RiskTopics

Long term lay-up and restart of process and industrial plant
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There are many reasons for a facility to be unoccupied or idled on a long-term basis. Regardless of why, consider the measures offered in this document to prepare the facility for shutdown, monitor the facility during the shutdown, and manage restart as normal operations.

Introduction

Whether a location is a retail store or manufacturing plant, there may be times when the location will be closed and unoccupied on a long-term basis. For the purposes of this document, long-term means more than one month.

During a long-term shutdown, implement the measures offered in this document to maintain care, custody, and control of the unoccupied location.

The measures offered in this document are for property protection purposes. Measures beyond property protection are outside the scope of this document.

Protecting idle assets

Expect unoccupied locations to gradually deteriorate unless deliberate steps are taken to care for the building as well as its utilities and contents.

Deterioration may be promoted by vandalism, rodents, birds, vermin, weather, humidity, moisture, water leaks, and a lack of periodic system operation. Minimize the impact of these and other sources of deterioration, by considering the guidance in this document.

These measures are intended to minimize the deterioration of idle assets and reduce the challenges of restoring normal operations once the idle period is over.

Discussion

Human presence and building monitoring

When a location is unoccupied on a long-term basis, the lack of normal human presence may delay the discovery of abnormal conditions such as vandalism; rodent, bird, or vermin damage; electrical faults; or even the loss of building heat during cold weather.

Early discovery of abnormal conditions may allow intervention before serious property damage develops.

Preparing for a shutdown

The object of Laying-up (mothballing) a plant (process or industrial machinery) is to preserve its condition so:

- Further deterioration is controlled.
- Restart may occur with a minimum of trouble.
- Most importantly, reduction of future life expectancy due to rapid or accelerated failure is controlled.

In this situation, there are several points to remember. It is anticipated:

- The shut-down will not be permanent, and the facilities will eventually restart.
- The lay-up process will protect equipment and enable a smooth restoration of operations.
- The shut-down will be longer than a typical extended maintenance outage and may even extend through several seasons.
- Unlike a typical maintenance outage, there will not be extensive maintenance works taking place.
- Maintenance staff may only be present on site periodically and in small numbers.

Guidance

This document provides general guidance to consider for the lay-up of process equipment and industrial facilities. It does not detail every action required or identify particular industry/equipment procedures.

If in doubt, consult with the equipment manufacturer, process designer, or other specialist service company for specific guidance.

Key objectives

- Plan any shut-down and restart operation.
- Consider equipment protection to mitigate potential damage using isolation, draining, disconnection, etc.
- Maintain records of all actions taken, all isolation points, all drain locations, any blanking plates fitted, etc.
- Identify all isolation points, blanking points, drain valves and electrical isolation.
- Provide or maintain measures such as security patrols, perimeter fencing, locks (doors, windows, and gates), lighting (inside and outside), CCTV, and intruder alarms to detect intruders and minimize exposures to threats such as vandalism, arson, or theft.

Boilers

- The object is to avoid moisture and corrosion damaging the furnace area or inside the boiler tubes.
- Boiler plant may be laid-up in a dry condition or in a wet condition. (Check with the boiler supplier which is recommended for your equipment.)

Temporary shutdown (A few days)

- Avoid stopping the boiler mid cycle
- Turn electric power supply off and isolate to avoid uncontrolled start up.
- Maintain the water level at the normal level until the boiler stops producing steam.
- Stop the feedwater pump and close the feedwater valves.
- Isolate fuel supply and lock off (verify lock off of each fuel if the boiler is dual fuel or has a separate pilot fuel).
- Leave crown valve open and open any service points to drain and vent steam pressure.

Wet lay-up (Up to 3 Months)

- Blow down the boiler to remove as much sediment as possible from the boiler shell or drum.
- Allow boiler to cool and reduce steam pressure to ambient.
- Fill the boiler with treated boiler water to completely exclude air from the water/steam section.
- Close the boiler water feed valves and the steam crown valve.

