EQUIPMENT MANAGEMENT PROGRAM

LOSS PREVENTION UNIT
OFFICE OF RISK MANAGEMENT
DIVISION OF ADMINISTRATION

20250701

CONTENTS

EQUIPMENT MANAGEMENT PROGRAM

Introduction 3

Components of Louisiana's Equipment Management Program: 4

- Agency Maintenance Policies and Procedures 4
  - Responsibilities 4
  - Specific Inventory 4
  - Preventive Maintenance Procedures 4
  - Preventive Maintenance Schedule 4
  - Testing Procedures 4
  - Documentation 4
  - Training 5
- Communication/Organization 5
- Audits and Record keeping 6

Personal Protective Equipment (PPE) 6

Work Order System 6

Lockout/Tagout (LO/TO) 7

Boilers 8

Elevators 8

Fire Alarm Systems 8

Confined Spaces 9

List of Equipment to Include in the Program 10

Example Preventive Maintenance Schedules 12

Louisiana Preventive Maintenance Program 40

Sample Lockout/Tagout Policy 41

Sample Lockout/Tagout Inspection Form 46

Sample Lockout/Tagout Procedure 47

Sample Confined Space Decision Chart 50

Sample Confined Space Permit 51

EQUIPMENT MANAGEMENT PROGRAM

Introduction:

All agencies housed in state-owned buildings shall implement an equipment management program for all electrical and mechanical equipment.

The Office of Risk Management has a comprehensive equipment program to assist all state agencies in conducting effective maintenance operations within their facilities. The program will assist agencies in lowering the high cost of insurance, reducing the number of unplanned outages and extending the life of the State's mechanical and electrical equipment. Equipment covered under the boiler and machinery policy is not depreciated; it is covered for the replacement value.

Program Goal:

The primary goal of an equipment management program is to ultimately decrease repairs to equipment by increasing the efficiency in managing the scheduled equipment maintenance. The State of Louisiana is committed to a continuing, aggressive program for maintenance of mechanical and electrical equipment at all levels of state government.

The Equipment Management section applies only to electrical and mechanical systems/equipment that are integral to the operation of the building and/or are an affixed (i.e., hardwired and/or plumbed) part of buildings/structures. It does not apply to mobile or portable equipment.

Portable and fixed generators that are used to supply power to any part of the operation of the building during an emergency will be included in the electrical portion of the Equipment Management Program. Portable generators that are used for any other purpose (welding, running a sump pump, running an irrigation pump, running power tools at a remote site, etc.) will not be included in the EM Program.

An effective program will reduce loss of equipment, decrease operational down time and extend the life of State mechanical and electrical and other equipment. The size, nature, and complexity of an operation dictate certain maintenance requirements. All systems shall be monitored so that temperature, humidity, plumbing, lighting, air quality, emergency, and safety equipment are maintained at an acceptable level.

Components of an Equipment Management Program:

I. Agency Maintenance Policies and Procedures:

A) Responsibilities - Each agency is responsible for implementing a viable equipment management program. *This program shall be made available and accessible to all maintenance or other designated personnel.* The program shall include designating personnel who are responsible for specific maintenance areas. Policies must outline the roles and responsibilities of managers, supervisors, and employees within the maintenance program. The Third-Party Administrator (TPA) will provide guidance and direction to agencies in developing an effective equipment management loss control and maintenance program.

B) Specific Inventory – Each agency shall develop a specific inventory of all mechanical and electrical equipment in the program, including the name of the equipment, location, model number, and serial number.

C) Preventive Maintenance Procedures –The agency shall develop preventive maintenance procedures for each piece of mechanical and electrical equipment included in the program that include:

- Tasks to be completed
- Trade skills needed to accomplish the task
- Estimated time required to complete task

If the agency has a preventive maintenance contract, the contract shall specify the work to be performed and a copy of the contract shall be available for review during the audit.

D) Preventive Maintenance Schedule – The agency shall develop preventive maintenance schedule(s) for each piece of equipment included in the program. It is recommended that the agency follow the suggested manufacturer's preventive maintenance (PM) on its equipment; however, if the manufacturer's information is not available, ORM's program contains some suggested schedules. Agencies using a preventive maintenance contract shall specify therein how often the work is to be performed.

E) Testing Procedures – Each agency shall develop testing procedures for each piece of equipment that requires testing. The program shall specify the test(s) to be performed and the frequency. It is recommended that the agency follow the suggested manufacturer's testing procedures on its equipment; however, should the manufacturer's information not be available, ORM's program contains some suggested tests and schedules.

F) Documentation – Each agency shall document its preventive maintenance and/or repair procedures, schedules, and testing procedures performed on the mechanical and electrical equipment. Handwritten notations, computer-based

programs or tables, and other forms of checklists that cannot be readily deciphered by the Loss Prevention Officer will need to be clarified. Typewritten notations may be required in these instances.

The documentation provides the agency with an equipment history and the following shall be included, if applicable:

1. What work was performed on the equipment
2. Who performed the work
3. How long did it take to perform
4. What replacement parts where used and their cost
5. Whether the work was billed to a tenant
6. If the agency is using a contractor to perform preventive maintenance, repairs, testing, etc., the agency shall require the contractor to provide clear, concise documentation of the work performed
7. Date work was performed/completed

G) Training – The agency shall provide documented training for all employees trained in areas related to the program, whether formal or on-the-job training, to include training on:

1. the written Equipment Management Program
2. the operation of equipment included in the program
3. the preventive maintenance of the equipment included in the program
4. the testing procedures for equipment and the operation of testing equipment
5. the safety precautions to be aware of when performing the preventive maintenance as well as the PPE needed before starting the procedure

NOTE: employees who come from elsewhere (public or private sector) with significant, relevant experience and/or training do not need to re-train provided there is proof of an agency policy where the agency reviews and determines an employee's level of training and competency to safely perform the job.

II. Communication/Organization:

The TPA shall, upon request, assist agencies in setting up the program within the agency. The Unit shall also assist agencies in identifying equipment to be included in the program. The State Loss Prevention Officer shall cite maintenance program deficiencies during their inspections at state facilities. These deficiencies, along with any recommendations for corrective action, shall be reported in writing to the Office of Risk Management. All correspondence shall then be forwarded to the agency location in question for a response to and/or corrective action plans addressing the recommendations.

Agencies that have commercial maintenance/service contracts in force will provide all relevant documentation to the Loss Prevention Officer upon request.

III. Audits and Record Keeping:

The TPA shall, upon request, assist agencies in reviewing and analyzing their equipment management maintenance program to determine if it is properly designed to have the intended impact. Records will be maintained for the life of the equipment on all program equipment including, but not limited to: preventive maintenance schedules, testing results, repair documents, replacement documents and all completed service documents. The documentation may be listed on the work order comments if using a computer-based Maintenance Management program designed specifically for maintenance management such as work orders, inventory, preventive maintenance, and time management. Loss Prevention audits shall be conducted on the program every three years. Recertification/Compliance reviews shall be conducted in subsequent years.

Personal Protective Equipment (PPE):

Each agency shall establish a written Personal Protective Equipment Program that includes:

- Performing an assessment of its workplace to determine if hazards requiring the use of PPE are present or likely to be present. (If possible, hazards should be reduced or eliminated with engineering or work practice controls rather than PPE. PPE should be a last resort.)
- Identifying appropriate PPE and supplying such at no cost to the employees.
- Training employees on the use of PPE including:
  - What PPE is required when performing job tasks
  - When PPE is required when performing job tasks
  - How to obtain the required PPE
  - How to properly use PPE, including properly donning/removing and fit testing the PPE
  - Limitations of the PPE
  - How to properly care for and store
  - Disposal
  - How and/from whom to request assistance concerning PPE
  - Identifying how the agency will enforce proper PPE usage
  - Identifying how the agency will provide for any required medical examinations (i.e. for respirator usage)
  - Identifying how and when to evaluate the PPE Program

The agency must be able to provide documentation of implementation of each area of the program as it applies.

Work Order System:

Each agency location shall have documented work order system procedures that address scheduled preventive maintenance and/or repairs. The procedures should include reporting work orders and assignments and documenting work completion. All repairs should be initiated, and serious ones completed, within thirty (30) days.

Handwritten notations, computer based programs or tables, and other forms of checklists that cannot be readily deciphered by the Loss Prevention Officer will need to be clarified. Typewritten notations may be required in these instances.

All employees shall be informed on the work order procedure for reporting problems. Documentation shall be available for audit review.

It is recommended that documentation of the most recently completed work orders for each type of repair be maintained and available for review upon request.

Lockout/Tagout (LO/TO):

Preventing worker injuries and deaths from the uncontrolled release of electrical, mechanical, and other types of hazardous energy is at the heart of any equipment management effort. The ORM Loss Prevention Unit requires that every state entity possessing electrical and mechanical equipment necessitating an equipment management program must include a written Lockout/Tagout plan. Any Lockout/Tagout Plan must first consider who is to be protected, as well as what forms of hazardous energy are present.

If any LO/TO work is to be performed by an outside contractor, the agency shall ensure that the contractor has its own written LO/TO program and that the agency's affected employees are trained on the contractor's program.

Employees to be protected are primarily those who service and maintain the machinery or equipment, and secondarily, those who operate or use such. These groups of employees are referred to, and defined as:

Affected Employee is the individual who operates or uses a machine or equipment on which servicing/maintenance is being performed under lockout or tagout, or whose job requires working in an area in which such servicing or maintenance is being performed.

Authorized Employee is the individual who locks out or tags out machines or equipment in order to perform servicing or maintenance. An *affected employee* is also an *authorized employee* when that employee's duties include performing servicing or maintenance on covered equipment.

Employees may be exposed to hazardous energy in several forms and combinations during installation, maintenance, or repair work: The forms of energy include:

- Kinetic (mechanical*) energy* in the moving parts of mechanical systems
- Potential energy stored in pressure vessels, gas tanks, hydraulic or pneumatic systems, etc. (Potential energy may be released as hazardous kinetic energy.)
- Electrical energy from generated electrical power, static sources, or electrical storage devices (such as batteries or capacitors)
- Thermal energy (high or low temperature) resulting from mechanical work, radiation, chemical reaction, or electrical resistance

Sample lockout/tagout (LO/TO) policies and procedures are included that can be modified for agency use. Each department/agency must tailor their LO/TO policy and

procedure to its own needs. Each agency shall train all of its **authorized** employees annually, and its **affected** employees once every three years, and document such.

