments
		Yes	No			

The Following Items Should Be Inspected At Least Monthly.

Any "No" response should be explained.

WET PIPE, DRY PIPE, DELUGE, AND PRE-ACTION SPRINKLER SYSTEMS

System ID	Alarm Tested?		Water Pressure			Heat Adequate?		Air/ Supv. Press.	Comments
	Yes	No	Static	Flow	Differential	Yes	No		

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FIRE EXTINGUISHERS, INSIDE HOSE CONNECTIONS, AND STANDPIPES

Each unit in service? ☐ Yes ☐ No ______

Checklist completed? ☐ Yes ☐ No ______

HYDRANTS, HOSE HOUSES, AND MONITOR NOZZLES

Monitor Nozzle/ Hydrant ID	Accessible?		Drained?		Equipment				Comments
					Adequate?		Cond. OK?		
	Yes	No	Yes	No	Yes	No	Yes	No	

FIRE DOORS

Fire doors and shutters in good condition? ☐ Yes ☐ No ______

Automatic closing devices operable? ☐ Yes ☐ No ______

SMOKE AND HEAT, AND EXPLOSION-RELIEF VENTS

Vents operable? ☐ Yes ☐ No ______

Areas around vents unobstructed? ☐ Yes ☐ No ______

PROTECTIVE SIGNALING SYSTEMS

All systems been tested satisfactorily? ☐ Yes ☐ No

OTHER PROTECTION DEFICIENCIES FOUND DURING THE COURSE OF EACH INSPECTION SHOULD BE REPORTED BELOW:

	Yes	No	If "Yes," note location.
Stock within 36 in. of sprinkler heads?	☐	☐	
Sprinkler heads or piping bent?	☐	☐	
Sprinkler heads painted?	☐	☐	
Sprinkler heads or piping corroded?	☐	☐	
Sprinkler heads loaded with debris?	☐	☐	
Items hanging from, or supported by sprinkler heads?	☐	☐	
Sprinkler heads obstructed by partitions?	☐	☐	
Signs of internal sprinkler piping obstruction?	☐	☐	
Fire doors blocked by materials?	☐	☐	

ADDITIONAL COMMENTS AND RECOMMENDATIONS

______

Report reviewed by: ______ (signed) Position: ______

Has prompt action been initiated? ☐ Yes ☐ No ______

FILE FOR REVIEW BY AXA XL RISK CONSULTING REPRESENTATIVE

OVERVIEW FORMS PACKET
(See PRC.1.12.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

SUGGESTED CHECKLIST FOR FIRE PUMP INSTALLATIONS

Facility: ______________________ Conducted By: ______________________

Location: ______________________ Date: ______________________

Pump Identification: ______________________ Type of Driver: ______________________

Make of Pump: ______________________ Location of Pump: ______________________

Rated Flow: ____________ Rated Pressure: ____________ Rated Speed: ____________

When checking each fire pump, the following should be determined. A "No" answer indicates a deficiency which should be corrected.

		YES	NO
1.	**For All Pump Installations**		
a.	Is fire pump suction valve(s) open and sealed?	☐	☐
b.	Is suction tank full and adequately heated?	☐	☐
c.	Is the pond, lake, reservoir, or other suction supply at a normal level?	☐	☐
d.	Is suction crib clean and free of debris, ice, or other obstruction?	☐	☐
e.	If a fire department connection is provided, is it accessible, and are the caps in place and the couplings free to rotate?	☐	☐
f.	Is fire pump discharge valve open and sealed?	☐	☐
g.	If a booster pump, are all valves on the by-pass open and sealed?	☐	☐
h.	Is jockey pump suction valve open and sealed?	☐	☐
i.	Is jockey pump discharge valve open and sealed?	☐	☐
j.	Is jockey pump controller switch “on”?	☐	☐
k.	Is jockey pump running normally, not excessively?	☐	☐
1.	Is controller in “automatic” position?	☐	☐
m.	Did pump start automatically upon drop in pressure?	☐	☐
n.	Was pump starting pressure proper?	☐	☐
o.	Is “shut-off pressure” normal?	☐	☐
p.	If pump takes suction under lift, did the priming system(s) function properly?	☐	☐
q.	Is circulation relief valve operating at shut-off pressure?	☐	☐
r.	Are pump bearings and seals running at the proper operating temperature?	☐	☐
s.	Did local and remote pump alarms and supervisory signals operate properly?	☐	☐
t.	Is valve to hose header shut, and is header drained?	☐	☐
u.	Is pump room clean and free of excess combustibles?	☐	☐
v.	Is there a Class BC fire extinguisher in this pump room?	☐	☐
w.	Is pump room adequately heated?	☐	☐
2.	**For Internal Combustion Engine-Driven Fire Pump**	☐	☐
a.	Is weekly program timer operating properly?	☐	☐
b.	Did the pump room combustion air damper open?	☐	☐

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		YES	NO
c.	Did the cooling water waste properly?	☐	☐
d.	Did the pump start on each set of batteries?	☐	☐
e.	Is lubricating oil level correct?	☐	☐
f.	Is engine coolant level correct?	☐	☐
g.	Is liquid at proper level in all batteries?	☐	☐
h.	Are battery hydrometer readings within acceptable limits?	☐	☐
i.	Is each battery pilot light on?	☐	☐
j.	Is battery charger functioning properly?	☐	☐
k.	Is fuel tank full?	☐	☐
l.	Is fuel line valve open and sealed?	☐	☐
m.	Did low oil pressure alarm test satisfactorily?	☐	☐
n.	Did high engine temperature alarm test satisfactorily?	☐	☐
o.	Did interruption of AC power to the controller cause engine to start or initiate a remote supervisory signal?	☐	☐
p.	Did the overspeed-shut-down-device-position switch work properly?	☐	☐
q.	Is interruption-of-battery-power alarm working properly?	☐	☐
r.	Is controller locked, and are keys accessible to authorized personnel?	☐	☐
s.	Was engine run for 30 minutes?	☐	☐
t.	Did engine achieve and maintain proper operating temperature?	☐	☐
3.	**For Electric Motor-Driven Fire Pump**	☐	☐
a.	Was pump run for 7 minutes?	☐	☐
b.	Did motor achieve and maintain proper operating temperature?	☐	☐
c.	Is the circuit breaker in the closed position?	☐	☐
d.	Is the “power available” light on?	☐	☐
4.	**For Steam-Driven Fire Pump**	☐	☐
a.	Is proper supply of lubricants on hand and is lubrication system operable?	☐	☐
b.	Is the steam chest or casing at operating temperature?	☐	☐
c.	Are steam traps operating, or was condensate manually drained?	☐	☐
d.	Is sufficient steam pressure maintained at all times?	☐	☐
e.	Was a “slip test” made?	☐	☐
f.	Was the pump run for 5 minutes?	☐	☐
g.	While operating at rated speed, was the vibration within acceptable limits?	☐	☐

Deficiencies or other comments: ______________________________

____

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SUGGESTED AUTOMOTIVE FIRE APPARATUS CHECKLIST

OVERVIEW FORMS PACKET
(See PRC.1.12.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

SUGGESTED AUTOMOTIVE FIRE APPARATUS CHECKLIST

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Make of Apparatus: ______________________ Type of Apparatus: ______________________

When checking automotive fire apparatus, the following should be determined. A "No" answer indicates a deficiency which should be corrected.

		YES	NO
1.	Are the terminals on the batteries clean and the cable clamps tightly connected?		
2.	Is each battery clean and securely mounted?	☐	☐
3.	Is battery liquid at proper level?	☐	☐
4.	Is each battery hydrometer reading within acceptable limits?	☐	☐
5.	Is the trickle or automatic charger operating?	☐	☐
6.	Is the crank case oil level correct?	☐	☐
7.	Is the coolant level in the radiator correct?	☐	☐
8.	Were the brakes pressure-tested by operating the foot pedal?	☐	☐
9.	Were the air brakes bled to remove condensate?	☐	☐
10.	Was the apparatus started and driven for 10 minutes and then allowed to idle for an additional 20 minutes at not less than 1000 rpm?	☐	☐
11.	Is the engine speed (rpm) maintained when the ignition switch is either in the A or B position?	☐	☐
12.	Is fuel tank full?	☐	☐
13.	Is booster tank water level full?	☐	☐
14.	Is foam tank full?	☐	☐
15.	Are tools, appliances, and portable equipment in proper location and in working condition?	☐	☐
16.	Are lights, sirens, and horns operable?	☐	☐
17.	Is engine clean, and free of an accumulation of oil and moisture around its wiring or electrical equipment?	☐	☐
18.	Is the underside of the apparatus clean?	☐	☐
19.	Is each tire properly inflated and free of cuts, breaks, and foreign objects?	☐	☐
20.	Are special extinguishing systems such as dry chemical, carbon dioxide, and Halon in working order?	☐	☐
21.	Did pump suction and discharge valves operate freely?	☐	☐
22.	Are pump caps and couplings free to turn?	☐	☐
23.	Are the hydraulic systems of aerials, ladders, elevated platforms, and articulating booms in proper operating condition?	☐	☐
24.	Has regular preventive maintenance been performed on the engine, chassis, pump, and other mechanical and electrical equipment?	☐	☐

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SUGGESTED FIRE EXTINGUISHER AND INSIDE HOSE CONNECTION REPORT FORM

OVERVIEW FORMS PACKET
(See PRC.1.12.0 in the OVERVIEW Manual)
Published as part of AXA XL Risk Consulting

SUGGESTED FIRE EXTINGUISHER AND
INSIDE HOSE CONNECTION REPORT FORM

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Fire Extinguishers

Number	Location	Type and Size	Charged?		Properly Installed?		Last Serviced	Comments
			Yes	No	Yes	No		

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Inside Hose Connections/Standpipes

Number	Location	Hose Size	Hose Length	Hose Cond.	Rack Cond.	Comments

Is any change in the distribution of extinguishers or inside hose connections needed?

☐ YES ☐ NO, Explain. ______________________________

____

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Additional comments and recommendations: ______________________________

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ANNUAL COLD WEATHER INSPECTIONS

Cold weather and freezing temperatures are a normal occurrence each year in much of the world. In some areas, however, cold weather is usually not considered a matter of concern. Temperatures in these areas seldom reach freezing and when they do, they remain there for a relatively short period of time, usually no more than a few hours.

Such lack of concern may not be justified. Loss experience illustrates that shifts in the jet stream can cause bitterly cold arctic air masses to press deeply into the warmer climes, sustaining freezing temperatures for periods of several days. At the same time, these unusual arctic air masses cause temperatures in normally cold areas to drop well below freezing, even well below zero, for periods of up to three weeks.

Therefore, facilities located in all but tropical latitude (less than 23.5°) must take precautions before the cold season each year. Unless proper precautions are taken before winter arrives, even the best fire protection equipment may freeze and leave a major portion of a facility defenseless. Neglect of proper precautions has directly contributed to many disastrous fires in past winters. While many of these precautions are actually taken by the maintenance department, the fire protection equipment inspector must make sure the following items have been completed by appropriate personnel before cold weather (see PRC.1.3.0.A).

- General
    - Promptly clear snow from access ways, control valves, hydrants, hose cabinets, heat and smoke vents, explosion-relief vents, and other essential equipment to permit effective operations in event of an emergency.
    - Weathertight all doors, windows, skylights, ventilators, and other openings so they will not admit cold air that could cause the fire protective system to freeze.
- Sprinkler and Inside Hose Systems
    - Maintain temperature above 40°F (4.4°C) at all times in buildings equipped with wet pipe sprinkler systems. Convert areas, which are inadequately heated to dry pipe or pre-action systems.
    - Inspect dry pipe sprinkler systems carefully to make sure that the piping is properly pitched for drainage. Drain any condensation that collects in low points in the piping. Remove excessive priming water.
    - Install sprinkler heads with the correct temperature rating in the immediate vicinity of steam pipes, unit heaters, or other heat producing appliances.
    - Test the solutions in all anti-freeze sprinkler systems and add anti-freeze as necessary.
    - Close, tag, and properly drain any “shut-in-winter” valves controlling small unheated areas. Consider converting such systems to either a dry pipe or a pre-action system.
    - Close, tag, and properly drain all wet standpipe systems with piping located in areas subject to freezing.
    - Inspect connections to water motor gongs and fire drain department connections.
- Fire Protection Water Tanks
    - Inspect expansion joint and riser boxing to see if they are in good condition. Gravity tanks must not leak, since an accumulation of ice on trestles can cause the tank structure to collapse.
    - Check the water temperature in the gravity tank daily during cold weather and maintained at no less than 42°F (5.5°C).

