# General Mechanical Maintenance Guideline

## Exhibit K

# Scope of Work

Reviewed By: _____

Approved By: _____

Version [VERSION NUMBER]
Date[DATE]
Author [AUTHOR NAME]

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*ii. Gas*
*iii.Electricity*

*h) Pneumatics System*

*Flues.....*

*Compressors/Condensors*

Legend of Servicing Frequencies

a) These specifications include the frequency in which certain tasks should ideally be accomplished. They are as follows:

| | |
|---|---|
| A | Annually |
| M | Monthly |
| Q | Quarterly |
| SA | Semi-Annually |

## 1. HEATING

### HEATERS - SAFETY

Cleaning and Maintenance

Due to possible difficulties of access, cleaning and maintenance should only be done by a trained person.

When applicable, isolate unit(s) from electrical supply by removing fuses or locking main switch in OFF position.

Always refer to the manufacturer's instructions/recommendations before undertaking any cleaning or maintenance.

Q

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SA

## 1a. BOILERS

### ROTARY CUP BURNERS (1 of 2)

Burners of this type should be serviced every three months, certain operations requires a lesser frequency and this is noted in the frequency column. These units are specialized and should only be serviced by trained personnel. This does not apply to the filters which should be cleaned by the customer at least once per week.

1. Operating status of burner
   Check whether plant is operating or not.

2. Oil, gas, electrical and ventilating systems
   Check that all are in accordance with codes of practice.

3. Igniter
   Check.
   Ignite, if possible. Carry out safety check of flame failure device.

**OIL**

1. Burner
   Renew seals and gaskets if necessary.

2. Linkages
   Check and adjust if necessary.

3. Oil metering system
   Renew seals and gaskets if necessary.

4. Main shaft on burner
   "Lift" bearings.

5. Atomizers and spray tip,
   if fitted Check.

6. Drive belts
   Check.

7. Combustion tests on both fuels
   Carry out and note any visual defects.

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SA

Q

## ROTARY CUP BURNERS (2 of 2)

### GAS

1. Joints — Carry out leak test of all joints downstream of interlock isolator.
2. Main gas valve — Check operation of leak test equipment.
3. Gas throughout — If practical – check.
4. Vent pipework — Check integrity.

### ELECTRICAL

1. Wiring — Check panel, junction box and terminals. Check rating.
2. Fuses
3. Overload relays — Check settings.

### GENERAL

Check security of mechanical parts and secure mounting of appliance.

### REPORT AND RECOMMENDATIONS

Should be signed by service engineer and kept by the client.

# BOILERS - LTHW AND MTHW

(Applies to boilers manufactured by casting or fabrication).

1. Check heating surfaces and fireside for corrosion, pitting, scale, blisters, bulges, soot.
   Inspect refractory.
   Clean fire inspection glass.
   Test safety/relief valve(s) after startup (Full Pressure Test).
   Clean flame safeguard scanner.
   Clean and adjust ignition electrodes.
   Check all burner linkage for excessive wear.
   Tighten all linkage set screws.
   Check gas valves against leakage (where test cocks are provided).
   Clean contacts in program timer.
   Check operation of safeguard control.
   Perform pilot turn down test.
   Check settings and test all operating and limit controls.

2. Review manufacturer's recommendations for boiler and burner start-up.
   Check fuel supply.
   Check auxiliary equipment operation. Inspect boiler burner and controls prior to start-up.
   Start burner, check operating controls, test safety controls and pressure relief valve.
   Review operating procedures and owner's log with boiler operator.
   Perform combustion analysis on boilers. Give report to owner.

3. Review owner's log. Log all operating conditions.

Inspect boiler and burner and make adjustments, as required.

Test low water cutoff and pressure relief valves.

Blow down and test low water cutoff and feed control(s).

Check for water, steam and fuel leaks.

Check sequence and operation of flame safeguard control.

Check setting and test operating and limit controls.

Check operation of modulating motor.

Blow down gauge cocks and try cocks to confirm glass water level.

Lubricate motor and shaft bearings, as required.

## CONDENSING BOILERS

The essential feature of a condensing boiler is that to increase the efficiency, the flue gases are cooled below their dew point with the result that water is produced which has to be removed from the system. In addition to all the maintenance requirements listed for atmospheric gas boilers and LTHW and MTHW boilers, additional tasks need to be carried out and these are listed below.

A 1. Condensate level probe (if fitted)
Clean and inspect.

A 2. Condensate drain pipe and U-pipe
Clean, inspect and flush.

A 3. Fan
Check operation and clean any deposits off blades.

A

A

A

A

A

A

A

## STEAM BOILERS - Pre-maintenance check

1. Status
   Check operating status.

2. Condition
   Check exterior for signs of damage, leakage from valves, manholes and any loose fittings.

3. Safety circuits
   Check operation.

4. Combustion test
   Ensure system is on load, and carry out combustion tests.

5. Thermostats, pressure sensors and gauges, and thermometers Check for correct operation and settings.

6. Shut down
   Shut off and isolate steam, water, fuel and electrical services.

7. Ventilation
   Check that ventilation fans and louvers are functioning properly.

A

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A

A

A

A

A

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A

## STEAM BOILERS - Maintenance schedule

1. Boiler breaching, combustion chamber, and connecting flue
   Open, remove by brushing and/or vacuum all soot and scale.

2. Fire tubes
   Open boiler enddoors and clean fire tubes by brushing or rotary scouring equipment.

3. Refractory linings
   Check condition and report.

4. Boiler breaching, doors and chamber
   Reseal, check for air leaks seal as necessary.

5. Flue
   Carry out smoke test.

6. Waterside
   Remove manholes, clean out scale and residues. Replace, reseal and ensure bolts are tight.

7. Boiler
   Refill, reconnect and bring on line.

8. Instrumentation and flame monitoring
   Check for operation and accuracy.

9. Combustion test
   Bring up to full load and carry out tests.

Q

Q

Q

Q

## ELECTRODE BOILERS

Note: In hard water areas, maintenance may need to be carried out more frequently. BEWARE - High water conductivity in the boiler circulated water can damage the boiler pressure vessel. Only work within the boiler manufacturer's values of conductivity.

1. Status
   Check and isolate by removing fuselinks.

2. Electrical connections
   Check all electrical connections in the cubicle and on the boiler electrodes for soundness and correct any defects.

### Porcelain insulators

Examine for defects and replace if necessary. Clean with non-abrasive material.

Examine all porcelain mechanical seals for water leaks.

3. Water drain unit
   Check for free flow of water by operating the valve. Repair any valve gland leaks.

4. Drain pipe
   Check for free flow, actuate main drain if necessary.

5. Feed solenoid (if fitted)
   Clean solenoid, manifold and strainer.

6. Load Control system
   Examine mechanism and lubricate. Examine for water leaks.

7. Boiler circulated water
   Test for correct conductivity at 155/170 F. Test the hardness. Test the pH index of the water.

8. Boiler sequence
   Replace all covers and reinstate electrical supply.

   Set the controls to ‘start’ and operate boiler in its normal mode and ensure the functions are correct.

   Read the current flow in each electrode circuit. (phase).

   The electrode phase current reading with the control shield fully exposed may not be high when the circulated

water is cold.

## GAS BOOSTER SETS

1. Belts
   Check for wear and tension, replace as necessary.

2. Pressure Switch
   Check operation.

3. Gas Booster System
   Check operation

4. Drive Motor
   Check operation and settings of switch.

   Check tightness of electrical connections.

   Carry out in accordance with gas safety regulations.

   Check bearings and lubricate as necessary.

   Inspect guards and covers.

   Ensure that all bolts, screws, etc. are in place and tight.

## 1a i. LIGHT OIL PRESSURE JET BURNER (1 of 2)

(fan assisted, nozzle, oil/air mix, fully automatic)

Q

1. Operating status of burner
   Check whether plant operating or not.

Q

2. Oil, electrical and ventilating systems
   Check that all are in accordance with codes of practice.

Q

3. Burner
   Switch on, carry out safety check of flame failure.

Q

4. Combustion test
   Carry out and note any visual defects. (Optional frequency is monthly.)

Q

5. Isolation from electricity and oil supply
   Switch off, remove fuses and turn off oil supply.

Q

6. Jet arm assembly
   Remove, clean combustion head, ignition electrodes and inspect HT leads.

Q

7. Nozzle and filter
   Clean filter and inspect nozzle for wear.

Q

8. Burner
   Reassemble and set heat to manufacturer's requirements.

Q

9. Motor and fan
   Remove, clean and lubricate as required, clean fan scroll.

Q

10. Oil pump filter
    Remove and clean, inspect pump seals for signs of wear.

## LIGHT OIL PRESSURE JET BURNER (2 of 2)

Q

11. Reassembling burner
    Inspect flexible oil line coupling, clean and renew oil line filter, clean photo cell and adjust.

Q

12. Burner
    Switch on and check flame shape and appearance if visible.

Q

13. Oil pressure
    Test, record oil pressure.

Q

14. Combustion tests
    Carry out and check for smoke.

Q

15. Flame failure device
    Test for satisfactory operation.

Q

16. General
    Check security of mechanical parts and secure mounting of appliance.

Q

17. Recommendation
    Provide written report which should be signed by the service engineer and kept by the client.

## HEAVY FUEL OIL PRESSURE JET BURNERS

There are four basic fuel systems which can be subdivided into those used for distillate and those for residual oils. The use of residual oils necessitates the inclusion of equipment of pre-heating the fuel oil prior to the burner. This includes preheater coils in the storage tank, line tracing and final preheater either before or right at the burner nozzle.

A

1. Immersion heater/steam coils and thermostat
   Check condition and test action of thermostat.

A

2. Preheater tank
   Inspect for soundness. Drain water from drain valve at base tank.

A

3. Trace heating
   Check thermostat setting, adjust if necessary.

A

4. Insulation
   Examine and replace or repair as necessary.

A

5. Filters
   Clean and change if necessary.

A

6. Steam traps and drain valves (steam-heated systems) Check operation, repair or adjust as necessary.

A

7 General
   Report on condition.

## 1a ii. ATMOSPHERIC GAS BURNERS

These burners operate by air and gas mixed by a ventura, to provide an efficient combustion flame. This principle is used mainly for domestic and small commercial equipment.

1. Operational status
   Check and note any defects.

2. Gas, electrical and ventilating systems
   Check that all are in accordance with current codes of practice.

3. Isolate electrically, disconnect or remove fuses, turn off and isolate gas supply.

4. Combustion test
   Carry out tests.

5. Thermocouple, probe pilot assembly spark electrode and main burners Check and adjust, refit along with main burner.

6. Spark electrode and thermocouple probe
   Check, adjust and refit along with main burner.

7. Wiring to igniter and/or probe, gas valve and boiler thermostats Check.

8. Flame failure device and associated controls
   Turn on gas, check and adjust pilot flame to envelope thermocouple, probe test flame failure device.

9. Electricity
   Switch on.

10. Gas
    Check and adjust pressure to main burner.

11. Combustion test
    Carry out.

12. Recommendations
    Provide written report.

## 1a iii. COAL FIRED BOILERS

The burning of coal is a complex operation involving the storage, handling and combustion of solid material, and the handling and disposal of gaseous and solid waste. The materials are abrasive and the wear and tear on mechanical equipment is considerable. Therefore, regular maintenance is vital to ensure continuous working and a clean environment. The maintenance of each section of the coal burning operation is examined in sequence.

WARNING:
Great care should be taken when entering any confined space such as a hopper, flue chamber or boiler to ensure that there is adequate ventilation and an absence of any fumes or flue gases.