Dry lay-up (Over 3 months)

- Drain the boiler water.
- The water tubes should be dried, sealed and inerted with nitrogen. A positive pressure should be maintained in the tubes to exclude moisture entry.
- Boiler fittings such as gauges, water level devices, valves, control and monitoring, water glasses, etc. should be removed, and stored in environmental conditions recommended by the manufacturer.
- Blank off main connections for water and steam.
- Shut off and blank gas fuel lines and blank with a spade plate. A section of pipe should be removed to avoid leakage into the idle boiler. The open pipe should be blanked to prevent insect access.
- Blank off fan inlets and outlets with plywood or similar material to avoid debris ingress and maintain the dry atmosphere.
- Periodically rotate fans by hand during the shutdown period.
- Seal electrical control equipment to avoid moisture ingress. Consider placing a desiccant inside to control moisture. A better alternative may be to maintain electrical cabinet heaters operational.

- Isolate the electrical supply to the boiler major equipment such as pumps and fans.
- Regularly monitor and inspect the condition of the boilers and the lay-up works, periodically replace any desiccant used during the shut-down period and provide general maintenance and security of the plant during the shutdown.

Other Pressure systems.

- Verify pressurized systems (compressed air, hydraulic, etc.) are depressurized and left inactive (isolated).
- Avoid stopping compressors under load.
- Turn off electric power supply and isolate to avoid uncontrolled start up.
- Verify system pressure is released, and potential equipment movement is minimized or allowed through its full travel range to minimize gradual creep or unexpected movement.
- Drain any water from compressed air tanks and supply lines. Leave drain valves open.
- Remove and store pressure relief valves.

Rotating Equipment

- Fill all gear reducers (gearboxes) and reservoirs with oil to prevent an air space or have corrosion inhibitor added at the suppliers recommended ratio (typically 2% per oil capacity ratio).
- Verify tank breathers are fitted to gearboxes. Where possible substitute breathers that incorporate desiccants to minimize moisture ingress.
- Add an inhibitor grease to all equipment bearings during scheduled lube routines.
- Coat exposed shafts, seals, coupling hubs, machined surfaces, slideways, etc. with a film of grease.
- Cover idle equipment inlets and discharges to minimize contamination.
- Cover equipment parts that cannot be coated with grease with a spray film of light oil.
- Either hand rotate or power rotate equipment per an "Equipment Rotation Schedule".
- Keep motor winding heaters energized, and rotate motors per an "Equipment Rotation Schedule".
- For motors with grease purge lines, grease and purge one time with the appropriate grease per a "Lube Schedule".

Tanks & Vessels

- Rinse and air-dry stainless-steel tanks and vessels.
- Rinse and air-dry carbon steel tanks and vessels.
- Provide corrosion protection to unpainted and uncoated tanks and vessels per manufacturer’s guidelines.
- Coat pressure relief valves with a rust inhibitor mist.

Instrumentation & Control systems.

- Backup all process and operation control data, and store copies off site.
- Shutdown control systems unless required by other authorities (for example, required for personal safety, process safety, legal compliance or environmental monitoring and control).
- Environmentally protect control rooms and controls systems should be environmentally protected as necessary including heating, cooling, HVAC.
- Remove any instrumentation and monitoring equipment subject to damaged or deteriorate during the lay-up period and store it in a dry condition.
- Cover and seal all instrumentation openings.
- Drain all piping low points.

Where control system remains in service

- Protect the system from power loss by UPS systems. Maintain the electrical supply to the control system throughout the shut-down period.
- Verify control systems will self-restore following a power outage that extends beyond the UPS back-up capacity.
- Where the control system is not self-restoring following a complete loss of power, provide a procedure to manually restore the control system within a specified time frame.
- Provide and maintain password-protected access to the control system to prevent unauthorized interference.

Process Equipment

- Drain and inert corrosive chemical lines and verify corrosion protection is provided.
- Clean effluent tanks.
- Decommission the process or service plant as necessary.
- Isolate all electrical power supplies except those required for security or other purposes.
- Isolate and blank all water and process gas supplies.

General notes

Buildings

For measures to consider for buildings during long-term unoccupied periods, consult the Risktopic ***Management practices: Locations unoccupied long-term and restart procedures***.

The following specific consideration are offered:

- Provide or maintain site and building controls to avoid access by unauthorized persons.
- Provide or maintain pest control.

- Cover or seal unwanted building openings.

  Note: If security patrols or maintenance patrols are planned, then maintain access and egress as needed.