   - Flush, inspect and repair, if necessary the tank heating system.
   - Tightly fit and fasten the tank roof-hatch cover.
- Hydrants and Underground Piping
   - Drain hydrants and fire pump hose headers. Leave outlet hose valves half open to prevent damage from freezing.
   - Properly drain and dry hoses.
   - Inspect the packing on post indicator valves for leakage.
   - Drain or otherwise protect against freezing, sections of exposed piping.
   - Inspect valve and meter pits to determine if they are dry and frost-proof.
- Verify portable and wheeled fire extinguishers are suitable for cold areas; otherwise store them in heated cabinets.
- Service Automotive Fire Apparatus for winter.

FIRE PROTECTION EQUIPMENT PERFORMANCE TESTS

In addition to weekly tests, numerous other fire protection equipment performance tests may be made during the year. When these tests involve shutting off fire protection, proper impairment handling procedures must be followed (see *OVERVIEW*, Section 1 [PRC.1.1.0]). Testing which involves flow of water should be conducted during periods of the year in which freezing is not a problem. Routine maintenance of fire protection equipment is appropriately covered in PRC.1.3.0.A, Maintenance Inspections.

ANNUAL TESTS

- Flow test all fire protection water supplies. These include individual performance tests of fire pumps, gravity tanks, pressure tanks, standpipes, reservoirs, connections to public water systems, and automotive fire apparatus.
- Trip test pre-action sprinkler systems and deluge sprinkler systems.
- Examine fire hose and hydrostatically test it to the maximum available system pressure.
- Test explosion-relief vents to be certain they will operate.
- Test fire doors and shutters to be certain they will operate. Close the door or shutter by tripping the detector or removing the fusible link.
- Trip test all dry pipe valves. A full flow test should be conducted every three years.

SEMI-ANNUAL TESTS

- Test (fully open and close) and lubricate all hydrants.
- Trip test quick opening devices on dry pipe sprinkler systems.
- Test detection, actuation, and alarms on deluge, pre-action, carbon dioxide, foam, dry chemical, explosion suppression, and spark extinguishing systems at least twice a year. A functional test of the entire system should be conducted annually.

PERIODIC TESTS

- Flow test public water supplies from public hydrants where private hydrants are not available. Tests should be conducted at least every five years by public water department personnel.
- Insist that the manufacturer's representative, contractor, or installer perform an acceptance test for each piece of newly installed fire protection equipment in accordance with proper procedures. This test should be run before the equipment is put in service.
- Test the detectors on each automatic fire alarm system semiannually in accordance with NFPA 72.
- Test protective signaling systems quartly in accordance with NFPA 72.
- Test and recalibrate combustible gas detection equipment monthly. Those that are located in severe environments should be tested and recalibrated more frequently.

HAZARD IDENTIFICATION AND EVALUATION

INTRODUCTION

Most operations, processes and machines have one or more hazards. Since each hazard represents a potential loss, each must be identified and evaluated. Such evaluations enable management to determine when control or protective measures are necessary, to decide what form those measures should take, and to set priorities that give immediate attention to the most severe or most probable hazards. Formal management recognition of the hazard identification and evaluation process is an essential part of an effective loss prevention and control program.

In the past, hazards were identified and evaluated on the basis of intuition and experience. At best, the experience of several persons would be combined to assess a given situation to identify and evaluate the hazards. As equipment and processes became more complex, it was not always possible to identify all the hazards. As a result, formal and improved methodologies were developed to identify and evaluate hazards. These methodologies are often complex and potentially time-consuming and expensive, but they are necessary.

While the need to identify, evaluate, and control hazards is continuous, the costs involved must be balanced against other demands on financial resources. Management should develop criteria for the use of hazard identification and evaluation procedures in specific processes, activities and equipment based on the potential consequences. Competent hazard evaluation leads to cost-effective loss prevention and by eliminating the “shotgun” approach to safety.

No single method of hazard identification and evaluation will suit every company or situation. Simple methods, utilizing the experience of loss prevention and operating personnel, work well in a broad range of operations and activities. When new, modified, or complex processes and equipment are introduced, more formal methods of hazard evaluation and risk analysis may be required.

POSITION

Establish and implement a program of hazard identification and evaluation as follows:

- Incorporate a hazard identification and evaluation philosophy into the corporate loss prevention policy statement. This should include specific criteria to establish:
    - Equipment, operations and processes that must be assessed and when the assessments are to be performed.
    - Components, systems or procedures that are “critical.” Critical components, systems, or procedures are those that, if out of service or not followed, could result in a catastrophic loss. These include fire, explosion, loss of containment of hazardous materials or

extended plant shutdown. If critical components or systems are out of service, the process or operation must be shut down.

- Assign specific responsibility for determining the magnitude of the potential loss associated with various operations, equipment and processes.
- Decide what methods and resources will be applied to existing operations, processes and equipment. Assign specific responsibility for implementing hazard identification and evaluation studies. Where formal methods of hazard identification and evaluation are warranted and personnel with training in these methods are not available in-house, consulting firms with the necessary capability to conduct the reviews and assessments of the hazards may be employed.
- Chose the type and level of loss prevention controls to be implemented in accordance with the results of the study and the magnitude of the potential loss.
- Confirm that critical components, systems or procedures are identified.

Since new hazards are as important as existing ones, the hazard identification and evaluation program must include attention to Management of Change (MOC) so that changes which require evaluation receive it. MOC is discussed in PRC.1.0.2.

DISCUSSION

In the early history of industry, simple processes were performed by artisans or by very close-knit guilds or similar organizations. Hazard analysis was either very simple or was performed by trial and error. Many hazards were not recognized. Later, industry began to use machinery and hazard recognition became more complex. It was eventually recognized that the Darwinian approach to hazard analysis was not cost-effective. However, technological advancement was slow enough that experience-based, subjective systems were still adequate. They represented the best available methods until the early 1950s. These methods still have limited application, and are capable of producing excellent results if the appropriate resources are available.

Gradually, methods and disciplines developed so that review of specific operations, processes or equipment could combine the experience of several persons in a formal procedure to identify and evaluate hazards. In addition, the study of “Systems Safety” generally concluded that hazards were products of the interaction of the persons involved, the machines or equipment in use, the media or environment, and the influences of the management which controlled the activity in question.

With the advent of complex aerospace systems and modern chemical plants, it became even less acceptable to learn about hazards the “hard way.” Considerable effort was directed at predictive procedures and techniques to identify and evaluate hazards and to assess the overall risks involved in processes for which no experience exists. A number of techniques have been developed that make it possible to identify and evaluate most hazards during the design stage of equipment and processes. While these methods have been tremendously improved, they are not infallible. Some of the techniques are complex, time-consuming and expensive.

A review of the more common techniques follows:

- Process/system checklists ensure compliance with standard procedures. The limitations are obvious - the process or equipment involved must be sufficiently well established that standards exist, and an individual with sufficient knowledge of the process and standards must be available to write the checklist. If this system is used, audit and update the checklist regularly. Occasional review of the checklist by an independent authority would be desirable.
- Safety reviews are similar in nature but more flexible in application. Also known as process reviews or loss prevention reviews, they are typically conducted by a specialty team. In addition to in-depth knowledge of the facility, processes and procedures, the team or inspector must have excellent people skills and extreme tact to avoid being perceived as an enemy trying to “get the goods” on the operating staff. Safety reviews require more resources than

checklists. However, they are capable of a much more complete analysis, and also have some ability to deal with changes immediately.

- "What if" analysis is the predictive form of the safety review. It involves an analysis in which a team postulates events and estimates their consequences. The technique is capable of sound qualitative risk analysis if the performing team is sufficiently skilled to ask the right questions. With no formal structure, there is no guarantee.
- Preliminary Hazard Analysis is a formal technique for qualitative risk assessment which is applied in the very early stages of a project to focus design attention on potential hazards while it is still possible to do so. It addresses specific areas such as raw materials, equipment, environment and the operations to be performed. The most important point is that this analysis can detect hazards at a time when elimination is possible - a far better tactic than dealing with the hazard later.
- Relative ranking is one technique for quantitatively assessing risk. The Dow and Mond Hazard indices are examples. The analyst examines the process, assigns penalties for materials and conditions which may contribute to loss, and assigns credits for safety features that may reduce exposure. Financial data may be incorporated, resulting in estimates of direct and indirect expense. While somewhat less subjective than the previous methods, the experience of the analyst is still important.
- The Hazard and Operability (HazOp) Study is designed to formally analyze new or novel technology not only for hazards but also productivity. The technique can be applied to existing processes as well. A properly performed HazOp study, while very efficient at ferreting out potential hazards, can be very expensive. It is usually performed by a team of five to seven persons, at least one of whom is specially trained in the technique. The team itself may require 3 h per major hardware item, with up to an additional two or three times as many hours for preliminary planning and data gathering.
- Failure Modes, Effects and Criticality Analysis (FMECA) and Failure Modes and Effects Analysis (FMEA) can be applied to new or existing operations. While not as in-depth (though consequently less costly than) as a HazOp study, they make a good first cut in a variety of circumstances. The principal weaknesses are that human errors are not addressed, and only single-component failures are considered. FMECA includes a ranking of risk; FMEA does not.
- Fault tree and event tree analysis tackle opposite sides of the same question; the former determines the faults which may lead to an accident event of interest and the latter considers the possible outcomes of an initiating event. Cause-consequence analysis is a blend of the two techniques. All produce results in an easily-communicated graphical form. Cost of such analysis depends upon the amount of ground to be covered; all can be easily applied to anything from a single valve modification to a greenfield chemical plant. They also are not as self-directing as HazOp and are therefore more dependent on the skill of the person selecting the events to be considered.
- Finally, human error analysis, as the name implies, addresses the most unpredictable side of the equation - the machine/operator interface. This analysis can predict probabilities of errors based on the environment, the layout of the controls and the nature of the required response. The procedure suggests changes to reduce error probabilities; it can also be used to trace the cause of a known error. The technique can be applied to a single procedure or an operating manual with the cost varying accordingly.

The most serious problem common to all the techniques is the general lack of reliable statistical failure rates for components. These data are inputs to some procedures and would be extremely useful in the interpretation and ranking of the results of any of them. Unfortunately, the present-day legal climate makes collection of such data difficult.

These various techniques may be controversial due to the expense involved and, in some cases, failure to adequately communicate the results or the meaning of the results. However, these or similar techniques are the only known way to provide the discipline and organization necessary to identify hazards that might otherwise be overlooked.

The hazard identification and evaluation method chosen for any given situation depends on several factors:

- Prior knowledge or experience with an activity. A number of published codes, standards and guides may identify and evaluate the hazards in a well known activity or process. Building and boiler codes, occupancy and equipment standards, and loss prevention bulletins issued by several industry groups, insurance companies, and loss prevention companies are examples of such guides.
- The size and complexity of the operation, process or equipment. The review of a metal grinding machine or dust collection system might be done by one person using a checklist, whereas the evaluation of a catalytic cracking unit in a refinery might require a team effort and a more formal approach.
- The overall potential for loss. The explosion or destruction of a boiler located in the midst of a chemical plant would produce considerably different results than the failure or malfunction of an isolated activity in the yard of a plant.
- The resources available to make the hazard identification and review. However desirable it may be to identify all hazards before a loss occurs, it may not be feasible to make highly sophisticated and expensive studies to locate every possible hazard. The process must be cost-effective within the context of the overall operation.

Once hazards have been identified, they should be qualified or ranked to enable management to set priorities for loss prevention and control measures. They may be ranked by an index, such as the Dow and Mond indices, by their relative severity, the expected frequency, and by the cost/effort to control them. With this information, priorities for loss prevention and control efforts can be intelligently set.

The application of hazard identification and evaluation programs should not be limited to plant employees and property. If an outside contractor’s on-site procedures and equipment are ignored, they can pose a severe threat to the facility. Outside contractors should receive the same treatment as the facility does.