A

1. Operational status
   Check and isolate from electricity supply. Remove fuses.

A

2. Bunkers
   Inspect for wear and corrosion and repair as necessary.

A

3. Belt conveyors
   Inspect, renew worn sections, and check and replace joints as necessary.

A

4. Screw conveyor
   Grease outrigger bearing on worm shaft and tube rotation guide.

## COAL FEED MECHANISMS - Under feed stokers

SA

SA

SA

SA

SA

SA

SA

SA

SA

SA

SA

1. Operational status
   Check and isolate from electricity supply. Remove fuses.

2. Clean-out
   Check and clean out.

3. Retort
   Check end feedscrew and refractory brickwork.

4. Ash
   Remove from plenum chamber.

5. Belts and chains
   Examine and report condition. Check pickup screw high tension bolt.

6. Smoke elimination tube
   Clean air hole and refit.

7. Overfire jet
   outlet
   Clean if
   fitted.

8. Stauffers
   Grease and lubricate.

9. Gearbox or angle stoker gear unit
   Drain oil and refill with new oil.

10. Dampers and linkages
    Check , free if necessary, and lubricate.

11. Shear pin alignment and bunker screw
    Check and adjust shear pin alignment if necessary.

12. Return to operation
    Close isolator switch. Run stoker and check sequence.

## COAL FEED MECHANISMS - Chain grate stokers

1. Operational status
   Check and isolate from electricity supply. Remove fuses.

2. Coal silo
   Empty and check internal and external coatings.

3. Level probes on coal surge bunkers
   Check and clean as necessary.

4. Drain sump
   Ensure excess water can be drained off. Check coal auger supports. Remove augers and check for wear and distortion. Reassemble and recoat coal tube.

5. Grit arrestors and internal baffles
   Check internally for signs of wear and fix as necessary.

6. Access doors
   Check security.

7. Insulation
   Check condition and security and repair or replace as required.

8. Stoker
   Withdraw and inspect for wear. Check condition of rear skid plate.

9. Stoker grate
   Renew rear side steel bars and any links showing signs of burning.

10. Stoker air box
    Check bottom plate and chassis for distortion.

11. Stoker ignition arch
    Repair or replace arch and, if necessary, firedoor lining.

12. Electrical
    Examine and renew switchgear contacts where necessary. Replace any worn or damaged regulator parts.

## 1a iv. MODULAR BOILERS (1 of 2)

Q

Q

General

1. Clean burner exterior and module cover filter

.

2. Check that safety devices operate correctly:
   Simulate flame failure and that burner goes to lockout.
   Simulate air pressure failure-- air pressure switch should cause burner to go into lockout.

Q

3. Check correct flame pattern on burner ribbon.

4. Check for any signs of leakage around module flanges and joints: water, gas, combustion gases.

Q

Q

5. Clean combustion fan and venturi housing.

Q

6. Check tightness of all cable terminations.

7. Check gas pressure at injectors (and governors for Ideal Concord Super Modular burners).

Q

8. Check correct thermostat/sensor settings.
   Remove boiler inspection plates from casing. Inspect modules, checking for any signs of leakage/damage. Also for any build up of debris on bottom of boiler casing, check drain is not blocked on bottom casing.

Q

9. Strip down burner assembly, clean combustion fan and venturi internally.

Q

10 Remove and clean burner ribbon, internal and external. Ensure that no holes are blocked and check condition of ribbon.

## MODULAR BOILERS (2 of 2)

After 3,000 hours operation:

Q 11. Inspect and clean flame and ignition probe, reset gap as per manufacturer's recommendations.

Q 12. Check condition of aluminum suction/pressure pipes and that they are clear from any blockages.

Q 13. Check operation of gas proportor, reset as per manufacturer's recommendations.

Q 14. All boiler modules to be removed from boiler and cleaned on dry side as per manufacturer's recommendations.

Q 15. Check wet side of module for any build-up of scale or debris. If required, clean as per manufacturer's recommendations.

Q 16. Check condition of overheat capillary and heat sensor cable and assembly.

Q 17. Check potentiometer settings on PCB and heat sensor.

## FORCED DRAFT GAS BURNER (1 of 2)

(A fan assisted nozzle-mix type with fully automatic operation creating an expanding flame.)

SA

1. Operating status of burner
   Check whether the plant is operating or not.

SA

2. Gas, electrical and ventilating systems
   Check that all are in accordance with current codes of practice.

SA

3. Burner
   Switch on, carry out safety check on flame failure.

4. Combustion test
   Carry out and note any visual defects.

SA

5. Isolation from electricity and gas supply
   Switch off, remove fuses and turn of gas supply at main cock.

SA

6. Fan and motor
   Remove, thoroughly clean, and lubricate if necessary.

SA

7. Fan scroll
   Clean and check air passages.

SA

8. Automatic gas valves
   Check gas for tightness.

SA

9. Removal of UV cell and head assembly
   Clean, adjust electrode and, if required, isolation probe.

SA

10. HT and probe leads
    Inspect for soundness

SA

11. Burner
    Reassemble and fire, check air and gas settings, carry out combustion efficiency test.

SA

12. Air pressure switch
    Test under no air conditions

## FORCED DRAFT GAS BURNER (2 of 2)

SA

13. Flame failure
    Test and take probe or UV cell readings.

SA

14. Gas booster sets
    Check operation and safety features.

SA

15. General
    Check security of mechanical parts secure mounting of appliance.

SA

16. Recommendation
    Provide written report which should be signed by the service engineer and kept by the client.

## GAS FIRED NATURAL AND FAN ASSISTED HEATERS

(Conventional and balanced flue)

A

A

A

A

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A

A

1. Protection guards
   Remove internal guard.

2. Heater casing
   Remove and inspect for damage.

3. Burner
   Disconnect gas union, remove burner assembly completely.

4. Ignition
   Check operation of ignition assembly.

5. Thermocouple
   Clean with fine wire brush reassemble pilot and test.

6. Burner controls
   Check operation and condition of all burner controls including combustion fan if fitted.

7. Flueways
   Inspect flue and flueways.

8. Gaskets
   Renew flue gaskets, ‘O’ rings and joints.

9. Heat exchanger
   Inspect for corrosion.

10. Room air distribution fan assembly (if fitted)
    Inspect fan bearings, fan wheel(s) or blades and check speed.

11. General
    Check settings and correct operation of thermostats and time clocks.

M

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## 1b FORCED AIR UNITS (1 of 2)

1. Filter

**Check manometer reading**

Renew filter media as indicated.

2. Guide vane actuators and modulating dampers Check operation.

3. Condensate drains

**Check for condensate carryover**

Check that drains are clear.

4. Humidifier pumps, sprays and water supply to tank Check operation.

5. Freeze Thermost at Check operation.

6. Air vent

Air should be vented from heating and cooling coils where fitted.

7. Drive belts

Check tension, alignment, and condition.

8. Drive pulleys

Check alignment, security.

9. Damper and guide vane pivots and linkages Lubricate lightly.

10. Motorized damper

Check to see that louvers are clear and not

obstructed Check that couplings are secure

Check that motor runs without excessive noise or vibration.

11. Heating and cooling coils

Check condition and clean

Check air and water pressure drops across coils.

12. Controls and electrical connections

Check operation and condition.

## FORCED AIR UNITS (2 of 2)

A

A

A

13. Valves

Check full range of operation and reset at the original setting.

14. Motors

Check motor brushes and replace if necessary

**Check, clean and test windings**

Check tightness of

terminals Check full

load current Check

bearing wear

Replace lubricant in motor bearings

15. Anti-vibration mountings and ductwork flexible connections Check condition for excessive dryness or cracking

**1b i Oil**

1. Burner
   Ignite if possible. Carry out safety check of flame failure device.
2. Linkages
   Check and adjust if necessary.
3. Oil metering system
   Renew seals and gaskets.
4. Main shaft on burner
   Lift bearings.
5. Nozzles
   Check.
6. Drive belts
   Check
7. Combustion tests
   Carry out and note visual defects.

**1b ii GAS**

1. Joints
   Carry out leak test of all joints downstream of interlock isolator.
2. Main gas valve
   Check operation of leak test equipment.
3. Gas throughout
   If practical – check.
4. Vent pipework
   Check integrity.

**1b iii ELECTRIC**

1. Wiring
   Check panel, junction box and terminals. Check rating.
2. Fuses
3. Overload relays
   Check settings.

SA

D

Q

Q

Q

Q

SA

Q

Q

Q

Q

## 1c HEAT PUMPS

### 1c i. CONTINUOUS LOOP

1. Electrical supply
   Check connections.

2. Closed loop water
   Check system temperature and pressure.

3. Filter
   Replace/clean.

4. Reversing valve
   Check operation

5. Compressor
   Check refrigerant.

6. Condensate pan/drain
   Check for debris (clean).

### 1c ii. SELF CONTAINED

1. Electrical supply
   Check connections

2. Filter
   Replace/clean.

3. Reversing valve
   Check operation.

4. Compressor
   Check refrigerant.

5. Condensate pan/drain
   Check for debris (clean).

## 1d HEATING EQUIPMENT

### 1d i. RADIANT STRIP

Maintenance of radiant heaters can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by dust and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a VCT tile floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

A

1. Panels and insulation:
   Examine condition of panels and insulation.

A

2. Pipework, valves, steam traps and associated equipment:
   Examine for corrosion or leaks. Where applicable, clean steam traps, strainers, non return valves and scale pockets. Examine condition of expansion joints.

A

3. Suspension:
   Check condition and security of drop rods, hangers and related equipment.

A

4. General:
   Leave unit in good working order.

## GAS RADIANT TUBE HEATERS

A

1. Isolation of heater from electrical and gas supply
   Switch off, remove fuses and turn off gas supply.

A

Burner

2. Disconnect gas union and remove complete burner unit.

A

3. Pilot burner jet
   Remove, clean and refit.

A

4. Main burner jet
   Remove, clean, inspect and refit.

A

5. Air filter
   Remove, clean and refit.

A

6. Spark plug
   Remove, clean and refit.

A

7. Pilot burner
   orifices
   Inspect
   and clean.

A

8. Burner grid
   Inspect and clean, removing all dust on back of ceramic block.

A

9. Observation windows
   Check and clean.

A

10. Vacuum switch
    Examine and check switching differentials for correct operation.

A

11. Acoustic joints
    Check for wear.

A

12. Condensate traps
    Check for blockages.

A

13. Vacuum motor pump
    If fitted, examine mountings.

A

14. Reflectors
    Inspect to ensure correct fitting.

A

15. Gas test
    Pressure drop test back to nearest gas cock to ensure soundness.

A

16. General - Undertake heat test.

## RADIATORS

Maintenance of radiators can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by fluff and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a linoleum covered floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

## RADIATORS

| | | |
|---|---|---|
| A | 1. | Panels and insulation<br>Examine condition of panels and insulation. |
| A | 2. | Pipework, valves, steam traps and associated equipment<br>Examine for corrosion or leaks. Where applicable, clean steam traps, strainers, non return valves and scale pockets. Examine condition of expansion joints. |
| A | 3. | Suspension<br>Check condition and security of drop rods, hangers and related equipment. |
| A | 4. | General<br>Leave unit in good working order. |

## 1d ii. HEATING EQUIPMENT – Package Heaters

Maintenance of unit heaters can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by fluff and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a linoleum covered floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

### UNIT HEATERS

A

SA

Q

Q

SA

A

1. Casing
   Examine condition of casing, discharge louvres and inlet guards.

2. Controls
   Check all thermostats and other controls operate satisfactorily and are set in accordance with the specification.