Appropriate LO/TO devices shall be available for employee use.

Boilers:

The Commercial Insurance Carrier shall perform boiler inspections on applicable equipment to ensure agencies are operating within the prescribed boiler/machinery code and law. The carrier shall forward a copy of this report to the affected agency for corrective actions, as well as a copy to the Office of Risk Management's Loss Prevention Unit. Upon completion of all required corrections, the agency shall report such back to the LP Unit.

Current inspection certificates shall be posted on or near the corresponding approved boilers.

Elevators:

A commercial elevator inspector shall conduct **semi-annual** elevator inspections at all agencies. Maintenance deficiencies, recommendations, and code violations for the elevator contractor and the building owner/manager shall be issued. The agency is responsible for the repair/replacement and documentation of all corrective action and code violations. The agency shall also provide clear documentation that all contractor and owner violations have been corrected.

Agencies should take any elevator out of service that poses an immediate threat to life or health until all necessary repairs are complete. Any elevator taken out of service is required to be re-inspected and approved for use by a qualified elevator inspector after repairs are complete prior to being placed back into service.

Each agency location with an elevator shall have written procedures concerning the availability of the fire service elevator key. It shall include a listing of personnel assigned the responsibility of the fire service key and procedures to ensure the fire service key is provided to the local fire Department or readily accessible upon their arrival. The elevator equipment room key and the fire service call key shall be in a lockbox, distinctly labeled, at an appropriate location (e.g., such as the building manager's or security office) and the elevator equipment room key may be attached to the fire service key.

Certificates/inspection reports shall be posted in the corresponding elevators or information on their availability must be posted.

Fire Alarm Systems:

As required by the State Fire Marshal, each fire alarm system must be inspected annually by a licensed fire alarm service company.

Confined Spaces:

The Office of Risk Management recognizes the risk to the State whenever confined spaces exist and the agency has no program for the employees to follow. The State also has liability when an agency does not require contractors to follow their own confined space procedures.

"Confined space" (non-permit required) means a space that:

- Is large enough and so configured that an employee can bodily enter and perform assigned work;
- Has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
- Is not designed for continuous employee occupancy.

Training

The primary goal of a Confined Space Program is to ensure all confined spaces are identified and no one is permitted to work in an unsafe environment. Training requirements should be appropriate for, and commensurate with, the nature of the work or exposure.

Components include the following:

Each state facility shall assess itself in accordance with the definition of a confined space to determine if any exist. The agency must know how to identify and classify a confined space and address the hazards associated with each. Any exception to this must be submitted in writing to the ORM Loss Prevention Manager for review/approval.

If no confined spaces exist or if the agency contracts out **all** work in identified confined spaces, the agency shall document this and a program does not have be developed. Provisions shall be available to ensure contractors are required to work under their own program.

If confined spaces do exist, the agency shall determine whether they are permitted or non-permitted spaces.

A permit-required space meets all of the above non-permit criteria plus one or more of the following:

- a substance that has the ability to engulf or asphyxiate the entrant
- a potentially hazardous atmosphere
- inwardly converging walls within the space or a floor the slopes downward, tapering to a small cross-section
- contains any other serious safety or health hazard

Department and/or agency heads are responsible for the development and implementation of a confined space program whenever state employees are required to work in these environments.

The TPA will assist agencies in setting up their program to include identifying confined spaces and determining whether they are permitted or not. The agency shall ensure that all appropriate equipment is available for personnel assigned to perform confined space entry related work.

Training on the written program shall be provided to all applicable employees:

(i) Before the employee is first assigned duties under this section;
(ii) Before there is a change in assigned duties;
(iii) Whenever there is a change in permit or non-permit space operations that presents a hazard about which an employee has not previously been trained;
(iv) Whenever the employer has reason to believe either that there are deviations from the permit or non-permit procedures or that there are inadequacies in the employee's knowledge or use of these procedures;
(v) or at least annually

and shall cover, as appropriate, the following:

- Equipment
- PPE
- Rescue
- Environmental Testing
- Permits

The TPA shall audit the agency's program to determine if it is written in compliance with current Federal, State, or local codes. Documentation shall be present at the time of the audit or compliance review to verify that the program parallels such standards. Program documentation shall be maintained on site for a minimum of three years.

Equipment Listing/Schedules:

The following is a sample list of equipment that shall be included in the program as well as a sample maintenance schedule for each:

OBJECT	PAGE
Water Heaters	12
Boilers (small heating and supply types)	12
Boilers	13
Steam Heating Boilers	14
Hot Water Boilers	14
Coil-Type Water Tube Boilers	15
Pressure relief Valves	15
Pressure Vessels	16
Air Conditioning Units (window units/heat pumps)	16

Heat Pumps 17
Large Air Conditioning Units 17
Air Conditioning Systems (chilled water type) 18
Compressors 18
Motors 19
Condensers 19
Evaporators 20
Cooling Towers 20
Piping 21
Purge System 21
Absorption Machine 21
Steam Turbines 21
Internal Combustion Engines 22
Reciprocating Compressor 23
Centrifugal Compressor 24
Pumps 24
Fans and Blowers 25
Gear Sets 25
Shaft Mounted Couplings 26
Base Mounted Couplings and Clutches 26
Fly Wheels and Pulleys 26
Electric Panels 26
Motor Control Equipment 27
Oil Circuit Breakers 27
Air Circuit Breakers 28
Transformers 29
Fuses 30
AC Generators 30
DC Generators (Rotary Converters) 32
Electric Motors 33
Storage Batteries 33
Relays 34
Lighting and Surge Protection Equipment 34
Rectifiers (Power Semi-Conductor Equipment) 34
Uninterruptible Power Supplies 35

Below are <u>examples</u> of various maintenance schedules provided to assist agencies in the development of their specific schedule needs. Agencies are reminded to follow manufacturer's recommended maintenance schedules in particular when a warranty is still in force. Agencies that encounter problems or have difficulty developing a PM are directed to contact their Loss Prevention Officer.

<u>Water Heaters:</u>

A. Monthly

1. Visually check pressure temperature relief valve for proper spring action and disk seating.
2. Check for leaks at all seams on the outer casing, around the bottom, and all plumbing connections.
3. Check the operation of the safety valve(s) by manually opening it.

B. Annually

1. Inspect the burner and burner controls for proper flame setting (gas fuel).
2. Flush the vessel and check for evidence of mineral deposits.
3. Check the resistance of the heating elements on electric water heaters. An infinite resistance indicates that the element is burned out and needs to be replaced.

<u>Boilers</u> (small heating and supply types)

A. Daily

1. Check the gauges and record the readings.
2. Check the water level and gauge glass.
3. Check operational water level.
4. Clean the boiler room when necessary.

B. Weekly

1. Check the control linkages for the burner.
2. Manually trip the low water cutoff and check its operation.
3. Check the air damper.
4. Check the valves on the gas train for proper operation and check for leaks.
5. Check the pilot light or the electronic ignition system.

C. Monthly

1. Check flame detector.
2. Blow down boiler (If chemically treated, this should be done only if sludge is present).

D. Yearly

1. Shut off the low water cutoff and check its operation and general condition.
2. Inspect the water side of the boiler and clean if necessary. (Hot water supply boilers annually, hot water heating boilers biannually)
3. Check the burner setting and adjust if necessary.
4. Inspect the fire side and repair if necessary.
5. Check the resistance of the elements if the boiler is electric.

Boilers

A. General

1. Provide a thorough water-side and fire-side inspection at least annually.
2. Inspection frequencies are most generally established by the legal jurisdiction.
3. Unattended boilers should have two low water fuel cutoffs. One should be of the manual reset type and should be located in the lower portion of the unit.
4. A daily log as well as records of all inspections, maintenance, and testing should be maintained.
5. Follow manufacturer's instructions for startup and operation.
6. If water level is noted below safe level on steam boilers, shut down immediately and cool slowly. Apply a hydrostatic test and inspect for leaks and overheating.
7. Following the operation of a safety device, always determine the cause and correct the deficiency before resuming operation.
8. On steam boilers, blow down water-wall heaters and economizers in accordance with manufacturer‘s instructions.
9. Keep blow down valve in good repair and free of leaks.
10. Water treatment should be controlled to retard corrosion and/or scale formation. A reputable water treatment specialist should conduct this.
11. ASME certified welders should do all boiler repairs that may affect the integrity of the pressure parts.
12. Perform a slow drain test on low water fuel cutoff on boilers whenever boiler is drained.

B. Daily

1. Continually monitor water level.
2. Check water gauge glass for proper water level on steam heating boilers.
3. Check pressure on altitude gauge on hot water heating boilers.
4. Blow down water gauge glass each shift on steam boilers.
5. Observe combustion conditions and check for leaks.
6. Make sure all drain valves and cocks are tightly closed after daily tests.

Steam Heating Boilers:

1. Operate each gauge cock.
2. Open blow off valve for a few seconds to drain off sediment.

Hot Water Boilers:

1. Check expansion tank glass to ascertain proper air cushion.
2. Check water temperature. It should never exceed 250 degrees Fahrenheit (120 degrees Centigrade).
3. On high-pressure steam boilers, test feed water regulators, low water fuel cutoff by a quick drain test and alarms.
4. Check boiler for water leaks. Leaks should be repaired.

C. Weekly

1. Blow down float (or electrode) chambers of each low water fuel cutoff, low water alarm, and feed water regulator to keep chambers free of sediment and operable. Testing of low water fuel cutoffs should be done with the burner in operation. If the burner fails to shut off, service immediately.
2. Low-pressure steam boilers, test low water fuel cutoffs using a quick drain test.
3. Flush low water fuel cutoff on hot water boilers.

D. Monthly: Perform prescribed inspections and tests of combustion safeguards at intervals recommended by manufacturers or at least once a month on gas or oil fired equipment. Include tests for tightness of safety shutoff valves, response to flame failure and proper action of fuel air interlocks.