One of the most important functions of a good Hazard Identification and Evaluation Program is the identification of and dissemination of information on critical components, systems and procedures. Critical systems and components typically monitor or control pressure, temperature, electric power, flammable vapors, rotor position or other entities. When deviation from normal conditions occurs, they should sound an alarm, initiate corrective action, or shut down the process or equipment to avoid one or more undesirable consequences. All critical components or systems should be documented; information should be furnished to the maintenance department so that they can receive priority maintenance treatment. (See *OVERVIEW*, Section 3, Maintenance [PRC.1.3.0].)

Critical procedures are standard operating procedures that must be followed to insure safe conditions. All critical procedures should be documented; information should be furnished to training personnel so that they can be included in employee training programs (See OVERVIEW, Section 4, Employee Training [PRC.1.4.0]). Loss prevention audits should determine if critical procedures, discussed and highlighted in operating procedures and manuals, are known to the operators and are being followed.

The definition of critical components and systems should be narrow. The list should include only those devices which could cause a catastrophic loss. The inclusion of “pet” components or systems intended only for productivity or quality control should be resisted.

Components and systems intended as loss prevention devices can introduce hazards by creating a false sense of security in the operators. If a hazard review identifies an exposure, the initial attempt to improve the condition may involve the provision of an alarm and automatic shutdown to relieve employees from having to take responsible action. These systems should be designed carefully, since human response may be more reliable than the instrumentation system. The operators may become conditioned to allow the plant to protect itself rather than monitor and analyze conditions.

The potential in most industrial operations for very large loss makes it essential that managers become familiar with hazards, risk assessment and loss control techniques with a view to making the most effective use of company resources.

PROPER HOUSEKEEPING

INTRODUCTION

A portion of any Management Program for Loss Prevention and Control, like *OVERVIEW*, involves the development and implementation of good housekeeping practices. Maintaining proper housekeeping is easy in some occupancies, but difficult in others.

By the very nature of their construction, some buildings are more difficult to keep clean than others. Some processes produce more waste, leakage and vapors than others. Further, some buildings were designed with such limited floor space that housekeeping is made more difficult. Such features increase the likelihood of housekeeping problems.

Additionally, unsettled conditions that occur during building and process changes are usually more difficult to supervise. The difficulty of controlling housekeeping increases when new construction, remodeling, process additions or process modifications take place. See PRC.1.0.2 for a discussion of Management Of Change procedures.

Poor housekeeping increases the potential for loss. It is also an almost certain indication of inadequate maintenance. It is not unusual to find an untidy facility is also rife with packing and joint leaks, missing covers and handwheels, unpainted rusting metal, nonfunctional gauges and temporary repairs. PRC.1.3.0 contains guidance concerning the development and implementation of effective maintenance programs.

Whether an easy or a difficult task, proper housekeeping is a vital part of preventing and controlling property losses. Proper housekeeping does not just happen. It requires the leadership and wholehearted support of management, and the cooperation of all employees.

POSITION

Create a written program for proper housekeeping with the goal of keeping all areas and equipment clean. The following actions will help in the development of an effective program:

- Appoint a Housekeeping Committee to be responsible for proper housekeeping. This may be an individual or a group.
- Establish acceptable levels of cleanliness in conjunction with the Housekeeping Committee.
- Clearly inform all employees of the Housekeeping Committee's authority and responsibility.
- Actively demonstrate support of proper housekeeping practices through regular, positive reinforcement. In addition to verbal reinforcements, written commendations and awards for individuals, areas and departments have been found effective.

Make the Housekeeping Committee responsible for initiating proper housekeeping practices, continuing to implement them and reporting their results or needed changes to management. To accomplish these duties, counsel the Committee to:

- Inspect the facility to determine current levels of housekeeping.
- Recommend desired cleanliness levels for management's review.
- Review existing cleaning schedules and modify them as necessary.
- Establish cleaning methods and make certain the necessary equipment is available.
- Establish responsibility for the completion of each cleaning task.
- Determine that a sufficient number of people are assigned to each cleaning task.
- Establish the procedures and schedule of housekeeping inspections and audits.
- Establish a liaison with other departments, such as the Loss Prevention and Maintenance Departments.
- Report to management on the housekeeping status after each inspection and audit.

DISCUSSION

Effects Of Housekeeping

Proper housekeeping controls process waste, leakage and vapors to prevent accumulations that can lead to increased losses. Such accumulations are typically from one of several causes:

- Trash or debris left because of carelessness;
- Trash or debris resulting from an inadequate pickup schedule;
- Dust or other material released from normally closed containers or systems;
- Leakage of process or lubricating fluids, steam or condensate;
- Improper or inadequate removal of accumulated process wastes or residues.

Proper housekeeping also controls storage or placement of tools and materials. Although it might be tempting to use the "free space" in switchgear, boiler, compressor and other equipment rooms for the storage of brooms, paint, spare parts and various other utility and maintenance supplies, it is essential to resist such practices. Suitable broom closets, paint lockers, spare parts storerooms, and utility rooms should be constructed for such contents.

Poor housekeeping contributes to an increased frequency of loss and greater loss potential. The added distribution of fuel:

- Increases the probability of fire and explosion.
- Causes a greater continuity of combustibles, making it easier for a fire to spread.
- Increases combustible loading, providing more fuel to feed a fire.
- Creates the potential for dust explosions when dust accumulates.
- Increases the probability of spontaneous ignition.

Poor housekeeping also increases electrical and mechanical breakdown loss potential. Even without considering the possibility of a resulting fire or explosion, electrical and mechanical breakdowns can result in total destruction of major equipment. Poor housekeeping affects property and can lead to breakdowns in these ways:

- Accumulations of dust and other debris can create a thermal blanket which prevents adequate cooling of electrical equipment and causes the equipment to fail or run hotter at reduced efficiency and with a reduced life expectancy.
- Oil, grease and other contaminants can damage electrical insulation on cables and in motor windings.

- Dirt, soot, moisture and other contaminants can provide paths for flashover or short circuiting in switchgear and other electrical equipment.
- Accumulations of water, certain vapors and other materials can damage paint and promote corrosion. Undetected corrosion has led to building collapse, pressure vessel failure, mechanical linkage separation and electrical breakdown.
- In machinery, debris of any sort can lead to accelerated wear or direct breakdown.

Poor housekeeping also increases other loss potentials. Product contamination is one such example. Scrap, leakage or other waste that gets into a product can affect its quality and cause product rejection.

All of these housekeeping problems directly affect a property and reduce plant reliability and output. The loss of property and productivity can be significant.

Indirect effects of housekeeping problems can also be important to loss control. People tend to work faster and more accurately when their surroundings are clean. Proper housekeeping will not only help prevent loss at a facility, but could also improve production levels and employee morale. Even firefighting and other loss control efforts are aided or obstructed by the level of housekeeping.

Following the initial inspection of a facility to determine current levels of cleanliness, the Housekeeping Committee should compile a list of specific areas and equipment to be cleaned. If it is the responsibility of first-line supervisors to enforce proper housekeeping, the facility should be divided into housekeeping zones that correspond to these production units.

When making the inspection, the committee should not overlook yards, roofs, basements, utility rooms, closets or remote storage buildings. The survey is not limited to only occupied floor spaces. Beams, trusses, columns, walls, piping, electrical conduit, raceways, locked rooms and idle areas are also checked.

Detailed notes should be taken about waste accumulation, leaks and spills. Any leakage should be brought to the attention of the maintenance department. Comments about current cleaning schedules and methods of cleaning should be included.

Perhaps the most difficult part of the proper housekeeping program is the establishment of desired levels of cleanliness. The first barrier to overcome is the notion that the level of cleanliness cannot be improved.

A key point in establishing cleanliness levels is to determine whether it is possible to eliminate the source of waste or leakage. Often, leaking equipment can be repaired and given more frequent maintenance so that the problem is eliminated or materially reduced.

Replacing equipment with new equipment having a more efficient design can also reduce or eliminate housekeeping problems. For instance, today's highly efficient dust collection systems might permit reducing the cleaning frequency and result in capturing product that was previously lost. Liaison with production management might be helpful in accomplishing reduction or elimination of certain housekeeping problems.

Clutter results when there is inadequate management emphasis on maintaining good housekeeping. If clutter is the problem, the provision of adequate and proper storage space might eliminate the cause. If space is available but clutter is evident, the problem could be employee training. See PRC.1.4.0.

For some areas, it may be necessary to make a major cleaning effort and then to observe the results of subsequent routine housekeeping efforts before an acceptable cleanliness level can be determined. Often, these initial cleanings can be better done by a reliable cleaning service with specialized equipment.

The length of time devoted to each cleaning task may vary. Trash and waste containers should generally be emptied once a shift, but the frequency will depend on the amount of debris each process generates. As a rule of thumb, dust accumulations that exceed $\frac{1}{32}$ in. (1 mm) should be avoided since this amount of combustible dust is generally capable of creating a secondary dust explosion if it is suspended in air.

Often, equipment cleaning schedules must be coordinated with maintenance schedules, process requirements, outside contractors or other service departments. Discussions with responsible parties from all involved groups may be necessary to set housekeeping schedules.

The responsibility for cleaning areas and equipment may be spread among several departments. Production workers may be responsible for cleaning their areas just before the end of the shift. Maintenance personnel may be assigned to custodial duties such as regularly emptying trash containers, sweeping floors and removing production scrap. Maintenance personnel may also be responsible for cleaning machinery as a part of normal preventive maintenance.

The proper equipment is necessary to accomplish any cleaning job. A sufficient number of brooms, mops, pails, dust cloths and trash receptacles should be conveniently located in or near work areas.

Ordinary plant machinery and equipment such as motors, work benches and shelves do not normally require unusual cleaning procedures. There are exceptions, such as electrical equipment with exposed windings or conductors. Items such as dust collectors, vapor removal systems, inside and outside ducts, and ovens can require special procedures. Unusual cleaning requirements should be identified in housekeeping program documentation.

Some cleaning jobs require special equipment, or are better handled by an outside contractor. These jobs can include cleaning the interior of ducts, window and wall washing, yard cleanup, and contract servicing of unusual equipment.

Materials used for cleaning and their methods of use may be important considerations in both hazardous materials evaluation and hazard identification and evaluation programs. Housekeeping activities should not be allowed to add unreasonable hazards to a facility. Refer to PRC.1.8.0 and PRC.1.13.0.

Areas housing dust-producing equipment and concealed spaces in which dust may accumulate should be cleaned with vacuum cleaners. Using compressed air to blow dust off surfaces is an unacceptable practice because dust suspended in the air during blow-down operations may achieve an explosive mixture. Vacuum cleaners may be either portable or attached to a central system. When portable units are used, they should be appropriately listed by a nationally recognized laboratory for use in any hazardous location at the facility.

Once cleanliness levels, cleaning schedules and responsibilities have been established and when proper cleaning equipment has been obtained, the Housekeeping Committee or other management representative must monitor the effectiveness of the program. This should be done by means of regularly scheduled audits. A written report of the results of each audit should be submitted to management and to those assigned responsibility for those specific cleaning tasks.

Finally, it is important to anticipate the unexpected. Liaison should be established with all departments so that construction, production and process changes can be discussed and needed housekeeping practices implemented before the situation gets out of hand. Emergency spills or leaks may require certain housekeeping actions be coordinated with the facility’s emergency coordinator. Emergency response should be planned in advance. See PRC.1.7.0.

Proper housekeeping does not just happen. It requires the leadership and the wholehearted support of management and the cooperation of all employees. When this effort is made, an increase in employee productivity will likely more than cover the increased cost. In addition, a major factor contributing to the severity of fires, explosions, collapse and other perils will be minimized.

BUSINESS CONTINUITY MANAGEMENT

INTRODUCTION

Business Continuity Management (BCM) covers the whole process of planning for, responding to and recovering from an organizational disruption. BCM is an essential part of organizational resilience as it can make the difference between an organization either recovering well from a disruption or failing because of it. Losing the ability to deliver key products and services in a timely manner following an emergency is almost certain to result in significant damage to reputation and profitability and potential loss of market share.

No matter how extensive and thorough loss prevention programs and procedures, management must ensure that each facility is prepared to deal with any internal or external event that can lead to an emergency at the facility. An emergency is an event that requires immediate response to limit the threat to life, property, the environment and business operations.