3. Heat exchanger
   Inspect and clean. Purge air from hot water units.

4. Filters
   Quarterly or As Needed.
   When fitted remove, examine and check for damage. Clean or replace.

5. Motor/fan assembly
   Lubricate bearings where applicable.

6. Pipework, valves, steam traps and associated equipment
   Examine for corrosion or leaks. Where applicable clean steam traps, strainers, non return valves and scale pockets.

7. General
   Leave unit in good working order.

## ENTRANCE HEATERS

Maintenance of entrance heaters can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by fluff and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a linoleum covered floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

## ENTRANCE HEATERS

| | | |
|---|---|---|
| A | 1. | Casing<br>Examine condition of casing, access panels and grilles. |
| SA | 2. | Controls<br>Check all thermostats and other controls operate satisfactorily and are set in accordance with the specification. |
| Q | 3. | Filters<br>Quarterly or As Needed.<br>When fitted remove, examine and check for damage. Clean or replace. |
| Q | 4. | Heat exchanger<br>Inspect and clean. Purge air from hot water units. |
| SA | 5. | Motor/fan assembly<br>Remove from heater casing if practical. Inspect and lubricate fan bearings and resilient mounts where applicable. Clean fans and motor. Examine wiring and connectors. |
| A | 6. | Pipework, valves, steam traps and associated equipment<br>Examine for corrosion or leaks. Where applicable clean steam traps, strainers, non return valves and scale pockets. |
| | 7. | General<br>Leave unit in good working order. |

## 1d iii. ELECTRIC / DUCT HEATER

Note: When cleaning, ensure that system fans are off to avoid dirt entering the system. Comply with lock out/tag out procedures.

A

1. Terminal box:
   a) External surfaces
   b) Lid retaining screws
   c) Internal connections

   Inspect for rust and clean and repaint as required. Check for tightness and secure if necessary.
   Check that terminal screws are tight. Check the integrity of the internal wiring.

A

2. Elements:
   a) Within terminal box
   b) Within casing

   Check insulation resistance of each element. Check continuity. Clean elements (comb out if finned type).

A

Casing

3. Inspect for rust and clean and repaint as required.

A

4. Mountings bolts

   Check for tightness and secure as necessary.

A

5. Thermostats/controls

   Check operation.

Q

Q

Q

A

A

A

## 1d iv. TRACE HEATING

1. Local disconnect
   Check operation.

2. Connections
   Check all connections are clean and tight.

3. Weather proof seals
   Check condition and remake as necessary.

4. Insulation
   Check for damage and integrity.

5. Controls
   Check functioning of controls.

6. Operation
   Check and record the current drawn.

## 1d v. HEATING EQUIPMENT - Fan Convector

Maintenance of fan convectors can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by fluff and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a linoleum covered floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

### FAN CONVECTORS

A

1. Casing
   Examine condition of casing, access panels and grilles.

SA

2. Controls
   Check all thermostats and other controls operate satisfactorily and are set in accordance with the specification.

Q

3. Filters
   Quarterly or As Needed.
   When fitted remove, examine and check for damage. Clean or replace.

Q

4. Heat exchanger
   Inspect and clean. Purge air from hot water units.

SA

5. Motor/fan assembly
   Remove from heater casing if practical. Inspect and lubricate fan bearings and resilient mounts where applicable. Clean fans and motor. Examine wiring and connectors.

A

6. Pipework, valves, steam traps and associated equipment
   Examine for corrosion or leaks. Where applicable clean steam traps, strainers, non return valves and scale pockets.

7. General
   Whenever working on unit, leave in good working order.

## HEATING EQUIPMENT - Natural Convectors

Maintenance of natural convectors can be divided into two main areas: namely, the fixtures and fittings directly associated with the supply of heat and the grills and heat exchange surfaces through and over which the air passes. The efficiency of the grills and heat exchange surfaces can be affected by fluff and fibers, the severity of which depends upon the location and the environment. Thus, a dusty carpeted room with perimeter skirt heating will require much more frequent cleaning of grills and heating surfaces than a linoleum covered floor in a clean environment. The frequencies shown in the table below refer to a clean environment but in extreme cases it may be necessary to clean grills and heat exchangers every two weeks.

## NATURAL CONVECTORS AND PERIMETER (Skirting) HEATING

A

Q

A

A

1. Casing
   Examine condition of casing, access panels and grills. Where applicable, check condition of damper seal.

2. Heat exchanger
   Inspect and clean. Purge air from hot water units. Where applicable, examine condition of expansion joints, guides and anchors.

3. Pipework, valves, steam traps and associated equipment
   Examine for corrosion or leaks. Where applicable, clean steam traps, strainers, non return valves and scale pockets.

4. Controls
   When fitted examine condition of damper seals.

5. General
   Leave unit in good working order.

## 1e. DIRECT FIRED WATER HEATERS (1 of 2)

Heat generation may be by electricity, light oil pressure jet burners, or forced draft by usually atmospheric gas burners. For specific maintenance instructions, check manufacturer's specifications.

### Flueways

A 1. Heat generation equipment
Remove and carry out necessary maintenance.

A 2. Fluepipe
Remove at slip collar and clean.

A 3. Draft diverter (where applicable)
Remove and clean.

A 4. Flue baffles
Remove and clean.

A 5. Flue tubes
Clean with suitable brush.

A 6. Reassembly
Reassemble in reverse order.

A 7. Smoke test
Carry out smoke test on flue.

### Waterways

A 1. Isolation
Turn off, isolate and remove heat generator. Where applicable, switch off electricity and remove fuses. Turn off water supply.

A 2. Drain down heater
Drain down using drain valve on side of heater.

A 3. Casing cover
Remove to gain access to inspection plate.

A 4. Waterways
Remove inspection plate, check for scale build up.

## DIRECT FIRED WATER HEATERS (2 of 2)

A

A

A

5. Sacrificial anodes

Check for condition, replace if necessary.

Gasket

6. After inspection of internal surfaces a new gasket should be fitted to inspection plate before reassembly.

7. Reassemble and test

Fill up and test for soundness. Refit heat generator in accordance with the manufacturer's instructions. Test fire.

## PACKAGED ELECTRIC WATER HEATERS

A

1. Operating status
   Check; if unit is out of service, ask client for reasons.

A

2. External case and pipework connections
   Visual inspection for leaks and damage.

A

3. Water temperature
   Measure temperature, check against thermostat settings. Adjust thermostat as necessary.

A

4. High temperature cut-out
   Check temperature settings.

A

5. Electrical supply
   Isolate, remove fuse and check that rating is correct.

A

6. Ball valve operation
   Check, if ball valve needs re-washering, isolate water supply and repair ball valve. Check for leakage and security.

A

7. Presence of scale
   Drain down unit, remove inspection covers and inspect for scale and corrosion. De-scale as appropriate or replace heating element.

A

8. Return to operation
   Refit all inspection covers, refill heater and cistern. Turn on water supply to unit and check for leaks. Fit fuse and turn on electrical supply.

## 2. COOLING

## 2a. CENTRIFUGAL CHILLERS - EVAPORATORS

### Evaporator (cooler)

A

1. Evaporator/shell
   Check external and internal condition, baffles and covers.

A

2. Valves and drains
   Check external condition, leak tightness of glands and seats. Ensure valve caps are tight and secure. Check operation.

A

3. Pipes and connections
   Check external condition and leak tightness.

A

4. Bearers, supports, holding down bolts
   Check for security and tighten as necessary.

SA

5. Record inlet & outlet temperatures
   Inspect for leaks.

SA

6. Record inlet & outlet pressures.
   Check condition and clean fins.

SA

7. Approach temperatures
   Saturated refrigeration temperature versus leaving chiller water temperature 4 to 6 degrees F are normal depending on vintage of machine.

5Y

8. Brush evaporator tubes

## CENTRIFUGAL CHILLERS - CONDENSERS - Water cooled

A

1. Compressor full load operation

   Record inlet and outlet temperature on water side, pressure drop across condenser, head pressure, condensing temperature, and condenser approach temperature.

A

2. Pump/Tower

   Check and record pressure drop across pump. Check for leakage, bearing noise and unusual bearing temperature. Lubricate according to manufacturer's instructions. Check motor current.

Q

3. Water

   strai
   ners
   Clea

A

   n.

A

4. Condenser tubes

   Open. Brush tubes. Inspect for alkaline deposits and/or corrosion.

A

5. Condenser shell

   Check for presence of non-condensable gases, purge or vent if necessary.

6. Isolating valves

   Check external condition, leak tightness of glands and seats, operational spindles and handwheels.

## 2a i. PACKAGED CHILLERS - AIR COOLED, RECIPROCATING

These machines come in a wide range of sizes; the larger machines can be complex both in terms of operation and maintenance requirements. In the case of compressors serving small air conditioning systems which may only run during the summer months, these may require less frequent maintenance. For the maintenance of compressors, refer to the manufacturer's maintenance instructions.

A

1. Start unit - check controls and calibrate. Check refrigerant and oil level.
   Check operation and refrigerant pressures.
   Make complete operating log and record readings. Check starter operation, voltage and current.
   Set up operating log with operator, instruct and advise troubleshooting. Check and tighten all electrical terminals and check contacts for wear. Tighten motor terminals and control panel terminals.
   Check crankcase heater.
   Check external interlocks, flow switch, pumps and fans. Report any uncorrected deficiencies noted.
   Pressure wash condenser coils.

A

SA

2. Pump down and winterize units.

3. Make a complete operating log and record proper operating temperatures, pressures, voltages and amperages.
   Check and adjust operating and safety controls. Check operation of crankcase heater.
   Check compressor oil level and add, as required. Check operation of control circuit.
   Check operating log with operator, discuss operation of the machine in general. Check water/air flow of evaporator and condenser.
   Check super heat.
   Check operation of all motors and starters.
   Report to operator any uncorrected deficiencies noted.

## PACKAGED CHILLERS - AIR COOLED - EVAPORATORS

### Shell and tube

A

1. Tank/shell
   Check external and internal condition, baffles and covers.

A

2. Valves and drains
   Check external condition, leak tightness of glands and seats. Ensure valve caps are tight and secure. Check operation.

A

3. Pipes and connections
   Check external condition and leak tightness.

A

4. Bearers, supports, holding down bolts
   Check for security and tighten as necessary.

### Coil - Direct expansion (DX)

SA

1. Leaks
   Inspect for leaks.

SA

2. Coil
   Check condition and clean fins.

SA

3. Condensate tray and drain
   Check and ensure drain is clear. Flush and sterilize if necessary.

SA

4. Condensate pump (if applicable)
   Check and ensure drain is clear. Flush and sterilize if necessary.

SA

5. Electric heaters
   Check condition and operation.

## 2a ii. ABSORPTION CHILLERS - Single stage, low pressure steam

1. Lithium bromide analysis
   Pull sample. Send out for analysis.

2. Low temperature cut out
   Check per manufacturer's instructions.

3. Octyl alcohol
   Add per manufacturer's instructions.

4. Valve diaphraThe Owners
   Replace per manufacturer's instructions.

5. Site glass
   Replace per manufacturer's instructions.

6. Vacuum tubes in electronic control center
   Replace per manufacturer's instructions.

7. Brush tubes in condenser and absorber section
   Per manufacturer's instructions.

8. Tests
   Perform running vacuum test or leak rate test per manufacturer's instructions.

9. Capacity control valve
   Lubricate linkage with cup grease.
   Check setting per manufacturer's instructions.

10. Evaporator
    Check evaporator water charge.

11. Bypass valve
    Check setting.

12. Torque valves, gaskets, joints, and diaphraThe Owner valves
    Check setting.

13. Hermetic pump
    Inspect for worn parts. Replace per manufacturer's instructions.

14. Vertical purge
    Check operation per manufacturer's instructions.

A

M

Q

A

A

Q

SA

A

A

A

Q

## 2b. COOLING TOWERS

1. Auto-air eliminators
   Check for operation

2. Ball valves
   Check for operation

3. Belt drives
   Check for wear and tension, replace if necessary

4. Direct drives
   Check operation

5. Motors
   Check operation

6. Strainers
   Check for clogging

7. Fan blades
   Check for looseness

8. Amprobe motor
   Check for proper electrical draw

9. Starter
   Check for operation

10. Float valve
    Check for operation

11. Water box nozzles (Marley)
    Check for leaks. Clean float chamber and needle valve assembly. Ensure valve opens/closes.
    Check condition and alignment. Correct tensioning if necessary. Check shaft alignment.
    Grease, remove purge plug as per manufacturer's instructions. Remove, clean and replace.
    Check and clean. Inspect for tightness.
    Record amperage.
    Check contactor points are clean. Tighten all electrical connections.
    Make sure valve closes off without leakage; no chatter.
    Clean out nozzle with screwdriver.