E. Quarterly: Test each low water fuel cutoff on high pressure and low pressure steam boilers in an actual test by slowly lowering the boiler water level until the burners shut off. When making this test, water level should never be permitted to fall out of sight in the gauge glass.

F. Annually: At a minimum, the low water cutoff should be inspected and cleaned as necessary to determine proper operation.

G. End of Heating Season (This only applies if the boilers are used for heating only).

Steam boilers

1. Drain boiler and remove closure plate and/or plugs from all access openings.
2. Remove all fuses from burner circuits.
3. Remove all soot and ash from furnace, tubes, and flue surfaces.
4. Flush boilers thoroughly to remove all sludge and loose scale particles from internal surfaces.
5. Repair or replace leaking tubes, nipples, stay bolts, packing and insulation.

6. Clean all controls, check operation, and overhaul automatic controls if necessary.
7. Check the condensate return system for tightness and integrity of components.
8. Leave steel boilers open and dry.
9. Attach a conspicuous sign warning that boiler is empty and not to be fired. (Note: This step may be accomplished at the disconnect supplying power to the boiler. Lockout/tagout may be used so the boiler cannot be fired until the proper procedures are followed.)
10. If wet, lay up is preferred, boiler should be completely filled with properly treated water to prevent corrosive action. A water treatment specialist should be consulted.
11. After draining and flushing cast iron boilers, refill with clean water to normal operating level.

Hot Water Boilers

Drain from bottom while boiler is hot until the water runs clear, then refill. If water treatment is used, sufficient treatment compound should be added to condition replacement water.

H. Beginning of Heating Season (if applicable)

After firing, test all automatic controls including: feed water regulator, low water fuel cutoff, alarm, and combustion safeguards. Also "pop test" safety valves to assure they will work under boiler pressure within allowable tolerances. At all times maintain a permanent boiler log book to record maintenance work, inspections, tests, and other pertinent data.

Coil-Type Water Tube Boilers

Annual: Excess temperature controls and low water cutoff should be provided and properly maintained (see Boilers for testing and maintenance).

Pressure Relief Valves

General: The testing interval should be based on operating experience and not exceed what is necessary to keep the safety valves in satisfactory condition. Any safety valve testing requirements established by regulatory bodies, including government agencies, must take precedence over other procedures.

Testing: Per manufacturer and/or jurisdiction specifications

Pressure Vessels

A. General

1. Pressure vessels are generally designed and fabricated for a specific service and should be used in accordance with the manufacturer's suggested operating and maintenance procedures. Pressure, temperature, corrosion, and cracking should be continuously monitored.
2. This section includes air receivers, heat exchangers, etc.
3. Repair and clean as needed based on previous records and inspection.
4. Periodic thickness checks should be conducted where there is a possibility of corrosion or erosion.

B. Weekly

1. Observe physical condition.
2. Where applicable, drain condensate.
3. Where applicable, inspect and record operating valves and controls.

C. Monthly: Test safety devices.

D. Annually: Test and calibrate all controls.

E. Every Two Years: Conduct an internal examination. Pressure vessels containing corrosive materials or involving erosion problems should be examined more frequently.

Air Conditioning Units (window units/heat pumps)

A. Monthly: (window units) clean the evaporator air filter or replace if it is a disposable type.

B. Annually: (window units)

1. Lubricate the fan motor.
2. Clean the evaporator and condenser coils (more often for severe conditions).
3. Clean the condensate drain.
4. Check for leaks throughout the system.
5. Check the electrical connections for looseness and tighten if necessary.
6. Winterize the system if necessary.
7. Check the Freon charge before summer use.

Heat Pumps

A. Monthly: Clean the evaporator air filter or replace if it is a disposable type.

B. Annually:

1. Lubricate the fan motor.
2. Clear the evaporator and condenser coils (more often for severe conditions).
3. Inspect for leaks throughout the system.
4. Test the defrost cycle.
5. Clean the condensate drain.
6. Check the electrical connections for looseness and tighten if necessary.
7. Check the fan belts, adjust or replace as necessary.
8. Check the Freon charge in the system.

Large Air conditioning units/DX units

A. Weekly: Check the oil level if applicable
B. Monthly: Same as for heat pumps
C. Annually: Same as for heat pumps

Air Conditioning Systems

A. During Off Season or Maintenance Shutdown (most systems run all year)

1. An annual vibration, oil analysis and heat scan should be done. These tests will determine whether there are internal problems that could affect the life of the equipment. The oil analysis shows whether there are metal particulates, moisture, or other symptoms that could be detrimental to the integrity of the equipment. The vibration analysis will show if the tolerances inside the machine are becoming unacceptable. The heat scan will show if there are unusual areas that are running hot, such as bearings.
2. Check the oil carefully and renew before spring startup. Drain the seal oil reservoir, atmospheric float chamber, and main oil pump and fill with new oil after service operations have been completed.
3. Make a thorough inspection for leaks and repair if necessary. The most likely places are around the cooler ruptured disc or relief valve, the cooler condenser expansion joint, suction, damper seal, low refrigerant cutout bulb in the cooler, and valves, flare and gauge connections in the purge.
4. Inspect the purge thoroughly for tightness of all connections. Make a leak test and an operational test.
5. Inspect electric dryers. Check starter contacts for burning and replace if necessary. Check for loose connections and starter operation.
6. Clean motors of foreign material. On variable speed motors, inspect the drum controller for smooth operation. Check the resistance element for loose connections.
7. Check operation and setting of all safety controls. This includes condenser high-pressure cutout, low refrigerant temperatures cutout, and low oil pressure switch. Inspect operating controls such as the chilled water controller. Inspect and clean all thermostats, hydrostats and relays. Check for proper calibration. Examine

sequence of operation of control instruments and operators such as damper motors and chilled water valves.

B. On a Regular Basis as Necessary

1. Clean or replace filters according to manufacturer's specifications.
2. Perform shutdown and startup inspections on condensers and/or cooling towers and check frequently for excess noise or vibration.
3. Obtain specific water treatment advice from a water treatment specialist since the major part of preventive maintenance on cooling towers and evaporative condensers is a good water treatment program.

Air conditioning systems (chilled water type)

A. Daily

1. Log equipment readings.
2. Check oil and Freon levels in the bull's-eyes.
3. Check to see if the controls are operating properly.

B. Annually

1. Check for leaks.
2. Tighten flange nuts and belts.
3. Check baffles and gaskets.

Compressors

A. Daily

1. Listen for unusual noises and vibrations.
2. Check and record suction and discharge pressures.
3. Check the oil level and look for oil leaks.
4. Check the bearing temperature.
5. Check for crank case sweating (reciprocating type).

B. Monthly: Check high and low pressure cutoff setting.

C. Annually
1. Check for Freon leaks.
2. Check couple alignment if it is an open drive.
3. Check unloading devices for proper operation.
4. Clean strainers and oil filters if it is determined by the annual oil analysis that it is needed or due to manufacturer's recommendations. (Note: Due to the improvement of the lubricants, most manufacturers recommend that if the oil analysis shows the oil is good condition, to leave it alone).
5. Check and test relief valves.

D. 5 Years: Perform an eddy current test on the condenser and evaporator.

Motors

A. Daily: Visually check the motor and bearings for excessive noise, vibration, or high temperature.

B. Monthly

1. Oil or grease the bearings according to manufacturer's specifications if necessary. (Note: The practice of greasing monthly often causes overheating of the bearings and premature failure. Only lubricate monthly if that is what the manufacturer recommends. It is usually based on hours of use rather than time dated such as monthly).
2. Check the brushes for arcing (DC only).

C. Annually

1. Clean the frame and air passages.
2. Check voltage and amperage.
3. Check vibration isolators and anchor bolts.
4. Check to see if the motor comes up to speed promptly.
5. Check all electrical connections for looseness and tighten if necessary.
6. Check the couple for alignment and tightness.

Condensers

A. Daily

1. Check cooling water for proper level and foreign materials.
2. Check and record water temperature and pressure.

B. Monthly: Check for cooling water leaks.

C. Annually

1. Check for Freon leaks.
2. Drain out all of the water and clean if necessary.
3. Check the tubes for corrosion/erosion and inspect for clogging.
4. Replace any damaged tubes.
5. Replace gaskets.
6. Check all the valves and repair if necessary.

Evaporators

A. Daily: Check and record inlet and outlet chilled water temperatures.

B. Monthly

1. Check for refrigerant leaks.
2. Check for chilled water leaks.

C. Annually

1. Check for refrigerant leaks.
2. Drain out all of the water and clean if necessary.
3. Check the tubes for corrosion or erosion and inspect the tube for clogging.
4. Replace any damaged tubes.
5. Replace all gaskets.

Cooling Towers

A. Daily

1. Check the water for proper water level and foreign materials.
2. Check the operation of spray nozzles or condition of tower fill.
3. Check the float for proper operation.

B. Monthly

1. Oil or grease bearing in the fan motor or as per manufacturer's recommendation. Visually check for leaks if the tower has a gearbox drive.
2. Check for algae growth in the pan.
3. Do a chemical analysis on the water.
4. Visually check the fan bearing for proper lubrication.
5. Check the fan rotation for imbalance.
6. Check the tension on the fan belt.

C. Annually

1. Drain and clean pan and inspect for rusting.
2. Repair or replace float valve if necessary.
3. Clean the spray nozzles, pan and/or tower fill.
4. Check fan drive and check bearing for water.
5. Check all valves and repair if necessary.
6. Drain and refill gearbox if applicable according to manufacturer's specifications.

Piping

A. Monthly: Check for leaks and repair if necessary.

B. Annually

1. Check all the valves and repair if necessary.
2. Check the piping for signs of rust and corrosion, repairing or replacing as necessary.
3. Clean the strainers (cooling water).
4. Check for signs of sweating on insulation and repair (chilled water or refrigerant lines).

Purge System

A. Weekly: Check the sight glass for evidence of water floating on the refrigerant and drain when necessary.

B. 3 Months: Check the belt tension.

Absorption Machine

A. Daily

1. Inspect for corrosion and leaks.
2. Check sight glasses.

B. Monthly

1. Test for hydrogen.
2. Check control wells. Clean and renew oil.
3. Grease and operate all valves.
4. Determine absorber loss.
5. Take lithium bromide samples.
6. Test the unit for non-condensable accumulation rate.
7. Clear motor cooling line strainer(s).