In general terms, emergency plans tend to deal with responding and reacting to the disruption itself whilst business continuity plans deal with continuing the business following the disruption. Many organizations incorporate both sets of activities into an overall BCM program since the two disciplines are strongly linked.

PRC.1.7.0 focuses on pre-emergency planning, response and recovery from the disruption itself and ensuring that effective crisis communications take place. This PRC Guideline provides guidance on implementing sound and effective BCM and what a BCM program should contain.

The principles of BCM typically follow a holistic lifecycle starting from the point of understanding an organization’s operations and how these could be affected by disruptions, through planning for such disruptions, training and enabling employees to respond, validating plans and making improvements.

POSITION

Develop a BCM for each facility. There are three components of a BCM Program, each of which has two subcomponents. The three components (see Figure 1) are:

- Understanding the Organization,
- Planning and Implementation,
- Review and Improvement.

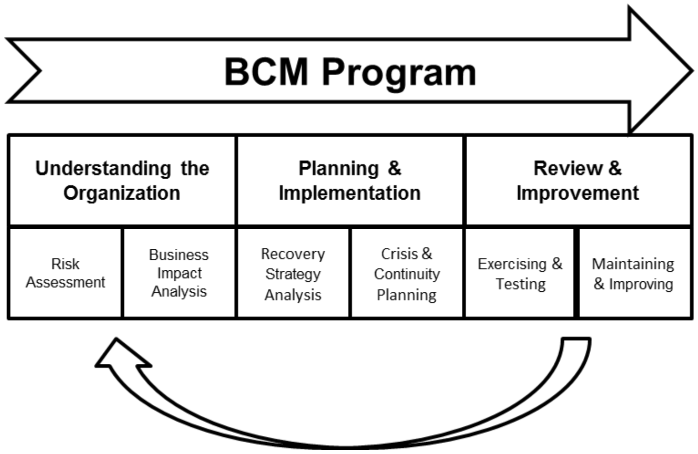


Figure 1. Illustration of an overall BCM program

Understanding the Organization

Understanding the organization has two subcomponents, Risk Assessment and Business Impact Analysis.

Risk assessment consisting of:

- Identifying and evaluating risks that might affect an organization, including hazards (see PRC.1.13.0);
- Managing/mitigating those risks;
- Implementing incident monitoring and escalation procedures in case any risks were to actually occur.

Business Impact Analysis, consisting of:

- Assessing the impacts of disruption (over time) to the activities and functions that support services and products;
- Defining recovery objectives for those activities/functions, based on priority;
- Identifying dependencies between activities/functions to highlight potential vulnerabilities;
- Identifying the skills, knowledge and resources required to support the activities/functions for continuation purposes;
- Identifying any Single Points of Failure (SPOFs) to feed into risk management processes.

Planning and Implementation

Planning and implementation has two subcomponents, Recovery Strategy Analysis and Crisis and Continuity Planning.

Recovery Strategy Analysis, covering the identification and selection of contingencies for the following:

- People – e.g. geographical separation, cross-trained staff;
- Premises – e.g. work area recovery/backup sites, facilities for working from home;
- Technology – e.g. disaster recovery for systems, network backup;
- Information – e.g. offsite storage, offsite data backup;
- Equipment – e.g. spare equipment, arrangements for replacements/repairs;
- Suppliers/supplies – e.g. resilient suppliers, alternate suppliers, spare supplies.

Crisis and Continuity Planning, consisting of:

- Documenting information, processes and procedures for managing an emergency/crisis and then recovering and continuing the business;
- Implementing thorough and appropriate training and awareness activities within the organization.

Review and Improvement

Review and improvement has two subcomponents, Exercising and Testing, and Maintaining and Improving. Exercising & Testing encompasses testing, exercising and rehearsing all crisis and continuity plans, procedures and arrangements at regular intervals/frequency.

Maintaining & Improving encompasses scheduling timely reviews and updates to plans, procedures and arrangements; and ensuring that audit and continuous improvement activities take place.

DISCUSSION

Industry Standards for Business Continuity

Standards for defining the components of an effective business continuity program are published and widely available. Standards are generally acknowledged and recognized as best practice guidelines, and aligning business continuity processes and procedures to these standards should help organizations feel confident about their overall business continuity capability and ability to recover from disruptions or disasters.

Two of the major standards utilized are NFPA 1600 and ISO 22301. NFPA 1600 was previously more commonly used in the US, while ISO 22301 is now widely used internationally following its introduction in 2012.

AXA XL Risk Consulting Business Continuity Services

AXA XL Risk Consulting has developed a set of guidelines and resources to help organizations make improvements to various parts of their business continuity management program (see Figure 2). They are:

- Strategic Business Continuity Management Assessment
- Concise questionnaire and scoring mechanism to indicate overall business continuity maturity at a high level and identify potentially weak or missing areas.
- Highlights where additional work can be undertaken to achieve a higher level of business continuity maturity and improved organizational resilience.
- Provides immediate identification of any focus areas.
- Industry Standards Assessment
- In-depth questionnaire and scoring mechanism to indicate the likely degree of alignment of a business continuity program to business continuity standards NFPA 1600 and ISO 22301.
- Provides better insight into the specifics of a business continuity program’s effectiveness.
- Scoring mechanism helps an opinion to be formed about the likely degree of alignment to the standards, and identifies potentially weak or missing areas.
- Provides immediate identification of any focus areas.
- Business Impact Analysis (BIA)
- Guidance and informational material explaining the importance and purposes of undertaking BIA. Details the key stages and expected outcomes, and includes a BIA template.
- Leads to a better understanding of the BIA process.
- Improves understanding of an organization’s critical business processes and the impact that a disruption might have on them.
- Leads to more informed incident response processes, thus reducing impact if any risk should manifest.

- Leads to more effective utilization of BIA information for business continuity planning purposes.
- Critical Supplier Analysis
- Guidance and informational material explaining the importance and purposes of undertaking Critical Supplier Analysis. Provides a series of steps for undertaking the analysis, and includes a supplier analysis template.
- Leads to a better understanding of supply chains, and the supplier analysis process.
- Identifies potential weaknesses in an organization's downstream supply chain and any vulnerabilities relating to suppliers/partners/vendors.
- Adds potential for achieving more robust supplier continuity and thus improving business continuity.
- Global Situational Awareness Assessment
- Guidance and informational material providing information on the key elements of an effective global situational awareness system. Includes a self-assessment tool to help identify where processes and procedures might need strengthening.
- Leads to a better understanding of global situational awareness systems.
- Provides an understanding of where incident alert, monitoring and escalation/management processes could be improved.
- Identifies areas of focus for improving global situational awareness and maximizing preparedness, thus improving organizational resilience.
- Business Continuity Plan (BCP)
- Guidance and informational material explaining what BCPs are and why they are needed and providing guidance on how they should be maintained and exercised. Includes an example of a BCP construction and contents page.
- Leads to a better understanding of business continuity planning.
- Provides better insight into the implementation of recovery strategies for business processes.
- Leads to improved/more effective BCPs, thus reducing impact if any risks were to manifest.
- Crisis Management Exercise Toolkit
- Set of 8 resources for running effective and valuable crisis management exercises.
- Roadmap, framework and instructive resources facilitate the running of effective crisis management exercises and highlight learning opportunities.
- Identifies areas for strengthening crisis management response and capability.
- Can help to identify levels of incident awareness and readiness within the organization.
- Strengthening exercise methodologies can lead to added risk mitigation in terms of crisis response procedures.
- Parts of the toolkit could be used to supplement an already established crisis management exercise program, or to check elements of it against best practice.

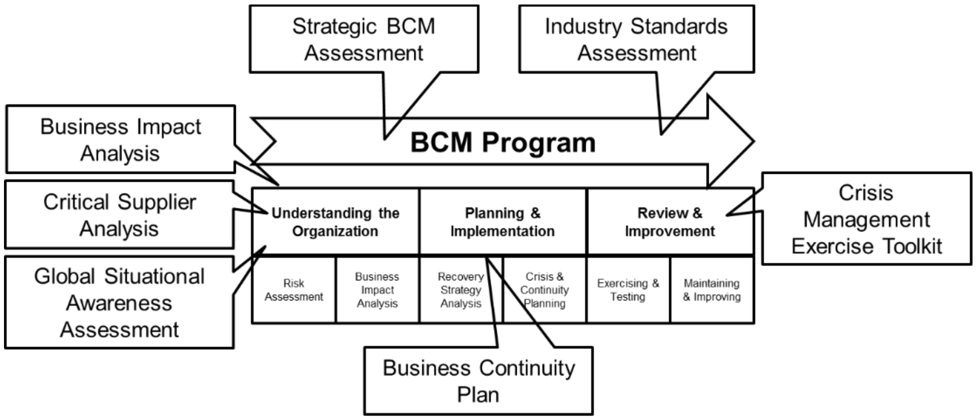


Figure 2. Illustration of how the services fit into an overall BCM program

OVERVIEW FORMS

SUGGESTED BOILER LOG SHEET

NOTE: This log is suitable only for boilers in heating systems which return 100% of the condensate to the boiler or which circulate hot water. It is not suitable for steam boilers with safety valves set higher than 15 psi (1.03 bar) or water boilers operating at greater that 160 psi (11 bar) or 250°F (121°C).

Boiler Number ______________ Person Responsible for Boiler ____________________________ Phone Number ______________

Inspector's Name/Agency ____ Phone Number

Last Inspection _____ _____ _____ Operating Certificate Expires _____ / _____ / _____

Location of Certificate (if not posted) ______________________________________

Annual Service _____ / _____ / _____ Service Firm ______________________________________ Phone Number ______________

The following tests and inspections may be recorded on the chart on the reverse side.

☐ **SAFETY OR RELIEF VALVE TEST**. With pressure in the boiler, fully open the valve, using the test lever provided, and let it snap shut. If the valve does not reseat properly, repeat. **If the safety or relief valve cannot be lifted, the boiler must be shut down immediately until the valve can be repaired or replaced**.

☐ **LOW WATER FUEL SUPPLY CUTOUT (LWFCO) RAPID DRAIN TEST**. With the burner in operation, rapidly flush the LWFCO chamber using the drain valve provided. The burner **must** shut off when the device is drained. **If the boiler does not have at least one properly functioning LWFCO, it must not be left unattended until repairs are made**.

☐ **LWFCO SLOW DRAIN TEST**. With the burner in operation, verify the function of the LWFCO by **slowly** reducing the level of the water in the boiler. Great care must be taken to prevent actually firing the boiler with insufficient water. This test should be performed quarterly for steam boilers and annually for water boilers.

☐ **DRAIN WATER GAUGE GLASS**. If necessary, drain and flush the water column and gauge glass.

☐ **BURNER CHECK**. Observe the boiler and burner for a long enough period to be certain that the burner operates normally. Test the combustion safeguard system (if possible).

☐ **CIRC OR COND PUMP CHECK**. For steam boilers, when testing the LWFCO, verify operation of the condensate pump and/or emergency feeder.

☐ **CHECK SYSTEM FOR LEAKS**. The entire system should be examined for leaks of steam and water with particular attention paid to pump and valve packings, automatic air vents, and condensate tank overflow lines. Leaks, in addition to possible water or humidity damage, are wasteful of energy and, over time, will result in scale buildup in the boiler.

☐ **WATER CHEMISTRY CHECK**. Test the boiler water as appropriate for your area. Quarterly is normally sufficient. The frequency must be determined by experience.

CALL YOUR SERVICE FIRM OR BOILER INSPECTOR IF YOU NEED ASSISTANCE WITH ANY OF THESE ITEMS

RECORD YOUR TEST AND INSPECT DATA HERE:

	SAFETY OR RELIEF VALVE TEST	LOW WATER FUEL SUPPLY CUTOUT RAPID DRAIN TEST					LWFCO SLOW DRAIN TEST	DRAIN WATER GAUGE GLASS	CHECK BURNER	CHECK CIRC OR COND PUMP	CHECK SYSTEM FOR LEAKS	CHECK OR VERIFY WATER CHEMISTRY
SEP												
OCT												
NOV												
DEC												
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												

Published as part of AXA XL Risk Consulting

CENTRIFUGAL AIR CONDITIONING LOG SHEET

NOTE: This log is recommended for fluorocarbon (Freon, Genetron, etc.) air conditioning systems with hermetic centrifugal compressors. With minor modification, it is suitable for similar equipment separately driven by a motor, turbine or engine.