SA

SA

## Y TYPE STRAINERS

Y type strainers are found in cooling towers.

1. Strainer cage/basket
   Remove bottom flange. Remove basket. Clean. Replace basket.

2. Blow down strainer
   Open blow off valve. Use 5 gallon pail to catch water.

## 2c. PACKAGED CHILLER UNITS - CONDENSER - AIR COOLED

M

1. Operating pressure
   Check pressure and pressure switches using gauges.

SA

2. Solenoid valves
   Ensure that they do not bypass.

M

3. Head pressure control (fan speed)
   Check operation.

SA

4. Motor mountings
   Check for security and tightness.

SA

5. Condenser coil
   Inspect and clean.
   Test for refrigerant leak.

SA

6. Casing
   Clean and secure.

SA

7. Sediment
   Remove; if substantial build-up has occurred, investigate cause.

Q

8. Alignment and wear of belt drives (where applicable) Check pulley alignment and belt wear.

SA

9. Head pressure control damper
   Lubricate control damper bearings.

SA

10. Electrical connections
    Check and tighten as necessary. Check condition of flexible conduits, wiring and insulation.

SA

11. Pipework
    Inspect connections, pipes and supports for damage, loose or missing fittings. Repair as necessary.

## PACKAGED CHILLER UNITS - WATER COOLED

These machines come in a wide range of sizes; the larger machines can be complex both in terms of operation and maintenance requirements. In the case of compressors serving small air conditioning systems which may only run during the summer months, these may require less frequent maintenance. For the maintenance of rotary compressors, refer to the manufacturer's maintenance instructions.

SA

1. Full load condition (discuss with client)
   Check and record suction and discharge pressure, oil pressure.

SA

2. Start and run currents
   Check and compare with manufacturer's recommended figures.

SA

3. Operating status
   Check whether plant is in use. If a meter is fitted, record hours run.

SA

Leaks

4. Check for oil and refrigerant leaks. Any leak of refrigerant should be dealt with immediately.

SA

5. Oil in crankcase
   Check level and condition.

SA

6. Crankcase heater
   Check operation.

SA

7. Compressor drive
   Check condition and alignment.

SA

8. Compressor and bearing temperatures
   Observe and include crankcase, seal housing and cylinder surface temperature.

SA

9. Safety cut-outs
   Test and ensure correct operation.

A

10. Refrigerant charge
    Check quantity and moisture content at liquid level sight glass.

SA

11. Noise and vibration
    Check for any abnormalities.

A

12. Electric motor
    Lubricate according to manufacturer's instructions. Check full load current.

**SINGLE ZONE ROOFTOP UNITS - AIR-COOLED, RECIPROCATING**
(natural gas heating/electric cooling, 3 ton to 20 ton)

SA

1. Start unit - check controls and calibrate. Check refrigerant and oil level.
Check operation and refrigerant pressures. Check starter operation, voltage and current.
Check and tighten all electrical terminals and check contacts for wear. Tighten motor terminals and control panel terminals.
Check crankcase heater.
Report any uncorrected deficiencies noted.

SA

*Pressure wash condenser coils.

2. Check and adjust operating and safety controls. Check operation of crankcase heater.
Check compressor oil level and add, as required. Check operation of control circuit.
Check air flow of evaporator and condenser. Check super heat at compressor inlet.

SA

Check operation of all motors and starters. Check for refrigerant leaks.

Change filters, GSH recommends quarterly.

3. Vacuum out burner assembly. Check burner operation (adjust).

Inspect flame failure controls. Clean & inspect ignition assembly. Inspect heat exchanger.

Check gas valve operation.

## 2d. SPLIT SYSTEM AIR CONDITIONING UNITS (1 of 2)

This text relates primarily to units with either integral or remote air cooled condensers working with direct expansion coolers for refrigeration or air conditioning applications. The frequency of servicing or cleaning will depend upon the working environment and the amount of usage.

SA

1. Compressor
   Check for undue noise or vibration and high or low cylinder head discharge pressure.

SA

2. Compressor suction/side
   Check for symptoms of liquid slugging or high superheat.

SA

3. Oil separator float valve (if fitted)
   Check condition and compressor crankcase oil level.

SA

4. Refrigerant
   a) Charge
   b) Leaks
   Check level in receiver and/or liquid line sight glass. Test accessible parts of system. Install gauge manifold.

SA

5. Condenser and evaporator fins
   Check for damage and/or dust accumulation. Clean as necessary.

SA

6. Fans and motors
   Check bearings and lubricate as necessary. Inspect and check on fan guard covers and inspection plates.

SA

7. Evaporator and drains, drip tray and pump
   Check and clean. Check condensate drain is clear and clean.

SA

8. Compressor capacity control and unloaded start valves
   Check for correct operation. Check motor current against nameplate data.

SA

9. Refrigerant pipework
   Check for vibration and rectify any loose or inadequate support / fixing.

## SPLIT SYSTEM AIR CONDITIONING UNITS (2 of 2)

SA

10. Insulation
    Check condition. Repair and reseal as necessary.

SA

11. General cleanliness
    Clean surfaces of compressors and components of condensing unit.

SA

12. Electrical
    Check for damage to flexible conduits. Tighten all terminal connections. Isolate local control panel and inspect for signs of overheating. Check integrity of electrical insulation.

SA

13. System operation
    Confirm that it is in accordance with design parameters.

## 2e. ROOM AIR CONDITIONERS

(Unitary reverse cycle heat pump terminal units with electric heating and reversing valve)

NOTE: If unit is ceiling mounted, cover office equipment immediately below any area of work.

SA

1. Status
   Isolate electrically.

SA

2. Heating/cooling coil
   Remove air entry filter, inspect coil for dirt and clean as required.

A

3. Fan and motor bearings
   Lightly oil.

SA

4. Condensate drain pan and pump
   Check pan and drain are clear.

SA

5. Air filter
   Wash, dry and refit, Replace if necessary
   . (Disposable filters Replace)

SA

6. Water loop connections
   Check for leaks.

SA

7. Refrigeration circuit
   Check for
   leaks.

SA

8. Electrical wiring and terminals
   Check integrity.

SA

9. Return to service
   Place on cooling cycle, isolate from water loop, and check high pressure safety device stops refrigeration compressor.

SA

10. Controls
    Return to standard settings.

SA

11. External cleaning
    Clean unit externally.

M

M

M

M

M

M

A

Q

Q

A

A

## 3a. AIR HANDLING UNITS (1 of 2)

1. F

Check manometer reading Renew filter media as indicated.

I

t

e

r

## AIR HANDLING UNITS (2 of 2)

2. Valves

   Check full range of operation and reset at the original setting.

3. M

   Check motor brushes and replace if necessary.

   Check, clean and test windings.

   Check tightness of terminals.

   Check full load current.

   Check bearing wear.

   Replace lubricant in motor bearings.

4. Anti-vibration mountings and ductwork flexible connections Check condition for excessive dryness or cracking.

## AIR HANDLING UNITS, BELT DRIVES

1. Belt drives

   Check for condition and alignment.

   Check sheaves for wear. Replace if needed. Correct tensioning if necessary.

## DRIVE ELEMENTS - MOTORS

NOTE: Before carrying out any work on electrical equipment, check status and isolate in accordance with Health and Safety legislation requirements.

Q 1. Mountings
Check condition.

Q 2. Motor casing
Check ventilating louvres are clear.

Q 3. Bearings
Lubricate where external nipples or lubricators are fitted.

A 4. Brushes
Check condition and replace if necessary.

A 5. Windings
Clean and test.

A 6. Terminals and connections
Check and ensure that they are secure.

A 7. Rating
Check motor running current.

A 8. Variable speed drives and other solid state controls Refer to manufacturer's specification.

## 3b FANS

### 3b i. MAKE-UP AIR UNITS

M

1. Filter
   Replace, wash if metallic.

M

2. B
   C Check alignment and condition.
   l
   t
   s

Q

Q

3. Gas, electrical, ventilating systems
   Check that all are in accordance with current codes and practice.

Q

4. Gas leak check
   Soap and water solution.

Q

5. Fan bearings, cock valves
   Lubricate.

Q

6. Flame safety controls
   Perform control test for fire eye M Series control with type 57AV7 tester.

Q

7. Spark plug
   Check ignition visually. Replace if burned.

8. Flame rod
   Check with DC voltmeter.

## AXIAL / FORCED DRAFT / INDUCED DRAFT FANS

Fixed and/or variable pitch.

Q

1. Impeller
   Clean and ensure no build up of dirt.

2. Motor bearings
   ("Sealed for life" bearings should not be serviced)
   Lubricate with recommended lubricant at intervals noted on fan nameplate.

Q

3. Belt drive (if fitted)
   Check tension and adjust if necessary. Replace if condition warrants it.

SA

4. Flexible conduit connections and wiring
   Check for soundness and ensure terminal connections are secure. Check integrity of electrical installation.

SA

5. Belt guards (where fitted)
   Check these are free from dirt build up. If necessary, clean.

SA

6. Impeller, variable pitch mechanism
   Check that there is no excessive movement at the wing root.

A

7. Adjustable pitch actuation
   Check correct operation.

SA

8. Back flow damper (where fitted)
   Check operation.

**3b ii. EXHAUST FANS - Including fire/smoke exhaust units, water-cooled and kitchen exhaust.**

Q 1. Controls
Check correct action.

Q 2. Motorized control dampers
Check operation.

Q 3. Electrical connections
Check all flexible connections and electrical insulation.

Q 4. Fan and motor
("Sealed for life" bearings should not be serviced) Lubricate according to manufacturer's instructions.

Q 5. Fan impeller and scroll
Check condition.

Q 6. Motor casing and louvres
Check condition and clean.

Q 7. Anti vibration mountings (where fitted)
Check mountings, belts and fixings for security.

Q 8. Back flow damper (where fitted)
Check operation.

## VENTILATING/TOILET EXHAUST FANS - General

The instructions in the table below refer to all air handling fans including exhaust, make- up, re-cirtion and small air handlers.

Before working on any moving machinery, switch ‘off’ and ensure that the equipment is isolated electrically in accordance with Lock and Tag Out, OSHA Section 269D - 1910.

SA 1. Bearings ("sealed for life" bearings should not be serviced) Inspect and lubricate as necessary.

SA 2. Housing
Clean and inspect for looseness and corrosion.

SA 2. Drives and belts
Inspect, check condition and alignment of drive and shaft. Adjust or replace if condition warrants it.

SA 4. Fan wheels
Check and clean. Inspect for tightness.