- Repair and secure all windows and doors to prevent weather ingress, or unauthorized entry.
- Monitor roofing as part of a general maintenance process.
- Check rain water gutters and down pipes are free flowing.
- Fix or replace damaged rain water systems.
- Maintain site and building security, including perimeter fencing, lighting and CCTV if available.
- Maintain fire detection and protection systems in operational condition and provide all periodic tests and inspections. Fire pumps should be run weekly.
- Periodically inspect buildings to detect water ingress or leakage.
- Verify any installed seismic control, flood control or lightning protection systems are functional.

Electrical power & Equipment

- Plan the electrical lay-up to consider the requirements of the building and equipment as well as equipment such as refrigerators, water heaters, computers, etc.
- Maintain normal and emergency power to building monitoring systems such as fire detection, fire protection, and CCTV.
- Where possible simplify the electrical distribution network by disconnecting power as close to the source as possible using a formal lock-out tag-out procedure.
- Keep an updated one-line diagram posted on the main switchgear and in the electrical room for consulting during the shut-down and the reestablishment period.
- Review and anticipate the change of silica gel for large or critical transformers.
- Maintain positive nitrogen pressure inside large or critical transformers.
- If switchgears are not energized, provide desiccant bags for moisture control.
- Close and lock electrical cabinets where possible to limit environmental contamination, exclude dust, and exclude insects.
- Check and maintain any back-up batteries or UPS systems.
- Avoid automatic-starting diesel-engine driven generators or water pumps as they may require additional monitoring and maintenance to minimize possible failure.

  Note: Diesel-engine driven fire pumps and emergency generators are excluded from this guideline.

Renewables

- Follow manufacturer or designer guidelines for photovoltaic, wind turbine, or similar systems if they are to be isolated.

Fuel (Gas, Oil)

- Shut off and blank all gas supplies as close as possible to the supply source. If a gas supply is required for critical equipment such as heating systems, then leave this supply operational, but isolate all remaining supplies.
- If possible, use electric heat heating rather than gas-fired heat as electric may be more easily controlled.
- Isolate fuel oil systems by shutting and locking the supply valves as close to the supply source (tank) as possible.
- Where possible, drain fuel oil feed lines to limit the potential for leakage or theft.

Process equipment - General

- In all cases, follow the manufacturers recommended parking/layup procedures.
- Remove any intermediate materials and residues from process equipment and clean to minimize corrosion and setting of contents. Leave enclosed equipment sections open to reduce condensation or dampness.
- Exposed metal surfaces may be subject to corrosion during the idle period. Follow manufacturer's guidance for measures to protect these surfaces. This may include applying a thin film of oil or grease in an effort to inhibit corrosion.
- In most cases, hydraulic systems may be left intact. However, isolate the supply tanks to prevent leakage.
- Verify tank breathers are fitted to gearboxes. Where possible substitute breathers that incorporate desiccants to minimize moisture ingress.
- Steam pressurized vessels and equipment (dryer rolls, steam heated reactors or process tank jackets, static dryers, etc.) should be drained to minimize any remaining condensate.

Process equipment - Furnaces and Kilns

- Protocols to shut-down of furnaces and kilns should be strictly followed (adequate time for cooling-curve development).
- Water cooling staves or coils should be drained for electric arc furnaces and similar equipment to avoid corrosion and settlement of solids.

Process equipment - Transport and conveying systems

- It is recommended that all belt conveyors, especially those handling combustible solids (such as grains, coal, and similar) should be emptied to reduce the static load over structures and belt tension systems.
- Remove any spillage and build-up on loading rolls.
- Consider cleaning and inspecting grain drag chain conveyors to detect any foreign material inside (jamming during reestablishment); inspection windows and gates should be closed and locked.

Lifts, Elevators and Escalators

- In all cases, follow the manufacturers recommended parking/layup procedures.

  Note: It is recommended that all lift/elevator lay-up and restoration should be performed by competent lift/elevator engineers.