Unit Number ____________________ Person Responsible for Unit ____ Phone Number ____________________

Inspector's Name/Agency ____ Phone Number ____________________

Startup Service ______/ ______/ ______ Winterizing (if applicable) ______/ ______/ ______

Service Firm ____ Phone Number ____________________

	COMPRESSOR							MOTOR			EVAPORATOR				CONDENSER				PURGE		AIR TEMP.		INITIALS
		Bearing Temp.		Oil							Refrigerant		Water		Refrigerant		Water						
Date/Time	Vane Position			Level	Reservoir Temp/Heater*	Cooler Outlet Temp.	Pressure	Volts	Amps	Vibration Level	Pressure/Level*	Temp.	In.et Temp.	Outlet Temp.	Pressure	Temp.	Inlet Temp.	Outlet Temp	Run Time	Water Level	Outdoor	Air Conditioned Space	Operator

On the back, list any additional information, including leakage or abnormal conditions observed, oil or refrigerant added, purged fluid drained, and any tests, repairs or adjustments performed. Record any automatic shutdowns, including their time and cause. "If the unit is not running, enter the refrigerant level in the evaporator and the status of the oil reservoir heater.

SUGGESTED ARCTIC FREEZE CHECKLIST WITH COLD WEATHER PRECAUTIONS

When preparing for an Arctic Freeze, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed - expressed in hours or days - to accomplish these tasks should be determined in advance so that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a winter watch or storm warning, check it off and move on to the next one.

	ACTION	TIME NEEDED	DONE
1.	Restore any cutback of heat to buildings or processes.	____________	☐
2.	Provide additional heat for normally cold areas.	____________	☐
3.	Make certain there is an adequate supply of fuel for the heating systems.	____________	☐
4.	Expedite the completion of any postponed repairs to the heating system.	____________	☐
5.	Forgo any planned heating plant or boiler inspections until the danger of the severe cold has passed.	____________	☐
6.	Keep someone on the premises who will continually monitor all areas of the premises for signs of impending trouble, and provide that person with an up-to-date list of emergency numbers to call should trouble be detected.	____________	☐
7.	Add heat tracing to process and protective system piping that might freeze.	____________	☐
8.	Check insulation on piping and structures to be certain it will protect them against the extreme cold temperatures.	____________	☐
9.	Where processes are shut down, drain piping and tanks to prevent freezing damage.	____________	☐
10.	Recheck the *Cold Weather* Precautions listed on this form.	____________	☐

Add other items unique to your facility.

COLD WEATHER PRECAUTIONS

Unless proper precautions are taken, cold weather can cause problems. Buildings may be loaded beyond their design by accumulations of snow and ice. Fire protection equipment may freeze, leaving a major portion of the facility without protection.

Prior to and during cold weather, the following precautions should be taken.

A. General

1. Plans should be made to remove snow from flat roofs or other structures which might collapse.
2. All doors, windows, skylights, ventilators, and other openings should be weather-tight so they will not admit cold air that could cause sprinkler systems to freeze.

B. Heating Systems

1. To determine that the entire system is in proper operating condition, it should be examined and deficiencies corrected. Burners, boilers, and flues should be clean. Obstructions should be removed from all pipes, radiators, and unit heaters. Controls of heating equipment should be tested for proper operation.
2. Where possible, an adequate reserve supply of fuel should be on hand at all times. Safe alternate energy sources should be investigated.
3. Temperatures about 40°F (5°C) must be maintained at all times in buildings equipped with wet pipe sprinkler systems; in all dry pipe, pre-action, and deluge valve closets; and in all pump houses.
4. Clearances should be maintained between heating system components and combustible floors, walls, partitions, platforms and stock.

(over)

C. Protective Systems

Some of the following maintenance procedures involve valve operation or other impairments to protective systems. Proper procedures should be followed in all such cases (see *OVERVIEW* Section 1, Impairments To Protective Systems).

1. Plans should be made to promptly clear snow from access ways, control valves, hydrants, hose cabinets, smoke and heat vents, explosion relief vents, and other essential equipment to permit effective operations in the event of an emergency.
2. Wet pipe sprinkler systems in areas which are inadequately heated should be converted to dry pipe or pre-action systems.
3. Dry pipe sprinkler systems and preaction or deluge systems dry pilot lines should be inspected carefully to make sure that the piping is properly pitched for drainage. Any condensation that collects in low points in the piping should be removed. Excessive priming water should also be removed.
4. Sprinkler heads in the immediate vicinity of steam pipes, unit heaters, or other heat-producing appliances should be of the correct temperature rating.
5. Solutions in all anti-freeze sprinkler systems should be tested and anti-freeze added as necessary.
6. Any "shut-in-winter" valves controlling small unheated areas should be closed, tagged with AXA XL Risk Consulting's cold weather shut-off tags, and properly drained. Consideration should be given to converting such systems to either a dry pipe or a pre-action system.
7. All wet standpipe systems with piping located in areas subject to freezing should be shut off, drained and tagged.
8. Connections to water motor gongs and fire department connections should be properly drained.

D. Fire Protection Water Tanks

1. Gravity tanks must not leak, since an accumulation of ice on trestles can cause the tank structure to collapse. The expansion joint and riser boxing should be in good condition.
2. The water temperature in the gravity tank should be checked frequently during cold weather and maintained at no less than 42°F (5.5°C).
3. The tank heating system should be flushed and put in good working order.
4. The tank roof-hatch cover should fit tightly and be fastened.

E. Hydrants and Underground Piping

1. Hydrants and fire pump hose headers should be drained. Outlet hose valves must be left half open to prevent damage from freezing.
2. Hose should be properly drained and dried.
3. Packing on post indicator valves should not be leaking.
4. Sections of exposed piping should be drained or otherwise protected against freezing.
5. Valve and meter pits should be dry and frost-proof.

F. Portable and Wheeled Fire Extinguishers located in cold areas should be suitable for such locations or installed in heated cabinets.

G. Automotive Fire Apparatus should be properly serviced for cold weather.

EARTHQUAKE
BUILDING INVENTORY

Bldg. Name/No. ______________ Inventory By ______________ Date ______________

Date of Construction ______________ Design Bldg. Code ______________ (Local. State. Nat'l) Code Adopted ______________ (Date)

Bldg. Use ______________

Drawings Available (Y/N) ______________

Number of Stories ______________ Height ______________ Size ______________ Footprint

Shape ______________
(Comment horizontal and vertical shape — Regular vs irregular)

Provide freehand sketch and section on back of form. (Note adjacent buildings.)

Construction

Structural System ______________
(Describe or classify)

Roof Construction ______________
(Describe or classify)

Exterior Walls ______________ (Construction) Floors ______________ (Construction)

Connections ______________
(Describe anchors for roof to wall, wall to floors or foundation)

____

Condition ______________
(Evaluate general condition of structure - Note prominent weakness)

____

Is bldg. on: ☐ Level Ground ☐ Sloping Ground ☐ Adj to earthen Bank

Is bldg. constructed on: ☐ Rock ☐ Natural Soils ☐ Fill ☐ Unknown

Nonstructural

Partitions ______________ (Type and Construction) Ceilings ______________ (Type and Construction)

Windows ______________
(Fixed or Movable - Wood or Metal Frame)

Light Fixtures ______________
(Hanging - Am they secure)

Mechanical Equipment ______________
(Floor, wall or ceiling mounted - secure mount or anchor)

Professional structural and hazard analysis needed? (Y/N)

Comments ______________

EARTHQUAKE PREPAREDNESS

The establishment of an Earthquake Preparedness program must accept the premise that earthquakes occur without warning. There will be no “watch” or “warning" period as issued for other natural hazards such as hurricane, flood, winter storm or arctic freeze. Current technology does not allow for precise time and location forecasting of a damaging earthquake. Efforts for loss mitigation must entail a continuing program consisting of preparations subject to repetitive review, reevaluation and upgrading. Drills and practice must contemplate after the fact response to property damage, physical destruction, interruption of utility services, personal injury and possibly loss of life. AND: you will be left to your own resources for a nominal period of time.

The following checklist notes items which, if appropriately addressed, will enhance the potential for your business to fully recover from the effects of an earthquake.

STRUCTURAL CONSIDERATIONS:

	ACTION	IMPLEMENTED	REVIEWED
1.	Make a seismic hazard appraisal of buildings and structures. If in doubt of the seismic health of the facility consult a structural engineer.		
2.	Inspect signs, tanks, stacks and chimneys for deterioration and proper support.		
3.	Plan upgrade strengthening where necessary for 1. and 2. above.		
4.	Designate –“safe" shelter or assembly areas.		
5.	Designate –“safe" evacuation routes from all areas to assembly areas.		

(Note: A minimum of two safe assembly areas and two evacuation routes should be established in case the primary area or route is inaccessible.)

NON-STRUCTURAL BUILDING RELATED CONSIDERATIONS:

	ACTION	IMPLEMENTED	REVIEWED
1.	Make an earthquake hazard/safety appraisal of buildings and operations. (Also identify or develop - Duck, Cover and Hold - locations along evacuation routes.)		
2.	Brace tall cabinets, shelves, tall machinery and equipment or other top heavy objects which could topple.		
3.	Brace and adequately support overhead mounted fixtures, drop ceilings, piping, heaters or other overhead devices.		
4.	Bolt down and restrain flammable fuel fired appliances and provide flexible connectors for fuel supply.		
5.	Provide frequent isolation valving for piping systems.		
6.	Provide safe independent alternate energy sources for vital equipment and services.		
7.	Provide auxiliary and backup equipment and energy sources for critical services such as communications and lighting.		
8.	Restrain and adequately support mainframe computers.		
9.	Safeguard vital records. (Include both physical and machine processing for update. storage and retrieval.)		
10.	Plan for continuation of Plant Security.		
11.	Consider that employees may remain on premises for up to 72 hours. Provide reasonable and adequate supplies of necessities.		
12.	Plan for Customer/Client/Supplier awareness and develop contingency plans for continued business operations. (include plans for alternate office facilities, financial procedures, data processing, communications and transportation.)		

(over)

RESPONSE CONSIDERATIONS:

	ACTION	IMPLEMENTED	REVIEWED
1.	MAKE A PLAN AND REVIEW IT ANNUALLY.	______	______
	NOTE: Earthquake aftershocks may occur-expect them -include the probability in your planning.		
2.	Acquire necessary up-to-date educational and emergency information materials.	______	______
3.	Involve all level of personnel in information discussions and repetitive meetings, drills and practice sessions. Allow for the contingency of on-site customers, vendors or visitors.	______	______
4.	Assign two responsible people in each department, each shift, who can “TAKE CHARGE” of their group immediately. This will reassure all employees that the situation is under control and enhance prompt response actions.	______	______
5.	Assign specific duties and responsibilities such as accounting for personnel, checking for injuries, building damage assessment, checking for fire and fire hazards, leaking gas or flammable/hazardous liquids, safe equipment shutdown, shutting off fuel lines, disconnecting power, containing hazardous materials and evacuating the premises, as much as practical.	______	______
6.	Suitable prearrangements will be necessary for the care and handling of injured and handicapped persons.	______	______
7.	Establish a communications network employing self contained devices such as radio transceivers. Include reporting of conditions from on premises locations and off premises sites as practical to a central on site control point such as the designated 'safe shelter assembly area." A bulletin board can be used to post situation reports of general interest regarding employee residence, specific landmarks, personal inquiries and general status notices.	______	______
8.	Establish an emergency transportation pool. Transportation beyond the immediate premises should not be attempted until accessibility is known. An inspection of the company properties will be necessary and mobile material handling equipment may need to be utilized on site.	______	______
9.	Establish contact with neighbors or other industrial mutual aid agreement participants.	______	______
10.	Establish contact with civil authorities such as police, fire, medical and emergency agencies to advise them of your situation and request or offer assistance as needed or available.	______	______

SUGGESTED FLOOD CHECKLIST

When preparing for a flood, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed - expressed in hours or days - to accomplish these tasks should be determined in *advance so* that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a *flood watch* or flood *warning,* check it off and move on to the next one.