SA 5. Sheaves and bearing collar
Check tightness.

SA 6. Mountings bolts
Check and tighten as necessary.

SA 7. Anti-vibration mountings
Check effectiveness.

SA 8. Backdraft damper
Check
operation.

## SMOKE REMOVAL FANS

NOTE: This type of fan, axial with the motor outside of the airstream, is normally used for fume extracts. e.g. kitchen fire and smoke extraction and for fume removal, particularly where corrosive.

Q 1. Unit
Check operation.

Q 2. Fan impeller
Check condition and clean.

Q 3. Lubrication
("Sealed for life" bearings should not be serviced)
Check and lubricate if necessary acing to the manufacturers instructions.

Q 4. Standby motor (where provided)
Check and rotate a few turns by hand or electrically.

Q 5. Flexible conduit connections and wiring
Check for soundness and ensure terminal connections are secure.
Check integrity of electrical insulation.

SA 6. Belt drive (if fitted)
Check wear, alignment and tension.

SA 7. Automatic shutters (usually fitted roof units). Clean and check operation.

A 8. Anti-vibration mountings
Check condition.

A 9. Ductwork including fixings and insulation (where fitted) Inspect external condition and report.

A 10. Motor
Check full load current and log.

A 11. Bearings
Check for wear. Remove oil/grease and clean.

A 12. Micro switches on automatic shutters
Check operations. Reset if necessary.

## 3c. DUCTING - BALANCING DAMPERS AND FIRE/SMOKE DAMPERS

Caution:

All balancing dampers are set up during commissioning and should not normally be subject to further adjustment unless modifications are made to the ductwork distribution system. If it is essential to move the damper for maintenance purposes, extreme care should be taken to ensure that the damper is returned to the position as set when commissioned. In the event of a ductwork modification, the system should then be recommissioned.

SA 1. Balancing dampers
Check position and ease of movement and security of locking devices.

SA 2. Fire and smoke dampers
Check action and proper operation. Inspect all dampers, apply a few drops of oil to the mechanism. Replace fusible links if required.

SA 3. Linkages on motorized dampers
Check for wear and lubricate if appropriate.

SA 4. Controls
Check condition and operation.

SA 5. Electrical
Check for damage to flexible conduits. Tighten all terminal connections. Isolate control panel and inspect for signs of overheating. Check integrity of electrical insulation.

## 3d. AIR HANDLING FILTERS

NOTE: In normal use, air filters do not present a health and safety hazard. However, used air filters do contain quantities of dust which, unless precautions are taken, may expose maintenance personnel to a "nuisance dust" hazard, as defined by the "Dust Hazards" section of OSHA Regulations 1000A - 1910. As a precaution, personnel should wear a dust/mask respirator, safety glasses, loose protective clothing and gloves when changing any air filter. Used filters should be sealed into plastic bags for disposal.

1. Filter elements

2. Seals and/or fasteners

Remove and replace according to manufacturer's recommendations. Ensure that any spillage or dust is vacuumed away. Some filters may have to be cleaned more frequently, depending upon site conditions and operating hours.

Do not attempt to wash or clean out and reuse.

Ensure that any damaged seals or fasteners are replaced.

**FILTERS (COMMON PROCEDURES)**

Q 1. Air flow
Stop any air flow to filter.

Q 2. Removal
On removal be sure that trapped dust remains in the filter

Q 3. Filter housing
Thoroughly clean, including surrounding ductwork and

Q 4. Housing
Inspect for damage and/or corrosion.

**REUSABLE (CLEANABLE) FILTERS**

Q 1. Filter elements
Clean and replace as per manufacturer's recommendations.
Filters may require more frequent cleaning where the air is heavily with dust of fumes.

Q 2. Kitchen exhaust grease filters
Remove and clean as per manufacturer's recommendations.

ions.  Frequency of

cleaning can vary from daily to weekly intervals. Generally, the use of a commercial dishwasher is possible/

Failure to change/clean filters when loaded with grease may result in the carryover of grease into the duct, leading to a greater risk of fire.

When cleaning, care should be taken to avoid damage to the filters either Mecally or by the use of aggressive solvents. Usually hot soapy water or an approved cleaning liquid is adequate.

## ABSORPTION TYPE

SA

1. Damage and corrosion
   Check and report if found.

## ROLLOMATIC FILTER TYPE

SA

1. Damage
   Check and report if found.

SA

2. Differential
   press
   ure
   Meas
   ure.

SA

3. Operation
   Check for correct operation.

M

## GREASE FILTERS

1. Condition
   Check and clean.

High efficiency – HEPA. The maintenance activities for these depend on the individual installation and operating conditions. Reference should be made to the design/operating manuals for the building.

## ELECTROSTATIC FILTERS

M

1. Electrical

a) Powerpack
Check for correct operation.

b) Rectifiers
Check operation and follow manufacturer's instructions.

c)Isolation
Isolate electrically in accordance with OSHA Lock & Tag Out Section 269D - 1910.

d) Ionizing wires
Check condition and, if broken, replace immediately.

M

2. Mechanical

a) Cells
Wash according to manufacturer's instructions.

## 3e. DUCTWORK SYSTEM - GENERAL

NOTE: Special requirements are necessary in the food and process industries and clean room applications.

A 1. Access doors
Inspect for any loose panels and secure.

A 2. Flexible connections
Check for condition, leaks and secure fittings.

A 3. Insulation
Inspect for any damage or deterioration.

A 4. Anti-vibration mounts
Inspect for permanent set (in springs).

A 5. Internal cleanliness
Check internal condition through sampling points (test points) where fitted.

## 3f. FAN COIL TERMINAL UNITS

SA

1. Status
   Switch off and isolate.

Q

2. Coil block
   Vent air from cooling and heating coils.
   Remove air entry filter, inspect coil block for dirt and clean as necessary.

SA

3. Condensate drain connection
   Check connection is clear.

SA

4. Permanent filters
   Clean and refit, ensuring proper location.

SA

5. Disposable type filters
   Replace ensuring proper location.

SA

6. Test unit
   Restore power supply and run unit. Check air flow is normal at correct speed setting.

SA

7. Casing
   Cle
   an.

A

8. Ductwork flexible couplings (if
   fitted) Check condition.

SA

9. Grills and diffusers
   Clean using vacuum or alternatively remove and clean.

## TERMINAL INDUCTION UNITS

SA

1. Secondary air filter
   Clean washable filter and retain for reuse.

SA

2. Coil block (where fitted)
   Inspect for dirt and/or obstructions, cleaning where necessary. Check also for water leaks and rectify as necessary.

SA

3. Primary air nozzles
   Check condition, cleaning if necessary by brushing. Push scratch awl in each nozzle.

SA

4. Nozzle air pressure
   Check with manometer.

SA

5. Damper and/or pneumatic valves
   Check correct functioning and rectify any defects.

SA

6. Chilled water/LPHW control valves
   Check functioning.

SA

7. Control thermostats
   Check
   operation.

SA

8. Isolation valves
   Check for leaks and rectify as necessary.

SA

9. U
   n
   i
   t

**Clean internally and externally. Refit secondary air inlet filter. Replace any casing which was removed.**

## VAV UNITS - Pneumatic-powered

A

1. Access to units
   Remove access panels or ceiling tiles as appropriate.

A

2. Control system
   (For information only)
   a) Pneumatic or
   b) Electrical
   Disconnect pneumatic control pipe and check unit motors to alternative setting.
   Disconnect electrical control and check that unit motors to alternative setting.
   Reconnect.

A

3. Air leaks
   Check and if found rectify.

A

4. Insulation
   Check condition and make good as necessary.

A

5. Actuator
   If visible, check for dirt, lightly oil mechanism as required.

A

6. Unit thermostat
   Operate and check VAV unit moves in relation to change in setting.
   Restore to original setting.

A

7. Filter
   Clean or replace as necessary.

A

8. Diffusers
   Clean, taking care not to stain ceiling.

## VAV UNITS - Fan-powered

SA

1. Fan motor
   Grease or oil bearings.

SA

2. Dampers
   Check operation and lubricate linkages if necessary.

SA

3. LPHW and CW coils
   Check operation and clean.

SA

4. Controls
   Check operation.

## VAV UNITS - Self-powered

SA

1. Thermostat
   Check operation.

A

2. Unit filter
   Check condition and change if necessary.

Q

3. Main filter
   Check condition**.**

## 3g. DIFFUSERS AND GRILLS

1. Grills

SA a) External
Examine, check mountings and clean.

A b) Internal
Examine, check fitting and clean.

A 2. Diffusers

Examine, check fitting and clean.

Q

Q

Q

A

## 4. MISCELLANEOUS EQUIPMENT

### 4a. HUMIDIFIERS - Compressed air

### type

NOTE: This schedule should be read in conjunction with those on air compressors.

1. Status
   Isolate electrically and hydraulically.

2. Nozzles
   Clean dust and debris from outside of nozzles.

3. 'Y' strainer
   Inspect and replace strainer screen.

4. Water pressure regulator
   Check condition and carry out maintenance in accordance with the manufacturer's instructions.

## ELECTRODE BOILER HUMIDIFIER

NOTE: In hard water areas maintenance may be required more frequently. If output is decreased due to heavy scaling renewal of the cylinder, refer to client.

BEWARE - High water conductivity in the boiler circulated water can damage the boiler drums. Only work within the boiler manufacturer's values of conductivity.

Q 1. Status
Check and isolate both water and electricity supplies.

Q 2. Steam drum

Check all electrical connections on the cylinder for soundness and correct any defects.

3. Drum exchange
As per manufacturer's instruction: Hard water areas 3/4 months.
Soft water areas 12 months.

Q 4. Water drain pump
Check for free flow of water by operating the pump. Repair any gland leaks. Check manual drain switch actuation.

A 5. Drain pipe
Check for free flow, actuate drain if necessary.

A 6. Feed valve
Clean strainer.

A 7. Unit testing after drum exchange
Set the controls to start and operate humidifier in its normal mode and ensure the functions are correct and humidistat is functioning.

A 8. Fully automatic modulating type humidifier Check output modulation.

## HUMIDIFIER - Direct steam injection type (1 of 2)

Note: When in operation, there is intermittent live steam injected from manifold within. DO NOT ATTEMPT TO SERVICE WITHOUT ISOLATING STEAM AND ELECTRICITY SUPPLIES.

Q 1. Status
Isolate electrically.

Q 2. Removal of deposits
Clean and flush out.

Q 3. Ball valve
Check operation.
Clean and renew washer.

Q 4. Water level
Check level in gauge glass corresponds with indicator plate.

Q 5. Humidistat
Check operation, clean if necessary.

Q 6. Misting sprays
Observe spray pattern, clean if necessary.

Q 7. Control and indicator lights
Check for correct functioning.

Q 8. Steam traps
Check operation and clean.

Q 9. Steam
pres
sure
Che
Q ck.

A 10. Stainer (where fitted)
Clean strainer on steam supply.

A 11. Water supply
Turn off at ball valve and empty via drain cock.

12. Steam manifold
Remove outer casing lid baffles. Remove any scale either physically or by using suitable chemical descaling agent.

A

A

A

SA

SA

SA

A

M

## HUMIDIFIER - Direct steam injection type (2 of 2)

13. Feed water line
    Check that it is clear.

14. Re-assembly
    Ensure all joint faces are clean and re-assemble using new gaskets.

15. Re-commission
    Put back into service and check operation.

## HUMIDIFIERS - Ultra sonic

1. Status
   Isolate electrically and hydraulically.

2. Water tank
   Clean out and refill.

3. Ultra sonic diaphraThe Owners
   Clean carefully with soft non-scratch cloth.

4. Ultra sonic generator
   Check operational efficiency as per manufacturer's instructions.
   Replace if necessary.

5. Sediment removal
   Remove as necessary from top of reservoir.

## HUMIDIFIER - Resistance heater type

In hard water areas more frequent maintenance may be required.