Steam Turbines

A. General

1. Conduct a complete warranty dismantle inspection by the manufacturer within the first year of operation if applicable.
2. A complete dismantle inspection should be made as follows:
   a. Every 25,000 operating hours or five years for units operating less than 8,000 hours per year and experiencing more than eight starts per year.
   b. Every 40,000 operating hours for units operating at least 8,000 hours per year and experiencing fewer than eight starts per year.
   c. Every 12,000 operating hours or three years for all other units.
3. The frequency of tests should be increased if indicated by operating experience.

4. Records kept should include: operating hours, repairs, tests, and other important data.
5. Manufacturer's suggested operating procedures should be followed for oil systems, temperatures, vibration, etc.

B. Weekly: Test units equipped with throttle valve stem, reheat stop valve, and interceptor valve stem exerciser.

C. Monthly- Check:

1. Overspeed trip
2. Low bearing oil pressure trip
3. Low vacuum trip
4. Thrust bearing oil trip
5. Lubricating oil for contamination

D. Semi-Annually

1. Test overspeed trip mechanism by overspeeding. If continuous operation, test annually or when coming online with unit.
2. Test solenoid trip, initial pressure regulator, thrust bearing trip and auxiliary governor while unit is out of service for overspeed tests.
3. Turbine units less than 1000 hp and not equipped with exercisers for simulating should be tripped by actual overspeeding test every 6 months to check the installed independent overspeed trip devices. For other turbines, test unit when going on line and coming off line.

E. Annually

1. Inspect speed governor system and replace any worn parts. Clean and lubricate.
2. Annual inspection should include stop valve assembly, bearings, and oil system. Access openings should be visually examined.

<u>Internal Combustion Engines:</u> (Excluding Automobiles)

A. Every 25 hours or 4 months

1. Adjust fan and alternator belt.
2. Add oil to oil cup for distributor housing if applicable.
3. Inspect air filter for cleanliness. Change oil in oil type air filter or clean or change according to manufacturer's specifications.

B. Every 50 hours or 6 months

1. Drain and refill crankcase.
2. Clean crankcase ventilation air cleaner.
3. Clean dry type air cleaner.
4. Check transmission oil.

5. Check battery.
6. Clean external engine surface.
7. Perform 25-hour service (above).

C. Every 100 hours or 8 months

1. Replace oil filter element.
2. Check crankcase ventilator valve.
3. Clean crankcase inlet air cleaner.
4. Clean or change fuel filter.
5. Replace dry type air cleaner.

D. Every 200 hours or 12 months

1. Adjust distributor contact points if applicable.
2. Check spark plugs for fouling and ensure proper gap.
3. Check timing if applicable.
4. Check fuel injection system.
5. Perform 25, 50, and 100-hour service.

E. Every 500 hours or 24 months

1. Drain and refill transmission if applicable.
2. Replace crankcase ventilator valve.
3. Replace fuel filter.
4. Check crankcase vacuum.
5. Check compression.
6. Perform 25, 50, 100, and 200-hour service (above).

<u>Reciprocating Compressor</u>

General

1. Daily documented visual inspection of lubrication oil level, oil pressure, and oil flow. Also check inlet filters and water condensate level in storage tank.
2. Daily documented visual inspection of cooling water inlet and outlet temperatures, plus high water temperature warning device to shut down compressor during prolonged high cooling water temperatures.
3. Check operating compressor for unusual vibrations and excessive external vibrations of attached piping.
4. Full capacity pressure relief valve between compressor discharge and first shutoff valve on the main compressed air pipeline if applicable.

Centrifugal Compressor

A. General

1. The internal or external lubrication system operating parameters should be monitored daily with all data documented to an operating log.
2. Inlet and outlet temperature of cooling media to compressor assembly should be monitored daily and documented on the operating log.
3. Lubrication oil in compressor gear case should be sampled and tested monthly for evidence of oil break down and early destruction of internal components.
4. Portable vibration monitoring should be done annually on the operating compressor and the data should be documented in a permanent equipment record.
5. Centrifugal compressor manufacturer's recommendations for tear down, cleaning, inspection, and rebuilding of their compressor and all auxiliaries should be incorporated into the plant maintenance program.
6. Daily documented visual inspection of lubrication system and cooling system parameters during vacuum pump operations.
7. Daily documented verification of actual vacuum gauge readings and actual operating temperatures of vacuum pump and discharged gases.
8. Special filtering equipment, with adequate capacity upstream of vacuum pump to prevent foreign material from entering the pump and causing subsequent internal damage.
9. Annual vibration and oil analysis.

Pumps

A. Positive Displacement

1. The internal or external pressure relief valve installed at the pump discharge should be cleaned, inspected, and tested on routine preventive maintenance program.
2. Clean or replace the strainer at pump inlet at programmed intervals to prevent foreign material entrance into the rotating elements and the pressure relief valve.
3. Installation of check valve at pump discharge to prevent backflow from main piping header through pump and into the suction lines.
4. Daily visitation for excessive noise levels produced by pump as a result of broken or worn internal parts.
5. Daily visual inspection for excessive vibration on piping system as a result of piping misalignment to the pump inlet and discharge connections.
6. The parameters of the pump heating or cooling fluids should be monitored daily and documented to the operating log book.
7. Lubrication of all pump bearings as recommended by pump manufacturer.

B. Centrifugal and Axial

1. Daily documented inspection of pump site to check for stuffing box leakage, excessive bearing temperatures, excessive pump noise, and excessive piping vibration.
2. Check valve at pump discharge to prevent reverse flow through pump, and subsequent impeller detachment from shaft.
3. Adequate fluid flow to mechanical seals should be monitored daily to prevent early destruction of the seal.
4. Factory lubrication recommendations should be followed during the life of the pump.
5. A generally accepted rule for maintenance of a centrifugal pump is, “as long as operation continues, the unit should be left alone”.

Fans and Blowers

1. Quarterly documented inspection of lubrication oil flow, oil clarity, reservoir oil levels, or grease lubrication system.
2. Quarterly documented verification of inlet and outlet temperatures of coolant supplied to fan housing or liquid cooled driver motors.
3. Very high temperature (over 800 degrees Fahrenheit) process fans and blowers should be equipped with high temperature sensors and inlet shutoff or automatic bypass at fan inlet to prevent overheated process gas damage to the fan wheel.
4. Documented quarterly portable vibration inspection of fan or blower housing during normal operations. (Note: This is not always necessary unless the fan or blower is essential for 24/7 operation or as a safety element such as being in a lab. Daily visuals of these components usually show problems well before a quarterly vibration inspection.)

Gear Sets

A. OPEN
    1. Annual documentation of visual inspection of lubrication grease film on gear teeth.
    2. Machine monitors on pinion gear bearings as a constant maintenance surveillance of all rotating parts in the gear set.
    3. Yearly surface pyrometer or infrared inspection of pinion gear tooth flank to verify alignment of gear set.

B. ENCLOSED
    1. Daily documented inspection of lubrication oil flow, oil clarity, and reservoir oil level.
    2. Daily documentation of gearbox temperatures, inlet and outlet temperatures of cooling medium used for external cooled heat exchanger.

3. Annual lubrication oil samples taken from the gearboxes should be tested for oil breakdown, atmosphere contamination, metallic particles from internal components, and moisture build-up from atmospheric condensate or liquid cooled internal heat exchanger.
4. Documented annual portable vibration inspection on gearbox input and output shafts for all machines critical to plant production.
5. Documented yearly visual internal inspection of all gear surfaced and gear box structural integrity.

Shaft Mounted Couplings

1. Documented annual portable vibration monitor signatures of bearings at each side of the shaft mounted couplings.
2. Scheduled lubrication as recommended by manufacturers of all shaft-mounted couplings.

Base Mounted Couplings and Clutches

1. Inlet and outlet temperature of cooling media on all coupling and clutches should be monitored daily with information documented in all operating logs.
2. Lubrication oils and coupling fluids should be monitored daily for temperature and fill level and documented in an operating log.
3. Lubrication oil samples from all couplings and clutches should be tested every three months for evidence of oil breakdown, oil contamination, and disintegration of internal components.
4. All electric clutches and couplings should have collector rings cleaned and tested as required by environmental conditions.
5. Manufacturers' recommended periodic tear down, cleaning, inspection, and rebuilding procedures should be incorporated into the existing plant maintenance program.

Fly Wheels and Pulleys

1. If overspeed devices are used on the drive system, they should be cleaned, inspected, recalibrated, and tested yearly.
2. During yearly scheduled shutdowns, a visual inspection of all painted surfaces will reveal any areas of over-stress that should be further inspected with the appropriate equipment.

Electric Panels: Conduct periodic visual inspection for discoloration of wiring, loose connections and cleanliness.

A. Daily

1. Listen for unusual noises.
2. Check for overheating.
3. After each fault interruption, check unit and replace damaged parts.

B. Weekly: Examine indoor enclosures for signs of moisture or water.

C. Annually (Environmental or operational conditions may warrant more frequent inspections.)

1. Keep interior clean and free of any dust or accumulation of foreign materials.
2. Check interior surfaces for moisture.
3. Check ventilation.
4. Check all insulating members for evidence of cracking.
5. Check high voltage switchgear for corona (white or gray powdery residue).
6. Check for thermal damage caused by exposure to excessive temperatures.
7. Check and tighten loose connections.
8. Examine the contacts for burning or pitting.
9. Exercise the breaker mechanism.
10. Test protective relays to trip breakers.

D. All wiring: Infrared scanning is required once every five (5) years to detect hot spots, loose connections, overloaded circuits, etc. Agencies without the proper testing equipment shall have the tests conducted by an outside contractor.

Motor Control Equipment

A. General: The proper cleaning frequency depends upon the operation and surrounding conditions.

B. Monthly

1. Clean and tighten all connections and lubricate bearings.
2. Check level and condition of oil.
3. Keep covers closed and latched and enclosures tight.

C. Annually

1. Inspect copper arching tip and renew when proper contour cannot be maintained.
2. Remove deposits from arc chutes and barriers.
3. Remove and replace barriers before they are burned through.
4. Check contact pressure and alignment.
5. Check controls for undesirable grounds.
6. Replace frayed or worn shunts.
7. Check busbar support insulators and keep clean.