	ACTION	TIME NEEDED	DONE
1.	Shut down processes safely, and drain open tanks of flammable or combustible liquids.	________	☐
2.	Brace unsupported structural members at construction sites.	________	☐
3.	Up-date important backup records, and move them to a location not vulnerable to flooding.	________	☐
4.	Anchor yard items that can be moved by flood waters, such as trailers, lumber, or loose yard storage. Move stored materials inside if practical. Barricade critical outdoor equipment with sandbags to provide protection against floating debris.	________	☐
5.	Assemble the following supplies and equipment at a central, secure location: ________ Portable pumps and hose ________ Mops and squeegees ________ Emergency lighting ________ Tarpaulins ________ Lumber and nails ________ Power and manual tools Shovels and axes ________ Sandbags		☐
6.	Ensure that the emergency crew remaining on the premises has the following: ________ Nonperishable food ________ Two-way radios ________ First aid equipment ________ Stored drinking water ________ Lighting	________	☐
7.	Fill emergency generator and fire pump fuel tanks	________	☐
8.	Inspect all fire protection equipment to be sure it is in service.	________	☐
9.	Check travel brakes on movable cranes and bridges. Anchor them in accordance with the manufacturer's out-of-service instructions.	________	☐
10.	Place sandbags at vulnerable building openings and around critical outdoor equipment. Divert water from critical areas such as holes in foundations, doorways, and sills.	________	☐
11.	Move important machinery, stock, and reports to higher elevations. By knowing the past flooding history of the area, reasonably safe areas can be selected. If major equipment cannot be moved, coat vulnerable metal surfaces with grease.	________	☐
12.	Shut off all flammable and combustible liquids and gases lines at their source to prevent the discharge of such liquids and gases from piping broken by floating debris. Support exposed piping properly.	________	☐
13.	Make sure above and below ground tanks are properly anchored to prevent flotation. Fill empty tanks with water or product, and extend vent lines on active tanks above the anticipated maximum water level.	________	☐
14.	Lash down portable containers of flammable or combustible liquids.	________	☐
15.	Shut off electrical power at the main building disconnect when that building is in imminent danger of flooding.	________	☐

TYPICAL BOMB THREAT CHECKLIST WITH MILITARY ORDNANCE DISPOSAL CONTROL CENTERS

INSTRUCTIONS: LISTEN, DO NOT INTERRUPT THE CALLER!

Name of Operator ______________________ Time __________ Date __________

Caller's Identity

Sex: Male ________ Female ________ Approximate Age Years ________

Origin of Call

______Local ______Long Distance ______Booth ______Internal (from within Bldg.?) If internal, leave plug in board.

VOICE CHARACTERISTICS	SPEECH	LANGUAGE	ACCENT	MANNER	BACKGROUND NOISES
____ Loud	____ Fast	____ Excellent	____ Local	____ Calm	____ Office Mach.
____ High Pitch	____ Distinct	____ Fair	____ Foreign	____ Rational	____ Factory Mach.
____ Raspy	____ Stutter	____ Foul	____ Race	____ Coherent	____ Bedlam
____ Intoxicated	____ Slurred	____ Good	____ Not Local	____ Deliberate	____ Animals
____ Soft	____ Slow	____ Poor	____ Caucasian	____ Righteous	____ Quiet
____ Deep	____ Distorted	____ Other	____ Region	____ Angry	____ Mixed
____ Pleasant	____ Nasal	________	____ Other	____ Irrational	____ Street Traffic
____ Other	____ Other	________	________	____ Incoherent	____ Airplanes
________	________	________	________	____ Emotional	____ Party Atmos.
________	________	________	________	____ Laughing	____ Trains
________	________	________	________	____ Other	____ Music
________	________	________	________	________	____ Voices

BOMB FACTS

If caller seems agreeable to further conversation, ask questions like:

KEEP CALLER TALKING

WHEN WILL IT GO OFF? Certain Hour ________ Time Remaining ________

WHERE IS IT PLANTED? Building ________ Area ________

WHAT KIND OF BOMB? WHERE ARE YOU NOW? HOW DO YOU KNOW SO MUCH ABOUT THE BOMB? WHAT IS YOUR NAME AND ADDRESS? HOLD ON LINE WHILE YOU NOTIFY SUPERVISOR LISTED BELOW:

Did caller appear familiar with plant or building by his description of the bomb location?

Write out the message in its entirety and any other comments on reverse side.

ACTION TO TAKE IMMEDIATELY AFTER CALL

Notify following persons in order given:

NAME ________________	PHONE NO. ________
NAME ________________	PHONE NO. ________
NAME ________________	PHONE NO. ________
NAME ________________	PHONE NO. ________

(over)

Military Ordnance Disposal Control Centers

FIRST U.S. ARMY
Control Center
542nd/549th ORD DET
Fort Meade, MD 20755
Telephone: (301) 677-5182 or 677-5183

Area of Responsibility:
Maine, New Hampshire, Vermont, New York, Massachusetts
Connecticut, New Jersey, Pennsylvania, Delaware
Maryland, Ohio, Virginia, West Virginia, Kentucky
Rhode Island, and District of Columbia

THIRD U.S. ARMY
Control Center
547th ORD DET
Fort McPherson, GA 30330

Telephone:
Duty Hours: (404) 752-3004 or 752-3055
Non Duty Hours: (404) 752-3113

Area of Responsibility:
North Carolina, South Carolina, Georgia, Florida
Alabama, Mississippi and Tennessee

FOURTH U.S. ARMY
Control Center
546th ORD DET
Fort Sam Houston, Texas 78234

Telephone:
Duty Hours: (512) 221-4646 or 221-5308
Non Duty Hours: (512) 221-5500 or 221-2907

Area of Responsibility:
Texas, Louisiana, Arkansas, Oklahoma, New Mexico

FIFTH U.S. ARMY
Control Center
543rd ORD DET
Fort Leonard Wood, Missouri 65473

Telephone: (314) 368-3814 or 368-4313

Area of Responsibility:
North Dakota, South Dakota, Wyoming, Colorado
Kansas, Missouri, Iowa, Wisconsin, Michigan, Illinois
Indiana, Minnesota, and Nebraska

SIXTH U.S. ARMY
Control Center
548th ORD DET
Presidio of San Francisco, California 94129

Telephone: (415) 561-4203 or 561-4312

Area of Responsibility:
California, Washington, Oregon, Arizona, Nevada,
Idaho, Montana, Utah

SUGGESTED HURRICANE CHECKLIST

When planning for hurricanes, a detailed checklist should be developed indicating the order in which processes are to be shut down and the facility secured. The length of time needed — expressed in hours or days — to accomplish these tasks should be determined in advance so that appropriate actions can be initiated at the proper time. Then, as each task is completed during either a *hurricane watch* or *hurricane warning*, check it off and move on to the next one.

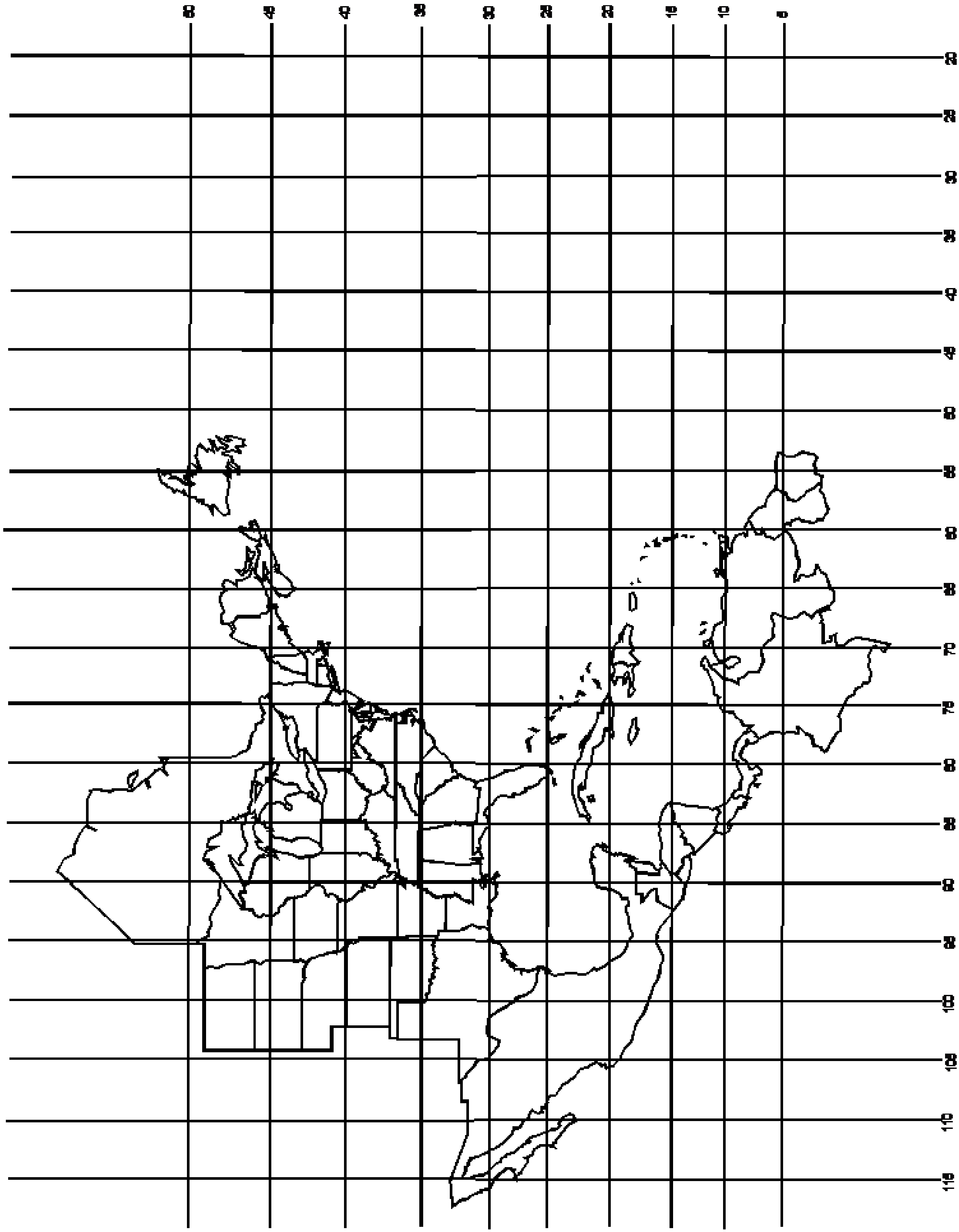
	ACTION	TIME NEEDED	DONE
1.	Shut down processes safely.	________	☐
2.	Inspect roof edging strips, gutters, flashing, covering, and drains.	________	☐
3.	Inspect sign and stack supports, guy wires, and anchorages.	________	☐
4.	Check for weak door and window latches or hardware or for insecure panel fastenings. Expedite repairs.	________	☐
5.	Protect vulnerable windows from flying debris.	________	☐
6.	Brace unsupported structural members at construction sites.	________	☐
7.	Protect important records from wind, debris, and rain.	________	☐
8.	Up-date important backup records and move them to a location not vulnerable to the same incident.	________	☐
9.	Fill aboveground tanks to capacity with product or water to minimize wind damage (see Flood Checklist for underground tanks).	________	☐
10.	Anchor structures in the yard that can be moved by high winds, such as trailers, lumber, or any loose yard storage. Move stored materials inside where practical.	________	☐
11.	Assemble the following supplies and equipment at a central, secure location: ________ Emergency lighting ________ Lumber and nails ________ Tape for windows ________ Sandbags ________ Roofing paper ________ Caulking compound ________ Tarpaulins ________ Power and manual tools ________ Shovels and axes ________ Chain saws	________	☐
12.	Ensure that the emergency crew remaining on the premises has the following: ________ Nonperishable food ________ First aid equipment ________ Lighting ________ Two-way radios ________ Stored drinking water	________	☐
13.	Fill emergency generator and fire pump fuel tanks.	________	☐
14.	Inspect all fire protection equipment to be sure it is in service.	________	☐
15.	Take extraordinary measures to secure outdoor traveling cranes and bridges in accordance with manufacturers' instructions. Besides setting rail clamps, secure with wedges and cable anchors.	________	☐
16.	Clean out drains and catch basins.	________	☐
17.	Be sure to prepare the Flood Checklist as well as the Hurricane Checklist.	________	☐

Add other items unique to your facility.