A

1. Status
   Isolate electrically and hydraulically.

A

2. Water boiling chamber
   Drain.

A

3. Resistance heater element
   Inspect and descale as necessary.

A

4. Scale collecting bag (where fitted)
   Change as necessary.

A

5. Float valve, or solenoid valve on make-up line Check operation.

SA

6. Control indicator lights (where part of humidifier) Check for correct functioning.

Q

7. Built-in step controller (where fitted)
   Check for correct operation.

*

8. Operation
   Restore services and put unit back on line.

## 4b. HEAT EXCHANGERS - HEATED BY LTHW OR MTHW

Low temperature hot water systems (LTHW or LPHW) are heating systems operating up to 140 bar (gauge) and 200(F and indirect systems complementary to them.

| | | |
|---|---|---|
| A | 1. | Operation and safety controls<br>Check, note, and report any visible defects. |
| A | 2. | Safety valves<br>Check operation of safety valves. |
| A | 3. Sensors | Thermostats, pressure sensors, altitude gauges and thermometers Check for correct operation and settings. |
| A | 4. | Auto controls and primary side<br>Shut down primary heat source. |
| A | 5. | Drain valve / drain cock on secondary side<br>Draw off a small quantity of water to remove any sediment. |
| 2Y | 6. | Heating surface and internal surfaces of shell<br>Drain down secondary side, remove manholes, inspect for scale formation and corrosion, and report. |
| 2Y | 7. | Bursting discs (where fitted)<br>Check condition. |
| | 8. | Put back into operation<br>Refit all manholes, refill secondary side. Put primary side into operation. |

## HEAT EXCHANGERS - HEATED BY STEAM

A

1. Check operations, in particular safety controls Note and report any visible defects.

A

2. Safety valves
   Check for corrosion and manually operate.

A

3. Thermostats, pressure sensors, altitude gauges and thermometers Check for correct operation and settings.

A

4. Auto controls and primary side
   Shut down primary heat source.

A

5. Drain valve/drain cock on secondary side
   Draw off a small quantity of water to remove any sediment.

2Y

6. Heating surface and internal surfaces of shell
   Drain down secondary side, remove manholes and inspect for scale formation and corrosion and report.

2Y

7. Bursting discs (where fitted)
   Check condition.

A

8. Gaskets
   Check gaskets on steam chest for leakage, replace as necessary.

2Y

9. Vacuum breaker (where fitted)
   Check operation and service as appropriate.

A

10. Steam trap
    Clean and overhaul steam trap.

A

11. Strainer on primary pipework
    Remove strainer, clean and refit.

A

12. Return to operation
    After completion of maintenance, refit all manholes, refill secondary side and put primary side into operation.

A

13. Check insulation for damage
    Repair or renew as necessary.

## HEAT EXCHANGERS - COILS

NOTE: When cleaning, ensure that system fans are off to avoid dirt entering into the system.

### WATER TO AIR

A

1. Drain pans
   Inspect for corrosion and clear obstructions (if any) in condensate drain piping on cooling side.

A

2. Coils
   a) External surface air side
   b) Water side
   Clean coils and comb out fins. Flush out coils to remove sediment.

A

3. Coil casing
   Inspect for rust and clean and repaint as required.

A

4. Coil mounting bolts
   Check for tightness and secure if necessary.

### STEAM TO AIR

A

1. Coils
   a) External surface air side
   b) Water side
   Clean coils and comb out fins. Flush out coils to remove sediment.

A

2. Coil casing
   Inspect for rust and clean and repaint as required.

A

3. Coil mounting bolts
   Check for tightness and secure if necessary.

A

4. Gas burners and associated equipment
   Service.

## 4c TANKS

### 4c i. EXPANSION TANKS

A

1. Condition
   Examine for damage or corrosion.

A

2. DiaphraThe Owners
   Check condition and pressure.

### DHWS Heat Exchanger

1. DiaphraThe Owner expansion tank(s)
   Q
   A
   Chec
   k.
   Inspe
   Q
   ct.

2. Non-return valve (cold water service (CWS) to heat exchanger) Check.

SA

SA

SA

SA

## 4c ii OIL STORAGE TANKS

1. Isolation valves

2. Fire valves

3. Tank

4. Gauges

Check operation. Examine for leaks.

Check for deterioration. Carry out a visual inspection and report findings to outer condition of tank.

Check operation and report any defects.

## 4c ii. CW STORAGE TANKS

NOTE: Storage tanks operate at atmospheric pressure whereas tanks are sealed vessels operating at pressures above atmospheric.

Q 1. Float-operated ball valve
Check operation, water level and shut off. Replace washer if necessary.
Check float for leakage and security.

SA 2. Level control switches (if fitted)
Check for scale deposits, clean as necessary and check operation.

SA 3. Cistern or tank body
Check for leaks and any structural weaknesses.

SA 4. Valves
Check valve stems are free to turn.

SA 5. Air vents and overflow screens
Check for blockage and condition.

SA 6. Insulation
Check condition, replace if necessary.

A 7. Manhole lid and access covers
Check condition of seals.

A 8. Cistern or tanks
Inspect and report cleanliness and condition.

A 9. Tanking
Ensure drains are clear, check condition.

A 10. Associated pipework
Check condition and rectify any faults.

A 11. Generally
Check that all items of equipment comply with:
a) legislation,
b) bylaws, and
c) codes of practice.

## COLD WATER TANKS - Including breaktanks

| | | |
|---|---|---|
| Q | 1. | Ball-valve<br>Check operation and tight shut off. Replace washer if necessary. |
| SA | 2. | Control switches<br>Check for scale deposits, clean as necessary and check operation. |
| SA | 3. | Tank body<br>Check for leaks and any structural weakness. |
| SA | 4. | Valves<br>Check valve stems are free to turn. |
| SA | 5. | Insulation<br>Check condition, replace if necessary. |
| A | 6. | Tank<br>Drain, clean, check condition and repaint where required. |
| A | 7. | Immersion heater<br>If fitted check for scale, de-scale if required and check electrical connections. |
| A | 8. | Associated pipework<br>Check condition and rectify faults. |
| SA | 9. | Associated valves<br>Check operation of valves on system. |
| A | 10. | Overflow pipe<br>Check for blockage. |

## 4d. PUMPS

Checks on pumps should only be carried out by trained personnel. LPHW pumps should be checked frequently (typically weekly) for excessive noise or vibration, excessive seal leakage, that the pressure differential is as required and that the casing is free from air. It may be appropriate to change over duty and standby pumps at the same time. Belt drives should be checked and adjusted as necessary (typically once per month), and anti- vibration mountings and flexible pipe couplings checked. Grease lubricated bearings intended for replenishments should be greased as recommended (typically every six months), taking care not to overfill.

General for all pumps

Q 1. Noise, vibration and overheating
Check, rectify if possible and report.

Q 2. Lubrication
Lubricate pump and motor bearings.

Q 3. Drives, pulleys, anti-vibration mounts and drive
couplings Check and adjust where necessary.

Q 4. Glands
Inspect and adjust if necessary. Repack if required.

A 5. Electrical connections
Check.

A 6. Motor vent
slots
Clear.

A 7. Suction line strainers
Clean.

A 8. Pressure switches and level controls
Check settings and test functionally.

A 9. Drive guards
Check and rectify security.

## PRESSURIZATION PUMPS

Q

1. Pump base and connections
   Ensure pump base is level and pipework not strained.

Q

2. Strainer
   elemen
   ts
   Clean.

Q

3. Pump and motor alignment
   Check and adjust if necessary.

Q

4. Motors and bearings
   Oil or grease where external nipples or lubricators are fitted.

Q

5. Drain holes, pipes and tank
   Clean and ensure that all blockages are cleared.

Q

6. Guards and shields
   Check for security and safety.

Q

7. Control and safety switches
   Inspect and check.

Q

8. Control, pressure relief and reducing valves, air vents, purgers and constant flow regulators

Q

9. Test for correct operation and rectify any faults.

Q

10. DiaphraThe Owner expansion tanks
    Inspect. Should be 20 PSI air pressure above bladder.

Q

11. Test run pressure booster sets, pressurizing units, and filling
    pump Carry out adjustments to ensure satisfactory
    operation.

## WATER PUMPING PRESSURE BOOSTING SETS

Q

1. Pump base and connections
   Ensure pump base is level and pipework not strained.

Q

2. Strainer
   elemen
   ts
   Clean.

Q

3. Pump and motor alignment
   Check and adjust if necessary.

Q

4. Motors and bearings
   Oil or grease where external nipples or lubricators are fitted.

Q

5. Drain holes, pipes and tank
   Clean and ensure that all blockages are cleared.

Q

6. Guards and shields
   Check for security and safety.

Q

7. Control and safety switches
   Inspect and check.

Q

8. Control, pressure relief and reducing valves and constant flow
   regulators Test for correct operation and rectify any faults.

Q

9. Hydraulic accumulator (if fitted)
   Inspect and check gas cushion pressure and adjust as necessary.

Q

10. Test pressure booster sets
    Run and carry out adjustments to ensure satisfactory operation.

Q

11. Building management system controls
    Simulate every function to ensure satisfactory operation.

## 4e. VALVES (1 of 4) GATE VALVES

Q

Q

A

Q

Q

A

Q

Q

A

1. Operational status

   Check, rotate handwheel sufficiently to indicate that wedge is not seized in closed position or jammed in open position. If normally open, close valve and reopen.

2. Gland leakage

   Check; within the first week slightly tighten gland nuts. If after a period leakage still occurs, replace gland.

3. Overall condition

   Inspect for external deterioration due to leaks at end flanges or aggressive environment.

### GLOBE VALVES

1. Operational status

   Check by rotating handwheel sufficiently to ensure freedom of movement.

2. Gland leakage

   Check; within the first week slightly tighten gland nuts. If after a period leakage still occurs, replace gland.

3. Overall condition

   Inspect for external deterioration due to leaks at end flanges or aggressive environment.

### LUBRICATED PLUG VALVES

1. Operational status

   Check by partially rotating plug to ensure freedom of movement.

2. Stem leakage

   If evidence of leakage, inject correct compound while simultaneously rotating plug

3. Overall condition

   Inspect for external deterioration due to leaks at end flanges or aggressive environment.

## VALVES (2 of 4)

## BUTTERFLY

Q

## VALVES

Q

1. Operational status
   Check by partially rotating disc to ensure freedom of movement.

2. Stem leakage
   Check for freedom from dirt particles. Tighten gland if adjustable type, if not replace proprietary seals (e.g. O rings).

A

3. Overall condition
   Check for deterioration externally or aggressive environment.

Q

## FLOAT OPERATED VALVES

1. Operational status
   Check for drips from valve indicating leaking seat.

A

2. Overall
   conditi
   on
   Check.

Q

## PARALLEL SLIDE VALVES

Q

1. Operational status
   Valve normally closed, rotate handwheel to ensure freedom of movement.

A

2. Gland leakage
   Check, within first week slightly tighten gland nuts. If after a period leakage still occurs replace gland.

A

3. Body leakage
   Check for body/cover joint leakage and tighten nuts to stop.

4. Overall condition
   Inspect for external deterioration due to leaks at end flanges or aggressive environment.

Q

## SAFETY VALVES

1. Operational status

Check by raising lever to discharge steam of air. Release gagging lever to reseat. Check for dirt or damage.