Oil Circuit Breakers

Annually

1. Perform complete inspection.
2. Test oil.

3. Thoroughly clean all parts inside and out. Lubricate those parts requiring it. Give particular attention to operating and tripping mechanisms and bushings.
4. Check contact alignment and adjustment.
5. Smooth slightly rough places on contacts with sandpaper or a fine file.
6. See that lift rods are not warped or cracked.
7. See that latches and triggers are properly adjusted and not badly worn or corroded.
8. Inspect flexible shunts, if any.
9. Examine main current paths for evidencing of overheating.
10. Check pins, bolts, nuts, and general hardware. Tighten and replace if necessary.
11. See that auxiliary switches are tightly mounted and contacts are in good condition.
12. Check control wiring for loose connections.
13. Check settings for auto tripping units and test their operation.
14. Check reliability and adequacy of circuit breaker and tripping current source.
15. Lubricate bearings, gears, etc.

Air Circuit Breakers

Annually

1. Clean the arc quenching or de-ionizing mechanisms.
2. See that arc chambers are properly aligned and securely fastened.
3. Perform complete inspection.
4. Thoroughly clean all parts inside and out. Lubricate those parts requiring it. Give particular attention to operating and tripping mechanisms and bushings.
5. Check contact alignment and adjustment.
6. Smooth slightly rough places on contacts with sandpaper or a fine file.
7. See that lift rods are not warped or cracked.
8. See that latches and triggers are properly adjusted and not badly worn or corroded.
9. Inspect flexible shunts, if any.
10. Examine main current paths for evidence of overheating.
11. Check pins, bolts, nuts, and general hardware. Tighten and replace if necessary.
12. See that auxiliary switches are tightly mounted and contacts are in good condition.
13. Check control wiring for loose connections.
14. Check settings for auto tripping units, and test their operation.
15. Check reliability and adequacy of circuit breaker tripping current source.
16. Lubricate bearings, gears, etc.

Transformers

A. General

1. A direct current (DC) high potential test should be scheduled whenever internal trouble is suspected.
2. If a transformer has handled severe overloads or there is indication of internal trouble, it should be inspected as soon as possible.
3. The need for spares depends on importance of the process or production served, repair time, and replacement lead time.

B. Daily: Listen for unusual noises.

C. Annually

1. Check liquid level on liquid-immersed units.
2. Check ambient temperature.
3. Check inlet and discharge cooling-water temperature for water-cooled units.
4. Check temperature of ingoing and outgoing cooling air for dry type.
5. Check temperature of oil entering and leaving the heat exchanger for a forced oil-cooled unit.
6. Check pressure/vacuum gauge on sealed type units.
7. Check any pumps and fans for proper operation.
8. Investigate the cause of unusual noise.
9. Check the ampere load on important transformers if changes have been made in power consumption.
10. Clean dirt and dust from exterior.
11. Check breather for any restrictions.
12. Check protective alarms such as temperature indicators.
13. If located outdoors, check surrounding area for vegetation, foreign objects stored there, or wildlife that pose a threat of grounding or shorting the phase conductors.
14. Complete an external inspection on liquid-immersed and gas cooled dry type units:
    a. external damage
    b. deterioration
    c. leakage
    d. accumulation of foreign deposits
    e. corrosion
    f. clean and test bushings
    g. check ground connections
15. Check tap changers and load ratio control apparatus when provided.
16. Analyze water for scale, corrosive properties, etc. for water-cooled units.
17. Service any pumps and fans by cleaning and overhauling.
18. Check ground connection resistance. Resistance of ground should be five ohms or less.

19. Check and clean lighting arrestors.
20. Clean, test, and recalibrate relays.

Fuses

1. Clean all insulators and inspect for damage.
2. Replace badly pitted or burned contacts. Check pressure and alignment.
3. Check expulsion fuses for mufflers to restrict gas discharge.
4. Check latch to be sure fuse assembly is firmly locked in when closed.
5. Check size of fuses and adequacy of interruption capacity.
6. Test insulation liquid for acid, moisture, color, gas and dielectric strength.
7. Insulation Test
   a. Insulation Resistance
   b. Dielectric absorption

AC Generators (High or Extreme Usage)

A. General

1. Peaking units may require more frequent inspections than base load machines.
2. Qualified personnel or a manufacturer's representative should conduct internal examinations.

B. Daily: Visually inspect collector rings for sparking, dust accumulations, or vibration.

C. Weekly

1. Blow excessive dust from collector ring insulation and brush rigging.
2. Check collector ring for smoothness of operation.
3. Inspect the lube oil system for possible leaks, excessive vibration and temperature.

D. Every Three Years (Totally Enclosed Recirculating) - this operation only for extreme conditions. This should be based on hours, not time dated.

1. Clean the stator and field windings. Re-varnish stator coils where required.
2. Check stator and field windings for looseness in slots and tightness of slot edges. Inspect condition and tightness of blocks and spacers and twine lashings. Check for tape separation and evidence of damage to the insulation due to corona discharge.
3. Examine rotor retaining rings and slot wedges for signs of movement, overheating and cracking.
4. Check bearings.
5. Check collector rings.
6. Check vibration of machine before and after each overhaul.
7. Service the exciter.
8. Test the insulation resistance of the rotor and stator windings.

9. Following a satisfactory insulation resistance test, make a dielectric absorption, over potential, or insulation power factor test.
10. Carefully inspect the oil lines, steam lines, valves, fittings, and other hot surfaces of the turbine.
11. Inspect all oil lines for the generator and eliminate all leaks and vibration. Inspect connections for gauges and similar accessories.

E. Unscheduled Shutdown (All Types): Recommendations 1 to 8 below should be performed at each major shutdown. If a dismantle inspection has not been made within twenty-four months, follow all recommendations.

1. Clean collector insulation thoroughly.
2. Check insulation resistance of the collector ring and the rotor winding.
3. Determine if collector rings are cylindrical and running true.
4. Inspect air filters and clean or replace.
5. Check gas or air coolers for effectiveness. Keep outer heat transfer surfaces of cooler tubes clean, and check drains for signs of leaks.
6. Check hydrogen-cooled machines for leakage by observing the ability of the system to maintain the gas pressure or by the gas purity indicator.
7. Remove end shields and check stator winding for oily deposits and corona. Clean winding if necessary and inspect insulation and connections. Check bracing and cording for looseness.
8. Check gas passages and remove any obstructions.
9. Check all connections, hose, and piping for leaks in liquid conductor-cooled machines.
10. Inspect armature core, fingerplate, and structural parts for hot spots.
11. Examine rotor for movement or distortion of field coils, blocking of end turns, dirt in ventilating ducts, loose wedges, and local hot spots on rotor surfaces between the retaining ring wedges and rotor body.
12. Examine stator lead bushings for cracks, loose parts, and oil leakage; clean thoroughly.
13. Inspect fan blades for cracking.
14. Test retaining ring for cracks by means of ultrasonic detection, liquid penetrant, or by the magnetic particle method.
15. At each major overhaul, dismantle the hydrogen seals and clean seal oil grooves and holes. Check the wearing surfaces of the seal ring and shaft for alignment and wear. The seal oil and vacuum pumps should be dismantled and carefully inspected at this time.
16. Check the bearing assembly for tightness and correct alignment.
17. Test all gas control equipment and the alarm system.
18. Remove all loose dust with a vacuum cleaner. Remaining oil or dirt should be removed by wiping exposed surfaces with clean cloths.
19. Inspect windings for evidence of deterioration.

AC Generators Normal Usage (Emergency Stand-by Only)

A. Weekly

1. Visually inspect entire unit for leaks (oil and water).
2. Visually inspect collector rings for sparking, dust accumulations, and excessive vibration or noises.

B. Monthly

1. Visually inspect entire unit for leaks (oil and water).
2. Check all fluid levels including fuel.
3. Visually check belts and hoses for correct tightness and general condition.
4. Check battery for cleanliness. Remove all corrosion from battery terminals and put a light coat of grease on the terminals to prevent corrosion.
5. Check electrolyte level in cranking battery and add distilled water if needed.
6. Visually inspect collector rings for sparking, dust accumulation, or vibration.
7. Run the generator manually or program the unit to start at a preset time. Also use the switch on the transfer switch or the generator to simulate a power failure to ensure that the generator starts in the event of a power failure.
8. Run the generator with a load from the building if possible.

C. Annually

1. Visually inspect entire unit for leaks (oil and water) and repair as necessary.
2. Change engine oil and filters or what is recommended by the manufacturer stipulated by hours of usage. The oil and filters shall be changed regardless of the hours if they are less than the manufacturer's specifications.
3. Check the belts and hoses on the cooling system. If cracks or hardness is detected, the components shall be changed during the annual inspection.
4. Perform a load test with a portable load bank that will produce at least 80% load of the KW rating on the generator.
5. Disconnect the main power from the generator via the building main to simulate a true power outage to confirm the operation of the transfer switch as well as ensuring the generator will start as designed during a power failure.

D. Every two years: The entire cooling system shall be drained, flushed, and refilled with the proper antifreeze mixture as recommended by the manufacturer.

DC Generators (Rotary Converters)

A. Weekly: Visually inspect bearings and commutators.

B. Annually: Check insulation resistance.

C. Every Two Years
   1. Check bearings and air gaps on sleeve-bearing units.
   2. Recondition commutator and slip rings if needed.
   3. Clean windings and reinsulate or revarnish if conditions require.
   4. Examine rotorband wires for corrosion or looseness.
   5. Check rotor coils, washers, and coil braces for looseness or mechanical defects.

Electric Motors Over 10 h.p.

A. Semi-Annually
   1. Open frame motors in dusty or linty locations should be cleaned with vacuum equipment unless designed for cleaning with low pressure compressed air. Air should be clean, dry, and less than 30 psi.
   2. Lubricate motor as per manufacturer's recommendations.
   3. Check the bearing temperature.
   4. Inspect motor surrounds for water, oil, steam, dirt, dust, and any loose objects.
   5. Observe motor for vibration and noise.
   6. Examine main current paths for evidence of overheating.
   7. Check grease in ball and roller bearings. Bearings sealed for life require no additional lubrication. If unit has sleeve bearings, drain, clean, and renew oil in cups. Drain, wash out, and renew oil in sleeve bearings.
   8. Check motor amperes.
   9. Check motor hold down bolts, end shield bolts, pulleys, couplings, gears, journal keys, set screws and alignment.