HURRICANE TRACKING DATA WITH MAP

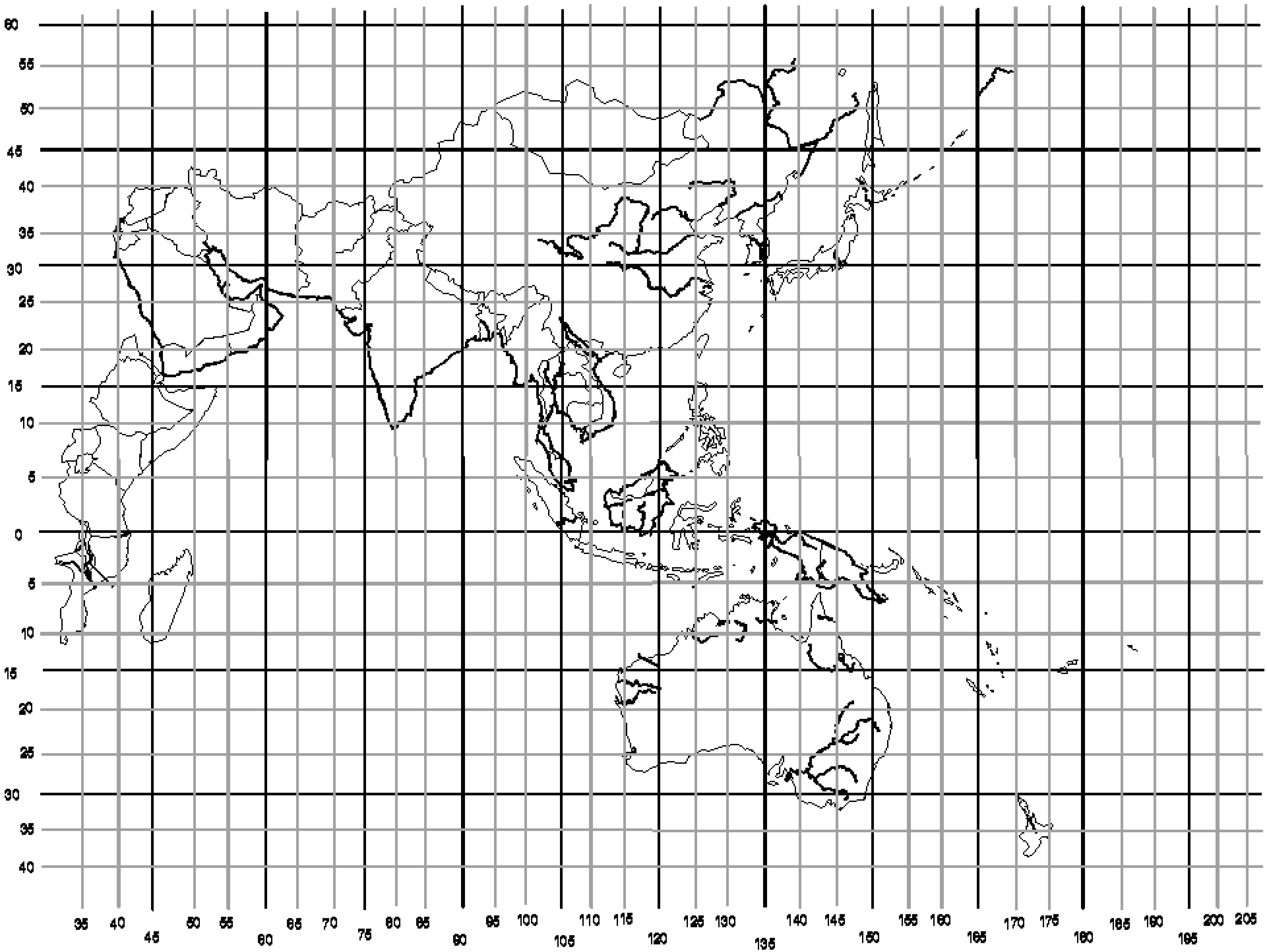
STORE NAME ______________________________

DATE	TIME	LATITUDE (DEG. N)	LONGITUDE (DEG. W)	MILES – – – FROM	MAXIUMU WIND (MPH)	CENTRAL PRESSURE (INCHES HG.)	FORWARD SPEED (MPH)	DIRECTION



TYPHOON TRACKING DATA WITH MAP

STORM NAME: ______________________					MAXIUMU WIND (MPH)	CENTRAL PRESSURE (INCHES HG.)	FORWARD SPEED (MPH)	DIRECTION
DATE	TIME	LATITUDE (DEG. N)	LONGITUDE (DEG. W)	KILOMETERS – – – FROM				



60
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35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205

CHEMTREC GUIDELINES FOR RESPONDING TO CHEMICAL OR HAZARDOUS MATERIAL EMERGENCIES

FOR CHEMICAL EMERGENCY

Spill, Leak, Fire, Exposure, or Accident

CALL CHEMTREC — DAY OR NIGHT

***800–424–9300**

Toll-free in the continental U.S.
*Add long distance access number if required

483-7616 in District of Columbia

For calls originating outside the Continental U.S.:
202–483–7616 –Washington, D.C., Collect
ALL CALLS ARE RECORDED

USER GUIDANCE

CHEMTREC can usually provide hazard information warnings and guidance when given only the NAME OF THE PRODUCT and the NATURE OF THE PROBLEM. For more detailed information and/or assistance, or if product is unknown, attempt to provide as much of the following additional information as possible:

Name of caller and call back number
Location of problem
Shipper or manufacturer
Container type
Rail car or truck number
Carrier name
Consignee
Local conditions

CHEMTREC Information

What It Is

CHEMTREC, the Chemical Transportation Emergency Center provides information and/or assistance to those involved in or responding to chemical or hazardous material emergencies. Established in 1971, it is a public service of the Chemical Manufacturers Association (formerly Manufacturing Chemists Association) in Washington, D.C.

CHEMTREC operates in two stages: First, on receipt of information regarding the name of a chemical, it provides immediate advice on the nature of the product and steps to be taken in handling the early stages of a problem. Second, CHEMTREC promptly contacts the shipper of the material involved for more detailed information and appropriate follow-up, including on-scene assistance when feasible.

While the Center's primary mission is to help in transportation incidents, it also provides support in chemical and hazardous materials emergencies in non-transportation situations.

CHEMTREC operates 24 hours a day, seven days a week to receive calls on phone numbers shown on the front panel of this folder. The number is widely circulated in professional literature distributed to emergency service personnel, carriers, the chemical industry, bulletins of government agencies, trade associations and others who may have need. It is *no*t circulated in the public press. The public need is best served through the emergency services.

CHEMTREC is not a reporting center. The Department of Transportation handles this function. CHEMTREC should be called only in those cases where assistance is needed.

CHEMTREC, in its years of operation, unfortunately has received many calls that were not pertinent to emergencies. These calls often interfere with the handling of legitimate emergencies. It is vital that callers understand CHEMTREC is neither intended nor equipped to function as a general information source.

Mode of Operation

Participating companies are requested to include the following on their shipping documents: "For Chemical Emergency — Spill, Leak, Fire, Exposure, or Accident, Call CHEMTREC 800-424-9300 day or night."

An emergency reported to CHEMTREC is received by the Communicator on duty. Recording details in writing, or on a video-screen, and by tape recorder, they question the caller to determine as much essential information on the problem as possible. This enables them as a first step, to provide the best available information on the chemical(s) reported to be involved, thereby giving specific indication of hazards, what to do, or what not to do in case of spills, fire or exposure.

Having advised the caller, the Communicator proceeds immediately to notify the shipper by phone or via electronic transmission. The known particulars of the emergency are relayed, and responsibility for further guidance — including dispatching personnel to the scene, or whatever seems warranted — passes to the shipper.

CHEMTREC Communicators are chosen for their ability to remain calm under emergency situations. To preclude unfounded personal speculation regarding a reported emergency, they are under instructions to abide strictly by the information provided for their use by technical experts employed by the industry.

The second stage of assistance becomes more difficult where the shipper is unknown. However, the Communicator has other resources. For example, on problems involving radioactive materials, CHEMTREC can call on the U.S. Department of Energy.

Mutual aid programs exist for some products. Here one producer will service the field emergencies involving another producer's product. Initial referral may be in accordance with the applicable mutual aid plan, rather than directly to the shipper. Arrangements of this sort are established on chlorine through the Chlorine Institute and on pesticides through the National Agricultural Chemicals Association.

The former has CHLOREP, the Chlorine Emergency Plan, in which the nearest producer responds to a problem. NACA has a Pesticide Safety Team Network (PSTN) of some 40 emergency teams distributed throughout the country. In addition, there are mutual assistance programs for other products, including vinyl chloride and hydrogen cyanide. CHEMTREC serves as the communication link for these programs.

CHEMTREC truly serves as the communication point for the entire emergency response system of the private sector and helps support that of the public sector. Many companies in the chemical and other industries have their own well-organized national response capabilities. The chemical industry is constantly working to expand this capability to assist others in planning such capabilities.

Identification of product and shipper is important to minimize time needed to provide necessary information and assistance. Shipping papers are carried by truck drivers and in the engine or caboose of trains. Car and truck numbers and carrier names can be useful in tracing unknown cargoes.

Relationship to Government

While CHEMTREC is in the private sector, its capabilities have been recognized for many years by the Department of Transportation, and a close and continuing relationship is maintained between CHEMTREC and the Department. More recently, formal acknowledgement of this arrangement was signed by DOT and CMA. Through the U.S. Coast Guard's National Response Center, the DOT is notified of significant incidents affecting personnel or the environment. The usual day-to-day incidents are not reported. Working closely together, the capabilities of each system will be enhanced.

Background

CMA is a trade association of chemical manufacturers, large and small, representing more than 90 percent of the production capacity for basic industrial chemicals in the United States and Canada. It has long been active in programs to improve the safety of chemical shipping containers, both package and bulk units, thereby minimizing failures and leakage of contents under extraordinary stress. Such efforts continued unabated.

Nevertheless, despite precautions taken, train derailments, truck upsets and collisions and barge accidents do happen. Such emergencies deserve to be handled as well as possible to minimize harmful effects on life and property.

Emergency services — fire and police — normally are well-prepared to cope with common materials. including certain flammables such as fuel oil and gasoline. Too often they are at a disadvantage when chemicals are involved, especially since "what should be done" and "what should not be done" in the early stages may bear heavily on the seriousness of the incident. They need accurate, clearly understandable information to help them act with proper precautions.

The concept of CHEMTREC was first explored by the Chemical Manufacturers Association in the mid 1960s following some major derailments. Officials of concerned federal departments approached CMA to determine what the industry could do to provide information to emergency services and carriers. After thorough consideration, the CHEMTREC concept was recommended and approved by CMA's Board of Directors in June 1970. The continuous and expanding operations since that time have confirmed the validity of the concept.

Other Associations

CMA and CHEMTREC coordinate their programs with many other trade associations and professional groups. The Bureau of Explosives of the Association of American Railroads is involved in many rail incidents. Members of the American Trucking Associations and National Tank Truck Carriers are also major users of CHEMTREC. Groups representing manufacturers of other hazardous materials work with CHEMTREC in providing information in emergencies. This, and cooperation with emergency services, is essential in maintaining an effective program.

For More Information

Questions regarding CHEMTREC should be sent to: Director, CHEMTREC.
c/o CMA, 2501 M Street, N.W., Washington, D.C. 20037. Telephone 202-887-1255.

INDIVIDUAL TRAINING RECORD

NAME ______________________________ POSITION ______________ SHIFT ____________

DATE	SUBJECT	HOURS		INSTRUCTING AGENCY	EXAMS			COMMENTS
		ACADEMIC	PRACTICAL		WRITTEN	ORAL	PRACTICAL	

REPORT OF FIRE BRIGADE DRILL

DEPARTMENT: ____________________

SHIFT: ____________________

TRAINER: ____________________

FIRE BRIGADE MET ON: ____________________

FIRE BRIGADE MEMBERS PRESENT:

____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________

FIRE BRIGADE MEMBERS PRESENT:

____
____
____
____
____
____

ANNUAL TRAINING PROGRESS

Date

Subject

Name																												

LOSS PREVENTION AUDIT REPORT

Audit to be made at least once a month.