- Temporary lay-up less than or equal to 3 months
  - Conventional lifts (elevators) and MRL (machine room less)
    - Return lift car to its priority floor.
    - Verify doors are closed.
    - Isolate at main isolator. (See lighting and controls section below)
  - Hydraulic Lifts
    - Return the lift to the lowest floor.
    - Isolate the main isolator. (See lighting and controls section below)
    - Close the hydraulic shut off valve to prevent creep
  - In car lighting, emergency lights, and safety communication
    - Electrical isolation will cause back-up batteries to discharge and may result in failure. If power is retained to the lift car, this may be avoided.
  - Lift controller PLCs (Programmable Logic Controllers)
    - If power is isolated to (removed from) the controller, the program memory may be lost. If power is retained, this may be avoided.
  - UPS Systems (Uninterruptible Power Supplies)
    - If these are a feature of the lift/elevator, isolate them prior to isolating the main power to avoid emergency initiation on power loss.
  - Escalators
    - Isolate at main power disconnect.
- Longer term Lay-up more than 3 months.
  - Where closure is expected to be longer than 3 months, isolate all lifts and escalators at the main power disconnects.
  - Remove batteries used for in-car devices and emergency lighting and stored fully charged.

Cranes. (In all cases, follow the manufacturers recommended parking/layup procedures.)

- Electrically isolate all cranes.
- Where possible, lower hooks/blocks to the ground to avoid unexpected movement.
- For external gantry cranes and other mobile cranes, verify they are secured against travel due to high winds (anchored). This included dock located ship unloaders and container handling equipment.
- Allow tower cranes to slew in the wind. Raise hooks and blocks to their full extent and lock the hoist mechanically.
- Secure the personnel access to all cranes to minimize unauthorized entry.

Spares Warehousing & Maintenance.

- Store spare parts to minimize potential deterioration.
- Review storage requirements and actions taken to maintain suitable storage environments. If needed, consider moving critical parts to suitable location.
- Review the critical spare parts maintenance program, and consider measures such as: periodic rotation of shafts of large rotating equipment, dust and corrosion protection of metallic components, etc.
- Provide nitrogen inerting for critical backup transformers. Also, provide dust protection for sensitive components such as electronic boards, etc.

Hazardous chemicals.

- Where possible remove hazardous chemicals from process equipment and return to storage.
- Isolate chemical supply lines close to the storage or tanks to minimize possible leakage.
- Where necessary maintain all safety features, such as inerting, cooling, heating etc.

Water/Sumps

- Verify sump pumps are operational, and that sump level monitoring and float switches are functioning as intended.
- Verify suction/priming valves are clean and working.
- Check suction hoses and strainers.
- If necessary, dredge and clean out sumps to restore their standing capacity.
- Check delivery hoses and fittings to main drains for leaks and condition.
- For critical sumps, verify necessary spares are available including pumps, cables, valves, hoses, fittings etc.
- Inspect sumps as part of a routine maintenance inspection. The period of inspection should be based on historical frequency of pump operation.
- Where possible, install remote water level monitoring.

Water-filled piping systems

- Where freezing is a possibility, drain all water-filled piping or provide heat to avoid freezing.
- Where freezing is not an issue or is not expected until winter, then systems can be left filled. However, to limit leaks consider isolating at the supply mains or at the header tank.
- Periodically review the freeze potential and take action to protect piping from freezing if cold weather is expected.

Waste Water Treatment plants

- Take measures to preserve the biological load (bacteria) of bio-digestion waste-water treatment processes to avoid loss of bacteria.

Resuming normal operations

When restarting idle facilities, consider the following actions before, during, and after start-up.

Allow only qualified persons to turn on utilities or restart processes. Qualified persons may include mechanical technicians, electricians, plumbers (for fuels), or process equipment operators.

A process and equipment restart must be a planned operation. It must follow manufacture's guidelines and comply with good engineering practice. It should be undertaken by trained staff or approved contractors.

The lay-up check list should be reviewed and used to make certain that all isolation and disconnection actions taken as part of the lay-up are reversed in a safe order.

Gas purging may be required for boilers and fuel gas lines.