B. Annually (The following pertains to open-type motors larger than 500 hp.)
   1. Clean foreign accumulations from windings and air passages.
   2. Check all electrical connections for tightness.
   3. Check the condition of coil insulation and examine all windings.
   4. Perform vibration analysis and heat scan.
   5. Lubricate according to manufacturers recommendation.
   6. If varnish has deteriorated, windings should be re-varnished in accordance with manufacturer's recommendations.

Storage Batteries

A. General
   1. Adequate ventilation should be provided for all battery storage areas to prevent hydrogen accumulation.
   2. Inspect battery terminals to make sure they are clean, tight, and free of corrosion.
   3. Remove any dust or dirt accumulations on top of cells and keep them clean and dry.
   4. Check level of electrolyte.
   5. Batteries in a common bank should be maintained at the same temperature. Therefore, windows in a battery room are not recommended (one reason).

6. Batteries should be supported on racks so they are not in direct contact with the ground.

B. Monthly: Check and record specific gravity and voltage of the pilot cell on each battery or group of cells.

C. Quarterly: Give the battery an equalizing charge to ensure that it is fully charged.

D. Semi-Annually

1. Check specific gravity and voltage of each individual cell. Uneven cell voltages and specific gravity indicate trouble or approaching failure.
2. Check ventilation in the area where the battery is located.

Relays

A. Daily: Observe indicating targets.

B. Semi-Annually: Inspect relays and condition of contacts.

C. Annually

1. Check contacts and replace if necessary.
2. Check calibration and operate to determine if relays will function as needed under fault conditions by setting up artificial conditions under simulated loads.
3. Check floor for matchbooks, folded paper, etc. used to prevent relay contacts from making contact (over-riding relay) which are removed just prior to your examination.

Lightning and Surge Protection Equipment

Annually

1. Inspect and clean all exposed insulation surfaces on lightning arrestors and capacitors. Occasionally, an enthusiastic maintenance person will put a coat of paint on arrestors or bushings. Beware!
2. Check line and ground leads for damage. Clean and tighten connections.
3. Test resistance of the ground connection. Resistance should be five ohms or less.

Rectifiers (Power Semi-Conductor Equipment)

General

1. Check for excess temperature build-up by installing thermocouple to the base or heat sink.

2. For forced cooling type units, ensure that the cooling medium is operating properly.
3. Clean any dirt accumulation with a solvent that is safe to use on that piece of equipment.
4. Check for looseness of connections and mounting and tighten if necessary.

Uninterruptible Power Supplies

General

1. Be sure all input and output power has been disconnected when work is to be done.
2. Discharge and ground all capacitor terminals in charger and inverter with a grounding stick.
3. Use a vacuum cleaner and a cloth to clean inside of charger and inverter cabinets.
4. Check for liquid contamination (battery electrolyte, oil from capacitors, etc.).
5. Tighten all terminals.
6. Inspect all terminations and control circuits for corrosion.
7. Check battery condition.
8. Connect source power and check control circuit power supply voltages per manufacturer's specifications.
9. Check and adjust voltage output and frequency per manufacturer's specifications.
10. After reconnection, check the output voltage and frequency under load.
11. Simulate a power failure and check for proper system operation.

NON-DESTRUCTIVE EXAMINATION METHODS

Documentation of Equipment Maintenance:

Individual maintenance schedule records for boiler and pressure vessels, motors and engines, gear sets, electrical equipment and transformers are provided in this program. These schedules should be tracked on a computer based program or typewritten.

All rotating machines need to be on a formal lubrication program with specific individuals assigned the task of lubricating. They should document how often lubrication is performed, what type of lubrication is used, quantity required in each piece of equipment, and keep an inventory record of the different lubricants needed.

MONITORING SYSTEMS TESTING EQUIPMENT

As applicable, this testing equipment should be included for a complete preventive maintenance program:

1. Vibration - installed on all critical rotating machines.

2. Infrared - used to find hot spots in electrical equipment such as transformers, switchgears, and cables.
3. Megger testing (insulation resistance) - used to detect grounds, damp windings, damaged insulation, current leakage to ground, and other conditions that contribute to electrical breakdown.
4. Transformer oil testing - used to detect dissolved gases in the transformer oil (annually).

It is recommended that on special equipment the agency follow suggested manufacturer's preventive maintenance.

ULTRASONIC: Used on metal, ceramics, plastic, etc. to detect surface and subsurface discontinuities, measure thickness of a material, and detect weld flaws.

Advantage: Only one side of a surface of an object needs be accessible.

Principle: High frequency vibration or sound waves are reflected as echoes from both the discontinuity and the front and back surfaces of the piece being tested. Echoes are converted to electric signals for amplification and display on an oscilloscope.

RADIOGRAPHY

Radiography is used to search for imperfections beneath the surface of fabricated metal in fired and unfired pressure vessels. It is also used to reveal internal discontinuities in welded joints. It will pick up gas pockets or voids, slag inclusions, incomplete fusion, and inadequate joint penetration.

Advantage: Gives a permanent record and in most instances, will detect a small discontinuity.

Principle: Short wavelength electromagnetic radiation, specifically X-ray or gamma ray, is used to penetrate objects opaque to longer wavelength visible light.

LIQUID PENETRANT

Liquid Penetrant is used to locate surface discontinuities in various products, such as fine surface cracks.

Advantage: Can provide indication of discontinuities in metals and other nonporous materials.

Principle: Liquid flows evenly over the object and into the tiny cavities of the specimen. Excess material is removed, leaving behind that which seeped into the discontinuity. A developer draws the material that seeped into the discontinuity by

capillary action. After drying, examination is performed under a white light or black light condition depending on whether visible dye or fluorescent penetrants were used.

MAGNETIC PARTICLE

Magnetic particle is used to detect discontinuities such as surface or slightly subsurface cracks in ferromagnetic materials.

Advantage: The sensitivity of the magnetic particle test is higher than that of the dye penetrant process.

Principle: Either dry powder or liquid fluorescent magnetic particles are used. The method consists of magnetizing an area to be examined and then applying magnetic particles of different colors to the surface. The particles are retained on the surface at cracks and discontinuities due to leakage in the magnetic field.

EDDY CURRENT

Eddy Current is used to check pipe and tubing for defects such as seams as shallow as .002 of an inch in such material as automotive valve spring wire. It can check over 150 feet of resistance per minute.

Advantage: Can detect flaws in materials not easily accessible.

Principle: A circulating electrical current is induced in an object being checked. This electrical whirlpool is known as an eddy current. Flaws in the test material disrupt the current and consequently, reveal themselves.

THERMAL OR INFRARED

Thermal or infrared is used to test the amount of heat or the heat flow through a piece of equipment and measure its quality for evaluation. It will pick up hot spots in electrical equipment such as switchboards, cables, etc.

Advantage: An entire plant can have its electrical equipment checked in a short period of time. It will point out hot spots and the degree of heat being admitted over normal temperatures.
Equipment can take a picture of the material showing the seriousness of the condition.

Principle: Infrared, known as thermovision, is equipment that detects admitted infrared radiation, converts it to video signal, and reproduces the thermal image in black and white on a monitor screen. It allows you to see heat images.

OVERPOTENTIAL

Overpotential determines if insulation on electrical equipment can withstand the normal or abnormal stresses to which it is subjected.

Advantage: Equipment for DC overpotential testing is relatively small, lightweight, portable and less expensive than the equivalent AC equipment. DC voltages are less damaging to insulation than A.C. and time is not critical.

Principle: The DC overpotential test is a controlled over-voltage test, sometimes referred to as a direct current leakage test or step voltage test. The current is measured at each step increase of applied direct current-potential and is constantly observed for any abnormalities since, in most cases, the test can be stopped before breakdown occurs.

INSULATION-RESISTANCE

Insulation–resistance is used to detect grounds, damp windings, carbonized or damaged insulation, foreign deposits, current leakage to ground, and other conditions that cause or contribute to electrical breakdown.

Advantage: Test equipment is generally lightweight and portable. Testing can also be completed in a short time.

Principle: A 500-volt DC megger is standard test instrument. Electrical equipment should be disconnected from all sources of power. Insulation resistance varies with changes in temperature, humidity, test voltage, and duration of test voltage application. Consequently, for a comparison of one set of readings with another, the conditions should be the same. Ideally, the insulation-resistant test should be administered by applying 500 volts for DC for one minute at a temperature of 40 degrees FC.

DIELECTRIC ABSORPTION

This test furnishes data concerning the relative condition of the insulation with respect to moisture and other contaminants.

Advantage: Test equipment is generally lightweight and portable. Access to only one surface is needed.

Principle: Insulation-resistance test equipment can be used for this test. A test voltage of 500 volts direct current is commonly used and applied for 10 minutes, with readings of the insulation resistance taken at definite intervals. For high voltage apparatus, a 2,500-volt test voltage is preferred. A graph of the insulation resistance in megohms as a function of time should be plotted. Readings are taken at 1/4-minute intervals for the first minute and every minute for the next 9 minutes. A steady increase in insulation resistance during the time that the voltage is applied is an indication of

clean dry windings. A moist or dirty winding will not have a steady increase and the curve will flatten out. This is the result of current leaking through, or over, the surface of the winding insulation.

POWER FACTOR

Sometimes known as the “dobble” test, power factor is used for determining the quality of the insulation in cables, circuit breakers, insulating liquids, regulators, rotating machines, and transformers. It is also used for determining the insulating qualities of bushings and insulators, machines, and transformers as well as the insulating qualities of bushings and insulators.

Advantage: Equipment is generally lightweight and portable.

Principle: Power factor is a measure of the energy component of the charging current and watts loss of insulation. The type of insulation, test voltage, and the moisture and voids in the insulation, principally affects the power factor of the insulation. An increase in the power factor over a period of time indicates deterioration. Results are recorded and compared with previous tests. A low power factor is an indication of a safe condition.