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Identify deficiencies, if any, in the following programs. Make appropriate comments concerning location, specific deficiency, and corrective action taken or required. Major changes in occupancy or construction, as they affect programs, should also be described.

OVERVIEW PROGRAM	Deficiencies None	Deficiencies Noted	COMMENTS
Management of Change	☐	☐	
Impairments to Fire Protection Systems	☐	☐	
Smoking Regulations	☐	☐	
Maintenance	☐	☐	
Employee Training	☐	☐	
New Construction	☐	☐	
Insurance Company Recommendations	☐	☐	
Pre-Emergency Planning	☐	☐	
Hazardous Materials Evaluation	☐	☐	
Cutting, Welding, and Other Hot Work	☐	☐	
Fire Protection and Security Surveillance	☐	☐	
Fire Protection Equipment Inspection	☐	☐	
Hazard Identification and Evaluation	☐	☐	
Proper Housekeeping	☐	☐	

ADDITIONAL COMMENTS (identify by program number): ______________________

Report reviewed by: ______________________ Position: ______________________
(signed)

FILE FOR REVIEW BY AXA XL RISK CONSULTING REPRESENTATIVE

FIRE PROTECTION EQUIPMENT INSPECTION REPORT

Facility: ______________________ Conducted By: ______________________

Location: ______________________ Date: ______________________

The Following Items Should Be Checked At Least Weekly.

Any "No" response should be explained.

WATER SUPPLY, SECTIONAL, AND SPRINKLER SYSTEM CONTROL VALVES

Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed	Valve ID	Open	Shut	Sealed

PUBLIC WATER

Public water supply in service? ☐ **Yes** ☐ **No** ______________________ Pressure: ________psi

Fire department connection accessible, caps in place, couplings free to rotate? ☐ **Yes** ☐ **No** ______________________

FIRE PUMPS

Pump ID	Type	Set For Auto.?		Operated Today?		Checklist Completed?		Comments
		Yes	No	Yes	No	Yes	No	

WATER SUPPLY TANKS

Tank ID	Tank Full?		Heater Working?		Water Temp.		Comments
	Yes	No	Yes	No			

AUTOMOTIVE FIRE APPARATUS

Each fully in service? ☐ **Yes** ☐ **No** ______________________

Checklist completed? ☐ **Yes** ☐ **No** ______________________

SPECIAL EXTINGUISHING SYSTEMS

System ID	Type	In Service?		Date Last Serviced	Date Last Tested	Comments
		Yes	No			

The Following Items Should Be Inspected At Least Monthly.

Any "No" response should be explained.

WET PIPE, DRY PIPE, DELUGE, AND PRE-ACTION SPRINKLER SYSTEMS

System ID	Alarm Tested?		Water Pressure			Heat Adequate?		Air/ Supv. Press.	Comments
	Yes	No	Static	Flow	Differential	Yes	No		

FIRE EXTINGUISHERS, INSIDE HOSE CONNECTIONS, AND STANDPIPES

Each unit in service? ☐ **Yes** ☐ **No** ________________

Checklist completed? ☐ **Yes** ☐ **No** ________________

HYDRANTS, HOSE HOUSES, AND MONITOR NOZZLES

Monitor Nozzle/ Hydrant ID	Accessible?		Drained?		Equipment				Comments
					Adequate?		Cond. OK?		
	Yes	No	Yes	No	Yes	No	Yes	No	

FIRE DOORS

Fire doors and shutters in good condition? ☐ **Yes** ☐ **No** ________________

Automatic closing devices operable? ☐ **Yes** ☐ **No** ________________

SMOKE AND HEAT, AND EXPLOSION-RELIEF VENTS

Vents operable? ☐ **Yes** ☐ **No** ________________

Areas around vents unobstructed? ☐ **Yes** ☐ **No** ________________

PROTECTIVE SIGNALING SYSTEMS

All systems been tested satisfactorily? ☐ **Yes** ☐ **No** ________________

OTHER PROTECTION DEFICIENCIES FOUND DURING THE COURSE OF EACH INSPECTION SHOULD BE REPORTED BELOW:

	Yes	No	If "Yes," note location.
Stock within 36 in. of sprinkler heads?	☐	☐	
Sprinkler heads or piping bent?	☐	☐	
Sprinkler heads painted?	☐	☐	
Sprinkler heads or piping corroded?	☐	☐	
Sprinkler heads loaded with debris?	☐	☐	
Items hanging from, or supported by sprinkler heads?	☐	☐	
Sprinkler heads obstructed by partitions?	☐	☐	
Signs of internal sprinkler piping obstruction?	☐	☐	
Fire doors blocked by materials?	☐	☐	

ADDITIONAL COMMENTS AND RECOMMENDATIONS

____

____

____

____

____

____

Report reviewed by: ________________ (signed) Position: ________________

Has prompt action been initiated? ☐ Yes ☐ No ________________

SUGGESTED CHECKLIST FOR FIRE PUMP INSTALLATIONS

Facility: ______________________ Conducted By: ______________________

Location: ______________________ Date: ______________________

Pump Identification: ______________________ Type of Driver: ______________________

Make of Pump: ______________________ Location of Pump: ______________________

Rated Flow: ____________ Rated Pressure: ____________ Rated Speed: ____________

When checking each fire pump, the following should be determined. A "No" answer indicates a deficiency which should be corrected.

			YES	NO
1.	**For All Pump Installations**			
	a.	Is fire pump suction valve(s) open and sealed?	☐	☐
	b.	Is suction tank full and adequately heated?	☐	☐
	c.	Is the pond, lake, reservoir, or other suction supply at a normal level?	☐	☐
	d.	Is suction crib clean and free of debris, ice, or other obstruction?	☐	☐
	e.	If a fire department connection is provided, is it accessible, and are the caps in place and the couplings free to rotate?	☐	☐
	f.	Is fire pump discharge valve open and sealed?	☐	☐
	g.	If a booster pump, are all valves on the by-pass open and sealed?	☐	☐
	h.	Is jockey pump suction valve open and sealed?	☐	☐
	i.	Is jockey pump discharge valve open and sealed?	☐	☐
	j.	Is jockey pump controller switch “on”?	☐	☐
	k.	Is jockey pump running normally, not excessively?	☐	☐
	1.	Is controller in “automatic” position?	☐	☐
	m.	Did pump start automatically upon drop in pressure?	☐	☐
	n.	Was pump starting pressure proper?	☐	☐
	o.	Is “shut-off pressure” normal?	☐	☐
	p.	If pump takes suction under lift, did the priming system(s) function properly?	☐	☐
	q.	Is circulation relief valve operating at shut-off pressure?	☐	☐
	r.	Are pump bearings and seals running at the proper operating temperature?	☐	☐
	s.	Did local and remote pump alarms and supervisory signals operate properly?	☐	☐
	t.	Is valve to hose header shut, and is header drained?	☐	☐
	u.	Is pump room clean and free of excess combustibles?	☐	☐
	v.	Is there a Class BC fire extinguisher in this pump room?	☐	☐
	w.	Is pump room adequately heated?	☐	☐
2.	**For Internal Combustion Engine-Driven Fire Pump**		☐	☐
	a.	Is weekly program timer operating properly?	☐	☐
	b.	Did the pump room combustion air damper open?	☐	☐

(over)

		YES	NO
c.	Did the cooling water waste properly?	☐	☐
d.	Did the pump start on each set of batteries?	☐	☐
e.	Is lubricating oil level correct?	☐	☐
f.	Is engine coolant level correct?	☐	☐
g.	Is liquid at proper level in all batteries?	☐	☐
h.	Are battery hydrometer readings within acceptable limits?	☐	☐
i.	Is each battery pilot light on?	☐	☐
j.	Is battery charger functioning properly?	☐	☐
k.	Is fuel tank full?	☐	☐
l.	Is fuel line valve open and sealed?	☐	☐
m.	Did low oil pressure alarm test satisfactorily?	☐	☐
n.	Did high engine temperature alarm test satisfactorily?	☐	☐
o.	Did interruption of AC power to the controller cause engine to start or initiate a remote supervisory signal?	☐	☐
p.	Did the overspeed-shut-down-device-position switch work properly?	☐	☐
q.	Is interruption-of-battery-power alarm working properly?	☐	☐
r.	Is controller locked, and are keys accessible to authorized personnel?	☐	☐
s.	Was engine run for 30 minutes?	☐	☐
t.	Did engine achieve and maintain proper operating temperature?	☐	☐
3.	**For Electric Motor-Driven Fire Pump**	☐	☐
a.	Was pump run for 7 minutes?	☐	☐
b.	Did motor achieve and maintain proper operating temperature?	☐	☐
c.	Is the circuit breaker in the closed position?	☐	☐
d.	Is the “power available” light on?	☐	☐
4.	**For Steam-Driven Fire Pump**	☐	☐
a.	Is proper supply of lubricants on hand and is lubrication system operable?	☐	☐
b.	Is the steam chest or casing at operating temperature?	☐	☐
c.	Are steam traps operating, or was condensate manually drained?	☐	☐
d.	Is sufficient steam pressure maintained at all times?	☐	☐
e.	Was a “slip test” made?	☐	☐
f.	Was the pump run for 5 minutes?	☐	☐
g.	While operating at rated speed, was the vibration within acceptable limits?	☐	☐

Deficiencies or other comments: ______________________________

____

____

____

____

SUGGESTED AUTOMOTIVE FIRE APPARATUS CHECKLIST

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Make of Apparatus: ______________________ Type of Apparatus: ______________________

When checking automotive fire apparatus, the following should be determined. A "No" answer indicates a deficiency which should be corrected.

		YES	NO
1.	Are the terminals on the batteries clean and the cable clamps tightly connected?		
2.	Is each battery clean and securely mounted?	☐	☐
3.	Is battery liquid at proper level?	☐	☐
4.	Is each battery hydrometer reading within acceptable limits?	☐	☐
5.	Is the trickle or automatic charger operating?	☐	☐
6.	Is the crank case oil level correct?	☐	☐
7.	Is the coolant level in the radiator correct?	☐	☐
8.	Were the brakes pressure-tested by operating the foot pedal?	☐	☐
9.	Were the air brakes bled to remove condensate?	☐	☐
10.	Was the apparatus started and driven for 10 minutes and then allowed to idle for an additional 20 minutes at not less than 1000 rpm?	☐	☐
11.	Is the engine speed (rpm) maintained when the ignition switch is either in the A or B position?	☐	☐
12.	Is fuel tank full?	☐	☐
13.	Is booster tank water level full?	☐	☐
14.	Is foam tank full?	☐	☐
15.	Are tools, appliances, and portable equipment in proper location and in working condition?	☐	☐
16.	Are lights, sirens, and horns operable?	☐	☐
17.	Is engine clean, and free of an accumulation of oil and moisture around its wiring or electrical equipment?	☐	☐
18.	Is the underside of the apparatus clean?	☐	☐
19.	Is each tire properly inflated and free of cuts, breaks, and foreign objects?	☐	☐
20.	Are special extinguishing systems such as dry chemical, carbon dioxide, and Halon in working order?	☐	☐
21.	Did pump suction and discharge valves operate freely?	☐	☐
22.	Are pump caps and couplings free to turn?	☐	☐
23.	Are the hydraulic systems of aerials, ladders, elevated platforms, and articulating booms in proper operating condition?	☐	☐
24.	Has regular preventive maintenance been performed on the engine, chassis, pump, and other mechanical and electrical equipment?	☐	☐

(over)

Deficiencies or other comments:

SUGGESTED FIRE EXTINGUISHER AND INSIDE HOSE CONNECTION REPORT FORM

Facility: ______________________ Inspector: ______________________

Location: ______________________ Date: ______________________

Fire Extinguishers

Number	Location	Type and Size	Charged?		Properly Installed?		Last Serviced	Comments
			Yes	No	Yes	No		

Inside Hose Connections/Standpipes

Number	Location	Hose Size	Hose Length	Hose Cond.	Rack Cond.	Comments

Is any change in the distribution of extinguishers or inside hose connections needed?

☐ YES ☐ NO, Explain. ____________________

Additional comments and recommendations: ____________________