Before start-up

Before start-up, consider the following:

- All systems
  - Verify environmental conditions are suitable (such as temperature and humidity).
  - Verify contaminants are controlled (such as dust, dirt, and oily residues).
  - Correct abnormal conditions before proceeding to start-up.
  - Depending on length of outage legally required inspections may be needed on pressure vessels, water heaters, and/or boilers prior to start-up.
  - Depending on local regulations, lifting equipment including public elevators, escalators etc. may also require a legal inspection and recommissioning.
  - Domestic water and some cooling systems may require sterilization as part of any pre-start procedure. If in doubt about the need for this, please seek professional advice from equipment suppliers or system designers.
- Utility systems
  - Before inspection and testing, verify electric disconnects are turned off.
  - Verify main switch gear, circuit breakers, and miscellaneous electrical apparatus are clean (air supply should not be used for cleaning), dry, and tight.
  - If idle longer than a 3-month period, electrical systems should be inspected and tested by a suitably qualified technician. This testing should include all safety systems.
  - Verify equipment fuel valves are shut off.

Returning after a wildfire evacuation

When returning to locations following a wildfire evacuation, clear accumulated soot away from air intakes before starting systems that may draw contaminants into equipment or buildings.

- Machinery
  - Follow manufacturer's pre-start instructions such as cleaning and lubrication
  - If process equipment (including motors, gearboxes, controls, etc.) have been subject to flooding, it is imperative that all objects are completely dried and serviced PRIOR to start-up.

- Lifts, Elevators, Escalators. These will require some routine maintenance during the lay-up period. It is recommended that a service is performed as part of the return to service procedure. (See below)

- Fuel-fired equipment
  - For fuel-fired equipment, have a certified technician test all fuel train and burner components in preparation for start-up.

During start-up

- All systems
  - Monitor for abnormal conditions such as circuit breaker trip, heating, sparking, vibration, noise, or odor.
  - Where abnormal conditions occur
    - Interrupt the start-up process.
    - Shut down the system.
    - Correct the source of the abnormal condition before resume the start-up process.
- Machinery
  - Follow manufacturer's start-up instructions.
  - Test electrical safety trips.
  - All critical safety controls for air, steam, or water supply should be tested by a certified technician.
  - In the event of a problems or abnormal operations, follow the manufacturer's emergency shut down procedures.
  - Undertake an oil sampling program for mechanical equipment to check oil quality.
  - Undertake a dissolved gas oil test of all critical transformers to check for oil quality and water absorption.
- Lifts, Elevators & Escalators. (It is recommended that a competent engineer carries out the restart after lay-up)
  - For Conventional lifts, MRL and escalators, it should be a simple process of switching the lift on at the main isolator.
  - Once powered up, but before use. Check that the lift accepts calls and travels to/from all floors.
- Hydraulic lifts
  - Open the hydraulic isolation valve before restoring power.
  - Once powered up, but before use. Check that the lift accepts calls and travels to/from all floors.
- Escalators
  - Restore power from the main isolator.

After start-up

During the 24 hours following start-up, monitor for signs of abnormal operation.

- Utility systems
  - Electric systems. As these systems are present in most building areas, tour the building to sense any abnormal conditions such as smoke or the odor of electrical breakdown.

  - Motor control centers and substations. These facilities should be inspected by a qualified electrician.
  - Fuel systems. As these systems are present between the fuel source and the points of use, tour the facility where the piping is routed to sense any abnormal condition such as the odor of natural gas or the leakage of fuel oil.
  - All systems. Where an abnormal condition is detected, have a qualified person isolate the condition by operating the nearest upstream disconnect or valve

- Machinery
  - Have qualified operator or technician attend the machinery with more frequent checks.
  - Follow manufacturer's pre-start instructions such as cleaning and lubrication.
  - To pick up any indications of damage to bearing, seals etc. It is recommended that a more intensive program of inspection is introduced in addition to any formerly practiced program.
  - Monitoring of bearing vibration and temperature.
  - Thermal imaging of rotating equipment to check bearing temperatures.
  - Undertake an oil sampling program for mechanical equipment to check oil quality and debris content.
  - Undertake a dissolved gas oil test of all critical transformers to check for oil quality and water absorption.
  - Where abnormal operation is detected, have the qualified operator implement the emergency shutdown procedure for the machinery involved.
  - Post restart consider intensifying the Predictive inspection program until the systems and equipment have settled down to pre-lay-up conditions. This may include additional thermal inspections for electrical switchgear or Ultrasonic testing for high voltage systems.

Conclusion

For locations that will be unoccupied for more than a month, consider the measures offered in this document to prepare the facility for shutdown, manage the facility during the shutdown, and manage restart as normal operations resume.

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