A

2. Bursting Discs (if fitted)
Check condition, report.

## VALVES (3 of 4)

### STEAM PRESSURE REDUCING VALVES

SA

1. Main valve seat and valve head
   Isolate and reduce pressure to zero. Remove screen and clean. Clean gasket fa

SA

2. Pilot valve chamber assembly
   Isolate and reduce air pressure to zero. Check dimensions of plunger gap and adjust if necessary.

SA

3. Pilot and main diaphraThe Owners
   Thoroughly clean upper and lower diaphraThe Owner chambers, ensure contact faces are clean, and reassemble.

### PRESSURE CONTROL VALVES

SA

1. Strainers preceding valves
   Clean strainer screens.

A

2. Control Valve
   Overhaul using standard maintenance repair kit.

A

3. Main valve and seat assembly
   Examine seat for damage, wear and scale build-up.

### DIAPHRATHE OWNER VALVES

A

1. V
   Isolate and check condition. Dismantle and clean body, threads, spring and diaphraThe Owner.
   a
   l
   v
   e

A

2. DiaphraThe Owner
   Change if condition suspect.

A

3. Re-assemble
   Tighten bolts diagonally. Do not overclose the diaphraThe Owner.

**VALVES (4**

**of 4)**

**BOILER**

**VALVES**

A 1. Main stop valve
Lap seats, inspect for corrosion, reset valve at correct set pressure and carry out accumulation test.

A 2. Main stop valve
Lap seat, repack gland and lubricate spindle, checking for ease of operation.

3. Water level controls
* * Daily or Weekly
Blowdown and check operation.
Lower boiler water level and check
operation. Clean out chambers of any
deposits.

SA 4. Sequencing valve
Clean and lap seats, check for ease of operation.

SA 5. Water level gauge
Refit sight glass, repack cock plugs and check for ease of operation.

A

A

## AUTOMATIC AIR ELIMINATORS VALVES

1. Valve

2. F
   l Check for leaks.
   o Clean float chamber and needle valve assembly.
   a
   t

## 4f. CONTROLS

### OPTIMIZERS

A 1. Outside air temperature sensor
Check outside sensor for calibration and display accuracy.

A 2. Inside air temperature sensor
Check inside sensor for calibration and display accuracy.

A 3. Program setting
Check program setting is correct.

A 4. Optimum stop/start operation
Check operation by simulation.

A 5. Battery
Check condition.

A 6. Output devices
Check that output devices respond to command signals.

A 7. Energy savings
Communicate with system operator if there is any other opportunities to save energy with the present sequence of operation.

## OUTDOOR RESET CONTROLLER

SA

1. Flow temperature sensor
   Check.

SA

2. Outside air temperature
   sensor Check.

SA

3. Settings
   Check that settings are correct.

SA

4. Output signal
   Check output signal and output device operation.

SA

5. Controllers
   Check and calibrate for correct relationship between outside and flow temperatures.

SA

6. System operation
   Check system under control for proper operation.

## HEAT EXCHANGER CONTROLS

Certain common maintenance procedures should be carried out for all controls. These are:

All control items, e.g. thermostats and the like, that have been switching contacts
- ensure that contacts make and break easily and that there is no arcing or pitting. Inspect thermostat phial and capillaries for mechanical damage.
Inspect thermostat pockets for corrosion and leakage.
Ensure immersion thermostats are secure in their pockets (and that the sensor is in contact with the end of the pocket).
Inspect motorized valves for leakage and damage to linkage.

A 1. Control thermostat
Check operation and confirm set point.

A 2. High limit thermostat (if fitted)
Check operation and confirm set point.

A 3. Temperature sensor controller; motorized valve Check operation and confirm set point(s).

A 4. Power fail return; motorized valve
Check operation.

A 5. Direct acting control valve
Check operation and confirm set point.

A 6. Direct acting control valve high limit
Check operation and confirm set point.

A 7. Temperature sensor
Controller

Motorized valve

### Power fail return motor

Check performance.

## HEATING SYSTEMS CONTROLS

Certain common maintenance procedures should be carried out for all controls. These are:

All control items, e.g. thermostats and the like, that have switching contacts – ensure that contacts make and break easily and that there is no arcing or pitting.

Inspect thermostat phial and capillaries for mechanical

damage. Inspect thermostat pockets for corrosion and

leakage.

Ensure immersion thermostats are secure in their pockets (and that the sensor is in contact with the end of the pocket).

A

1. Room thermostat
   Check operation. Confirm the set point.

A

2. Zone motorized
   valve Check
   operation.

A

3. Temperature
   sensor
   Motorized valve
   Check operation. Confirm set points.

A

4. Temperature
   sensor Controller
   Motorized valve
   Check
   performance.

## 7. 4f i ALARMS

## BOILERS - FIRE AND SAFETY CIRCUITS (1 of 2)

Is the plant safe? It should be noted that fire prevention and fire alarms are not included in the scope of this document. Any steam plant over 15 psi needs a City of Chicago licensed engineer to operate it. It is essential that the operation of all indicator lights should be checked regularly and that any malfunctions should be corrected as soon as possible.

1. O
   Manual fire valve
   Check valve and associated couplings for positive oil shut off.
   Quick release mechanism
   Actuate and check that any dead weight or solenoid valves operate correctly.
   Valve and quick release system
   Reset.

2. G
   Manually operated valves
   Check to establish positive shut off gas is achieved.
   Pressure switches on gas boosters
   Check for operation and sensitivity.
   Gas detection unit
   Test sensitivity.
   Manual quick release mechanism
   Actuate and recheck operation of the dead weight valve or solenoid.
   Valves and quick release mechanism
   Reset.

3. Solid fuel
   Fusible links, inter-connecting tension wire and pulleys Inspect.

4. Pressure switches
   Check operation.

3. Foam inlets
   Ensure foam inlet pipes are free from blockage.

## BOILERS - FIRE AND SAFETY CIRCUITS (2 of 2)

SA

6. Smoke/heat detection
   Check operation.

SA

7. General
   Check all fuel supply valves for free operation.

A

8. Combustion air source into plant room
   Check that original provision has been left clear of any obstruction dirt.

## PNEUMATIC ACTUATORS

Pneumatic actuators do not have an electrical supply but function by air pressure alone. Therefore should there be any loss in pressure, the performance of the actuator (and thus the whole system) will be impaired making it inefficient.

A 1. Pressure/leakage/seizure
Check operation between actuator and controller. Test diaphraThe Owner for leakage (pump up gauge).

A 2. Pipe connections
Check condition of glands and seals, Check pipework for deterioration.

A 3. Air quality
Check that any filters are clear of water and oil (filter may not be local to the actuator).

A 4. Manual operation (if fitted)
Check to ensure actuator achieves stroke limits. Check for minimum/maximum setting.

A 5. Linkage assembly
i.e., nuts, bolts, spring, valve stem or damper assembly Check
a) Wear
b) Security, and
c) Corrosion.

A 6. Lubrication and cleaning
As recommended.

SA 7. Actuator function
Check calibration-controller output to actuator position.
Note: More than one actuator may be fed from the control supply.

A 8. Auxiliary control units
e.g. positioners, electrical feedback units, end switches
Check operation.

## MOTOR DRIVEN ACTUATORS

A

1. Electricity supply
   Check supply voltage and that polarities are correct.

A

2. Control signal
   Check for presence and that polarity is correct.

A

3. Auxiliary control functions
   i.e., on/off switches, frost protection, position indicators, feedback potentiometers Check operation.

A

4. Manual operation (if fitted)
   Check to prove actuator will mechanically open/close valve or damper to its working limits.

A

5. Actuators position on power failure

Check for correct position for application when power fails.

SA

6. Reaction to safety signal
   i.e., fire, smoke
   Check that the actuator assumes correct position (if applicable).

A

7. Reaction to control signal
   Check for correct response to signal.

A

8. Running time (if applicable)
   Check.

## 4g HVAC SUPPLY/DISTRIBUTION

### 4g i. OIL

Q 1. Burner
Fire, if possible. Carry out safety check of flame failure device.

Q 2. Linkages
Check and adjust if necessary.

Q 3. Oil metering system
Renew seals and gaskets if necessary.

Q 4. Main shaft on burner
"Lift" bearings.

Q 5. Atomizers and spray tip, if fitted
Check.

## 4g ii GAS

A

A

A

A

1. Joints
   Carry out leak test of all joints downstream of interlock isolator.

2. Main gas valve
   Check operation of leak test equipment.

3. Gas throughput
   If practical - check.

4. Vent pipework
   Check integrity.

SA

SA

SA

Q

## 4g iii ELECTRICAL

1. Wiring
   Check panel, junction box and terminals.

2. Fuses
   Check rating.

3. Overload relays
   Check settings.

## GENERAL

Check security of mechanical parts and secure mounting of appliance.

## REPORT AND RECOMMENDATIONS

Should be signed by service engineer and kept by the client.

## 4h. PNEUMATICS SYSTEM/AIR COMPRESSORS (1 of 4)

It should be noted that to ensure dry, clean, and oil free air there are a number of daily and weekly tasks which the plant operator must carry out as part of his or her duties. These include daily condensate drainage, pressure drop checks across filters, oil contamination check and audible leaks.

A 1. Capacity test

Pump up receiver from zero atmospheric pressure to working pressure and note time taken.

A 2. General condition

Check the following:

a) Condition of guards,
b) Interstage cooler drains,
c) Bearers and holding down bolts,
d) Hand operated valves, and
e) Moisture traps.

A 3. Status

Switch off and isolate electricity.

A 4. Oil

Note level and change using recommended lubricating oil.

A 4. Belt and drive

Check tension and condition of belts and drives.

A 6. Condensate removal

Check condensate drainage system and clean as necessary.

A 7. Pressure relief valve

Operate and check valve for condition, operation, setting and leak tightens. Adjust if necessary.

A 8. Air filter

Cle
an.

A 9. Electrical connections

Check and tighten all connections. Check condition of wiring and insulation.

## AIR COMPRESSORS (2 of 4)

A

10. Gauges
    Check operation.

A

11. Pipes and connections
    Check external condition and leak tightness. Tighten connections as necessary.

A

12. Controls
    Check operation of pressure switches and auto change over solenoids.

A

13. Offloaders, mechanical and electrical
    Check operation.

A

14. Main air intake air quality
    Check air source for possible contamination and dangerous gases.

## COMPRESSED AIR DRYERS

1. Refrigeration type

Q

2. Pipe connections
   Check for leak tightness. Remedy as necessary.

A

3. Electrical wiring and conduits
   Check condition of contacts. Clean or replace.

A

4. Discharge air dewpoint
   Measure and record.

Q

5. Condensate trap bowl
   Drain, clean with soapy water and replace.

Q

6. Evaporator fins
   Clean and straighten.

## WATER COOLED AFTER COOLERS

A

1. Pipe connections
   Check for
   leaks.

**AIR COMPRESSORS (3 of**

**4) WATER ABSORPTION**

Q

**TYPE**

Q

1. Drying medium
   Remove from container, check condition and treat as necessary.

2. Cleaning
   Where applicable, dismantle and clean with dry oxygen free nitrogen.
   Examine, test, refit or renew items listed under notes.

Q

3. Discharge air quality
   Check and record.
   a) Air dewpoint,
   b) Air temperature.

Q

4. Re-activation drying time
   Time change-over period.

5. Cartridge
   Change complete container.

**COMPRESSED AIR DISTRIBUTION NETWORK**

Q

1. Filter and pressure reducing station
   a) Check particle filters and change as required.
   b) Check oil filter and change as required.
   c) Check pressure reducing valve settings.
   d) Check low pressure safety valve.