DISSOLVED GAS ANALYSIS

GAS CHROMATOGRAPHY (GC)

The most informative method of fault gas detection is dissolved gas analysis. In this laboratory method, an oil sample is taken from a transformer, the dissolved gases are then extracted, separated, identified, and quantitatively determined.

Various lab methods have been used, including infrared absorption and mass spectroscopy, but gas chromatography has emerged as the most popular technique. Electrical arcing or corona action under oil creates acetylene and other combustible gases; therefore, the presence of combustible gases dissolved in the oil is indicative of incipient faults. These incipient faults can often be found in advance of failure. Many costly failures, both from the standpoint of rewind costs and unit downtime, have been avoided, based on GC test results.

Diffusion of gases between liquid and gaseous spaces takes time, during which serious equipment damage can occur undetected, if only gas samples from the transformer headspace are analyzed for combustibles.

Monitoring the oil for dissolved gases offers both the required sensitivity, and gives the earliest possible detection of a newly formed fault. The only disadvantage for GC lies in that it can't be done readily (as yet) in the field. On the other hand, this method is not

only applicable to all types of oil-filled equipment, it gives the information required to properly evaluate the transformer's ability to properly perform its intended function.

LOUISIANA PREVENTIVE MAINTENANCE PROGRAM

(Revised January 2000)

Funds are appropriated from the Legislature for the continuation of the State's Mechanical and Electrical Preventive Maintenance Program.

To apply for funds for internal inspection repairs, replacement and/or overhaul of boiler/machinery and air conditioning equipment owned by the State:

1. To be eligible for funds, you must have a written Loss Prevention Maintenance Program for all mechanical and electrical equipment that will contain the history of each piece of equipment, and will include maintenance responsibilities, when maintenance is to be performed, and how records will be maintained. This program must be audited and found to be in compliance by the Office of Risk Management (ORM).

2. A written request shall be submitted to the assigned Loss Prevention Officer, who will forward his recommended concurrence/non-concurrence to the Loss Prevention Unit Manager, Office of Risk Management, stating the amount of funding needed for each piece of equipment. Each request shall refer to each piece of equipment by location, manufacturer's name, model and serial number. Three bids must accompany the request.

3. <u>A statement from the Agency Head must also be included stating no funds are available within the agency budget to perform the necessary repairs.</u>

4. An inspection of the equipment may be made by engineers of the Mechanical and Electrical Insurer for the State and/or by an ORM Loss Prevention Officer.

5. Contract price from factory representative or low bidder to perform operation necessary to effect an inspection must not exceed $1,500.00.

6. After receiving approval from FP&C, coordinate all future activities with FP&C.

SAMPLE
LOCKOUT/TAGOUT POLICY

1.0 POLICY

1.1 It is the policy of *(department/agency name)* that any individual engaging in the maintenance, repairing, cleaning, servicing, or adjusting of prime movers, machinery, or equipment on department/agency property will abide by the procedures outlined in this document and specific procedures outlined in the (name of department/agency) Equipment Management Program.

1.2 Lockout is a first means of protection; warning tags only supplement the use of locks. Tags alone may be used only when the application of a lock is not feasible and with approval of the appropriate supervisor (provided the employer complies with the provisions of the standard that requires additional training and more rigorous periodic inspections).

2.0 PURPOSE

To ensure that all individuals are protected from accidental or unexpected activation of mechanical and/or electrical equipment during maintenance, repairing, cleaning, servicing, or adjusting said equipment.

3.0 DEFINITIONS

3.1 LOCKOUT: The practice of using keyed or combination security devices ("locks") to prevent the activation of mechanical or electrical equipment.

3.2 TAGOUT

a. The practice of using tags in conjunction with locks to increase the visibility and awareness that equipment is not to be energized or activated until such tags are removed.
b. Tagout devices will be of the non-reusable type, attachable by hand, self-locking, and non-releasable with a minimum unlocking strength of no less than 50 pounds.

3.3 ACTIVATION/ENERGIZATION: To set machinery into motion by starting, switching, pushing, moving, or otherwise engaging power sources for such equipment. To provide a flow of electricity or complete a circuit that is the main power source for the machinery/equipment.

3.4 ENERGY CONTROL PROCEDURES: Use of lockout/tagout equipment to ensure safe work practices.

3.5 HAZARDOUS MOTION: Motion of equipment under mechanical stress or gravity that may abruptly release and cause injury. Hazardous motion may result even after power sources are disconnected. Examples are coiled springs or raised hydraulic equipment.

3.6 PRIME MOVER: Power driven machinery and equipment.

4.0 RESPONSIBILITIES

4.1 Department Head or Qualified Designee

a. Provide training to authorized/affected employees on lockout/tagout procedures.
b. Inspect energy control procedures and practices at least annually to ensure that general and specific lockout/tagout procedures are being followed.

i. Inspections must be carried out by persons other than those employees directly utilizing energy control procedures.
ii. Inspections will include a review of each authorized employee's responsibilities.
iii. Certify that periodic inspections have been performed
(See: LOCKOUT/TAGOUT INSPECTION FORM)

c. Maintain a record of equipment, machinery, and operations that require the use of lockout/tagout procedures. The record will include the location, description, power source, and primary hazards of equipment/machinery, a list of the primary operators/maintenance personnel, and a list of lockout/tagout equipment that is used and maintained on site.

4.2 Department Head or Qualified Designee: Ensures that each supervisor adheres to procedures.

4.3 SUPERVISORS

a. Ensure that all employees and all contractor/vendor employees engaging in work requiring locking/tagging out of energy sources understand and adhere to adopted procedures.

b. Ensure that employees have received training in energy control procedures prior to operating the machinery/equipment.

c. Provide and maintain necessary equipment and resources, including accident prevention signs, tags, padlocks, and seals.

d. Where applicable, incorporate operation specific lockout/tagout procedures into the department/agency Equipment Management Program.

e. Notify the designated individual(s) of new or revised equipment, machinery, or operations that require the use of lockout/tagout devices during servicing, maintenance, or repair.

4.4 EMPLOYEES

a. Adhere to specific procedures outlined in this document for all tasks that require the use of lockout/tagout procedures.

b. Maintain lockout/tagout supplies in maintenance vehicles.

5.0 SPECIFIC PROCEDURES

The following simple lockout procedure is provided to assist agencies in developing their own procedures. For more complex systems, more comprehensive procedures may need to be developed, documented, and utilized.

5.1 PREPARATION FOR LOCKOUT/TAGOUT: Conduct a survey to locate and identify all isolating devices to determine which switch(es), valve(s), or other energy isolating devices apply to the equipment to be locked or tagged out. More than one energy source (electrical, mechanical, stored energy, or others) may be involved.

5.2 SEQUENCE OF LOCKOUT/TAGOUT SYSTEM PROCEDURE

a. Notify affected employees that a lockout or tagout system is going to be utilized and the reason why. The authorized employee shall know the type and magnitude of energy that the machine/equipment utilizes and shall understand the hazards thereof.

b. If the machine/equipment is operating, shut it down by the normal stopping procedure (depress stop button, open toggle switch, etc.).

c. Operate the switch, valve, or other energy isolating device(s) so that the equipment is isolated from its energy source(s). Stored energy (such as that in springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, blocking, bleeding down, etc.

d. Lockout/Tagout the energy isolating devices with assigned individual lock(s) or tag(s). No copies of keys shall be made or distributed.

e. After ensuring that no personnel are exposed, verify the energy sources have been disconnected. Operate the push button or other normal operating controls to make certain the equipment will not operate. CAUTION: Return operating control(s) to neutral or off position after the test.

f. The equipment is now locked out or tagged out.

5.3 RESTORING MACHINES OR EQUIPMENT TO NORMAL OPERATIONS

a. After the servicing and/or maintenance is complete and equipment is ready for normal production operations, check the area around the machines or equipment to ensure that no one is exposed.

b. After all tools have been removed from the machine or equipment, guards have been reinstalled, and employees are in the clear, remove all lockout or tagout devices. Operate the energy isolating devices to restore energy to the machine or equipment.

5.4 PROCEDURE INVOLVING MORE THAN ONE PERSON

In the preceding steps, if more than one individual is required to lockout or tagout equipment, each shall place his/her own personal lockout/tagout device on the energy isolating device(s). When an energy-isolating device cannot accept multiple locks or tags, a multiple lockout or tagout device (hasp) may be used. If lockout is used, a single lock may be used to lockout the machine or equipment (with the key being placed in a lockout box or cabinet that allows the use of multiple locks to secure it). Each employee will then use his/her own lock to secure the box or cabinet. As each person no longer needs to maintain his or her lockout protection, that person will remove his/her lock from the box or cabinet.

5.5 TEMPORARY REMOVAL OF LOCKOUT/TAGOUT DEVICES

In situations where lockout/tagout devices must be temporarily removed from the energy isolating device and the machine or equipment energized to test or position the machine, equipment or component thereof, the following sequence of actions will be followed:

a. Remove non-essential items and ensure that machine or equipment components are operationally intact.
b. Notify affected employees that lockout/tagout devices have been removed and ensure that all employees have been safely positioned or removed from the area.
c. Have employees who applied the lockout/tagout devices remove them. Energize and proceed with testing or positioning.
e. De-energize all systems and reapply energy control measures in accordance with section 5.2 of these procedures.

5.6 MAINTENANCE REQUIRING UNDISRUPTED ENERGY SUPPLY- Where maintenance, repairing, cleaning, servicing, adjusting, or setting up operations cannot be accomplished with the prime mover or energy source disconnected, such operations may only be performed under the following conditions:

a. The operating station (e.g. external control panel) where the machine may be activated must be under the control of a qualified operator at all times.

b. All participants must be in clear view of the operator or in positive communication with each other.

c. All participants must be beyond the reach of machine elements that may move rapidly and present a hazard.

d. Where machine configuration or size requires that the operator leave the control station to install tools, and where there are machine elements that may move rapidly if activated, such elements must be separately locked out.

e. During repair procedures where mechanical components are being adjusted or replaced, the machine shall be de-energized or disconnected from its power source.

6.0 EMPLOYEE TRAINING- Authorized employees shall receive annual lockout/tagout training from a qualified individual. Affected employees shall receive awareness level training every three (3) years.

7.0 RECORDKEEPING

7.1 INSPECTION RECORDS

The maintenance unit supervisor will maintain inspection records in accordance with 4.1 B of this document, as well as complete and maintain all LOCKOUT/TAGOUT INSPECTION FORMS

7.2 TRAINING RECORDS

Training records will be maintained and include an outline of topics covered and a sign in sheet of those employees attending.

SAMPLE LOCKOUT/TAGOUT INSPECTION FORM

1. Inspection Date:_____

2. Inspector (Printed

Name/Signature):_____/_____

3. Employee(s) Inspected
(Printed/Signature):_____/_____
_____/_____
_____/_____
_____/_____

4. Machine/equipment on which the energy control procedure was being utilized:
_____

_____

_____

_____

Item	Yes	No
Does employee have access to adequate lockout/tagout devices?		
Has employee tested the effectiveness of his/her lockout/tagout devices?		
Has employee received lockout/tagout training in the last year?		
If this is an outside contractor, has a supervisor informed him/her of the necessity for adhering to these procedures?		
Have all procedures been followed?		
Were tagouts legible and clearly displayed?		

SAMPLE LO/TO PROCEDURE

The following lockout procedure is provided to assist agencies in developing procedures to meet the requirements of this standard. When the energy isolating devices are not lockable, tagout may be used provided the employer complies with the provisions of the standard that require additional training and more rigorous periodic inspections. When tagout is used and the energy isolating devices are lockable, the employer must provide full employee protection (see paragraph (c)(3)) and additional training and more rigorous periodic inspections are required. For more complex systems, more comprehensive procedures may need to be developed, documented, and utilized.

Lockout Procedure

Lockout Procedure for_____

(Name of entity for single procedure or identification of equipment if multiple procedures are used).

Purpose

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization or startup of the machine or equipment or release of stored energy could cause injury.

Compliance With This Program

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure. All employees, upon observing a machine or piece of equipment that is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment.

_____
(Type of compliance enforcement to be taken for violation of the above)

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

_____
(Name(s)/Job Title(s) of affected employees and how to notify)

(2) The authorized employee shall refer to the agency procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

_____
(Type(s) and magnitude(s) of energy, its hazards and the methods to control the energy)

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).

_____
(Type(s) and location(s) of machine or equipment operating controls)

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

_____
(Type(s) and location(s) of energy isolating devices)

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors; springs; elevated machine members; rotating flywheels; hydraulic systems; and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

_____
(Type(s) of stored energy - methods to dissipate or restrain)

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.

Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

_____
(Method of verifying the isolation of the equipment)

(8) The machine or equipment is now locked out.

"Restoring Equipment to Service." When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken.

(1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

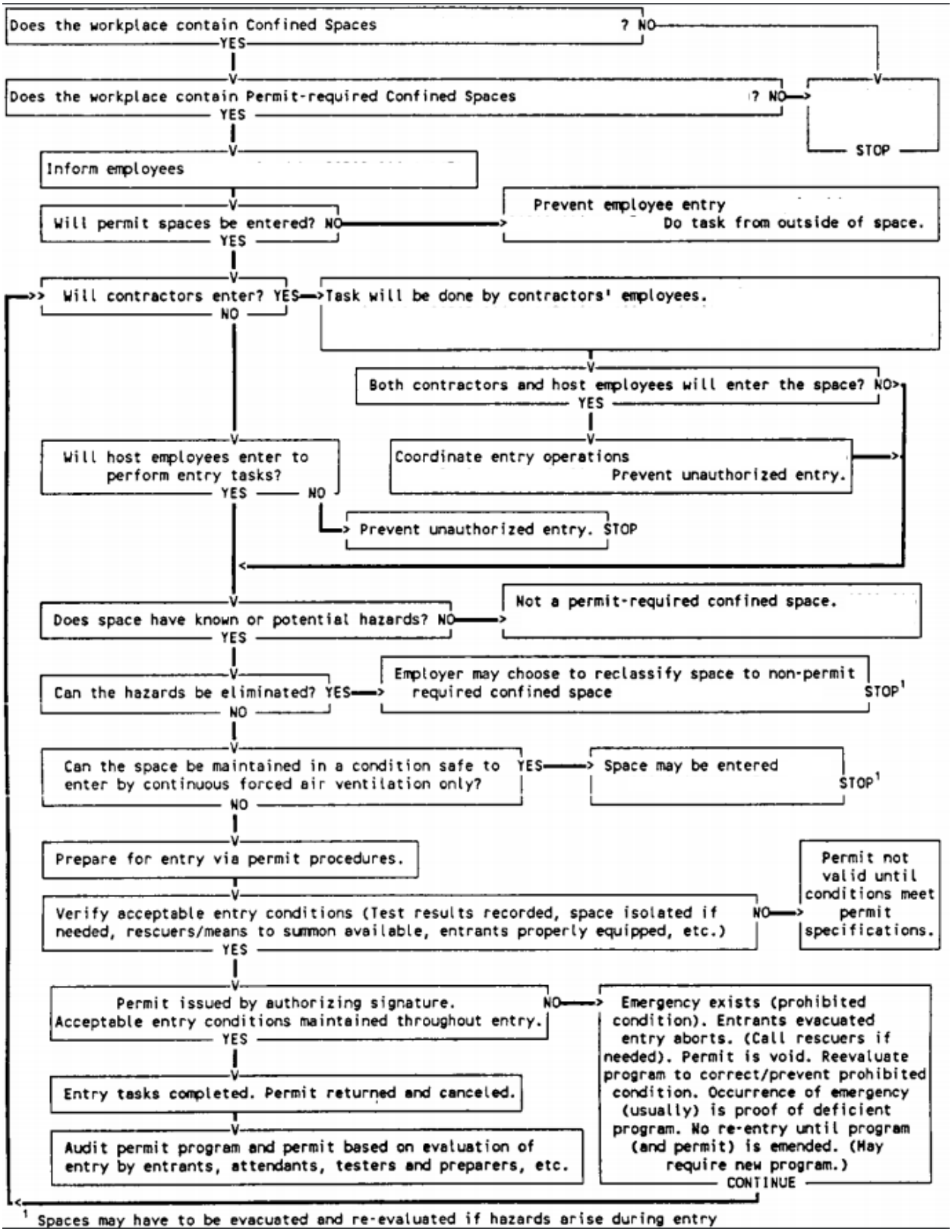
(2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

(3) Verify that the controls are in neutral.

(4) Remove the lockout devices and reenergize the machine or equipment. Note: The removal of some forms of blocking may require reenergization of the machine before safe removal.

(5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for use.

SAMPLE CONFINED SPACE DETERMINATION CHART



CONFINED SPACE ENTRY PERMIT

Confined Space Location/Description/ID Number **Date:**

_____

Purpose of Entry

_____

_____

Time In: _____ **Permit Canceled Time:** _____

Time Out: _____ **Reason Permit Canceled:** _____

Supervisor: _____

Rescue and Emergency Services-

Hazards of Confined Space	Yes	No	Special Requirements	Yes	No
Oxygen deficiency			Hot Work Permit Required		
Combustible gas/vapor			Lockout/Tagout		
Combustible dust			Lines broken, capped, or blanked		
Carbon Monoxide			Purge-flush and vent		
Hydrogen Sulfide			Secure Area-Post and Flag		
Toxic gas/vapor			Ventilation		
Toxic fumes			Other- List:		
Skin- chemical hazards			**Special Equipment**		
Electrical hazard			Breathing apparatus- respirator		
Mechanical hazard			Escape harness required		
Engulfment hazard			Tripod emergency escape unit		
Entrapment hazard			Lifelines		
Thermal hazard			Lighting (explosive proof/low voltage)		
Slip or fall hazard			PPE- goggles, gloves, clothing, etc.		
			Fire Extinguisher		

Communication Procedures:

_____

DO NOT ENTER IF PERMISSABLE ENTRY LEVELS ARE EXCEEDED		**Test Start and Stop Time:** **Start**	**Stop**
	Permissable Entry Level		
% of Oxygen	19.5 % to 23.5 %		
% of LEL	Less than 10%		
Carbon Monoxide	35 PPM (8 hr.)		
Hydrogen Sulfide	10 PPM (8 hr.)		
Other			

Name(s) or Person(s) testing: _____

Test Instrument(s) used- Include Name, Model, Serial Number and Date Last Calibrated:

CFM-Ventilation	Size-Cubic Feet	Pre Entry Time	❑ Central Notified Before Entrance	Time Notified:	
			❑ Central Notified After Entrance	Time Notified:	

Authorized Entrants	Authorized Attendants
_____	_____
_____	_____
_____	_____

PERMIT AUTHORIZATION **I Certify that all actions and conditions necessary for safe entry have been performed.**	
Name-Print:	
Signature:	
Date:	Time:

Entry Procedure Checklist: Complete the following steps before, during, and after a confined space entry:

Step 1
Obtain a Permit-Confined Space Entry Form from Program Coordinator.

Step 2
Notify Supervisor before the **Confined Space Entry**

Step 3
Verify Confined Space Meter has been calibrated and is in working order

Step 4
Complete the top portion of the Permit-Confined Space Entry Form

Step 5
Ensure all rescue equipment (e.g. tripod, body-belt, lanyard) is in place prior to entry

Step 6
Monitor the confined space with the MSA 4-Gas Detector prior to entry. The entrant and attendant should sign the permit authorization section on the bottom of the permit to ensure all actions and conditions necessary for safe entry have been performed.

Step 7
Employee entering the confined space should wear the 4-Gas Detector after the pre-atmosphere test. The employee should also have a full body harness and lanyard attached to the rescue tripod. Employee shall have a radio and any other necessary personal protective equipment.

Step 8
Employee can enter the confined once Step 7 is completed. The entrant and attendant should complete the Hazards of Confined Spaces and Special Requirements Section of the Permit-Confined Space Entry Form once the employee is within the confined space. The entrant should also gather the % Oxygen, % Explosive Gases, Carbon Monoxide, and Hydrogen Sulfide readings and communicate them to the attendant to place on the Permit Form.

Step 9
The attendant should maintain constant communication with the entrant until the entrant has exited the confined space.

Step 10
The attendant should contact Supervisor once the entrant has exited the confined space.

Step 11
The Permit-Confined Space Entry Form should be given to program coordinator, to file in the Confined Space Records.