Q

2. Moisture drain
   Check operation.

A

3. Valves Check external condition operation, leak tightness of glands and seats, spindles and handwheels.

A

4. Safety and reducing valves
   Examine external condition check operation, settings and leak tightness.

## AIR COMPRESSORS (4 of 4)

A

5. Drains and trap
   Check external condition, operation and leak tightness.

A

6. Filters and strainers
   Check external condition, operation and leak tightness.

A

7. Gauges
   Check operation, condition, leak tightness.

A

8. Pipes and connections
   Check external condition and leak tightness. Ensure correct "signwriting" (color coding).

A

9. Pipe insulation
   Check condition of insulation on drain legs, etc. and replace if defective.

## PNEUMATIC RELAYS

ELECTRIC TO PNEUMATIC, PNEUMATIC TO ELECTRIC AND PNEUMATIC TO PNEUMATIC.

SA

1. Input
   sign
   al(s)
   Che
   ck.

SA

2. Output
   signal
   (s)
   Chec
   k.

SA

3. Operation
   Check for correct relationship between input and output signals.

M

A

A

A

A

A

A

A

A

A

A

## 4i. FLUES

1. Drain plugs at the base of the flue
   Remove, allow any accumulated condensate to drain away and replace.

2. Supports
   Inspect security of supports and condition of paintwork. Treat any signs of rust or corrosion.

3. Flue terminals
   Check flue terminals at roof level.

4. Boiler flue and vertical chimneys
   Clean thoroughly with custom made flue brushes and tools.

5. Balanced flue terminals
   Check for obstruction, corrosion, and if fan assisted, check safety circuit.

6. Induced draught
   Check for obstruction and condition of bearings.

7. Fan dilution units

8. Modular boiler flue systems

9. Condensing boilers
   Check for obstruction and corrosion. If fan assisted check safety circuit.

10. Stabilizers (explosion doors)
    Check condition and ensure movement is free.

11. Structural stability
    Check condition and if free standing, examine condition of guy ropes.

## 4j. REFRIGERATION COMPRESSORS - Centrifugal - R11 or R-123 Refrigerant (1 of 2)

NOTE: More frequent maintenance checks should be carried out by the plant operators and local maintenance personnel.

Q 1. Operation

**Check running conditions, oil pressure, purge unit operation, oil level and oil return system. Look for signs of leakage.**

Q 2. Refrigerant charge

Check level and carry out leak test.

Q 3. Holding down bolts

Check compressor and motor holding down bolts and tighten if necessary.

Q 4. Purge unit

Check frequency of discharges.

Q 5. Controls

Check oil pressure differential and chilled water temperature and flow rate.

Q 6. Purge unit filter driers (if fitted)

Change in accordance with manufacturer's instructions.

A 7. Compressor oil

Take sample for analysis.

SA 8. Oil filter

Change both filter and oil drier return system.

A 9. Purge unit valves, valves and associated equipment

Clean and inspect.

A 10. Float assembly

Remove and flush shell with degreaser. Clean the orifices.

A 11. Oil return filter drier

Change.

A 12. Foul gas supply filter

Change.

## REFRIGERATION COMPRESSORS - Centrifugal - R11 or R-123 Refrigerant (2 of 2)

A 13. Oil return filter drier

Change the filter/drier, check that eductor tee is undamaged, clean. Clean dirt leg.

A 14. Main oil filter

Change.

A 15. Electrical and safety controls

Check that they are working satisfactorily.

A 16. Condenser and evaporator

Check water pressure drops.

A 17. Cooling tower

Check settings of cooling tower fans controls.

A 18. Motors

Hermetic/Open Type
Open Type
Carry out electrical insulation tests with megaohm meter.
Check motor/fan is clean and efficient. Check motor and compressor alignment.

## CONDENSER – WATER COOLED

A

1. Compressor full load operation
   Record inlet and outlet temperature on water side, pressure drop across condenser, head pressure and condensing temperature.

A

2. P
   u
   m
   p
   Check and record pressure drop across pump. Check for leakage, bearing noise and unusual bearing temperature. Lubricate according to manufacturer's instructions. Check motor current.

A

3. Water
   strai
   ners
   Clea
   n.

A

A

4. Condenser tubes
   Open. Brush tubes. Inspect for alkaline deposits and/or corrosion.

A

5. Condenser shell
   Check for presence of non-condensable gases, purge or vent if necessary.

6. Isolating valves
   Check external condition, leak tightness of glands and seats, operational spindles and handwheels.

## CONDENSER – AIR COOLED

Q

1. Operating pressure
   Check pressure and pressure switches using gauges.

Q

2. Solenoid valves
   Ensure that they do not bypass.

Q

3. Head pressure control (fan speed)
   Check operation.

A

4. Motor mountings
   Check for security and tightness.

Q

5. Condenser coil
   Inspect and clean.
   Test for refrigerant leak.

Q

6. Casing
   Clean and secure.

Q

7. Sediment
   Remove; if substantial build-up has occurred, investigate cause.

Q

8. Alignment and wear of belt drives where
   applicable Check pulley alignment and
   belt wear.

SA

9. Head pressure control damper
   Lubricate control damper bearings.

A

10. Electrical connections
    Check and tighten as necessary. Check condition of flexible conduits, wiring and insulation.

A

11. Pipework
    Inspect connections, pipes and supports for damage, loose or missing fittings. Repair as necessary.

## 4k. WATER TREATMENT
## CHEMICAL ANALYTICAL SERVICES - Testing of Closed Systems

The following systems are covered:

(a) Heating systems
- (i) LTHW / LPHW
- (ii) MPHW
- (iii) HPHW

(b) Chilled Water System
- (i) Glycol Systems
- (ii) Non-Glycol systems

(c) Constant temperature closed circuits, e.g., Versatemps

(d) Condenser Water Closed systems

## Method Statement

(1) Sample drawn from system, in the case of heating systems a sample cooler should be utilized if installed.

(2) Sample analyzed using the following parameters:

T.D.S., pH, p ALK, m ALK, Total and Dissolved from iron, Inhibitor, Glycol

Depending on the system, the inhibitor will be specified for that system, and will have been added with regard to the system metallurgy and operating conditions (e.g., temperature).

Details of types of inhibitors are included in the Chemical Products Section, including both user instructions and OSHA Safety Data Sheets.

(3) The chemical analysis is compared to the specified limits set for each system and any anomalies noted.

(4) If analysis shows any anomalies, then the required action is either taken directly or written instruction issued to responsible person for any remedial work to be done.

(5) If system has bypass feeder fitted (dose pot) or dose pump and tank fitted to system, then operative will dose additional inhibitor into system if analysis shows low levels.

(6) If no simple method of dosing system is available, written instruction will be sent to site responsible person for dosing to be performed in some other manner.

## CHEMICAL ANALYTICAL SERVICES - Method Statement For Non-Acidic Clean And Flushing Of Closed Systems

1. With circulating pumps running, allow system water to drain while make-up flushes clean water into system. Drain at farthest point from make-up. Ensure all

drain cocks flushed out.

2. Add treatment to system via dose pot to give concentration of 1000ppm of product in system.

3. Allow system to circulate for a minimum of 24 - 48 hours.

4. Begin flushing treatment and debris from system while keeping circulating pump running.

5. Continue flushing, including flushing all drain points to remove settled sediment until all suspended solids have been removed and the dissolved iron level in the circulating water is the same as the incoming mains.

6. Redose system with scale/corrosion inhibitor

## CHEMICAL ANALYTICAL SERVICES - Routine Monitoring Of Cooling Towers/ Evaporative Condensers (1 of 16)

All work to be in compliance with EPA and local authorities.

(1) Full survey of system to have been carried out prior to setting up of cooling tower log book. (Appendix I)
(2) Record all system data in log book. (Appendix I)
(3) Prepare water treatment program. (Appendix II)
(4) If site requires weekly tests or if site is manned, then weekly checks are carried out and recorded in site log book. (Appendix III - XI)
(5) At monthly site service visits, the following will be carried out:

i. Analytical tests as per water treatment program.
ii. Dipslides taken from cooling tower.
iii. Check of weekly records.
iv. Chemical usage checked and recorded.
v. Water usage checked and recorded.
vi. Written report left on site with all changes detailed.
vii. Results logged. (Appendix XII)

(6) Sample shall be taken at every six months and should be submitted for specific analysis for Legionella Pneumophilla by an independent laboratory. Such results to be certified and logged.

(7) Biannually, cooling tower will be cleaned and disinfected as designated the preceding Specification for Carrying Out Risk Assessment on Building Water Systems. Such work shall be suitably certified and logged in the site log book. (Appendix XIII)

## Work Schedules and Log Sheets

Appendix I Cooling Tower System Data
Appendix II Cooling Tower Water Treatment Program
Appendix III Cooling Tower Weekly Tests
Appendix IV Chemical Stock / Usage
Appendix V Operation of Bleed
Appendix VI Water Meter Readings / Water Usage Appendix VII pH Levels
Appendix VIIITDS / Conductivity Levels Appendix IX Bromine Levels
Appendix X Softener Hardness
Appendix XI Dipslides
Appendix XII Cooling Tower Monthly Checks Appendix XIIICooling Tower Routine Chlorinations

## Appendix I

Site:
System Data:

Make and Model of Tower:
System Volume:
Re-circulation Rate:
Temperature Drop:
Evaporation Rate: Bleed Rate: Operation - hrs/day:
- days/year: Make-up Water Quality:
Water Treatment Chemicals in Use
Inhibitor:
Biocide 1:
Biocide 2:
Bleed Control System Pre-

treatment Plant Type

## Appendix II

Site:

WATER TREATMENT PROGRAM
Control Parameters
1. Total / Ca Hardness :
2. Alkalinity (M) :

3. Chloride :
4. TDS/Conductivity :
5. pH :
6. Inhibitor Levels :
7. Concentrate Ratio :
8. Total Bromine :
9. Microbiological Activity : All

or some of the above may be used.

See following chart concerning product application.
Product Application
Product Initial
Dose
Maintenance Dose
Dosing Equipment

Dosing equipment settings may change frequently. See Analytical Service Reports for current settings.

## Appendix III

COOLING TOWER WEEKLY TESTS
Work Schedule

1. Check chemical stock, recording levels and weekly usage.
2. Check operation of bleed and record.
3. Record water meter readings. Calculate and record water usage.
4. Test and record pH levels in tower(s).
5. Test and record TDS/conductivity level in tower(s).
6. Test and record bromine level in tower(s).
7. Test and record softener hardness (if applicable).
8. Take a dipslide from each tower. Record results after incubating for the required time.

## Appendix IV

Site:
1. CHEMICAL STOCK / USAGE
System Reference :
Chemical Reference : 1= 2=
3=
4=
Date

Chem. Stock
Chem. Usage
Obs. / Action
Signature

Appendix V Site:
2. OPERATION OF BLEED
System Reference:
Date
S or NS Action
Signature

## Appendix VI

Site:
3. WATER METER READINGS / WATER USAGE
System Reference:
Date
Water Meter Reading
Water Usage Signature

## Appendix VII

Site:
4. pH LEVELS System
Reference:
Parameters:
Date pH
S or NS
Action
Signature

## Appendix VIII

Site:
5. TDS / CONDUCTIVITY LEVELS
System Reference:
Parameters:
Date TDS/Cond.

S or NS Action
Signature

## Appendix IX

Site:
6. BROMINE LEVELS
System Reference:
Parameters:
Date
Bromine Level S or
NS Action
Signature

## Appendix X

Site:
7. SOFTENER HARDNESS
System Reference: Parameters: