

Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R)



Recurring Work Program (RWP) Standards

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THE NEED FOR A RECURRING MAINTENANCE PROGRAM

1.1 INTRODUCTION: This document sets forth the basic concepts on how to develop and effectively manage your HVAC/R recurring maintenance requirements.

1.2 BACKGROUND: The majority of facilities on our military installations were built over 40 years ago. With funding cutbacks increasing at an alarming rate, the funding that was once plentiful, is not available today to construct new facilities. Therefore, many of these facilities which are in need of replacement are still being used today. During the Infrastructure Assessment Team visits and other staff assist visits, we find the HVAC RWP suffering from manpower availability to execute the required maintenance on the mechanical systems. Manpower constraints will continue to be a challenge. Also, the equipment inventory and Maintenance Action Sheets (MAS) are not updated. However, a poorly planned and unorganized RWP program can be improved. Typically, the HVAC shop spends on average 10 to 15% of their total man-hours on RWP. The challenge is to optimize use of available man-hours through a well-planned RWP plan.

1.3 HVAC/R SYSTEMS: All facility systems, especially heating, ventilation, and air conditioning deteriorate from use. No facility system is completely maintenance-free. If these systems are not maintained at peak efficiency, the question is not, will they breakdown, it's when will they breakdown. HVAC systems cost about 15% - 20% of the construction costs. Preserving this investment is important. Recurring maintenance, when performed regularly, will preserve the initial investment. Also, a comprehensive recurring maintenance plan allows the facility HVAC system to operate at peak efficiency for the useful life of the equipment.

1.4 BENEFITS FROM A RECURRING MAINTENANCE PROGRAM:

- Reduced Maintenance/Repair Cost
- Improved Equipment Efficiency
 - Reduced Utility Bill
- Acceptable Indoor Air Temperatures/Quality
- Avoid Surprises/Emergency Repairs
- Ensure System Reliability & Mission Support
- Customer Satisfaction

1.5 SUMMARY: There will be premature equipment failure when HVAC/R systems are operated without some basic recurring maintenance tasks such as, changing the oil, greasing the bearings, changing filters, adjusting v-belts and adjusting the safeties. It is a known fact, as the level of recurring maintenance increases the number of service calls or unscheduled work decreases. We should be in the proactive maintenance phase and not the reactive phase. With the decrease in personnel and the same maintenance requirements, we need to work smarter and not harder.

TYPES OF MAINTENANCE PROGRAMS

2.1 Types of Maintenance Program: There are several maintenance avenues to consider. They range from an in-depth recurring maintenance plan to no maintenance at all. Listed below are some different types of maintenance programs available.

- Comprehensive Recurring Maintenance Program
- Non-destructive Maintenance Program
- Break Down Maintenance

2.1.1 Comprehensive Recurring Maintenance Program: This type of maintenance program is an in-depth program used to identify and schedule by frequency and hours, all maintenance requirements associated with each system component. It takes into account the age, location, environment, past maintenance practices, history of unscheduled work orders and the condition of the equipment. Taking into account these factors, you may need to adjust the frequencies or hours to meet your needs.

2.1.2 Non-destructive Maintenance Program: Non-destructive maintenance allows recurring maintenance to be performed with minimal interruption to the system or occupants. It allows the technician to gather information about a component without dismantling it. If a facility has old chill/hot water pipes and it is suspected that, due to the age, corrosion and erosion, the pipe wall thickness is thin, you can use ultrasonic measuring method to determine the thickness of the metal pipe. Most importantly, non-destructive maintenance supplements recurring maintenance and is not intended to replace a regularly scheduled maintenance program. Listed below is some non-destructive maintenance procedures that can be performed.

- Ultrasonic pipe measuring analysis
- Eddy current testing for all heat exchanger surfaces
- Vibration analysis for rotating equipment
- Lubrication oil analysis
- Water treatment analysis
- Indoor Air Quality (IAQ) analysis
- Leak testing of chiller/air conditioning units

2.1.3 Break Down Maintenance: Break down maintenance is when the system/equipment is operated with no preventive maintenance plan in place. The

equipment is repaired or replaced when it breaks down. Operating equipment in this mode causes the equipment's efficiency and useful life to rapidly deteriorate. There are situations within a recurring maintenance program when break down maintenance should be used. Equipment such as water coolers, window A/C, fractional horsepower (HP) motors, exhaust fans, and any other type equipment that is not cost effective to maintain should not be included on your recurring maintenance program.

2.2 SUMMARY: Although there are several maintenance programs to consider when developing and planning your recurring work, we recommend using a combination of all three to achieve an extensive recurring work program.

Developing a Recurring Maintenance Plan

3.1 Developing a Maintenance Program: The first step in establishing a recurring maintenance program is to inventory the existing systems or equipment that are in the field. This inventory should be as complete as possible. After the inventory has been established, it can be reduced to a manageable prioritized list of equipment that is based on the following guidelines.

- Occupants safety
- Mission Critical Facilities
- High repair/replacement cost
- High energy consumption
- Difficulty in purchasing parts due to lack of availability

As explained in section 2 par 2.1.3, Break Down maintenance, some items would not be included in your recurring maintenance program. The cost of repair or replacement would out weight the man-hours and materials required to perform recurring maintenance. If you have questions whether to include the equipment on your recurring maintenance schedule, follow the guidelines above.

3.1.2 Gathering the Information: Once it has been determined what to include in your recurring maintenance program, develop a equipment inventory sheet . Here is some basic information you should include on your inventory sheet. Section 7 contains a sample equipment inventory sheet you can use to assist in updating your HVAC equipment inventory.

- Manufacturer's name
- Date manufactured
- Model number
- Serial number
- Electrical requirements (volts, amps, phase, etc.)
- Fan information (CFM, rotation, diameter, etc.)
- Bearing sizes (s)
- Belt size and number of belts
- Filters size and number of filters
- Location of equipment

If there is some equipment that has no data plate, select a similar piece of equipment as a starting point so you can estimate the frequency and hours required to load the information into your recurring maintenance program.

3.1.3 Scheduling Your Recurring Maintenance: After you have completed your equipment inventory, the next step is developing a recurring maintenance schedule. To

adequately schedule all of your RWP needs, the schedule should be extended to cover a 52-week period. Some considerations you might want to take into account when scheduling are the holiday seasons, i.e., Christmas. During this time manning tends to be low because of all the personnel on leave. Each piece of equipment has a suggested frequency for proper maintenance. Below are some frequencies commonly used:

- Weekly
- Monthly
- Quarterly
- Semi-annually
- Annually
- Greater than annually

Listed in section 4, are recurring maintenance equipment frequencies and hours you can use as a starting point to develop your recurring maintenance program. If some equipment tends to have more problems than others, you might need to review your recurring maintenance schedule and increase some frequencies. Section 5 contains recurring maintenance tasks that should be performed during RWP as a minimum.

3.1.4 Identifying Equipment Problems: Once a recurring maintenance program has been developed and is in use, this will help identify system problems before a major breakdown occurs. Recurring maintenance work will help record out-of-normal conditions. Depending on the severity of the problem, corrective actions can be scheduled.

3.1.5 Summary: If a recurring maintenance program is established and closely followed, it will identify system problems and correct these problems allowing the facility to operate efficiently and extend the life of the HVAC equipment. Also, the RWP equipment inventory listing and Maintenance Action Sheets (MAS) should be reviewed and updated annually.

Preventive Maintenance Frequency Schedule

*PM Card No	Components	Frequency	Hours/ Freq.
A-1	Unitary, Heating and Cooling Unit	Annual	3.50
A-2	Steam Coil Humidification Systems	Semiannual	1.00
A-3	Air Compressor	Annual	2.30
A-4	Air Compressor (Control Air)	Semiannual	1.00
A-5	Air-Conditioning Machine Package Unit	Annual	
	Comfort Cooling		
	10 tons and under		3.00
	Over 10 tons		6.00
A-6	Air-Conditioning Machine, Package Unit	Annual	
	Special Purpose		
	10 tons and under		1.00
	Over 10 tons		1.00
A-7	Air-Cooled Condenser	Annual	
	20 tons and under		4.00
	Over 20 tons		5.00
A-8	Heat Pumps	Annual	
	5 tons and under		3.00
	6 to 10 tons		6.00
	Over 10 tons		9.00
A-9	Air Handler Unit	Annual	
	Under 5000 c.f.m.		2.00
	5,001 to 15,000 c.f.m.		4.50
	15,001 to 30,000 c.f.m.		8.25
	30,001 to 50,000 c.f.m.		13.25
	50,001 to 75,000 c.f.m.		19.25
	Over 75,000 c.f.m.		21.25
	Note: Add one additional hour if unit has a direct		

	expansion cooling coil.		
A-10	Glycol Dry Cooler		
	Comfort Cooling		
	20 tons or less	Annual	3.50
	Over 20 tons to 40 tons	Annual	4.50
	Over 40 tons (add 0.50 man hrs for each additional 10 tons)		
	Special Purpose		
	20 tons or less	Semiannual	3.50
	Over 20 tons to 40 tons	Semiannual	4.50
	Over 40 tons (add 0.50 man hrs for each additional 10 tons)		
A-11	Air Conditioning Unit, Ceiling/Wall Mounted		
	Comfort Cooling	Annual	3.00
	Special Purpose	Monthly	3.00
A-12	Air Washer or Wet Coil System		
	Air Washer		
	20,000 CFM or less	Annual	4.00
	20,001 to 50,000 CFM	Annual	5.00
	50,001 to 75,000 CFM	Annual	6.00
	Over 75,000 CFM (add 1.0 man hrs for each additional 25,000 CFM)		
	Wet Coil		
	20,000 CFM or less	Annual	1.50
	20,001 to 40,000 CFM	Annual	2.00
	Over 40,000 CFM (add 0.5 man hrs for each additional 20,000 CFM)		
B-1	Boiler (Coal, Oil, and Gas)		
	120 MBTU's or less	Annual	2.50
	120 to 300 MBTU's	Annual	5.00
	300 to 500 MBTU's	Annual	8.00
	500 to 700 MBTU's	Annual	24.00
	700 to 1,000 MBTU's	Annual	32.00
	Over 1,000 MBTU's	Annual	40.00

B-2	Burner, Gas	Annual	2.00
B-3	Burner, Oil	Annual	3.00
B-4	Boiler Instruments/Controls	Annual	1.00
C-1	Remote Air Intake Dampers	Annual	0.50
C-2	Coils, Preheat, Reheat, etc. (Remote Locations)	Annual	0.75
C-3	Central Mini-Computer, HVAC systems	Quarterly	4.00
C-4	Automatic Mixing Box, Pneumatic or Electric	Annual	1.00
C-5	Controls, Central System, HVAC	Annual	1.00
C-6	Condensate or Vacuum Pump	Annual	1.00
C-7	Cooling Tower, Maintenance	Annual	
	50 tons and under		6.00
	Over 50 to 500 tons		30.00
	Over 500 to 1,000 tons		50.00
	Over 1,000 tons add 10.75 hours for each increment.		
C-8	Cooling Tower, Cleaning	Quarterly	
	50 tons and under		20.00
	Over 50 to 500 tons		30.00
	Over 500 to 1,000 tons		40.00
	Over 1,000 tons add 10.00 hours for each increment.		
C-9	Evaporative Condenser	Annual	
	50 tons and under		15.00
	Over 50 tons		20.00
C-10	Condensing Unit, Refrigeration		
	Comfort	Annual	
	20 tons and under		5.50
	Over 20 tons		7.00
	Critical	Annual	

	20 tons and under		5.50
	Over 20 tons		7.00
E-1	Motor Starter, less than 600 volts 25hp to less than 100hp	Annual	1.00
F-1	Fan, Centrifugal		
	Up to 5,000 c.f.m.	Annual	1.00
	Over 5,000 to 10,000 c.f.m.	Annual	1.30
	Over 10,000 to 15,000 c.f.m.	Annual	1.60
	Over 15,000 to 20,000 c.f.m.	Annual	1.95
	For each additional 5,000 c.f.m. over 20,000 c.f.m. add 0.30 man hrs		
F-2	Filter, Moveable Curtain, Oil Coated	Quarterly	1.75
F-3	Filter, Roll Type, Disposable Media	Quarterly	1.75
F-4	Filters, Viscous Type	Quarterly	0.50
F-5	Filter, Roll Type, Disposable Media, Manual or Motor Driven	Annual	2.00
F-6	Filter, Throw Away	Quarterly	0.08
F-7	Filter, Electrostatic	Quarterly	2.50
F-8	Filter, Throw Away, Bag Type (by depth)	Semiannual	
	Over 4" to 6"		0.08
	Over 6" to 12"		0.10
	Over 12" to 24"		0.20
	Over 24" to 48"		0.25
G-1	Fuel Oil Filter/Strainer	Semiannual	0.50
H-1	Hot Water Converter (Steam)	Annual	6.00
H-2	Hot Water Heater, Gas	Annual	0.60
H-3	Hot Water Heater, Steam Coil		
	Up to 1,000 gallons	Annual	6.00

Add 0.5 for each additional 1,000 gallons.

H-4	Hot Air Furnace		
	120 MBTU's or less	Annual	2.50
	120 to 300 MBTU's	Annual	5.00
	300 to 500 MBTU's	Annual	8.00
	500 to 700 MBTU's	Annual	24.00
	700 to 1,000 MBTU's	Annual	32.00
	over 1,000 MBTU's	Annual	40.00
H-5	Heater, Fuel Oil, Unit	Annual	16.00
I-1	Fan Coil Unit, Under	Annual	0.40
I-2	Induction Unit, Under Window Type	Annual	0.40
I-3	Fan Coil Unit, Ceiling Hung	Annual	1.00
I-4	Fan Coil Unit, Ceiling Hung VAV Box with Electric Heat	Annual	1.00
M-1	Motors		
	1 to 7.5 hp	Annual	0.30
	Over 7.5 to 50 hp	Annual	0.50
	Over 50 hp	Annual	0.60
P-1	Pump, Centrifugal		
	1 to 24 hp	Annual	1.50
	25 to 100 hp	Annual	5.50
	Over 100 hp	Annual	6.50
P-2	Pump, Gear And Reciprocating	Annual	1.50
R-1	Radiator, Heating	5 Years	0.15
R-2	Refrigeration Machine (Absorption)		
	Up to 500 tons	Annual	60.00
	Over 500 to 1,000 tons	Annual	100.00
	Over 1,000 tons	Annual	140.00
R-3	Central Chilled Water , Package Unit		
	Comfort Cooling or Central Drinking Water	Annual	

	25 tons and under		18.00
	25 to 50 tons		26.00
	50 to 75 tons		34.00
	75 to 100 tons		42.00
	100 to 150 tons		50.00
	Add 10 man-hours for each additional compressor over one compressor.		
	Special Purpose or Computer Cooling	Quarterly	
	25 tons and under		18.00
	25 to 50 tons		26.00
	50 to 75 tons		34.00
	75 to 100 tons		42.00
	100 to 150 tons		50.00
R-4	Refrigeration Machine, Centrifugal	Annual	
	50 tons and under		20.00
	50 to 250 tons		28.00
	250 to 500 tons		50.00
	500 to 750 tons		70.00
	750 to 1,000 tons		90.00
	Add 20 man-hours for each additional 250 ton increment over 1,000 tons.		
R-5	Refrigeration Machine, Reciprocating and Scroll	Annual	
	50 tons and under		20.00
	50 to 100 tons		24.00
	100 to 250 tons		28.00
	Add 4 hours for additional increments.		
R-6	Refrigeration Machine, Screw	Annual	
	50 tons and under		20.00
	50 to 250 tons		28.00
	250 to 500 tons		50.00
	500 to 750 tons		70.00
	750 to 1,000 tons		90.00
	Add 20 man-hours for each additional 250 ton increment over 1,000 tons.		
R-7	Control Panel - Central, Refrigeration Unit	Annual	4.00

R-8	Radiation, Baseboards/Convectors (Steam, hot water, or electric - per linear ft)	2 Years	0.50
R-9	Refrigeration Controls, Central System	Annual	1.00
R-10	Non-Destructive Chiller Tube Analysis	3 Years	9.00
R-11	High Efficiency Purge Units	Annual	2.00
S-1	Strainer, Y-Type	Annual	0.50
S-2	Strainer, Bolted Flange (Water and Steam)		
	6 to 14 bolts	Annual	2.00
	14 to 34 bolts	Annual	8.00
	34 to 58 bolts	Annual	16.00
	over 58 bolts	Annual	36.00
T-1	Tank, Air/Refrigerant//LP Gas	Annual	6.25
U-1	Unit Heater (Gas and Oil Fired)	Annual	1.00
V-1	Valve, Safety Relief	Annual	0.50
V-2	Valve Regulating	Annual	0.60
V-3	Valve, Manually Operated		
	Main Line or Critical	Annual	0.40
	Other over 2 inches	Five years	0.40
V-4	Valve, Motor Operated	Annual	0.40
V-5	Valve, Hydraulic/Pneumatic/Electric	Annual	1.50
W-1	Water Treatment for Cooling Systems	Monthly	2.00
W-2	Water Treatment for Heating Systems	Monthly	2.00
X-1	Heater Unit, Electric	Annual	0.75
X-2	Chemical Feeder	Annual	1.00

*** PM Card Number Corresponds to Maintenance Frequency Tasks in Section 5**

A-1 Unitary, Heating and Cooling Unit

Frequency: Annual

Application:

This guide card applies to self-contained heating and cooling units containing a complete cooling system and heating unit (gas or oil burner). These are normally installed on rooftops, but can be in other locations. They are also referred to as climate changers, roof packs, etc.

Special Instructions:

1. Schedule shutdowns with operating personnel, as needed.
2. Review manufacturer's instructions.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. Schedule PM card, (B-2) Gas Burner or (B-3) Oil Burner, when performing this activity.
5. De-energize, lock and tag electrical circuits.
6. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
7. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
8. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
9. Recover, recycle, or reclaim the refrigerant as appropriate.
10. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal.
11. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
12. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
13. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Remove debris from air screen and clean underneath unit.
2. Inspect gaskets. Look for leaks between unit and structure, caulk as necessary.
3. Clean condenser, cooling coil fins, and fans.
4. Remove dirt or dust from all interior parts.
5. Replace filter.
6. Inspect and adjust damper.
7. Lubricate motor and fan bearings.
8. Check bearing collar set screws on fan shaft to make sure they are tight.
9. Check dampers for dirt accumulations. Check felt. Repair or replace as necessary.

10. Check damper motors and linkage for proper operation.
11. Lubricate mechanical connections of dampers sparingly.
12. Clean coils by brushing, blowing, vacuuming or pressure washing.
13. Check coils for leaking, tightness of fittings:
 - a. Check for refrigerant leaks using a halogen detector or similar testing device. If leaks are not stopped or corrected, report leak status to supervisor. Consult the Material Safety Data Sheets (MSDS) for disposal requirements. Reclaimed and recycled CFCs are exempt from hazardous waste regulations (Consult 40 CFR Part 261).
 - b. Check refrigerant levels and recharge if needed.
14. Use fin comb to straighten coil fins.
15. Flush and clean condensate pans and drains.
16. Check belts for wear, adjust tension or alignment and replace belts when necessary. Multi-belt drives should be replaced with matched sets.
17. Check rigid couplings for alignment on direct drives and for tightness of assembly. Check flexible couplings for alignment and wear.
18. Check electrical connections for tightness.
19. Check mounting for tightness.
20. Check for corrosion.
21. Check mounting bolts and tighten if needed.
22. Check and adjust, or replace if necessary, vibration eliminators.
23. Compressor
 - a. Check compressor oil level.
 - b. Run machine, check action of controls, relays, switches, etc., to see that:
 - (1). Compressor(s) run at proper settings.
 - (2). reheat coils activate properly.
 - (3). crankcase heater is operating properly.
 - (4). suction and discharge pressures are proper.
 - (5). discharge air temperature is set properly.
24. Heating Unit.
 - a. Gas and/or oil fired (if equipped).
 - (1). Check burner for flashback and tight shutoff of fuel.
 - (2). Check operation of controls. Clean and adjust if necessary.
 - (3). Clean burner, chamber, thermocouple and control. (Use a high suction vacuum and/or brush.) Check combustion chamber for cracks, holes, or other defects.
 - (4). Adjust pilot or electric ignition device.
 - (5). Inspect vent and damper operation.
 - (6). Operate unit and adjust burner.
 - (7). Check operation of safety pilot, gas shutoff valve, and other burner safety devices.
 - (8). Check temperature differential and controls.
 - (9). Check frame of unit with ohmmeter for proper electric ground.
 - (10). Replace covers (if any) and clean area.
 - b. Electrical (if equipped).
 - (1). Visually inspect for broken parts, contact arcing or any evidence of overheating. Inspect all wiring for deterioration.

(2). Check name plate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)

(3). Check line and load connections and heater mounting screws for tightness.

Tools & Materials:

1. Standard Tools - Basic
2. Grease gun and oiler
3. Pressure washer
4. Vacuum
5. Fin comb
6. Cleaning tools, approved refrigerant, and materials. Consult the MSDS for hazardous ingredients and proper personal protective equipment.
7. Safety goggles and gloves.
8. CO2 analyzer
9. Self sealing quick disconnect refrigerant hose fittings
10. Refrigerant recovery/recycle unit
11. EPA/DOT approved refrigerant storage tanks.

A-2 Steam Coil Humidification Systems

Frequency: Semiannual

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."
3. Turn off water supply.
4. Secure electrical service before servicing humidification system, if applicable.
5. Use of work gloves may be necessary due to caustic residual mineral deposits.

Check points:

1. Operate humidistat through its throttling range to verify activation, or deactivation of humidifier.
2. Clean and flush condensate pans, drains, water pans, etc. Remove corrosion, and repaint as needed. If a corrosion preventive chemical is used, ensure that it does not become a part of the indoor air by creating large amounts of volatile organic compounds or irritants. Check the Material Safety Data Sheet (MSDS) to see what hazardous products are present. If hazardous products are present rinse very well before the system is returned to use. Ensure that the paint lead level is 0.06% or less.
3. Check condition of heating element. Clean steam coils.
4. Clean steam/water spray nozzles. Adjust/replace as needed.
5. Chemically clean exterior of coil to remove scale and encrustations.
6. Inspect steam trap for proper operation.
7. Inspect pneumatic controller for air leaks.
8. Inspect water lines for leaks and corrosion. Tighten all connections and repair leaks.

Tools & Materials:

1. Standard Tools - Basic
2. Psychrometer
3. Coil cleaning chemical. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
4. Work gloves
5. Safety goggles
6. Respirator

A-3 Air Compressor

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions
2. Coordinate motor PM on an annual basis. See Guide M-1.
3. Tank should be inspected and tested by qualified inspector.
4. Secure the electrical service.

Check points:

1. Perform normal tour checks and operations.
2. Change compressor crankcase oil as needed.
3. Clean air intake filter.
4. Check air dryer, automatic condensate drains, and air tank for proper operation. Clean condenser coils and cover grills.
5. Inspect belt alignment and condition. Adjust or replace belts as required.
6. Check for corrosion and scale on water-cooled units.
7. Clean heat exchange surfaces.
8. Check accuracy of gauges with calibrated test gauge.
9. On two-stage compressor, check intermediate pressure.
10. Test relief valves, replace if leaking or the relief range is incorrect. Do not readjust safety relief valves in the field.
11. Check operation of compressor unloaders, repair or replace if not loading and unloading properly.
12. Check compressor suction and discharge valves for proper operation. Replace leaking valves.
13. Check tightness of all electrical connections.
14. Check cut in and cut out of compressor pressure controller, readjust if necessary for proper air pressure requirements. Do not exceed ASME maximum tank pressure.
15. Check to make sure belt guard is installed prior to putting air compressor back in service.
16. No pressure vessel is to have its hand hole or man hole covers removed unless the vessel is at atmospheric pressure.

Tools & Materials:

1. Standard Tools - Basic
2. Belts
3. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
4. Fin comb
5. Vacuum cleaner commercial type
6. Test gauge

A-4 Air Compressor (Control Air)**Frequency: Semiannual****Application:**

This guide card applies to those air compressors that are used on air conditioning equipment control systems i.e. pneumatic.

Special Instructions:

1. Review manufacturer's instructions
2. Coordinate motor PM on an annual basis. See Guide M-1.
3. Secure the electrical service.

Check points:

1. Perform normal tour checks and operations.
2. Change compressor crankcase oil as needed.
3. Clean air intake filter.
4. Check air dryer, automatic condensate drains, and air tank for proper operation. Clean condenser coils and cover grills.
5. Inspect belt alignment and condition. Adjust or replace belts as required.
6. Test relief valves, replace if leaking or the relief range is incorrect. Do not readjust safety relief valves in the field.
7. Check tightness of all electrical connections.
8. Check cut in and cut out of compressor pressure controller, readjust if necessary for proper air pressure requirements. Do not exceed ASME maximum tank pressure.
9. Check to make sure belt guard is installed prior to putting air compressor back in service.

Tools & Materials:

1. Standard Tools - Basic
2. Belts
3. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
4. Vacuum cleaner commercial type
5. Test gauge

**A-5 Air-Conditioning Machine Frequency: Annual
Package Unit (Comfort Cooling)**

Application:

This PM guide applies to units that may have the evaporator, compressor, fan unit components, and condenser within a single housing or may have the condenser separate from the housing. If the condenser is separate, perform the PM on the condensing unit using PM Guide A-7 at the same time.

Special Instructions:

1. Review manufacturer's instructions.
2. De-energize, lockout, and tag the electrical circuits.
3. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
4. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
5. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
6. Recover, recycle, or reclaim the refrigerant as appropriate.
7. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the appliance.
8. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
9. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
10. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check points:

1. Thoroughly inspect and clean interior and exterior of machine with vacuum cleaner, (remove panels).
2. Clean drain-pan and note excessive corrosion, prepare metal and paint as necessary. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less.
3. Check for refrigerant leaks using a halogen detector or similar testing device. Repair all leaks before recharging unit. If leaks are not stopped or corrected, report leak status to supervisor. Consult the MSDS for disposal requirements. Reclaimed and recycled CFCs are exempt from hazardous waste regulations (Consult 40 CFR Part 261).
4. Check refrigerant levels for proper charge and recharge as needed.
5. Check condition of cooling and reheat coils. Use fin comb if needed to straighten fins.
6. Clean coils, use coil cleaner detergent solution and high pressure water.
7. Check belts for wear, adjust tension or alignment, and replace when necessary.

8. Drain and clean humidifier drip pan, if applicable. Remove corrosion; prime, and paint as needed.
9. Lubricate motor and fan bearings, if not sealed. Check alignment of motor and fan.
10. Replace prefilters if needed.
11. Replace final filters if needed.
12. Check compressor oil level, if compressor has an oil sight glass.
13. Run machine, check action of controls, relays, switches, etc., to see that:
 - a. compressor(s) run at proper settings.
 - b. reheat coils activate properly.
 - c. humidistat activates humidifier.
 - d. suction and discharge pressures are proper.
 - e. discharge air pressure is set properly.
14. check and tighten any loose unit electrical terminals, disconnect switches, or connectors.
15. Check and adjust vibration eliminators. Replace if required.
16. Remove all trash or debris from work area. Consult the MSDS for proper personal protective equipment (PPE).

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning tools and materials, vacuum wet/dry, fin comb, grease gun and oil, filters and prefilters, spare belts.
3. Approved refrigerant.
4. Paint and brushes as required. Consult the MSDS to ensure that the paint lead level is 0.06% or less.
5. Self sealing quick disconnect refrigerant hose fittings
6. Refrigerant recovery/recycle unit
7. EPA/DOT approved refrigerant storage tanks.
8. Safety goggles.
9. Gloves.
10. Electronic leak detector.

**A-6 Air-Conditioning Machine
Package Unit (Special Purpose)**

**Frequency: Annual
* Monthly**

Application:

This equipment is typically found in computer rooms, CAD rooms, laboratories, etc. It is identical in design and configuration to the A-5 unit for comfort cooling. One difference is that it may use a glycol dry cooler during favorable outside air conditions.

Special Instructions:

1. Review manufacturer's instructions and the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
2. De-energize, lock out, and tag electrical circuits.
3. Perform any required dry-cooler (PM guide A-10) or air-cooled condenser (PM-guide A-7) maintenance simultaneously with this PM.
4. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
5. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
6. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
7. Recover, recycle, or reclaim the refrigerant as appropriate.
8. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the equipment.
9. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
10. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
11. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check points:

1. Thoroughly inspect and clean interior and exterior of machine with wet/ dry vacuum, (remove panels).
2. Clean drain-pan and note excessive corrosion, prepare and paint necessary. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less.
3. Check for refrigerant leaks using a halogen detector or similar testing device. If leaks are not stopped or corrected, report leak status to supervisor.
4. Check refrigerant levels and recharge if needed. Consult the MSDS for disposal requirements. Reclaimed and recycled CFC's are exempt from hazardous waste regulations (Consult 40 CFR Part 261).
5. Check condition of cooling and reheat coils. Use fin comb if needed to straighten fins.

6. A dirty coil surface can be cleaned using a coil cleaner solution and warm water.
- *7. Drain and clean humidifier drip pan, replace pan if applicable. Remove scale and paint if necessary.
8. Lubricate motor and fan bearings, if not sealed. Check alignment of motor and fan. Clean fan or blower.
- *9. Check belt tension and condition. Adjust or replace as required.
- *10. Replace prefilters if needed.
- *11. Replace final filters if needed.
12. Check compressor oil level if compressor has a sight glass.
- *13. Run machine, check action of controls, relays, switches, etc. to see that:
 - a. compressor(s) run at proper settings.
 - b. reheat coils activate properly.
 - c. humidistat activates humidifier.
 - d. suction and discharge pressures are proper.
 - e. discharge air temperature is set properly.
14. Check and adjust vibration eliminators. Replace if required.
15. Check and tighten all electrical terminals, connections, and disconnect switches.
- *16. Remove all trash or debris from work area. Consult the MSDS for proper personal protective equipment (PPE).

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning tools and materials, vacuum, fin comb, grease gun and oil, filters and prefilters, spare belts.
3. Clamp meter (volt-ohm-amp meter).
4. Paint and brushes as required. Consult the MSDS to ensure that the paint lead level is 0.06% or less.
5. Self sealing quick disconnect refrigerant hose fittings
6. Refrigerant recovery/recycle unit
7. EPA/DOT approved refrigerant storage tanks.
8. Safety goggles.
9. Gloves.
10. Electronic leak detector.

A-7 Air-Cooled Condenser Frequency: Annual

Application:

This PM guide applies to equipment, which has the condenser fan(s), and fan motor(s) enclosed within the same housing. The compressor and other components are at a separate location. PM of these other devices should be scheduled simultaneously with the units serviced by the condenser. If the condenser motor(s) is/are rated at 1 HP or higher, schedule PM of motor(s) at this time with PM guide M-1.

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".
4. De-energize, lock out, and tag electrical circuit breaker.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the equipment.
10. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
11. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check points:

1. Remove debris from air screen and clean underneath unit.
2. Pressure wash coil with coil cleaning solution.
3. Straighten fin tubes with fin comb.
4. Check electrical connections for tightness.
5. Check mounting for tightness.
6. Check for and remove all corrosion or rust from unit and supporting steel, prime and paint as necessary. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less. Consult the MSDS for proper personal protective equipment (PPE).

7. Check fan blades and belts. Clean fan blades as necessary.
8. Check headpressure controls for proper operation.
9. Check wires at condenser electrical fused safety switches for tightness and burned insulation. Repair as necessary.
10. Clean up work area.

Tools & Materials:

1. Standard Tools - Basic
2. High pressure washer
3. Fin comb
4. Paint brushes
5. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
6. Respirator
7. Safety goggles
8. Gloves.
9. Self sealing quick disconnect refrigerant hose fittings
10. Refrigerant recovery/recycle unit
11. EPA/DOT approved refrigerant storage tanks.

A-8 Heat Pumps Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions and the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
2. De-energize, lockout, and tag electrical circuits.
3. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
4. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
5. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
6. Recover, recycle, or reclaim the refrigerant as appropriate.
7. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the equipment.
8. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
9. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
10. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check points:

1. Inspect piping for evidence of leaks and vibration. If leaks are not able to be stopped or corrected, report leak status to supervisor.
2. Inspect all wiring for deterioration, and tighten electrical contacts. Check for corrosion, clean, prime, and paint as necessary.
3. Check mounting bolts and tighten if needed.
4. Check crankcase heater.
5. Check fan for vibration or excessive noise. Lubricate fan and motor if required.
6. Check refrigerant levels, recharge if necessary. Check for leaks if loss of refrigerant is detected, using halide leak detector and soap bubbles. If leaks are not stopped or corrected, report leak status to supervisor. Consult the Material Safety Data Sheets (MSDS) for disposal requirements. Reclaimed and recycled CFCs are exempt from hazardous waste regulations (Consult 40 CFR Part 261).
7. Check temperature drop across condensing coil.
8. Clean air intake and screens; change filters as necessary.
9. Brush or pressure wash coil surfaces. Straighten fins with fin comb.
10. Check all electrical connections and fused disconnect switches.
11. Check all controls, indoor and outdoor thermostats, timers, and control delays, especially for units with electric supplemental heaters. Repair or replace as necessary.
12. Check oil if compressor is equipped with a sight glass.

13. Clean up work area.

Tools & Materials:

1. Standard Tools - Basic
2. Lubricants - Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
3. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
4. Fin comb
5. Vacuum or pressure washer.
6. Self sealing quick disconnect refrigerant hose fittings
7. Refrigerant recovery/recycle unit
8. EPA/DOT approved refrigerant storage tanks.
9. Safety goggles.
10. Gloves.
11. Approved refrigerant.
12. Electronic leak detector.

A-9 Air Handler Unit Frequency: Annual

Special Instructions:

1. Schedule shutdown with operating personnel, as needed.
2. Review manufacturer's instructions.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. De-energize, lock out and tag electrical circuit(s).
5. Schedule PM on motor per guide M-1, air intake dampers C-1, preheat and reheat coils C-2, and motor starter E-1 in conjunction with this guide.
Include the following additional special instructions in cases where the air handler is equipped with a direct expansion-cooling coil:
6. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
7. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
8. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
9. Recover, recycle, or reclaim the refrigerant as appropriate.
10. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the equipment.
11. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
12. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
13. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check points:

1. Check fan blades for dust buildup and clean if necessary.
2. Check fan blades and moving parts for cracks and excessive wear.
3. Check bearing collar set screws on fan shaft to make sure they are tight.
4. Check dampers for dirt accumulations, clean as necessary. Check felt and repair or replace as necessary.
5. Check damper actuators and linkage for proper operation. Adjust linkage on dampers if out of alignment.
6. Lubricate mechanical connections of dampers sparingly.
7. Clean coils by brushing, blowing, vacuuming, or pressure washing.
8. Check coils for leaking, tightness of fittings. On direct expansion units, check for refrigerant leaks on all lines, valves, fittings, coils, etc., using a halogen leak detector or similar testing device. If leaks are not stopped or corrected, report leak status to supervisor.
9. Use fin comb to straighten coil fins.

10. Flush and clean condensate pans and drains, remove all rust prepare metal and paint. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less. Hose down coils and drain pans and wash with an appropriate EPA approved solution approved solution. Treat condensate pans with an EPA approved biocide.
11. Check belts for wear and cracks, adjust tension or alignment, and replace belts when necessary. Multi-belt drives shall only be replaced with matched sets.
12. Check rigid couplings for alignment on direct drives, and for tightness of assembly. Check flexible couplings for alignment and wear.
13. Before heating season (chilled water coils only); Drain cooling coils; blow down to remove moisture; refill with antifreeze and water solution; drain.
14. Check freezestat for proper temperature setting and operation.
15. Vacuum interior of unit.
16. Lubricate fan shaft bearings while unit is running. Add grease slowly until slight bleeding is noted from the seals. Do not over lubricate. Remove old or excess lubricant.
17. Clean up work area.

Tools & Materials:

1. Standard Tools - Basic
2. Grease gun and oiler
3. Pressure washer
4. Vacuum.
5. Fin comb
6. Cleaning tools and materials. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
7. Safety goggles.
8. Gloves.

A-10 Glycol Dry Cooler Frequency:
Comfort - Annual
Year Round - Semiannual

Application:

These units will be associated with A-5, A-6, packaged air conditioning units, R-3 and R-4 refrigeration units, or in the case of free cooling, would stand-alone.

Special Instructions:

1. Schedule outage with operating personnel.
2. Obtain and review manufacturer's instructions for starter to be tested (including the time current characteristic curve).
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."
5. De-energize, tag, and lock out circuit.

Dry Cooler Check Points:

1. Remove debris from air screen and clean underneath unit.
2. Pressure wash coil with coil cleaning solution. Check the Material Safety Data Sheets (MSDS) to ensure that the coil cleaner does not contain hydrofluoric acid or another irritating or hazardous compound.
3. Straighten fin tubes with fin comb.
4. Check electrical connections for tightness.
5. Check mounting for tightness.
6. Check for corrosion. Clean and treat with rust inhibitor and touch up paint as needed. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).

Motors and Fans Check Points:

1. Inspect pulleys, belts, couplings, etc.; adjust tension and tighten mountings as required. Change badly worn belts. Multi-belt drives should be replaced with matched sets.
2. Perform required lubrication and remove old or excess lubricant.
3. Clean motor with vacuum or low-pressure air (less than 40 psi). Check for obstructions in motor cooling and airflow.

Expansion Tank Check Points:

1. Examine exterior of tank, including fittings, manholes, and hand-holes for leaks, signs of corrosion. Repair and paint as necessary.
2. Inspect structural supports and repair or replace damaged insulation or covering.
3. Clean, test, and inspect sight glasses, valves, fittings, drains, and controls.
4. Perform hydrostatic test if required.
5. Check antifreeze level with hydrometer and add antifreeze as required for protection to minus 40 degrees Fahrenheit.

Electrical Controls Check Points:

1. Visually inspect for broken parts, contact arcing, or any evidence of overheating.
2. Check motor nameplate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the Regional Design Engineer's approval.)
3. Check line and load connections and heater mounting screws for tightness.

Tools & Materials:

1. Standard Tools - Basic.
2. Pressure washer
3. Fin comb
4. Paint brush
5. Cleaning materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
6. Respirator
7. Safety goggles
8. Antifreeze
9. Rust inhibitor. Consult the MSDS for hazardous ingredients and proper PPE.
10. Vacuum cleaner
11. Hydrometer (to check antifreeze level)

**A-11 Air Conditioning Unit,
Ceiling/Wall Mounted**

Frequency:

**Comfort Cooling - Annual
Special Purpose - Monthly**

Application:

This guide card applies to ceiling or wall mounted air conditioning units, i.e., mini-mates. The unit may be for comfort or special purpose cooling and can be either air-cooled or water-cooled. Humidifiers will be operated on those units serving computer space and will be inventoried and serviced under this guide card.

Special Instructions:

1. Schedule outage with operating personnel.
2. Schedule PM on associated equipment in conjunction with this guide, i.e., air cooled condensers, glycol dry coolers, cooling tower, etc.
3. Review manufacturer's instructions and the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. De-energize, lockout, and tag electric circuits.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the equipment.
10. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
11. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Thoroughly inspect and clean interior and exterior of machine with vacuum (remove panels).
2. Clean drain pan and note excessive corrosion. Correct as necessary.
3. Check for refrigerant leaks using a halogen leak detector, soap bubbles, or similar testing device. If leaks are not stopped or corrected, report leak status to supervisor. Consult the Material Safety Data Sheets (MSDS) for disposal requirements. Reclaimed and recycled CFC's are exempt from hazardous waste regulations (Consult 40 CFR Part 261).

4. Check refrigerant levels and recharge if necessary.
5. Check condition of cooling and reheat coils. Use fin comb as needed.
6. Clean coils using detergent solution and warm water if coil is heavily soiled.
7. Drain and clean humidifier pan or pad, whichever applies. Replace pad if required. Remove corrosion, prime, and paint as needed.
8. Lubricate motor and fan bearings, if not sealed. Check alignment of motor and fan. Clean all fans or blowers.
9. Check belt tension and condition. Adjust or replace as required if belt driven.
10. On direct drive units, check set screws on fan shaft to make sure they are tight.
11. Replace filters as needed.
12. Check compressor oil level (not on hermetically sealed units) if compressor is equipped with a sight glass.
13. Run machine. Check action of controls, relays, switches, including fused disconnect type, etc., to see that:
 - a. compressor(s) run at proper setting.
 - b. reheat coils activate properly (if applicable).
 - c. humidistat activates humidifier (if applicable).
 - d. suction and discharge pressures are proper.
 - e. discharge temperature is set properly.
14. Clean up work area.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning tools and materials.
3. Vacuum.
4. Fin comb.
5. Grease gun and oiler.
6. Ladder - ceiling mounted units. Check ladder for defects. Do not use defective ladders.
7. Self-sealing quick disconnect refrigerant hose fittings.
8. Refrigerant recovery/recycle unit.
9. EPA/DOT approved refrigerant storage tanks.
10. Safety goggles.
11. Gloves.
12. Approved refrigerant.
13. Electronic leak detector.

A-12 Air Washer or Wet Coil System Frequency: Annual

Application:

This guide card applies to those installations that utilize an air washer or a wet coil system on their air handler units. Air washers consist of a spray chamber, without coils, into which chilled water is sprayed for the purpose of cooling the air flowing through it. In a wet coil system, water is sprayed onto a chilled water coil for the purpose of providing better heat transfer between the coil and air. The air handler will be serviced using guide card A-9 and the air washer or wet coil system should be scheduled for accomplishment at the same time.

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Schedule outage with operating personnel.
4. Open, lock, and tag out electric circuits serving motors for the air handler and spray pump.
5. Preventive maintenance on associated equipment should be accomplished at this time.
6. Secure and tag all water valves supplying the pan or sump.

Check Points:

1. Examine and wire brush all structural elements including doors, chamber, piping, supports, pans, sumps, and framing.
2. Clean tank or sump and examine for leaks.
3. Treat with rust inhibitor and paint as required. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less.
4. Clean suction screens.
5. Remove nozzles and clean. Replace as required.
6. Check piping for blockage or buildup. Clean or replace as required.
7. Check operation of float valve, mixing or automatic control valves and thermometers.
8. Check lights for water seal and operation. Replace as necessary.
9. Pumps and motors less than 1 HP will be serviced as part of this PM. Pumps and motors 1 HP and larger will be serviced using PM guide cards P-1 and M-1 respectively.
 - a. Clean and lubricate pump. Check and replace packing if applicable.
 - b. Blow out or vacuum motor windings and lubricate if required.
10. Remove tags and lockout from circuits for spray pump only.
11. Check with operating personnel before restoring circuits to the air handlers, to be certain personnel are not working on the unit.

Note: Pans and sumps should remain dry during winter operation. Tags should be removed from supply valves at the completion of this work, but the valves should be opened by operating personnel only when the unit is to be filled and placed in service.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning tools and materials, vacuum, grease gun and oil.
3. Rust inhibitor and paint. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
4. Gasket material
5. Goggles

B-1 Boiler (Coal, Oil, and Gas) Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions and ASME Boiler and Pressure Vessel Codes for boilers.
2. Review the Standard Operating Procedure for "Selection, Care and Use of Respiratory Protection."
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. De-energize, tag, and lock out circuits.
5. Close and tag all hand or motorized valves required to isolate the boiler. Chain and lock all valves that are closed for safety. These valves shall not be unlocked and reopened unless authorized by the originator of the work authorization. Enter this information in the boiler log and sign.
6. Wear appropriate respirator, goggles, and gloves while in contact with hazardous materials. Contact the Safety and Environmental Management Division/Branch if you have questions.
7. If materials to be worked on are known or suspected to contain asbestos, check the building's asbestos management plan to see if they have been tested for asbestos. If they are suspect but have not been tested, have them tested. Manage asbestos in accordance with the plan.
8. Account for all tools and materials before closing boiler.

Check points:

1. Apply hydrostatic test of safety pop-off valve (1.5 times operating pressure, safety valve gauged).
2. Drain boiler, tag valves and controls. NEVER attempt to remove a manhole or hand-hole cover without first properly venting the water or steam side of a boiler to the atmosphere. Prior to opening or entering a boiler it must be at atmospheric pressure. To protect the boiler from unnecessary stresses the boiler water temperature should be allowed to reach the boiler room temperature before draining the boiler.
3. Brush all tubes clean of scale.
4. Brush plate surfaces clean, use vacuum cleaner.
5. Clean breaching, ducts, fireboxes, or main fire tube, and flue passage.
6. Check and replace worn or damaged insulation. Repair the damage and remove the debris. If the insulation contains asbestos, follow the asbestos management plan for isolation, notification, work practice, and waste disposal.
7. Check refractory and brick work; if damaged notify supervisor and enter this data in boiler log.
8. When the boiler has cooled to the ambient boiler room temperature, wash out mud legs, and flush boiler
9. Refill boiler with water and chemicals if boiler is to be put back in service or if wet-lay-ups are to be employed.

10. Determine if there is ample provision for expansion between the sections.
11. Check for excessive rust build-up between sections (cast iron type).
12. Examine all steam and water line to controls to determine that they are clear of scale and arranged to insure proper control operations.
13. Clean stems and shafts, and tighten packing nuts on valves and pumps. Replace pump packing if necessary.
14. Flush fuel oil strainer baskets and oil solenoid valve seats.
15. Dismantle low water fuel cut off and water feeders to insure freedom from obstructions and proper functioning of the working parts. Always replace old gaskets before reassembling.
16. Inspect connecting lines to boiler for accumulations of mud, scale, etc., and clean as needed.
17. Examine all visible wiring for brittle or worn insulation, and make sure electrical contacts are clean and functioning properly.
18. On electrical type detection devices, replace vacuum tubes annually, and replace defective solid state devices.
19. Replace fusible plugs, if applicable.
20. Replace water level sight glass.

Tools & Materials:

1. Standard Tools - Basic
2. Scrapers, wire brush, cleaning materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Combustion testing equipment
4. Hydrostatic pump and safety valve gag
5. Respirator
6. Safety goggles
7. Safety signs
8. Suitable chain and locks for securing isolation valves.
9. Boiler chemicals as directed by a competent water treatment company. Consult the MSDS for hazardous ingredients and proper PPE.
10. Vacuum cleaner wet/dry type.

B-2 Burners, Gas Frequency: Annual

Special instructions:

1. Review manufacturer's instructions.

Check points:

1. Check boiler room for adequate ventilation in accordance with AGA burner requirements.
2. Check operation of all gas controls and valves including: manual gas shutoff; petal gas regulator; safety shutoff valve (solenoid); automatic gas valve; petal solenoid valve; butterfly gas valve, motor, and linkage to air louver; safety petal solenoid (if used).
3. Check flue connections for tight joints and minimum resistance to airflow. (See that combustion chamber, flues, breaching, and chimney is clear before firing.)
4. Draft regulators should give slightly negative pressure in the combustion chamber at maximum input.
5. On forced draft burners, gas manifold pressure requirements should correspond with modulating (butterfly) valve in full open position and stable at all other firing rates.
6. Take flue gas readings to determine the boiler efficiency. Use the manufacturer's instructions if available. If they are not, use the attached table as a guide for the performance criteria. If efficiency is low, check baffling and passes for short circuiting, and boiler for air infiltration. Adjust dampers and controls to optimize efficiency. Tests should be run at the following load points.
 - a. 100%, 70%, and 40% of rated full load for boilers having metering controls or modulation capacity at these load points.
 - b. At the high and low fire rates on boilers equipped with OFF/LOW FIRE/HIGH FIRE control.
 - c. At the single firing load point on boilers equipped with OFF/ON controls only.
7. Check burner for flashback and tight shutoff of fuel.
8. Check operation of controls. Clean and adjust, if necessary.
9. Satisfactory operation and adjustments should conform with manufacturer's instructions.

**Performance Criteria for Gas Burners
Natural Gas (1,000 BTU/SCF)**

Percent Load	Carbon Dioxide	Carbon Monoxide	Oxygen	Excess Air	Smoke Scale
40.0%	8.5%	0	6.0%	40.0%	0
70.0%	9.0%	0	5.0%	25.0%	0
100.0%	10.0%	0	4.0%	20.0%	0

1. Combustibles should be zero or negligible percent in the flue gas.
2. Output (steam or water flow) where meters are available should correspond to combustion level not less than 100% of rated capacity at rated load.
3. Boiler section outlet flue gas temperature is not more than 30øF (17øC) higher than rated. When the expected gas temperature is not known, the manufacturer should be contacted for typical conditions for the type of boiler being tested.
4. Boiler section outlet flue gas temperature should not be more than 150øF to 180øF (84øC to 100øC) higher than the corresponding saturated steam temperature for water tube boilers and 100øF to 125øF (56øC to 70øC) for fire-tube boilers.
5. Excess air should be within 5 percent of manufacturer's performance level.
6. Feed-water temperature, burner atomizing pressure, draft loss, and combustion appearance should be in accordance with manufacturer's data or be close to industry standards.

Tools & Materials:

1. Standard Tools - Basic
2. Flue gas analyzer.
3. Clean wiping cloths.

B-3 Burner, Oil Frequency: Annual

Special Instructions:

1. Review Manufacturers Instructions.

Check points:

1. Test and inspect burner (with or without firing) at rated pressure for leaks.
2. Timed trial for ignition for pilots and burners should be in accordance with the instructions in the programmer timer.
3. Check operation of automatic controls and combustion flame safeguards for normal operation. There should be no presence of oil discharge, ignition or flame.
4. Check pre-ignition purging capability of burner, combustion chamber, boiler passes, and breaching. Stack dampers should be fully open during purge and light off period.
5. Check delivery of fuel in relation to its response to the ignition system. Examine electrodes for carbon buildup, discoloration, distortion, and burning of parts, clean and adjust as necessary for proper operation. Check porcelain insulators for cracks.
6. Check ignition transformer to supply dependable arc, adjust and regulate as required for clearance and air gap.
7. Clean and adjust draft regulator and air shutter on a natural draft burner to ensure excess air quantities are minimum for complete combustion. Test with flue gas analyzer.
8. On mechanical draft burners clean and check power-driven fan blower.
9. Check out forced draft fan, clean fan and fan housing, check bearings, pulleys and or couplings and adjust belt tension if required replace worn belts and lubricate pivot points on linkages as necessary.
10. Check and clean filters, water separators, primary, and secondary strainers.
11. Clean, check operation, and adjust controls and safeties.
12. Burners designed to change firing rates automatically should be checked for adequate proportioning changes in fuel and air rates.
13. Check oil level sight glass to see that burner maintains proper oil level (within 1/3") at rated output.
14. Check to ensure that power cannot feed back and energize ignition devices or feed valves after a control shuts off burner.
15. Clean or replace nozzles or cups, and check for tight shutoff of fuel.
16. Check stacks for smoke or haze and adjust burner accordingly.
17. Take flue-gas readings to determine the boiler efficiency. Use the manufacturer's instructions if available. If they are not, use the attached table as a guide for the performance criteria. If efficiency is low, check baffling and passes for short circuiting, and boiler for air infiltration. Adjust dampers and controls to optimize efficiency. Tests should be run at the following load points.
 - a. 100%, 70%, and 40% of rated full load for boilers having metering controls or modulation capacity at these load points.

- b. At the high and low fire rates on boilers equipped with OFF/LOW FIRE/HIGH FIRE control.
- c. At the single firing load point on boilers equipped with OFF/ON controls only.

Performance Criteria for Oil Burners

LIGHT OILS, Grade 2, Diesel Fuel, JP5, Navy Distillate

Percent Load

40.0%
70.0%
100.0%

Carbon Dioxide (CO₂)

10.5%
11.0%
12.5%

Carbon Monoxide (CO)

0
0
0

Oxygen (O₂)

6.0%
5.0%
4.0%

Excess Air (XA)

40.0%
30.0%
20.0%

Smoke Scale No.

2
2
2

MEDIUM OILS, Grade 4, NFSO

Percent Load

40.0%
70.0%

100.0%

Carbon Dioxide (CO₂)

11.0%

12.0%

13.0%

Carbon Monoxide (CO)

0

0

0

Oxygen (O₂)

6.0%

5.0%

4.0%

Excess Air (XA)

40.0%

30.0%

20.0%

Smoke Scale No.

3

3

3

HEAVY OIL, Grades 5 & 6

Percent Load

40.0%

70.0%

100.0%

Carbon Dioxide (CO₂)

12.0%

12.6%

13.6%

Carbon Monoxide (CO)

0

0

0

Oxygen (O₂)

6.0%

5.0%

4.0%

Excess Air (XA)

40.0%

30.0%

20.0%

Smoke Scale No.

0

0

0

1. Combustibles should be zero or negligible percent in flue gas.
2. Output (steam flow or water flow) where meters are available should correspond to combustion level not less than 100% of rated capacity at rated load.
3. Boiler section outlet flue gas temperature is not more than 30øF (17øC) higher than rated. When expected gas temperature is not known, the manufacturer should be contacted for typical conditions for the type boiler being tested.
4. Boiler section outlet flue gas temperature should not be more than 150øF to 180øF (84øC to 100øC) higher than the corresponding saturated steam temperature for water tube boilers and 100øF to 125øF (56øC to 70øC) for fire-tube boilers.
5. Excess air should be within 5 percent of manufacturer's expected performance level.
6. Feed-water temperature, burner atomizing pressure, fuel oil viscosity at the burner, draft loss and combustion appearance should be in accordance with manufacturer's data or be close to industry standards.

Tools & Materials:

1. Standard Tools - Basic
2. Flue gas analyzer.
3. Varsol and rags. Use varsol in well-ventilated area! Dispose of as hazardous waste!
4. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
5. Clean wiping cloths.

B-4 Boiler Instrument/Controls Frequency: Annual

Application:

This guide card applies to large boiler room operations where the boiler PM guides do not sufficiently cover the maintenance required for the boiler room controls. These boiler controls include such items as boiler masters, draft and oil controllers, levelometers, flow transmitters and recorders, ratio transmitters and totalizers, recorders and indicators, etc.

Special Instructions:

1. Read and understand manufacturer's instructions before making any adjustments or calibrations.
2. Schedule work with operating personnel, as needed.
3. Review control wiring and piping diagrams.
4. Review and understand sequence of operation.

Check Points:

1. Visually check equipment sensing lines, operating valves, and internal assembly for leaks.
2. Perform friction test.
3. Zero meter to scale, check pen(s) for zero indication, make necessary adjustments.
4. Simulate flow by use of check weights, provided water column, or other appropriate external simulation devices.
5. Check pen or indicator for proper chart or scale percentage at recommended checkpoints; (or discretionary check points, if none are recommended) record actual indication; make minor adjustments as necessary.
6. Check control over full range. Set zero and full range stops as necessary.
7. Mark integrator or counter checks by simulating flow (usually 50% of full scale) and check number of counts over specific time period (minimum period of 30 minutes is recommended). Calculate correct number of counts for time period used and make necessary minor adjustments. Re-check after any adjustments, ascertain that the integrator or counter does not count at zero.
8. Repeat step #6.
9. Open meter supply line to check for plugging. Put meter back in service.
10. Check electronic stations for proper electrical connections and pneumatic stations for any leaks by using a leak detector (soap solution).
11. Check operation of station panel switch and manual control for excessive friction and looseness of control knobs.
12. Check for correct supply pressure or voltage to the station.
13. Compare sender over it's range of control with an accurate external measuring device such as a U-tube, pneumatic calibrator, or electronic calibrator (all other measurements in the control loop should be made with the same device).

14. Check all indicators by simulating pneumatic or electronic signals to the appropriate port of terminal for proper indication to the related gauge or indicator (in most cases, mathematical calculations will be necessary to determine the proper indication at each test point).

15. Ascertain that the automatic signal is not restricted when the station is activated.

16. Record and report all deficiencies.

Tools & Materials:

1. Standard Tools - Basic

2. Calibration device for meter being checked.

3. Differential flow meter and indicator.

4. Soap solution for air leak test, accurate test gauges (check before use).

C-1 Remote Air Intake Dampers

Frequency: Annual

Check points:

1. Check damper for freedom of movement and proper operation.
2. Observe damper operation through full operating range, by activating controller. Adjust linkage on vanes if out of alignment.
3. Check damper surfaces for wear and clean vanes.
4. Check actuator/damper linkage for proper operation. Adjust if needed. Tighten operator arm set screws.
5. Lubricate mechanical connections sparingly. Wipe off excess.
6. Check actuator for proper operation. If it does not stroke properly, check for binding drive stem. If actuator still does not operate properly, replace the diaphragm (pneumatic actuators).
7. Check for air leaks around actuator and in air line between controller and actuator.
8. Lubricate actuator linkage sparingly. Wipe off excess lubricant. **DO NOT LUBRICATE** actuator/drive stem.
9. Clean off any corrosion or rust on damper frame and or damper blades, coat with proper type and color paint.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Lubricants

**C-2 Coils Preheat, Reheat, Etc. Frequency: Annual
(Remote Locations)**

Application:

This guide applies to coils that are not part of an air washer or air-handling unit.

Special Instructions:

1. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."

Check points:

1. Vacuum or blow out the fins, coils, etc.
2. Remove obstructions to airflow.
3. Check coils. Correct or report any leaks.
4. Test and inspect controls that protect coils against freezing.
5. Check for rust or corrosion around coil frame and coil mounting bracket. Clean, prepare for painting and coat with proper type paint as necessary.

Tools & Materials:

1. Standard Tools - Basic
2. Vacuum Cleaner wet/dry
3. Radiator brush
4. Coil cleaner. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
5. Respirator
6. Safety goggles
7. Materials to properly prepare and paint metal. Consult the MSDS to ensure that the paint lead level is 0.06% or less.

**C-3 Central Mini-Computer, Frequency: Quarterly
HVAC Systems**

Special Instructions:

1. Schedule maintenance with operating personnel.
2. Obtain and review manufacturer's information for servicing, testing and operating.
3. Obtain "AS BUILT" diagrams of installation.

Check points:

1. Clean, calibrate and adjust all central (mainframe), remote (peripheral) and interface systems.
2. Test and analyze results for systems operational integrity.
3. Test all power supplies and battery charging networks.
4. Test all software and firm ware programs for applied results.
5. Prepare a written service report as to test results and service performed and file with the buildings manager.

Tools & Materials:

1. Standard Tools - Basic
2. Manufacturer's testing instruments
3. Cleaning tools and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
4. Lubricants. Consult the MSDS for hazardous ingredients and proper PPE.

**C-4 Automatic Mixing Box
Pneumatic or Electric**

Frequency: Annual

Special Instructions:

1. Review manufacturer's specifications.

Check points:

1. Check to see that the operating control thermostat activates the damper per design specifications. If not, re-calibrate. Replace if it is defective with the same type action (direct or reverse action) and temperature range.
2. Check damper linkage for tightness or damage. Lightly oil moving parts.
3. Inspect dampers for free movement in mixing box. Replace felt or other type seals as required.
4. Inspect mixing box and hot and cold connecting ducts for air leaks. Correct leaks with duct tape or tighten connections, as required.
5. Inspect damper actuators for tightness to mounting brackets.
6. Tighten electrical connections to servomotors, and test if applicable.
7. If pneumatic actuator does not stroke properly, correct sticking valve stem or binding linkage. Replace diaphragm or actuator if necessary.
8. Inspect for air leaks around actuator and in air line between controller and actuator.
9. Inspect thermostat for proper location and check main and branch air lines at thermostat for crimps, breaks, etc. Repair if needed.

Tools & Materials:

1. Standard Tools - Basic
2. Control drawings
3. Calibration tools
4. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
5. Duct tape
6. Cleaning materials and equipment. Consult the MSDS for hazardous ingredients and proper PPE.
7. Safety goggles

**C-5 Controls, Central System
Heating and Air-Conditioning**

Frequency: Annual

Special Instructions:

1. Read and understand manufacturer's instructions before making adjustments or calibration.
2. Obtain control system diagrams.
3. Before calibrating or adjusting pneumatic controls, adjust the pressure of the main control air supplying pneumatic sensors, thermostats, and controllers to manufacturer's specifications.
4. Servicing of pneumatic air compressors and control air reducing stations shall be performed at the same time to prevent duplication of some service check points.

Check points:

1. Check set point of controls (temperature, humidity, or pressure).
2. Compare control point with an external measuring device, note deviations, and adjust.
3. Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.
4. Check for control point cycling.
5. Check for correct pressure differential on all two-position controllers (on-off-open-closed).
6. Check condition and action of primary elements in the controllers (bi-metallic strips, and or sealed bellows with capillary tubing for remote sensing).
7. Note the action of the controlling device (thermostats, humidistats, and pressurestats) which changes the action of the controlled device (motors, valves, dampers, etc.)
8. On electronic controls check the source of the signal and its amplification.
9. Check air systems for leaks, check for correct main control air pressure to control devices. Check units for proper closing and loose connections.
10. Check the condition and the ability of humidity sensing control elements (hair, wood, leather, or similar substances) to read the moisture changes and their action on the control mechanism.
11. Check resulting action of the pressure-sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.
12. Replace air filters in sensors, controllers, and thermostats as required.
13. Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system.

Tools & Materials:

1. Standard Tools - Basic
2. Pressure gauge and psychrometer
3. Volt Ohm Meter

4. Air filter replacements
5. Control spares as needed

C-6 Condensate or Vacuum Pump

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. This maintenance should only be performed when it will not prevent operation of the steam boiler.

Check points:

1. Operate unit to check for steam binding.
2. Check condensate temperature. It should be approximately 30°F (17°C) below steam temperature if traps are not leaking.
3. Examine flanges for steam leaks and replace gaskets as necessary.
4. Pump receiver down.
5. Turn condensate to sewer.
6. Shut down unit.
7. Clean and examine receiver, vent pipe, inlet and discharge openings for corrosion; remove all external corrosion, and paint with appropriate type paint.
8. Clean and adjust motor float switch and float operation on high low water level. Inspect float rods and pressure switches. Make any adjustments as necessary.
9. Check alignment of motor and pump coupling with straight edge. Align if necessary.
10. Lubricate pump and motor.
11. Adjust packing glands and change packing when necessary.
12. Examine vacuum breaker operation.
13. Inspect ball floats, rods, and other linkage, adjust as necessary.
14. Properly dispose of all debris.

Tools & Materials:

1. Standard Tools - Basic
2. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Clean wiping cloths.
4. Gasket materials as required.
4. Metal cleaning materials and appropriate paint as necessary. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
5. 6" level and straight edge.

C-7 Cooling Tower Maintenance

Frequency: Annual

Special Instructions:

1. Schedule performance of this PM activity prior to seasonal start-up. Consider the time needed to effect any required repairs.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Perform cleaning of the tower in accordance with PM guide C-8 before performing this PM activity.
4. Review manufacturer's instructions.
5. De-energize, lock out, and tag electrical circuits.
6. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".
7. Properly dispose of any debris, excess oil, and grease.
8. Check the building's asbestos management plan to see if the wet deck panels have been tested for asbestos. If they are suspect but have not been tested, have them tested. Manage asbestos in accordance with the plan.

Check Points:

Exterior Structural:

1. Inspect louvers for correct position and alignment, missing or defective items, and supports.
2. Inspect casings and attaching hardware for leaks or defects. Check the integrity and secure attachment of the corner rolls.
3. Inspect for loose or rotten boards on wood casings. Examine from the interior. Extensive damage may require replacement with fiberglass sheathing.
4. Inspect condition of access doors and hinges. Repair as necessary.
5. Inspect the distribution system including flange connectors and gaskets, caulking of headers on counter-flow towers, deterioration in distribution basins, splashguards, and associated piping on cross-flow towers. If configured with water troughs check boards for warpage, splitting, and gaps.
6. Examine the drain boards for damage and proper drainage. Check the fasteners also.
7. Inspect stairways including handrails, knee rails, stringers, structure and fasteners for rot, corrosion, security and acid attack.
8. Shake ladders to verify security, and check all rungs.
9. Check the security, rot, and corrosion on walkway treads. Check treads, walkways, and platforms for loose, broken, or missing parts. Tighten or replace as necessary.
10. Ladders must be checked for corrosion, rot, etc. Verify compliance with Occupational Safety and Health regulations regarding height requirements. Check ladder security.
11. Check fan decks and supports for decay, missing and broken parts, and gaps. Check the security.

12. Fan cylinders must be securely anchored. Check fastening devices. Note any damaged, missing, or corroded items. Watch for wood rot and corrosion of steel. Verify proper tip clearance between the fan blade and interior of cylinder. Verify compliance with OSHA requirements regarding height. Check its condition.

13. Apply protective coatings as needed on exterior surfaces. Be sure rust and dirt have been removed first.

Interior Structural:

14. Inspect the distribution system piping for decay, rust, or acid attack. Check the condition and tightness of connections and branch arms. Observe spray pattern of nozzles if possible and note missing and defective nozzles. Note condition of the redistribution system under the hot water system.

15. Inspect mechanical equipment supports and fasteners for corrosion. Wood structural members in contact with steel should be checked for evidence of weakness. Check condition of springs or rubber vibration absorption pads, including adjusting bolts, ferrous members, and rubber pads.

16. Check valves and operating condition of fire detection system. Check for corrosion of pipes and connectors. Check wiring of any thermocouple installed.

17. Check drift eliminators and supports. Remove any clogging debris. Replace missing blades.

18. Inspect tower fill for damage, ice breakage, deterioration, and misplaced, missing, or defective splash bars.

19. Examine interior structural supports. Test columns, girts, and diagonal wood members for soundness by striking with a hammer. A high pitched, sharp sound indicates good wood, whereas a dull sound indicates softwood. Probe rotted areas with a screwdriver to determine extent of rot. Look for iron rot of metal fasteners in contact with wood. Check condition of steel internals. Check condition and tightness of bolts.

20. Inspect the nuts and bolts in partitions for tightness and corrosion. Look for loose or deteriorated partition boards. Note if partitions are installed so as to prevent wind milling of idle fans. Make sure wind walls parallel to intake louvers are in position. Boards or transite members should be securely fastened. Check condition of wood or steel supports for rot and corrosion.

21. Check wooden cold water basins for deterioration, warps, splits, open joints, and sound of wood. Inspect steel basins for corrosion and general condition. Inspect concrete basins for cracks, breaking joints, and acid attack.

22. Check all sumps for debris, condition of screens, antiturbular plates, and freely operating drain valves.

Mechanical:

1. Check alignment of gear, motor, and fan.

2. Inspect fans and air-inlet screens and remove any dirt or debris.

a. Check hubs and hub covers for corrosion, and condition of attaching hardware.

b. Inspect blade-clamping arrangement for tightness and corrosion.

3. Gear box
 - a. Clean out any sludge.
 - b. Change oil. Be sure gear box is full to avoid condensation.
 - c. Rotate input shaft manually back and forth to check for backlash.
 - d. Attempt to move the shaft radially to check for wear on the input pinion shaft bearing.
 - e. Look for excessive play of the fan shaft bearings by applying a force up and down on the tip of a fan blade. Note: Some output shafts have a running clearance built into them.
4. Power transmission.
 - a. Check that the drive shaft and coupling guards are installed and that there are no signs of rubbing. Inspect the keys and set screws on the drive shaft, and check the connecting hardware for tightness. Tighten or install as required.
 - b. Look for corrosion, wear, or missing elements on the drive shaft couplings.
 - c. Examine the exterior of the drive shaft for corrosion, and check the interior by tapping and listening for dead spots.
 - d. Observe flexible connectors of both ends of the shaft.
 - e. Inspect bearings, belts, and pulleys for excessive noise, wear or cracking, alignment, vibration, looseness, surface glazing, tension. Replace or repair as required.
5. Check water distribution. Adjust water level and flush out troughs if necessary. Check all piping, connections, and brackets for looseness. Tighten loose connections and mounting brackets. Replace bolts and braces as required.
6. Check nozzles for clogging and proper distribution.
7. Inspect key and key way in motor and drive shaft.

Electrical:

1. Check electric motor for excessive heat and vibration. Lubricate all motor bearings as applicable. Remove excess lubricant.
2. Inspect fused disconnect switches, wiring, conduit, and electrical controls for loose connections, charred or broken insulation, or other defects. Tighten, repair, or replace as required.
3. Remove dust and/or scale from air intakes, and check for corrosion. Check TEFC motors for conditions of air passages and fans.
4. If there is a drain moisture plug installed, see if it is operational.
5. Check amps and volts at operating loads-recommend pitching of fan blades to compensate.
6. Look for corrosion and security of mounting bolts and attachments.

Tools & Materials:

1. Standard Tools - Basic
2. Protective coating, brushes, solvent, etc. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

3. Manufacturer approved lubricants. Consult the MSDS for hazardous ingredients and proper PPE.
5. Cleaning tools and materials. Consult the MSDS for hazardous ingredients and proper PPE.
6. Respirator
7. Safety goggles
8. Work gloves
9. OSHA approved ladders of appropriate size or scaffolding. Check ladder for defects. Do not use defective ladders.
10. Amp probe and volt meter.
11. High-pressure washer.

C-8 Cooling Tower, Cleaning

Frequency: Quarterly

Application:

This applies to all cooling towers and evaporative condensers. Those located on the mezzanine or lower levels and near fresh air intakes are particularly important.

Special Instructions:

1. Perform work before seasonal start-up (unless system has remained clean and free of bio-deposits), before seasonal shutdown, and quarterly during the cooling season.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Review manufacturer's instructions.
4. De-energize, tag, and lock electrical circuits.
5. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".
6. Ensure that there are safe and sturdy ladders and platforms to perform the lifting and cleaning required.
7. If biological growth is excessive, have a qualified water treatment specialist review your treatment program.
8. Refer to Table A for information on chlorine use.
9. Check the building's asbestos management plan to see if the wet deck panels have been tested for asbestos. If they are suspect but have not been tested, have them tested. Manage asbestos in accordance with the plan.

Check Points:

1. Close building air intake vents within the vicinity of the cooling tower until the cleaning procedure is complete.
2. Shut down, drain, and flush the cooling tower with water (check with state to determine if there are any restrictions on discharging the water). Isolate the cooling tower from the rest of the condenser water system where applicable.
3. Clean the wet deck, remove all debris, and dispose of properly. If the wet deck panels contain asbestos, follow the asbestos management plan for isolation, notification, work practice, and waste disposal.
4. Inspect the tower, the tower basin and holding tank for sediment and sludge, and any biological growth.
5. Using low pressure water hose or brushes, clean the tower, floor, sump, fill, spray pans and nozzles and removable components such as access hatches, ball float, and other fittings until all surfaces are clean and free of loose material. Porous surfaces such as wooden and ceramic tile towers will require additional cleaning and brushing. Clean cracks and crevices where buildup is not reached by water treatment.
6. Clean all system strainers and strainer housings.

7. Remove drift eliminators and clean thoroughly using a hose, steam, or chemical cleanser.
8. Check fan and air inlet screens and remove any dirt or debris.
9. Reassemble components, and fill tower and cooling system with water.
10. Monitor the water pH and maintain pH within a range of 7.5 to 8.0. The pH can be monitored with litmus paper or a pH meter.

If a more thorough disinfectant cleaning is needed;

11. Add a silicate-based low or non-foaming detergent as a dispersant at a dosage of 10-25 pounds per thousand gallons of water in the system.
 - a. Use a silicate-based low or non-foaming detergent such as Cascade, Calgonite, or equivalent product. (Trade names mentioned do not imply endorsement by the government).
 - b. If the total volume of water in the system is not known, it can be estimated to be ten (10) times the re-circulating rate (gallons per minute) or 30 gallons per ton of refrigeration capacity.
 - c. The dispersant is best added by first dissolving it in water and adding the solution to a turbulent zone in the water system, such as the cooling tower basin near the pump suction.
 - d. Contact a professional water treatment specialist for a dispersant, which may be safely used without interfering with the operation of the system.
12. Add chlorine disinfectant to achieve 25 parts per million (ppm) of free residual chlorine.
 - a. Maintain 10 ppm of free residual chlorine in water returning to the cooling tower for 24 hours.
 - b. A swimming pool test kit may be used to monitor the chlorine. Follow the manufacturer's instructions. Test papers such as those used to monitor restaurant sanitizing tanks may also be used.
 - c. Monitor every 15 minutes for two hours to maintain the 10-ppm level. Add chlorine as needed to maintain this level.
 - d. Two hours after the slug dose or after three measurements are stable at 10 ppm of free residual chlorine, monitor at two hour intervals to maintain the 10 ppm of free residual chlorine.
 - e. Some kits cannot measure 10 ppm. In this case dilute the test sample with distilled water to bring it within the test set range.
13. After 24 hours, drain the system (check with state to determine if there are any restrictions on discharging the water).
14. Adjust bleed, float, and central valve for desired water level.
15. Open any building air vents that were closed prior to the cleaning of the cooling tower.
16. Implement an effective routine treatment program for microbial control.
17. Document all maintenance and cleaning procedures by date and time. Record the brand name and the volume or weight of chemicals used.

Tools & Materials:

1. Standard Tools - Basic
2. Pressure washer with hose and nozzle.
3. Cleaning tools and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
4. Appropriate chemicals and detergents (see guide card for details). Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
5. Respirator with acid/gas/mist/HEPA filters. For other chemicals, refer to the Material Safety Data Sheet (MSDS) for recommended respirator).
6. Safety goggles.
7. Waterproof clothing (while working inside a wet tower).
8. Gloves (refer to MSDS on chemicals used for the type of gloves required).
9. Rubber boots if wet.
10. Litmus paper or pH meter.
11. Swimming pool test kit.

TABLE A

Chlorine Compounds*	Percent Available Chlorine	Weight per** 1,000 gallons
Hypochlorites		
Calcium, Ca(OCl) ₂ (HTH)	70	0.3 lb.
Sodium, NaOCl		
Industrial grade	12-15	1.5 lb.
Domestic grade (bleach)	3-5	5.25 lb.
Potassium or sodium chlorinated isocyanurates***		
	55-65	0.4 - 0.33 lb.
	66-90	0.33 - 0.25 lb.

* Only those compounds commonly available in most communities are listed. A water treatment specialist may suggest other appropriate compounds.

** These weights are approximate and are calculated to attain a free chlorine level of 25 ppm in a theoretical cooling tower system with no biodeposits. If biodeposits are present, additional chlorine will be required. Calculate the volume of the entire cooling tower system, including the cooling tower water and the re-circulating water; it should be several times more than the holding capacity of the tower.

*** Select only fast-release compounds, which are available in pellets, granular or extra granular forms in the 55-65% available chlorine category. Compounds with higher

percentages of available chlorine (66-90%) release more slowly; use only the granular or extra granular forms.

C-09 Evaporative Condenser

Frequency: Annual

Special Instructions:

1. Perform cleaning of the condenser in accordance with PM guide C-8 before performing this PM activity
2. Schedule performance of this PM activity prior to seasonal start-up.
3. Review manufacturer's instructions.
4. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
5. De-energize, lock out, and tag electrical circuits.
6. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
7. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
8. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
9. Recover, recycle, or reclaim the refrigerant as appropriate.
10. If disposal of the appliance is required, follow regulations concerning removal of refrigerants and disposal of the appliance.
11. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
12. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
13. For refrigerant type units, closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.
14. Properly dispose of any debris, excess oil, and grease.

Check points:

Exterior Structural:

1. Inspect louvers for correct position and alignment, missing or defective items, and supports. Examine for ice damage.
2. Inspect casings and attaching hardware for leaks or defects.
3. Inspect condition of access doors and hinges. Repair as necessary.
4. Inspect the distribution system, including flange connectors and gaskets, caulking of headers, deterioration in distribution basins, splashguards, and associated piping.
5. Check screens.
6. Inspect stairways (if applicable), including handrails, knee rails, stringers, structure, and fasteners for rot, corrosion, security, and acid attack.
7. Shake ladders (if applicable) to verify security. Check all rungs. Verify compliance with Occupational Safety and Health (OSHA) regulations regarding height requirements.

8. Fan cylinders must be securely anchored. Check fastening devices. Note any damaged, corroded, or missing items. Verify proper tip clearance between the fan blade and interior of the cylinder. Verify compliance with OSHA requirements regarding height. Check its condition.

9. Apply protective coatings as needed on metal surfaces. Be sure rust and dirt have been removed first.

Interior Structural:

10. Inspect the distribution system piping for decay, rust, or acid attack. Check the condition and tightness of water and coil connections. Observe spray pattern of nozzles if possible and replace missing and defective nozzles.

11. Inspect mechanical equipment supports and fasteners for corrosion. Check condition of springs or rubber vibration absorption pads, including adjusting bolts, ferrous members, and rubber pads.

12. Check valves, float valve, and continuous bleed line (should be open). Check operating condition of fire detection system, if installed. Check for corrosion of pipes and connectors. Check wiring of any thermocouple installed.

13. Inspect condenser fill for damage, ice breakage, deterioration, or misplaced, missing, or defective splash bars.

14. Examine interior structural supports. Look for iron rot of metal fasteners. Check condition of steel internals. Check condition and tightness of bolts.

15. Inspect the nuts and bolts in partitions for tightness and corrosion. Check condition of steel supports for rot and corrosion.

16. Check steel cold-water basins for corrosion and general condition.

17. Check all sumps for debris, condition of screens, antiturbular plates, and freely operating drain valves.

Mechanical:

1. Check alignment of gear, motor, and fan(s).

2. Check fan(s) and air inlet screens. Remove any dirt or debris.

a. Check hubs and hub covers for corrosion and condition of attaching hardware.

b. Inspect blade-clamping arrangement for tightness and corrosion.

3. Gear box:

a. Clean out any sludge.

b. Change oil in gear reducer. Be sure gear box is full to avoid condensation.

c. Rotate input shaft manually back and forth to check for backlash.

d. Attempt to move the shaft radially to check for wear on the input pinion shaft bearing.

e. Look for excessive play of the fan shaft bearings by applying force up and down on the tip of a fan blade. (Note: Some output shafts have a running clearance built into them.)

4. Power transmission:

- a. Check that the drive shaft and coupling guards are installed and that there are no signs of rubbing. Inspect the keys and set screws on the drive shaft and check the connecting hardware for tightness. Tighten or install as required.
 - b. Look for corrosion, wear, or missing elements on the drive shaft coupling.
 - c. Examine the exterior of the drive shaft for corrosion. Check the interior by tapping and listening for dead spots.
 - d. Observe flexible connectors of both ends of the shaft.
 - e. Inspect bearings, belts, and pulleys for excessive noise, wear or cracking, alignment, vibration, looseness, surface glazing, tension. Replace or repair as necessary.
5. Inspect condenser coil, fins, sprays, connections, etc. Clean if required.
 6. Check water distribution. Adjust water level and flush out troughs if necessary. Check all piping, connections, and brackets for looseness. Tighten loose connections and mounting brackets. Replace bolts and braces as required.
 7. Check nozzles for clogging and proper distribution.
 8. Check pump. Lubricate as required.
 9. Check water treatment equipment for proper operation and condition. Clean and paint as necessary.

Electrical:

1. Check electrical motor for excessive heat and vibration.
2. Inspect wiring, conduit, and electrical controls for loose connections, charred or broken insulation, or other defects. Tighten, repair, or replace as necessary.
3. Remove dust from air intakes and check for corrosion. Check TEFC motors for condition of air passages and fans.
4. If there is a drain moisture plug installed, see if it is operational.
5. Check motor and starters. Check amps and volts at operating loads.
6. Look for corrosion and security of mounting bolts and attachments.

Tools & Materials:

1. Standard Tools - Basic
2. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
4. Safety goggles.
5. Work gloves.
6. OSHA approved ladders of appropriate size or scaffolding.
7. Volt-amp meter.
8. High-pressure washer.
9. Protective coatings, brushes, solvents, etc. Consult the MSDS for hazardous ingredients and proper PPE.

C-10 Condensing Unit, Refrigeration

Frequency: Annual

Application:

This guide card applies to those units that have the compressors located inside the air-cooled condenser housing. These units are considered one-half of a split system. Normally installed where compressor noise and/or vibration is undesirable and normally associated with air handlers (PM Guide A-9), and modular A/C units, ceiling/wall mounted, split system (PM guide A-11). The unit may stand-alone and be associated with walk-in freezers and refrigerators.

Special Instructions:

The frequency of maintenance for these units will be the same frequency as is established for the air handler or packaged A/C unit it services. Normally, once yearly for air handlers and comfort cooling A/C units and monthly for special purpose A/C units.

Comfort cooling units should be serviced just prior to the cooling season.

1. Schedule outage with operating personnel.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Obtain and review manufacturer's instructions.
4. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".
5. De-energize, tag, and lock out electrical circuit.
6. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
7. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
8. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
9. Recover, recycle, or reclaim the refrigerant as appropriate.
10. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the item.
11. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
12. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly
13. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Remove debris from air screen and clean underneath unit.
2. Pressure wash coil with coil cleaning solution. Rinse and neutralize (cleaning solution) in accordance with manufacturer's recommendations.
3. Straighten fin tubes with fin comb.
4. Check electrical connections for tightness.
5. Check mounting for tightness.
6. Check all refrigeration lines for support and signs of wear.
7. Thoroughly inspect and clean interior and exterior of machine.
8. Clean and treat all rusted areas. Touch up prime and paint as needed.
9. Check for refrigerant leaks using a halogen leak detector, soap bubbles, or similar testing device. If leaks are not stopped or corrected, report leak status to supervisor.
10. Perform required lubrication and remove old or excess lubricant.
11. Clean motor with vacuum or low-pressure air (less than 40 psi). Check for obstructions in motor cooling and airflow.
12. Visually inspect fused disconnect switches and contactors for condition, proper operation, arcing or any evidence of overheating.
13. Check line and load connections and heater mounting screws for tightness.
14. Check fan blades for dust buildup and clean if necessary.
15. Check fan blades and moving parts for excessive wear.
16. Check bearing collar set screws on fan shaft to make sure they are tight, if applicable.
17. Check dampers for dirt accumulation. Check felt; repair or replace as required.
18. Check damper motors and linkage for proper operation. Adjust linkage on vanes if out of alignment, if equipped.
19. Lubricate mechanical connections of dampers sparingly, if equipped.
20. Check compressor oil level (non-hermetically sealed units only) if compressor is equipped with a sight glass
21. Run machine with service gauge manifold attached, checking action of controls, relays, switches, etc. to see that:
 - a. compressor(s) run at proper settings.
 - b. controls activate properly.
 - c. controls activate unit.
 - d. suction and discharge pressures are proper.
 - e. check refrigerant levels and recharge if needed.
22. Check setting on controls and return to normal operation.
23. Clean up the work area and properly dispose of debris and waste.

Note: Seal off all service ports with flare caps. Report any missing caps or dust covers.

Tools and Materials:

1. Standard Tools - Basic
2. Refrigeration manifold.
3. Pressure washer.

4. Fin comb.
5. Paint brush.
6. Cleaning materials and tools, vacuum, grease gun, and oil. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
7. Respirator
8. Safety goggles.
9. Gloves
10. Rust inhibitor and protective coatings. Consult the MSDS for hazardous ingredients and proper PPE. Consult the MSDS to ensure that the paint lead level is 0.06% or less.
11. Self-sealing quick disconnect refrigerant hose fittings.
12. Refrigerant recovery/recycle unit.
13. EPA/DOT approved refrigerant storage tanks.
14. Approved refrigerant.
15. Electronic leak detector.

**E-1 Motor Starter
25 HP to less than 100 HP
and less than 600 volts**

Frequency: Annual

Application:

This guide card applies to individually enclosed and electrically supplied motor starters rated at less than 600 volts and between 25 horsepower to less than 100 horsepower.

Special Instructions:

1. Schedule outage with operating personnel.
2. Obtain and review manufacturer's operation and maintenance instructions.
3. De-energize and tag circuit. NOTE: Some starters by design may be supplied from more than one power source (for supply or control). Check all circuits for voltage.

Check Points:

1. Visually inspect for broken parts, contact arcing, or any evidence of over heating.
2. Check motor nameplate for current rating and controller manufacturer's recommended heater size (report discrepancy to supervisor).
3. Check line and load connections for tightness (check manufacturer's instructions for torque specifications).
4. Check heater-mounting screws for tightness.
5. Check all control wiring connections for tightness.
6. On units equipped with motor reversing capacity, check mechanical interlock.
7. On units equipped with two-stage starting, check dash pots and timing controls for proper operation. Adjust as required.
8. On units equipped with variable speed starters:
 - a. Check tightness of connections to resistor bank.
 - b. Check resistor coils and plates for cracking, broken wires, mounting and signs of over heating. Clean as required.
 - c. Check tightness of connections to drum controller.
 - d. Check contacts of drum controller for arcing and over heating. Apply a thin film of lubricant to drum controller contacts and to rotating surfaces.
9. Check starter contact connections by applying a thin film of black contact grease to line and load stabs, operate contacts and check surface contact.
10. Lubricate all moving parts with proper lubricant.
11. Clean interior of cabinet.
12. Clean exterior of cabinet.
13. Energize circuit and check operation of starter and any indicator lights. Replace as required.

Tools and Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials.
3. Vacuum cleaner.
4. Electrical contact lubricant.
5. Ladder.

F-1 Fan, Centrifugal

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Schedule shutdowns with operating personnel, as needed.
3. De-energize, lock out and tag fan motor electrical circuit.

Check points:

1. Check fan blades for dust buildup and clean if necessary.
2. Check fan blades and moving parts excessive wear. Clean as needed.
3. Check bearing collar set screws on fan shaft to make sure they are tight.
4. Vacuum interior of unit if accessible. Clean exterior.
5. Lubricate fan shaft bearings while unit is running. Add grease slowly until slight bleeding is noted from the seals. Do not over lubricate. Remove old or excess lubricant.
6. Check belts for wear, adjust tension or alignment, and replace belts when necessary. Multiple belt drives should be replaced with matched sets.
7. Check structural members, vibration eliminators, and flexible connections.
8. Schedule PM on motor per Guide No. M-1 at same time.
9. Remove all trash and clean area around fan.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials
3. Vacuum
5. Grease guns, lubricants
6. Respirator

**F-2 Filter, Movable Curtain, Frequency: Quarterly
Oil Coated**

Special Instructions:

1. Review manufacturer's instructions.
2. De-energize fans and filter motor, lock out and tag circuits.

Check points:

1. Inspect framework, and structure. Look for loose or missing bolts, air leaks, condition of flashing or caulking, etc.
2. Examine all moving parts for proper alignment, freedom of motion, excessive clearance or play, etc.
3. Inspect and adjust motor and drive unit, gear reducer, sprockets, drive chains, belts, etc. Perform required lubrication.
4. Inspect pressure sensing device, pressure switches (if automatic), selector(s), starters, electric controls, warning and/or indicator lights, etc. Clean and adjust as necessary.
5. Remove sludge from pit, change or replenish oil.
6. Remove tags, restore to service and check operations.
7. Remove all trash from work area, and clean up oil spills.

Tools & Materials:

1. Standard Tools - Basic
2. Lubricants

F-3 Filter, Roll Type, Disposable **Frequency: Quarterly**

Application:

This applies to changing dirty roll filter media.

Special Instructions:

1. Review manufacturer's instructions.
2. De-energize fan, media motor; tag and lock out circuit.

Check points:

1. Remove old filter media roll and install new roll.
2. Vacuum heavy accumulation of dust and remove debris.
3. Inspect for proper alignment and operation of automatic controls and adjust as necessary.
4. Remove all trash from area, put equipment back in operation.

Tools & Materials:

1. Standard Tools - Basic
2. Respirator
3. Goggles

**F-4 Filters, Viscous Type Frequency: Quarterly
(Wire Mesh)**

Application:

This guide is for reusable filters and includes time for removing, cleaning, and replacing the filters. The throwaway filters are usually more economical than the viscous type. Therefore, this filter shall only be used where economically justified.

Check points:

1. Remove filters and replace with filters that have been cleaned and re-coated. Examine frame and clean it with a high suction vacuum.
2. Move dirty filters to cleaning station.
3. Clean, re-coat, and store filters removed until next scheduled change.

Tools & Materials:

1. Standard Tools - Basic
2. Respirator
3. Goggles
4. Vacuum
5. Filter replacement

**F-5 Filter, Roll Type Disposable Frequency: Annual
Media, Manual or Motor Driven**

Special Instructions:

1. Review manufacturer's instructions.
2. De-energize power to fan motor and media motor drive, tag and lock out circuits.

Check points:

1. Inspect framework and structure. Look for loose or missing bolts, air leaks, condition of flashing or caulking, etc.
2. Inspect all moving parts for proper alignment, freedom of motion, excessive clearance or play, etc. Clean, adjust or tighten as necessary.
3. Inspect powered roll, and take-up roll for correct tracking of media. On manual operation, check wheel or hand crank.
4. On motor drives, check pressure sensing device(s) and/or pressure switches. Test settings for starting and stopping motor.
5. Inspect motor, starter, controls, selector switch for auto warning or indicator lights.
6. Check oil in gear case. Change or replenish as required. Perform required lubrication using graphite where it is suitable. Remove old or excess lubricant.
7. Remove all trash and debris.

Tools & Materials:

1. Standard Tools - Basic
2. Respirator
3. Goggles
4. Appropriate lubricants

F-6 Filter, Throw Away Frequency: Quarterly

Special Instructions:

1. De-energize tag and lock out fan motor circuit.
2. Filters should be replaced when static pressure reading indicates filters are dirty.

Check points:

1. Remove old filters.
2. Vacuum filter section of air handler.
3. Inspect frame, clamps, etc.
4. Install new filters. Make sure direction of airflow corresponds to the airflow shown on the filter, and filters are properly sized to cover the opening.
5. Remove tags, and restore to service.
6. Clean up work area and remove trash.

Tools & Materials:

1. Standard Tools - Basic
2. Filter replacement
3. Vacuum
4. Respirator

F-7 Filters, Electrostatic Frequency: Quarterly

Special Instructions:

1. De-energize power supply, tag and lock out disconnect switch.
2. Ground bus trips, top to bottom.
3. Review manufacturer's instructions.

Check points:

1. Before securing unit, check indicators for defective tubes or broken ionizing wires.
2. Secure filter unit and fan.
3. Wash down each manifold until clean. Units with water wash spray require approximately four (4) minutes with warm water or seven (7) minutes with cold water.
4. If dry filters are dirty, remove dirt or replace filter.
5. While cells are drying, look for defects, particularly broken wires or hum suppressors. Wipe insulators with soft dry cloth.
6. If unit requires disassembly, check it thoroughly, clean, and adjust as required.
7. Restore to service and check for evidence of shorts.
8. Always clean up work area and remove trash

Tools & Materials:

1. Standard Tools - Basic
2. Respirator
3. Cleaning equipment and materials

F-8 Filter, Throw Away, Bag Type**Frequency: Semiannual****Application:**

This guide card applies to bag type, throw away filters. These bag type filters come in various sizes, as do all filters, and in depths from four inches to four feet. Some are simple inserts while others are required to be fitted over a wire frame or clipped to hanger bars.

Special Instructions:

1. Open and tag switches controlling the air handler.
2. Filters should be changed when static pressure reading indicates.
3. Special handling precautions shall be taken when changing filters for shooting or target ranges. NIOSH approved respirator, disposable clothing, and other protection from exposure as needed will be used.
4. Special disposal precautions should be taken to place filters into plastic bags with a minimum of handling. Vacuum bags used to clean filter housings will be disposed of as soon as work on the range filters is completed.

Check Points:

1. Remove old filters.
2. Vacuum filter section of air handler.
3. Inspect frame, clamps, etc.
4. Install new filters. Make sure direction of air flow corresponds to the airflow shown on the filters and that filters are properly size to cover the opening.
5. Remove tags and restore to service.
6. Properly dispose of filters.

Tools and Materials:

1. Standard Tools - Basic
2. Filter replacements
3. Vacuum
4. Respirator (NIOSH approved)
5. Protective disposable clothing
6. Plastic trash bags and wire ties, if required

G-1 Fuel Oil Filter/Strainer**Frequency: Semiannual****Application:**

This guide card applies to inline cartridge filters used on light fuel oils No. 1, 2, or 4, as well as the larger basket type used on heavier oils (#5 or #6).

Special Instructions:

1. Flammable liquids are being handled. Use all applicable safety precautions.
2. Check with operating personnel before starting work.
3. Secure and tag pumps, burners, and other necessary equipment.
4. Shut off and tag inlet and outlet valves.
5. Wear gloves while cleaning strainer. Consult the Material Safety Data Sheets (MSDS) for proper personal protective equipment (PPE).

Check Points:

1. Drain housing, bowl, etc.
2. Remove covers, bowls, housing, etc. to filter/strainer.
3. Remove filter/strainer. Check gasket and replace if required.
4. Clean bowl, housing, etc. with approved solvent.
5. Clean strainer with approved solvent.
6. Replace filter. Reinstall strainer.
7. Replace cover bowl and clean any spillage from the outside.
8. Open inlet valve and vent air.
9. Check for leaks.
10. Open outlet valve, remove tags from valves, pumps, burners, or other equipment.
11. Operate equipment and re-check filter.

Tools and Materials:

1. Standard Tools - Basic
2. Gaskets and filters
3. Solvents approved for use with fuel oils. Consult the MSDS for hazardous ingredients and proper PPE.

H-1 Hot Water Converters (Steam)

Frequency: Annual

Application:

This guide does not apply to boilers or hot water heaters.

Special Instructions:

1. Review manufacturer's instructions.
2. Obtain operating logs.
3. Review operating logs to check loss of efficiency of heat exchange surfaces, indicating scale and/or corrosion build-up.
4. If the insulation is known or suspected to contain asbestos, check the building's asbestos management plan to see it has been tested for asbestos. If it is suspect but has not been tested, have it tested. Manage asbestos in accordance with the plan.

Check points:

1. Inspect element header for signs of leaking or corrosion. Remove corrosion and encrustation.
2. Remove heat exchanger element and clean only if a loss of efficiency is indicated, or signs of leaking around header are evident.
3. Tighten all bolts around header.
4. Renew paint/protective coating/insulation as required.
5. Drain storage and expansion tanks, flush to remove sediment, scale, etc.
6. Clean sight glasses on tanks.
7. Clean strainer and check condition of trap. Report leaks.
8. Clean pump, controls, switches, and starters. Check condition of pump seal or packing, and replace as required.
9. Clean up work area and remove trash.
10. If the insulation contains asbestos, follow the asbestos management plan for isolation, notification, work practice and waste disposal.

Tools & Materials:

1. Standard Tools - Basic
2. Wrenches from stock for large bolts
3. Paint and brushes. Consult the Material Safety Data Sheet to ensure that the paint lead level is 0.06% or less.
4. Cleaning materials. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Hose
6. Goggles

H-2 Hot Water Heater - Gas Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. If the insulation is known or suspected to contain asbestos, check the building's asbestos management plan to see it has been tested for asbestos. If it is suspect but has not been tested, have it tested. Manage asbestos in accordance with the plan.

Check points:

1. Drain several gallons from tank to remove sediment.
2. Manually check operation of safety valve. Check for corrosion.
3. Check all connections - electric, gas and water. Tighten as necessary.
4. Check operation and setting of aquastat. Check hot water temperature with dial thermometer, and set aquastat at minimum value.
5. Check pilot and burner assembly. Clean and adjust nozzles for proper flame distribution and quality.
6. Check operation of electric ignition device, if applicable. Check spark gap and adjust if needed.
7. Check flue for proper draft, leaks, and corrosion. Check thermocouple for corrosion or soot. Clean if required.
8. Clean up work area and remove all debris.
9. If the insulation contains asbestos, follow the asbestos management plan for isolation, notification, work practice and waste disposal.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Thermometer
4. Clamp-on ammeter
5. Gap gauge (auto ignition)

H-3 Hot Water Heater - Steam Coil

Frequency: Annual

Application:

This guide applies to independent domestic hot water heaters, which consists of a hot water storage tank with coils for hot water or steam submerged into the water to be heated. The storage capacity is from 100 to 1000 gallons, with a temperature rise from 90 deg. F to 140 deg. F. The tank will require manholes or handhole inspection plates.

Special Instructions:

1. Review manufacturer's instructions.
2. Review operating logs to check loss of efficiency of heat exchange surfaces, indicating scale and corrosion buildup.
3. If the insulation is known or suspected to contain asbestos, check the building's asbestos management plan to see it has been tested for asbestos. If it is suspect but has not been tested, have it tested. Manage asbestos in accordance with the plan.

Check points:

1. Inspect element header and exterior of tank including fittings, manholes, and handholes for leaks and signs of corrosion.
2. Hand operate and test pressure relief valve.
3. Drain and flush tank.
4. Remove tank inspection plate and inspect tank interior. Record the size and depth of pits, presence of cracks, and condition of openings, fittings, welds, rivets, and joints.
5. Check condition of heat exchanger element. Remove and clean as necessary.
6. Inspect condition of epoxy tank lining.
7. Replace all gaskets and manhole inspection plates, and tighten all bolts as required.
8. Fill tank and check for leaks.
9. Clean strainer and check condition of trap. Report leaks.
10. Clean pump, controls, switches, and starters. Check condition of pump seal or packing, replace as required.
11. Clean, test, and inspect sight glasses, valves, fittings, drains.
12. Inspect structural supports, and repair or replace damaged insulation or covering.
13. Return tank to service and observe temperature control operation. Adjust as required.
14. If the insulation contains asbestos, follow the asbestos management plan for isolation, notification, work practice, and waste disposal.

Tools and Materials:

1. Standard Tools - Basic
2. Wrenches from stock for large bolts

3. Paint and brushes. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less.
4. Cleaning and patching materials. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Hoses
6. Goggles

H-4 Hot Air Furnace

Frequency: Annual

Application:

Hot air furnaces are used primarily to heat, but can be used with refrigerant coils to cool or as a backup for heat pump applications using multi-speed fan motors. The furnace is equipped with a gas/oil burner that is serviced by using guide cards B-2/B-3. The housing contains the burner, heat exchanger, circulating fan, fan motor, controls and safeties. These units can be horizontal or vertical, heating only or heating/cooling. Cooling would be provided by utilizing a C-10 refrigeration-condensing unit, with a refrigerant coil located in the furnace plenum.

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."
4. Schedule shutdown with operating personnel.
5. Coordinate other related preventive maintenance items, such as, burners (B-2/B-3).
6. Shut off fuel and power; tag and lock out all circuits.

Check Points:

1. Remove furnace ends and access panels if applicable.
2. Check the firebox liner or refractory for cracks and leaks.
3. Check smoke stack for obstructions, leaks, etc.
4. Clean bottom of smoke stack (breaching).
5. Clean all fans and motors.
6. Check operation of controls and safeties.
7. Lubricate as required.
8. Check and clean plenum (clean cooling coils and check for leaks, if equipped.)
9. Replace furnace and access panels ends if removed.
10. Check all motors, belts, pulleys, shafts, etc. for alignment.
11. Treat all rusted areas with rust inhibitor and touch up paint.
12. Remove lock out and tags. Restore fuel and power supply.

Tools and Materials:

1. Standard Tools - Basic
2. Vacuum cleaner and attachments
3. Rust inhibitor, paint, brushes. Consult the Material Safety Data Sheet (MSDS) for hazardous ingredients and proper personal protective equipment (PPE). Consult the MSDS to ensure that the paint lead level is 0.06% or less.

4. Cleaning and patching materials. Consult the MSDS for hazardous ingredients and proper PPE.
5. Respirator, goggles and gloves.
6. Flue and stack cleaning brushes.

H-5 Unit Heater, Fuel Oil

Frequency: Annual

Application:

These heaters are used to heat heavy oils between the time it leaves the tank and arrives at the burners.

Special Instructions:

1. Schedule outage with operating personnel.
2. Close and tag all steam and oil valves serving the unit. Drain oil from unit.
3. If the insulation is known or suspected to contain asbestos, check the building's asbestos management plan to see it has been tested for asbestos. If it is suspect but has not been tested, have it tested. Manage asbestos in accordance with the plan.

Check Points:

1. Check traps.
2. Check action of temperature controller.
3. Check exterior insulation for damage.
4. Check action of suction valve.
5. Check relief valve setting.
6. Pull head and check tubes. Punch tubes as required.
7. Check pressure-regulating valve, adjust as required.
8. Check gauges and thermometers, replace if defective.
9. Replace all gaskets.
10. If the insulation or gaskets contain asbestos, follow the asbestos management plan for isolation, notification, work practice, and waste disposal.

Tools & Materials:

1. Standard Tools - Basic
2. Varsol and rags. Use Varsol in well-ventilated areas; do not pour used Varsol down drain. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients, disposal, and proper personal protective equipment (PPE).
3. Tube cleaning material. Consult the MSDS for hazardous ingredients and proper PPE.
4. Gasket material
5. Lubricants - Consult the MSDS for hazardous ingredients and proper PPE.

I-1 Fan Coil Units, Under Window Type

Frequency: Annual

Special Instructions:

1. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".

Check points:

1. Check unit for noise and vibration.
2. Check V-belt condition and tension. Adjust if needed, or replace.
3. Clean and wash permanent filters. Recharge wire mesh filters with oil.
4. Replace disposal filters.
5. Drain and clean condensate pan.
6. Lubricate fan shaft bearings (if not sealed).
7. Lubricate motor bearings sparingly using SAE 10W motor oil (if not sealed).
8. Clean coils by vacuuming or brushing.
9. Use fin comb to straighten coil fins.
10. Clean strainers for accumulation of dirt.
11. Check controls, control valve, trap, freeze-stat, and control-stat for proper operation.
12. Clean fan blades and interior unit surfaces to remove soil.
13. Damp wipe exterior surfaces.
14. Clean surrounding floor area, and remove any dirt and debris from work area.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Fin comb
4. Oiler
5. Filters
6. Belts
7. Vacuum
8. Respirator
9. Goggles

I-2 Induction Units, Under Window Type**Frequency: Annual**

Check points:

1. Clean and wash permanent filters. Recharge wire mesh filters with oil.
2. Replace disposable filters.
3. Drain and clean condensate pan.
4. Clean coils by vacuuming or brushing.
5. Use fin comb to straighten coil fins.
6. Clean strainers for accumulation of dirt.
7. Check controls, trap, freeze-stat, and control stat for proper operation.
8. Check induction nozzles. Clean if required.
9. Clean interior unit surfaces to remove soil.
10. Damp wipe exterior surfaces.
11. Clean surrounding floor area, and dispose of dirt and debris properly.

Tools & Materials:

1. Standard Tools - Basic
2. Filters, if disposable
3. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
4. Vacuum
5. Fin comb

I-3 Fan Coil Unit, Ceiling Hung

Frequency: Annual

Application:

This guide card applies to those ceiling hung units that provide heating and/or cooling and have functions similar to the I-2 fan coil units. They may be equipped with a hot and/or cold water coil or a direct expansion (refrigerant) coil. Those ceiling hung fan coil units with direct expansion coils will have a refrigeration condensing unit (C-10) associated with them and maintenance on this equipment should be accomplished in conjunction with this activity. Ladders, scaffolds, and/or lifts may be required to service this type unit.

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
3. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."
4. Schedule shutdown with operating personnel.
5. Open, lock, and tag electrical circuits.

Check Points:

1. Check unit for noise and vibration.
2. Check V-belt condition and tension. Adjust or replace as necessary.
3. Clean and wash permanent filters. Recharge wire mesh filters with oil. Replace disposable filters.
4. Drain and clean condensate pan.
5. Lubricate fan shaft bearings (if not sealed).
6. Lubricate motor bearings sparingly, using SAE 10W motor oil (if not sealed).
7. Clean coils by vacuuming or brushing.
8. Use fin comb to straighten coil fins.
9. Check for leaks on all lines, valves, strainers, coils, etc. Report leaks to supervisor.
10. Clean strainers for accumulations of dirt.
11. Check controls, control valve, trap, freezestat, and control-stat for proper operation.
12. Clean fan blades and interior surfaces of unit to remove soil.
13. Damp wipe exterior surfaces.
14. Clean up work area.

Tools and Materials:

1. Standard Tools - Basic
2. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

3. Fin comb
4. Oilers
5. Filters
6. Belts
7. Vacuum
8. Respirator
9. Goggles
10. Ladder, scaffold, or lift (as required). Check ladder for defects. Do not use defective ladders.

**I-4 Fan Coil Unit, Ceiling Hung,
VAV Box with Electric Reheat**

Frequency: Annual

Application:

This guide card applies to those ceiling hung units that provide heating and/or cooling and have functions similar to the I-2 fan coil units.

Special Instructions:

1. Review manufacturer's instructions.
2. Review Standard Operating Procedures for "Controlling Hazardous Energy Sources."
3. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection."
4. Schedule shutdowns with operating personnel.
5. De-energize, lock, and tag circuits.

Check Points:

1. Check to see that operating control-stat activates damper/control valve per design specifications. Replace if malfunctioning.
2. Check damper linkage for tightness or damage. Lightly oil moving parts.
3. Inspect dampers for free movement in duct or mixing box. Replace felt or other type seals as required.
4. Inspect mixing box and connecting ducts for air leaks. Correct leaks with duct tape or tighten connections as required.
5. Inspect damper activators for tightness to mounting brackets.
6. Tighten electrical connections to servomotors. Clean vent ports.
7. If pneumatic actuator does not stroke properly, correct sticking valve stem or binding linkage. Replace diaphragm if necessary.
8. Inspect for air leaks around actuator and in air line between controller and actuator.
9. Check unit for noise and vibration.
10. Check V-belt condition and tension. Adjust or replace as necessary.
11. Clean and wash permanent filters. Recharge wire mesh filters with oil.
12. Replace disposable filters.
13. Lubricate fan shaft bearings if not sealed.
14. Lubricate motor bearings sparingly, using SAE 10w motor oil if not sealed.
15. Clean coils by vacuuming or brushing.
16. Clean fan blades and interior surfaces of unit to remove soil.
17. Damp wipe exterior surfaces.
18. Clean up work area.

Tools and Materials:

1. Standard Tools - Basic
2. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Fin comb
4. Oilers
5. Filters
6. Belts
7. Vacuum
8. Respirator and goggles
9. Ladder, scaffold, or lift as required. Check ladder for defects. Do not use defective ladders.

M-1 Motors

Frequency: Annual

Application:

This guide is for induction, wound-rotor and synchronous motors in excess of 1 horsepower. The maintenance specified by this guide is not intended to require disassembly of the motor. This guide does not normally apply to motors rated less than 1 horsepower, for which maintenance is normally limited to cleaning and lubrication, and is done with the maintenance of the driven machine.

Special Instructions:

1. If necessary, schedule shutdown with operating personnel.
2. Review manufacturer's instructions.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
4. De-energize, tag, and lock circuit-serving motor, when applicable.

Preventive Maintenance Check points:

1. Check ventilation ports for soil accumulation, clean if necessary.
2. Clean exterior of motor surfaces of soil accumulation.
3. Lubricate bearings according to horsepower ratings:
 - a. Remove filler and drain plugs (use zerkl fittings in place of filler plug if not installed).
 - b. Free drain hole of any hard grease (use piece of wire if necessary).
 - c. Add grease - use good grade lithium base grease unless otherwise noted.
4. Check motor windings for accumulation of soil. Blow out with air if required, air pressure must not exceed 30 psig.
5. Check hold down bolts and grounding straps for tightness.
6. Check for proper voltage and phase balance.
7. Record amps at full load or at maximum design load to be on system with results expected to be less than nameplate full load amps. Note: An ammeter will give this result.
8. Restore all equipment as it was when this work was started. Remove tags and return to service. Clean up work area.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Lubricants - Consult the MSDS for hazardous ingredients and proper PPE.
4. Volt meter.
5. Amp meter.

P-1 Pump, Centrifugal Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
3. Pump maintenance should be scheduled to coincide with drive motor maintenance Guide No. M-1 where applicable.
4. De-energize, lockout and tag circuit.

Check points:

1. Check that base bolts are securely fastened.
2. On pumps with oil ring lubricated bearings, drain oil, flush, and fill to proper oil level with new approved type oil.
3. Clean pump suction strainers, and pump packing water seal filter/strainer.
4. Check pump packing and adjust or replace as necessary.
5. Start and stop pump, noting vibration, pressure, and action of check valve.
6. Adjust packing.
7. Lubricate impeller shaft bearings. Do not over lubricate.
8. Check motor and pump alignment.
9. Check drive shaft coupling.
10. Clean up work area and remove all debris.

COUPLING SIZE	ALLOWABLE ALIGNMENT
1"-2"	0.101 total ind. reading
Over 2"-4"	0.015 total ind. reading
Over 4"-7"	0.020 total ind. Reading

Tools & Materials:

1. Standard Tools - Basic
2. Alignment indicator
3. Grease gun
4. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

P-2 Pump, Gear and Reciprocating Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
3. Pump maintenance should be scheduled to coincide with drive motor maintenance guide M-1.
4. Open, tag, and lock out circuits serving motor when applicable.

Check Points:

1. Check that base bolts are securely fastened.
2. Observe pump in operation, noting unusual noises or vibration, pressure or leakage.
3. After shutdown, check suction and discharge valves for holding.
4. Lubricate all fittings.
5. Drain oil, flush, and fill to proper level with new oil. Review the Material Safety Data Sheets (MSDS) for proper disposal of used oil. If appropriate, recycle oil at an authorized station.
6. Clean strainer and replace any cartridge type filters.
7. Check packing and adjust or replace as necessary.
8. If applicable, check belts for wear, adjust tension and alignment, and replace belts as necessary.
9. If applicable, check drive shaft coupling and motor and pump alignment.

Tools and Materials:

1. Standard Tools - Basic
2. Grease gun, grease, oil

R-1 Radiator, Heating Frequency; Five Years

Special Instructions:

1. Perform preventive maintenance prior to heating season.

Check points:

1. Remove and inspect seat of trap. Clean out trap is applicable.
2. Replace thermo-element with new or tested unit. NOTE: Replace defective seats in traps fitted with removable type.
3. Check radiator valve for free turning and seating at same time. Check packing.
4. If radiator has automatic temperature regulating valve, remove valve cover and remove dirt by vacuuming.
5. For hot water radiators, check bleed valve.
6. Clean work area.

Tools & Materials:

1. Standard Tools - Basic
2. Radiator brush
3. Vacuum

**R-2 Refrigeration Machine
(Absorption)**

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.

Check points:

1. Clean unit strainer. Clean unit pump motor cooling circuit in accordance with manufacturer's instructions.
2. Check and clean all strainers and traps in steam or hot water supply, condensate return, and condensing water circuit.
3. Use oil-dry nitrogen under positive pressure to check for air leaks around valves, gaskets, seals, etc.
4. Units with external purge pump system:
 - a. Check pulley alignment and V-belt extension.
 - b. Clean purge drive belts with safety solvent.
 - c. Change purge pump vacuum oil in accordance with manufacturer's instructions.

Review the Material Safety Data Sheets (MSDS) for proper disposal of used oil. If appropriate, recycle oil at an authorized station.

5. Lubricate purge pump motor with machine oil.
6. Check and service system controls in accordance with manufacturer's instructions.
7. Add octyl alcohol to working fluids per manufacturer's charts and procedures.
8. Inspect and clean cooling water circuit.
9. Inspect system water circuit. Check log sheets for indications of increased temperature trends.
 - a. If cleaning is required, use chemical flushing methods.
 - b. If chemical flushing is not effective, brush or punch tube bundles until scale is removed.
10. Check pumps, motors, controls, and lubricate as required (evaporator pumps, solution pump).

Tools & Materials:

1. Standard Tools - Basic
2. Gloves.
3. Goggles.
4. Lubricants - Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.

R-3 Central Chilled Water Open Type Unit: Frequency:
Comfort Cooling or Drinking Water, ----- Annual
Special Purpose or Computer Cooling ----- Quarterly

Application:

This guide card applies to chilled water producing units that are self-contained, consisting of refrigeration compressors, air cooled condenser, chilled water coils, refrigerant receivers, fan and motor, etc., contained in a common housing or assembly.

These units are normally installed where:

1. Several packaged air conditioning units are required for seasonal service. One central chilled water packaged unit will serve several packaged air conditioning units.
2. Drinking water is cooled at a central location and circulated to remote fountains.

Special Instructions:

1. If necessary, schedule shutdown with operating personnel.
2. Review manufacturer's instructions.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
4. De-energize, lock out, and tag electrical circuits serving motor when applicable.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the item.
10. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
11. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.
13. Remove access covers prior to accomplishing check points.

Check Points:

1. Condenser.
 - a. Remove debris from air screen and clean underneath unit.
 - b. Pressure wash coil with proper cleaning solution.

- c. Straighten fin tubes with fin comb.
 - d. Check electrical connections for tightness. Check fused disconnect switches for condition and operation.
 - e. Check mounting for tightness.
 - f. Check for corrosion. Clean and treat with inhibitor as needed.
 - g. Clean fan blades.
 - h. Inspect pulleys, belts, couplings, etc.; adjust tension and tighten mountings as necessary. Change badly worn belts. Multi-belt drives should be replaced with matched sets.
 - i. Perform required lubrication and remove old or excess lubricant.
2. Compressor(s).
- a. Lubricate drive coupling.
 - b. Lubricate motor bearings (non-hermetic).
 - c. Check and correct alignment of drive couplings.
 - d. Inspect evaporator tubes for scale. Clean if required. Leak test tubes using a halogen leak detector or suitable substitute.
 - e. Add refrigerant per manufacturer's instructions if needed.
 - f. Check compressor oil level.
 - g. Run machine; check action of controls, relays, switches, etc. to see that:
 - (1). Compressor(s) run at proper settings.
 - (2). Suction and discharge pressures are proper.
 - (3). Outlet water temperature is set properly.
 - h. Check and adjust vibration eliminators. Replace as necessary.
3. Controls.
- a. Check operation of all relays, pilot valves, and pressure regulators.
 - b. Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure.
4. Motors.
- a. Check ventilation ports for soil accumulations; clean if necessary.
 - b. Clean exterior of motor surfaces of soil accumulation.
 - c. Lubricate bearings according to manufacturer's recommendations.
 - (1). Remove filler and drain plugs (use zerk fittings if installed).
 - (2). Free drain hole of any hard grease (use piece of wire if necessary).
 - (3). Add grease. Use good grade lithium base grease unless otherwise specified.
 - d. Check motor windings for accumulation of soil. Blow out with low pressure air or vacuum as needed.
 - e. Check hold-down bolts and grounding straps for tightness.
 - f. Remove tags, start unit, and check for vibration or noise.

Tools & Materials:

1. Standard Tools - Basic
2. Pressure washer
3. Fin comb

4. Paint brushes
5. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
6. Respirator
7. Safety goggles.
8. Gloves.
9. Self sealing quick disconnect refrigerant hose fittings
10. Refrigerant recovery/recycle unit
11. EPA/DOT approved refrigerant storage tanks.
12. Approved refrigerant.
13. Electronic leak detector.

R-4 Refrigeration Machine, Centrifugal

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Coordinate PM of refrigeration machine controls (PM guide R-7) in conjunction with this PM activity.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
4. De-energize, lock out, and tag electrical circuits.
5. The replacement filter-drier cores for the high efficiency purge unit absorb water vapor from the ambient air. They are shipped in sealed containers and are not to be opened until they can be installed and sealed in the purge tank.
6. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
7. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
8. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
9. Recover, recycle, or reclaim the refrigerant as appropriate.
10. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the item.
11. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
12. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
13. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Lubricate drive couplings.
2. Lubricate motor bearings (non-hermetic)
3. Lightly lubricate vane control linkage bearings, ball joints and pivot points. **DO NOT LUBRICATE** the shaft of the vane operator.
4. Remove refrigerant in accordance with manufacturer's instructions. Sample test the refrigerant and oil to verify compliance with the Air Conditioning and Refrigeration Institute standards.
5. Drain and replace oil in compressor oil reservoir including filters, strainers and traps. Have oil analyzed to determine bearing conditions. Review the Material Data Safety Sheets (MSDS) for proper disposal of used oil. If appropriate, recycle oil at an authorized station.
6. Drain and replace oil in purge compressor.
7. Drain and replace oil in purge gearbox. Check and clean oil strainer.
8. Check and correct alignment of drive couplings.

9. Inspect cooler and condenser tubes for scale. Clean if required.
10. Clean all water strainers in the system.
11. Use oil-dry nitrogen to test for leaks per manufacturer's instructions. If leaks are not stopped or corrected, report leak status to supervisor.
12. Pull vacuum on refrigeration machine in accordance with manufacturer's instructions. Add refrigerant as required per specifications.
13. Megger compressor and oil pump motors and record readings.
14. Check dash pot oil in main starter.
15. Tighten all starter, control panel, motor terminals, overloads, and oil heater leads, etc.
16. Check all contacts for wear, pitting, etc.
17. Check and calibrate overloads, record trip amps and trip times.
18. Check and calibrate safety controls.
19. Clean up the work area. Properly recycle or dispose of materials in accordance with environmental regulations.

Tools & Materials:

1. Standard Tools - Basic
2. Gloves
3. Safety goggles
4. Lubricants and gear box oil. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
6. Self sealing quick disconnect refrigerant hose fittings
7. Refrigerant recovery/recycle unit
8. EPA/DOT approved refrigerant storage tanks.
9. Tube cleaning pressure washer.
10. Paint and brushes as required.
11. Dry nitrogen gas, cylinder, and regulator.
12. Approved refrigerant.
13. Electronic leak detector.
14. Megger.
15. Variac.

**R-5 Refrigeration Machine
Reciprocating and Scroll**

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Coordinate PM of refrigeration machine controls (PM Guide R-7) in conjunction with this activity.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
4. De-energize, lock out, and tag electrical circuits.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the item.
10. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
11. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Service drive-coupling and check alignment.
2. Lubricate motor bearings (non-hermetic).
3. Check sequence if multiple stage.
4. Sample test the refrigerant and oil to verify compliance with the Air Conditioning and Refrigeration Institute standards.
5. Drain and replace oil in compressor oil reservoir, including filters, strainers and traps if necessary. Review the Material Data Safety Sheets (MSDS) for proper disposal of used oil. If appropriate, recycle oil at an authorized station.
6. Check crankcase heater if applicable.
7. Inspect cooler and condenser tubes for scale. Clean if required. Leak test the tubes using a halogen leak detector. Inspect condenser coil for cleanliness if air-cooled.
8. Clean all water strainers in the system.
9. Check external interlocks, flow switch, fans, and pumps. Calibrate operating and safety controls.
10. Check and tighten all electrical, control panel, and motor terminals. Check contacts or wear.

11. Check appropriate temperatures and pressures (some are combined for multi-staged scroll systems).
12. Clean up the work area. Recycle or dispose of materials in accordance with environmental regulations.

Tools & Materials:

1. Standard Tools - Basic
2. Gloves
3. Safety goggles
4. Lubricants. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
6. Self sealing quick disconnect refrigerant hose fittings
7. Refrigerant recovery/recycle unit
8. EPA/DOT approved refrigerant storage tanks.
9. Tube cleaning pressure washer.
10. Paint and brushes (as required).
11. Approved refrigerant.
12. Electronic leak detector.

**R-6 Refrigeration Machine
Rotary Screw**

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Coordinate PM of refrigeration machine controls (PM Guide R-7) in conjunction with this activity.
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
4. De-energize, lock out, and tag electrical circuits.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If disposal of the equipment item is required, follow regulations concerning removal of refrigerants and disposal of the item.
10. If materials containing refrigerants are discarded, follow regulations concerning hazardous waste where applicable.
11. Refrigerant oils to be removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and all labels on refrigerant containers.

Check Points:

1. Perform chemical oil analysis, change oil if required.
2. Change compressor oil filter element; clean housing.
3. Inspect filter for metal particles that could indicate bearing wear. Inform supervisor if any are found.
4. Oil return system.
 - a. Clean Strainer.
5. Electrical controls and safety cutouts.
 - a. Check for loose or burnt connections.
 - b. Check oil-heating circuit.
 - c. Check for proper factory settings on safety shutdown controls.
6. Check tightness of motor mounting screws.
7. Check for refrigerant leaks at each joint and weld. Tighten flare nuts or flange bolts as required. Repair weld leaks using certified recovery and recycling equipment to conserve refrigerant. Upon completion of any repairs, unit should be pressure and vacuum tested in accordance with the manufacturer's literature. If leaks can not be stopped or corrected, report leak status to supervisor.

8. Sample test the refrigerant and oil to verify compliance with the Air Conditioning and Refrigeration Institute standards.
9. Tighten all starter, control panel, and motor terminals, oil heater leads, and overloads, etc.
10. Check all contacts for wear, pitting, etc.
11. Check and calibrate overloads and record trip amps and trip times.
12. Clean up the work area. Properly recycle or dispose of materials in accordance with environmental regulations.

Tools & Materials:

1. Standard Tools - Basic
2. Gloves.
3. Safety goggles.
4. Lubricants - Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
5. Cleaning materials. Consult the MSDS for hazardous ingredients and proper PPE.
6. Self sealing quick disconnect refrigerant hose fittings
7. Refrigerant recovery/recycle unit
8. EPA/DOT approved refrigerant storage tanks.
9. Tube cleaning pressure washer.
10. Paint and brushes (as required).
11. Approved refrigerant.

**R-7 Control Panel, Central
Refrigeration Unit**

Frequency: Annual

Application:

This guide card applies to central control panels that are installed to regulate and control large capacity central refrigeration machines. It includes service to controls, controllers, transmitters, sensors, relays, etc., associated with the central control panel.

Special Instructions:

1. Schedule shutdown with operating personnel.
2. Obtain and review manufacturer's information for servicing, testing, and operating.
3. Obtain "As Built" diagrams of installation.

Check Points:

1. Clean and calibrate all controlling instruments.
2. Clean or replace orifices and/or contacts.
3. Check for pneumatic leaks and/or loose wiring and repair.
4. Replace charts, add ink, and check calibration of flow meter, temperature recorders, and kilowatt charts.
5. Check for bad indicator lights and gauges and replace as necessary.
6. Test all controllers and set at proper set points.
7. Check operating data and analyze for proper operation.

Tools and Materials:

1. Standard Tools - Basic
2. Cleaning materials and equipment. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Pressure gauge
4. Temperature analyzer
5. Multi-meter

**R-8 Radiation - Baseboards/Convectors
(Steam, Hot Water, or Electric, per
Linear Foot)**

Frequency: 2 Years

Application:

This guide card applies to baseboard radiator and convector heating units using hot water, steam, or electricity as the heating medium. These units will be found in offices, entrance lobbies, vestibules, etc. They vary from simple finned tube baseboard units with no controls to zoned or individually controlled units.

Special Instructions:

1. Review building plans for special instructions where removal of wall panels is necessary.
2. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".
3. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
4. Secure, lock out, and tag circulating pumps, steam valves, and electric circuits supplying the units to be serviced.
5. Coordinate PM of associated equipment.
6. Rope off or post signs at vestibules or entrances where work involves these areas.

Check Points:

1. Remove covers or wall panels. Note: Extreme care must be taken when removing marble or granite wall panels. These panels are extremely heavy and very fragile.
2. Check housing, braces, supports, hangers, and hardware for signs of deterioration or damage.
3. Wire brush and treat with rust inhibitor all rusted areas.
4. Check coils, piping, and fin material for damage, leaks or looseness. Straighten finned material as necessary.
5. Check temperature or flow controls, shutoff valves, vents and traps for proper operation.
6. Vacuum or blow out finned tube area and interior housing.
7. Touch up paint as required.
8. Clean and replace covers or wall panels and caulk wall panels as required.

Tools & Materials:

1. Standard Tools - Basic
2. Vacuum and/or portable air tank
3. Goggles, respiratory protection, and gloves
4. Rope and/or out of service signs

5. Rust inhibitor and appropriate paints. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less and for the proper personal protective equipment (PPE).

**R-9 Refrigeration Controls, Frequency: Annual
Central System**

Application:

This guide card applies to those controls used to protect and control the operation of central refrigeration units. Included are electric, electronic, pneumatic or a combination of several or all of them. Including, but not limited to capacity controllers, demand controllers, and temperatures as well as pressure controls and safeties.

Special Instructions:

1. Read and understand the manufacturer's instructions.
2. Obtain "As Built" diagrams of the control and safety systems.
3. Replace defective control safeties found while performing preventive maintenance.

Check Points:

1. Check flow or pressure differential switches for proper operation. Calibrate or replace as necessary.
2. Check oil temperature control and safety for proper operation. Calibrate or replace as necessary.
3. Check set point of low temperature control and safety for proper operation. Calibrate or replace if necessary
4. Check capacity controller or demand limiter for proper operation. Calibrate or replace if necessary.
5. Check oil pressure control and safety for proper operation. Replace if necessary.
6. Check high-pressure cutout for proper setting and operation. Adjust or replace if necessary.
7. Check and clean all electrical contacts and pneumatic orifices.
8. Check pneumatic tubing for leaks or damage. Repair or replace as required.
9. Check electrical wiring insulation and connections. Tighten or replace if necessary.
10. Check damper or unloader controller for proper operation.
Check position of damper for proper operation. Calibrate or replace if necessary.
11. Check all settings and set points with manufacturers instructions.

Tools & Materials:

1. Standard Tools - Basic
2. Pneumatic Control Gauge
3. Volt Ohm Meter
4. Manufacturer's Control Kit

R-10 Non-Destructive Chiller Tube Analysis **Frequency: Three Years**

Application:

This guide card applies to all centrifugal and absorption type chillers.

Special Instructions:

1. Coordinate performance of this PM activity with performance of annual PM on the central or packaged chilled water units (PM guides R-2, R-3, R-4, R-5, and R-6, as applicable).
2. Complete an eddy current test of all heat exchanger tubes, both evaporator and condenser (plus concentrator and absorber in absorption units).
3. The test shall be performed in accordance with current requirements and procedures of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section V, Nondestructive Examination, Article 8, Eddy Current Examination of Tubular Products and applicable recommended practice standards of the American Society for Testing and Materials for Eddy Current Testing.
4. A Certified Level II or higher technician or equivalent shall be used for this analysis in accordance with the American Society of Non-destructive Testing Recommended Practices, SNT-TC-1A, or current version.
5. The test is to be witnessed by the Contracting Officer's Representative or designated inspector.

Procedure:

1. Prepare equipment for non-destructive testing (NDT). Remove heat exchanger heads, piping, clean tubes, and erect scaffolding as necessary.
2. Test shall be recorded as required by the ASME code Section V (Article 8 - Appendix I, Article I-20).
3. System calibration shall be confirmed hourly.
4. The written procedure in paragraph I-23, Article 8 - Appendix I in the ASME code is required to be followed.
5. Strip chart recordings shall be provided for:
 - a. Each calibration standard and artificial discontinuity comparator used. Annotate to identify each defect machined in the standard and calibration of each division on the chart.
 - b. Typical good tube in each bundle.
 - c. For each defective tube, annotate to identify tube. Indicate nature and extent of defect.
6. Test each tube to detect, as a minimum, leaks, saddle damage, pitting, interior erosion/corrosion, gasket condition, presence of "tramp" metal, presence of tube bulges, tube seam condition; visual inspection, if possible, of scale build-up, and tube sheet condition.

7. Correct deficiencies as directed.
8. Restore equipment to service.

Reports and Records:

1. A copy of the magnetic tape record shall be maintained by the NDT contractor and furnished if requested by the Government.
2. A preliminary job site report shall be provided as soon as the test is completed.
3. Within ten (10) working days following completion of the test, the NDT contractor shall provide two complete test reports.

Include the following:

- a. Written test procedure
- b. Recommendations - List all tubes recommended for replacement or isolation.
- c. Make complete description of defects (location, depth, inside or outside surface).
- d. Map location - Show tube row, number, and support for each tube bundle.
- e. Name of technician performing tests and evaluating data.
- f. Contractor's certification of technician qualifications.

R-11 High Efficiency Purge Units

Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
3. De-energize, lock out, and tag electrical circuits.
4. The replacement filter-drier cores absorb water vapor from ambient air, so they are shipped in sealed containers. Do not open them until the cores can be installed and sealed in the purge tank.
5. Comply with the latest provisions of the Clean Air Act and Environmental Protection Agency (EPA) regulations as they apply to protection of stratospheric ozone.
6. No intentional venting of refrigerants is permitted. During the servicing, maintenance, and repair of refrigeration equipment, the refrigerant must be recovered.
7. Whenever refrigerant is added or removed from equipment, record the quantities on the appropriate forms.
8. Recover, recycle, or reclaim the refrigerant as appropriate.
9. If appliance is disposed, follow regulations concerning removal of refrigerants and disposal of the appliance.
10. If materials containing refrigerants are discarded, comply with EPA regulations as applicable.
11. Refrigerant oils removed for disposal must be analyzed for hazardous waste and handled accordingly.
12. Closely follow all safety procedures described in the Material Safety Data Sheet (MSDS) for the refrigerant and to all labels on refrigerant containers.

Check Points:

1. Check out and Water Removal
 - a. Perform the purge system control check as described in the controls section of the manufacturer's instructions.
 - b. Purge tank service.
 - 1). Isolate the purge tank by closing the valves on the purge tank inlet and liquid return lines.
 - 2). With the purge condensing unit turned off, pressurize the purge tank through the purge tank drain valve to manufacturer's specifications and test the solenoid valves to insure they seal properly.
 - 3). Check the purge tank sight glass to determine if there is water in the purge tank. If the refrigerant level is visible in the sight glass but there is no water in the tank, then perform the following:
 - a). Connect a refrigerant hose from the purge tank Schrader valve to an access valve on the evaporator.
 - b). Open the vapor line and disconnect the refrigerant hose.
 - c). Proceed with the service procedure.

If, on the other hand, there is a layer of water on the refrigerant in the purge tank sight glass, then perform the following.

a). Connect a refrigerant hose from the purge tank Schrader valve to an approved containment vessel.

b). Disconnect the line at the pump-out compressor.

c). Hold the service switch in the ON position. This will energize the solenoids and allow the purge tank to fill with air. The liquid refrigerant will drain into the container.

d). Pour or siphon the water from the top of the refrigerant in the container. Seal the refrigerant in the container for later use or other disposition.

2. Filter-drier service.

a. Empty the purge tank and relieve the test pressure. Lift the purge tank body from the base plate by removing the mounting bolts that secure it.

b. Remove the cap from the top of the upper filter-drier core. Then remove the two filter-drier cores from inside the purge tank.

c. Visually inspect the core and all internal parts. Clean where necessary.

d. Inspect the tank drain valve and line to insure it is free of any debris.

e. Replace the tank gasket.

f. Install new filter-drier cores and gaskets as necessary.

g. Put the tank back in place using a new gasket and replace the mounting bolts that secure it to the base plate. Torque the bolts to manufacturer's specifications.

h. Reconnect the pump-out line and solenoid valve.

i. Pressurize the purge tank to manufacturer's specifications through the isolation solenoids, with the solenoids energized. Check for leaks. Release the pressure.

j. Switch the purge system to the manual ON position and wait for the pump-out compressor to start.

k. If refrigerant needs to be returned to the system, remove the cap from the purge tank drain valve and connect a hose from the drain valve to the container. As the pump-out compressor operates, a vacuum is created in the purge tank, drawing the liquid refrigerant from the container into the purge tank. Disconnect the hose when completed and replace the valve cap.

l. Open the valves on the purge tank inlet and liquid return lines.

3. Purge pump-out and fault check. This procedure tests the ability of the purge to remove non-condensibles from the unit. This is done by isolating the purge, adding air to the purge tank, and then using the purge compressor to remove the air again.

a. Note the timer setting and reset to for the time recommended by the manufacturer.

b. Set purge control switch on purge control panel to OFF and then to MANUAL ON or depress the RESET switch for a minimum of 1/2 second. This will reset the fault timer and turn on the purge-condensing unit.

c. Close the shutoff valves on the purge tank inlet and liquid return lines to isolate the purge tank.

d. Disconnect the inch line from the inlet of the pump-out compressor.

e. Press and hold service switch in the MOMENTARY ON position for approximately five seconds, energizing the pump-out solenoids and pump-out compressor. The purge will draw air into the purge tank back through the isolation solenoid valves.

NOTE: Repeat this procedure until sufficient air is drawn into the purge tank to initiate a pump-out sequence. Within approximately five minutes the pump-out compressor should start and run until the fault timer setting is exceeded. The pump-out compressor then shuts down.

f. De-energize the purge by turning purge control switch to OFF. NOTE: On retrofit (field-installed) purges, this will reset the fault circuit. On factory-mounted purges, however, press the reset switch to reset the fault circuit.

g. Reconnect the line at the inlet of the pump-out compressor.

h. Restore original fault timer setting.

i. Restart the purge by turning the purge control switch to AUTO.

j. Open the shutoff valves on the purge tank inlet and liquid return lines.

S-1 Strainer, Y-Type**Frequency: Annual****Application:**

This guide card applies to those Y-type strainers that are at remote locations or that are not included under the guide card of equipment that they are associated with (i.e., guide cards P-1, V-2, etc., include the strainers, whereas guide cards A-9, H-1, V-4, etc. do not include the strainers).

Special Instructions:

The maintenance of Y-type strainers, as outlined by this guide card, should be scheduled to coincide with the maintenance of the equipment that they are associated with.

Check Points:

1. Secure strainer isolation valves.
2. Drain strainer housing.
3. Back flush if possible or remove and clean strainer cage, if applicable.
4. Replace cartridge type and clean out strainer housing, if applicable.
5. Reassemble unit or replace drain plug and open isolation valve.
6. Check unit for leaks.

Tools & Materials:

1. Standard Tools - Basic
2. Hose and bucket
3. Gaskets or gasket material
4. Cartridge filter replacements

**S-2 Strainer, Bolted Flange Type
(Water and Steam)**

Frequency: Annual

Application:

This guide card applies to the maintenance of bolted flange type strainers that is not performed along with the equipment they are associated with. See Guide Card S-1 for maintenance of "y" type strainers.

Special Instructions:

1. The maintenance of bolted flange type strainers, as outlined by this guide card, should be scheduled to coincide with the maintenance of the equipment that they are associated with (M-1).
2. Review manufacturer's instructions.
3. Secure and tag inlet and outlet valves.

Check Points:

1. Remove flange cover bolts.
2. If required, use hoist or crane to remove cover plate.
3. Remove device or devices; clean and inspect for damage.
4. Clean strainer housing cover plate and any interior apparatus. Check for cracks and deterioration.
5. Install new cover gasket and reassemble.
6. Remove tags and open valves; check for leaks.

Tools & Materials:

1. Standard Tools - Basic
2. Hose and bucket
3. Gaskets or gasket material
4. Crane or hoist

T-1 Tank, Air/Refrigerant/LP Gas**Frequency: Annual****Application:**

This guide card applies to three types of fixed storage tanks; air, refrigerant, and LP gas. These are large permanently mounted supply or supply or reserve tanks. Not included are main supply tanks serviced by the supplier, or small returnable tanks used on mobile equipment or for maintenance.

Special Instructions:

1. Maintenance shall be coordinated with required inspections.
2. Review the Standard Operating Procedure for "Confined Space Entry."
3. Review the Standard Operating Procedure for "Selection, Care and Use of Respiratory Protection."
4. When personnel are required to enter tanks, test for oxygen deficiency and supply each with proper respirator and ventilating equipment.
5. Secure and tag supply valves.
6. No smoking or open flames permitted.
7. Schedule valve maintenance (guide card V-3) in conjunction with this activity.
8. If asbestos containing materials are present, check the building's asbestos management plan as described in the Environmental Management portion of the Safety and Environmental Management Program. Manage asbestos in accordance with the asbestos management plan.

Check Points:

1. Examine exterior of tank, including fittings, gauges, manholes, and handholes for leaks, rust, and corrosion. Wire brush and touch up paint.
2. Open tank and remove rust, scale and sludge by scraping, wire brushing, or shot cleaning. If the material removed from the tank is hazardous waste, contact the Regional S&EM office for instructions.
3. Inspect interior of tank carefully, recording the size and depth of pits, presence of cracks and condition of openings, fittings, weld, rivets, and joints.
4. Touch up interior coat with an approved protective coating.
5. Inspect structural supports and condition of insulation, if any. If insulation contains asbestos and is damaged or eroded, remove all debris while keeping debris wet; dispose of this material as asbestos-containing waste.
6. Perform hydrostatic test, if required.

Tools & Materials:

1. Standard Tools - Basic
2. Paint. Consult the Material Safety Data Sheet (MSDS) to ensure that the paint lead level is 0.06% or less.

3. Protective coating material. Consult the MSDS for hazardous ingredients and proper personal protective equipment (PPE).
4. Expansion meter or gas meter
5. Approved fire extinguisher. Ensure that the fire extinguisher is properly serviced and that it is in proper working condition.
6. Respirator.

U-1 Unit Heater (Gas and Oil Fired)

Frequency: Annual

Special Instructions:

1. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources."
2. Open and tag electric circuit.
3. Review manufacturer's instructions.

Check points:

1. Clean and adjust heater deflector fins and element.
2. Clean fan and lubricate motor.
3. Clean burner, chamber, thermocouple and control. (Use a high suction vacuum and/or brush.)
4. Adjust pilot or electric ignition device.
5. Inspect vent and damper operation.
6. Operate unit and adjust burner.
7. Check operation of safety pilot, gas shut-off valve, and other burner safety devices.
8. Clean up work site.
9. Test the room air around the unit for carbon monoxide emission. Ensure that carbon monoxide level averages less than 9ppm/day (parts per million/day). If the level of carbon monoxide in the room exceeds 9ppm, turn the unit off and repair. Retest the unit before it is placed back into service.

Tools & Materials:

1. Standard Tools - Basic
2. Fin comb
3. Vacuum
4. CO₂ analyzer
5. CO analyzer
6. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

V-1 Valve, Safety Relief

Frequency: Annual

Application:

This guide card applies to safety relief valves installed on boilers, steam lines, and other equipment. The safety valves are designed to safely relieve excessive pressure, thus preventing rupture or explosion of the pressure parts. Safety valves differ from relief valves in that the safety relief valve opens fully when the applied pressure exceeds its lifting set-point and remains open until the applied pressure drops below its reset point. Relief valve start to open when pressure overcomes the spring pressure and remains open to the degree that the applied pressure pushes it open. When pressure drops, the spring closes the valve.

Special Instructions:

1. The safety relief valves are designed to be operated by steam and should only be tested when sufficient pressure exists to clear the seating area of any debris.
2. Check with foreman and operating personnel before performing this test.

Check Points:

1. Inspect condition of spring, flanges, and threaded connections.
2. Inspect and hand lift the manual lifting lever, checking for binding of the stem or seat. Note that valve returns to proper position when the lever is released.
3. Inspect support brackets and tighten as required.
4. Check that the discharge piping support is tight and not causing stress on the valve.
5. Clean the valve body.
6. Lubricate the stem and lever pivot.

Tools & Materials:

1. Standard Tools - Basic

V-2 Valves, Regulating Frequency: Annual

Application:

This applies to single or double seated, diaphragm or spring loaded pilot operated valves.

Check points:

1. Inspect for dirt collected at bleed port and restriction elbow. Clean if necessary.
2. Inspect joints for leakage. Tighten all bolts
3. Remove and clean line strainer (back-flush where possible).
4. Inspect pressure reading against set point.
5. Inspect pilot line for leaks.
6. Clean up work area and remove all debris.

Tools & Materials:

1. Standard Tools -Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

V-3 Valve, Manually Operated

Frequency:

**Main Line or Critical -- Annual
Other Over Two Inches -- 5 years**

Application:

This applies to valves other than those used on Fire Protection systems. Maintenance for valves used on fire protection systems are described under the appropriate guide for the specific item of fire protection equipment.

Check points:

1. Operate valve in full open/closed position. Loss of ability to close tightly will require inspection of valve seals and discs for wear and contaminant build-ups.
2. Check for sticking valve stems and lubricate stems and fittings sparingly.
3. Replace packing; dress, re-bush, or replace packing gland assembly, if required.
4. Check for freedom of motion on valves equipped with wheel and chain for remote operation.
5. Clean up work site.

Tools & Materials:

1. Standard Tools - Basic
2. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

V-4 Valve, Motor Operated**Frequency: Annual**

Check points:

1. Clean unit and make visual examination of all parts.
2. Operate from limit to limit. Observe operation, look for binding, sluggishness, action of limits, etc.
3. Determine if valve seats and holds properly.
4. Check condition of packing.
5. Check condition of dials and positioners.
6. Apply graphite to moving parts of valve.
7. Lubricate motor and gear box as necessary.
8. Inspect contacts, brushes, motor, controls, switches, etc. Clean and adjust as necessary.
9. Clean up work site.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Lubricants - Consult the MSDS for hazardous ingredients and proper PPE.

V-5 Valve, Hydraulic/Pneumatic/Electric**Frequency: Annual****Application:**

This guide card applies to those valves that are equipped with electric or pneumatic motors or hydraulic drivers. The primary difference between these and other valves is the use of motors to drive them open or closed. They are applied wherever automatic or remote operation is essential. V-4 valves use diaphragms, bellows, or small electric modulating motors to operate the valve, whereas the V-5 valves use electric motors and gear box, air turbines, or hydraulic pistons.

Special Instructions:

1. Review the Standard Operating Procedure for "Controlling Hazardous Energy Sources".
2. Schedule an outage with operating personnel if required.
3. Secure, tag, and lock out associated electric circuits, pneumatic or hydraulic lines before servicing motor, gearbox, or piston.

Check Points:

1. Clean unit and visually examine all parts.
2. Operate from limit to limit and observe. Look for binding, sluggishness, action of limits, etc.
3. Determine if valve seats and holds properly.
4. Apply graphite to moving parts of valve.
5. Clean solenoids.
6. Inspect cylinder, piston, washers or "O" rings, controls, and switches.
7. Clean and adjust as necessary.
8. Clean up work site.

Tools & Materials:

1. Standard Tools - Basic
2. Cleaning equipment and materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).
3. Lubricants - Consult the MSDS for hazardous ingredients and proper PPE.

W-1 Water Treatment for Cooling Systems Frequency: Monthly

Application:

This is applicable to both condenser water and chilled water systems. Included are open re-circulating systems, closed systems, air washers, and sprayed coil unit and evaporative condensers. Once through systems are not applicable.

Note: This maintenance guide does not eliminate daily testing where it is an established policy.

Special Instructions:

1. Chemicals must comply with the Environmental Protection Agency (EPA) regulations and handled in accordance with occupational safety requirements. Employ personal protection against corrosive or hazardous treatment chemicals as appropriate.
2. Be familiar with the Material Safety Data Sheets of any chemicals used in the water treatment program.
3. Water treatment specialists must be properly trained.
4. Water treatment must be based on proven standard engineering practices. Treatment methods that claim mysterious magnetic or catalytic forces shall not be used.
5. Follow treatment as directed by manufacturer or water treatment company.
6. Maintenance includes chemicals, chemical feeding, maintaining proper water conditions, controlling bleed off, protecting idle equipment, and recordkeeping.
7. Select water treatment methods, which protect the life of equipment, maximize heat transfer, and minimize scale, corrosion, solid matter buildup, algae, fungi, biological growth, and water usage. Alternate biocides. Changes to higher dosage levels may be required to control growth.
8. Ensure chemicals are properly stored, test equipment clean, and that chemicals have not passed expiration date.
9. Special attention must be paid to wooden towers and solar heating systems, which can be more difficult to properly maintain.
10. Physical inspections of towers and piping systems are to be made to determine water treatment effectiveness.
11. Maintain records and test results.

Check Points:

1. Inspect cooling tower and piping system to determine effectiveness of water treatment.
2. Test each system for proper pH, total dissolved solids, conductivity, biological dosage level, scale and corrosion inhibitors; test supply water for base conditions.
3. Test for biological growth using either on-site or laboratory. Include iron-related bacteria, sulfate reducing bacteria, slime forming bacteria, fluorescing pseudomonas, and blue-green algae.
4. Add or adjust chemical and biological treatment dosage and water bleed off rate as appropriate.

- a. Follow treatment as directed by manufacturer or water treatment company.
- 5. If makeup is excessive, determine source of leak and correct.
- 6. Monitor and test corrosion coupons as applicable.
- 7. Record test results, action taken, type of chemicals, and treatment quantities used.
- 8. If treatment is not effective, it may require a change in the treatment used or cleaning and preservation of the cooling tower and piping system.

Supplemental Information:

Make-up Water:

- 1. It is advisable to frequently test the quality of make-up water used. Have the water tested and a report performed to show the results. The following is an example of such a report.

REPORT OF
WATER ANALYSIS

DATE:

SOURCE:

DATE ANALYZED:

TOTAL DISSOLVED SOLIDS	ppm	CALCIUM	ppm
ORGANIC MATTER	ppm	MAGNESIUM	ppm
SUSPENDED MATTER	ppm	SODIUM &	
CHLOROFORM (Oil, etc.)	ppm	POTASSIUM	ppm
pH		BICARBONATE	ppm
PHENOLPHTHALEIN ALK.	ppm	CARBONATE	ppm
METHYL ORANGE ALK.	ppm	HYDROXIDE	
HYDROXIDE ALK.	ppm	(as OH)	ppm
HARDNESS	ppm	SULPHATE	ppm
SPECIFIC CONDUCTANCE	ppm	NITRATE	ppm
SILICA	ppm	CARBON DIOXIDE	ppm
IRON	ppm	TURBIDITY	ppm
OTHER	ppm	OTHER	ppm

- 2. Adjust the application of chemicals as determined by the water analysis.

Cycles of Concentration:

The cycle of concentration is determined by the bleed-off rate. Typically, a cooling tower is run between 4 to 6 cycles of concentration. Bleed-off may need to be increased if other indicators determine adverse impact on the tower. Note that the bleed-off rate must be substantially increased as the cycles of concentration approaches two (2). Since bleed-off

adversely impacts water conservation, try to be as conservative as possible while still achieving an effective program.

W-2 Water Treatment for Heating Systems

Frequency: Monthly

Application:

This is applicable to boilers and both steam and hot water distribution and return systems.

Note: This maintenance guide does not eliminate daily testing where it is an established policy.

Special Instructions:

1. Chemicals must comply with the Environmental Protection Agency (EPA) regulations and handled in accordance with occupational safety requirements. Employ personal protection against corrosive or hazardous treatment chemicals as appropriate.
2. Be familiar with the Material Safety Data Sheets of any chemicals used in the water treatment program.
3. Water treatment specialists must be properly trained.
4. Water treatment must be based on proven standard engineering practices. Treatment methods that claim mysterious magnetic or catalytic forces shall not be used. Follow treatment methods as directed by the manufacturer or water treatment company.
5. Maintenance includes chemicals, chemical feeding, maintaining proper water conditions, controlling blow down, protecting idle equipment, and records.
6. Select water treatment methods, which protect the life of equipment, maximize heat transfer, and minimize scale, corrosion, solid matter buildup, biological growth, and water usage.
7. Ensure chemicals are properly stored, test equipment clean, and that chemicals have not passed expiration date.
8. Special attention must be paid to infrequently used boilers, or boilers subjected to long periods of idleness.
9. Physical inspections of boilers and supply and return piping systems are to be made to determine water treatment effectiveness.
10. Maintain records and test results.
11. Follow the Recommended Rules for Care and Operation of Heating (or Power) Boilers as contained in the American Society of Mechanical Engineers.
12. When boilers are out of service, they must be protected from corrosion either by draining the boiler and keeping surfaces thoroughly dry or by completely filling the boiler with properly tested water.

Check Points:

1. Inspect boiler and piping system to determine effectiveness of water treatment.
2. Test each system for proper pH, alkalinity, total dissolved, hardness, conductivity, scale and corrosion inhibitors, and sludge conditioners. Test supply water for base conditions.
3. Add or adjust chemical and biological treatment dosages and water blow down as appropriate.

4. If make up is excessive, determine source of leaks and correct.
5. Record test results, action taken, type of chemicals, and treatment quantities used.
6. If treatment is not effective, it may require change in current methods and procedures.

X-1 Unit Heater, Electric Frequency: Annual

Special Instructions:

1. Review manufacturer's instructions.
2. Disconnect, tag, and lock out electrical circuit.

Check Points:

1. Clean coils and other components with vacuum.
2. Change filter, if necessary.
3. Check for loose electrical connections in unit and tighten as necessary.
4. Clean and wipe any excess dust or dirt and oil as required.
5. Oil motor bearings as necessary.
6. Check operation of fan motor for excessive bearing wear.
7. Check operation of all controls, such as PE switches, dampers, damper operators, and thermostats.

Tools & Materials:

1. Standard Tools - Basic
2. Vacuum
3. Lubricants - Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

X-2 Chemical Feeder Frequency: Annual

Application:

This guide card applies to tank type water chemical feeders with pumps and agitators.

Special Instructions:

1. Review the Standard Operating Procedure for "Selection, Care, and Use of Respiratory Protection".

Check Points:

1. Drain chemical from feeder into storage containers.
2. Flush and clean feeder tank.
3. Flush piping with water.
4. Remove agitator and clean shaft and propeller; lubricate as required.
5. Check oil in pump reservoir.
6. Lubricate pump pistons.
7. Check operation of pressure relief valve.
8. Lubricate motors.
9. Replace chemicals into feeder storage tank.

Tools & Materials:

1. Standard Tools - Basic
2. Rubber gloves and apron
3. Filter air mask
4. Goggles
5. Grease gun and oiler
6. Cleaning materials. Consult the Material Safety Data Sheets (MSDS) for hazardous ingredients and proper personal protective equipment (PPE).

Equipment Life Expectancy

The following list of systems and average age is based on regular preventive maintenance properly performed at prescribed frequencies. There are many other factors that can effect the average useful life. However, this list serves as a guide for future recurring maintenance planning.

System Equipment	Average Age
1. Air Conditioners	
a. Window Unit	10
b. Residential Single or Split Package	15
c. Commercial Through-the-Wall	10
d. Water-Cooled Package	10
e. Computer Room Unit	15
2. Air Handling Units	
a. Built-Up	30
b. Packaged	25
3. Heat Pumps	
a. Residential Air-to-Air	12
b. Commercial Air-to-Air	15
c. Commercial Water-to-Air	18
4. Roof-Top Air Conditioners	
a. Single Zone	15
b. Multizone	15
c. VAV	15
5. Boilers, Hot Water	
a. Steel Water-Tube	24
b. Steel Fire-Tube	25
c. Cast Iron	35
d. Electric	15
6. Boilers, Steam	
a. Steel Water-Tube	28
b. Steel Fire-Tube	25
c. Cast Iron	30
7. Burners	18

8. Furnaces		
	a. Gas Fired	18
	b. Oil Fired	18
9. Unit Heaters		
	a. Gas	13
	b. Electric	10
	c. Hot Water	20
	d. Steam	19
10. Radiant Heaters		
	a. Electric	10
	b. Hot Water	25
	c. Gas	18
11. Air Terminals		
	a. Diffusers, Grills, Registers	27
	b. Induction Units	25
	c. Fan-Coil Units	20
	d. VAV Boxes Cooling Only	25
	e. CAV Boxes	25
	f. Double Duct Boxes	25
	g. Fan Powered VAV Boxes	17
	h. Variable Volume Temperature Boxes	15
12. Air Washers		15
13. Ductwork		30
14. Dampers		20
15. Fans		
	a. Centrifugal	25
	b. Axial	20
	c. Propeller	15
	d. Ventilating Roof-Mounted	20
16. Coils		
	a. Direct Expansion	18
	b. Water	18
	c. Steam	22
	d. Electric	12
17. Heat Exchangers		
	a. Commercial - Shell and Tube	
	i. Steam to Domestic Hot Water	13

ii.	Steam to Heating Water	20
iii.	Water to Domestic Water	20
iv.	Water to Water	25
b.	Residential Immersion Coil	25
c.	Plate and Frame	25
18.	Reciprocating Air Compressors	15
19.	Package Chillers	
a.	Reciprocating	20
b.	Centrifugal	28
c.	Absorption	30
d.	Screw	20
e.	Scroll	15
20.	Cooling Towers	
a.	Galvanized Metal	18
b.	Wood	20
c.	Ceramic	34
d.	Fiberglass	35
21.	Condensers	
a.	Air-Cooled	20
b.	Evaporative	15
22.	Pumps	
a.	Base Mounted	25
b.	Pipe Mounted	10
c.	Sump-Submerged	10
d.	Well-Submerged	10
e.	Condensate	15
23.	Steam Turbines	30
24.	Electric Motors	18
25.	Motor Starters	20
26.	Controls	
a.	Pneumatic	18
b.	Electric	20
c.	Electronic	20
d.	Computer - Direct Digital Controls	20

27. Valve Actuators	
a. Hydraulic	15
b. Pneumatic	20
c. Self-Contained	10
28. Damper Actuators	
a. Pneumatic	20
b. Electric	18
29. Heating and Cooling Piping System	30

HVAC Equipment Inventory Sheet

Date_____

Facility Number_____

Type of Equipment (Boiler, Chiller, etc.)_____

Location of equipment_____

Number of Items_____

Date Installed_____

Manufacturer's Name_____

Date manufactured_____

Model number_____

Serial number_____

Size or Cap_____

Electrical requirements (volts, amps, phase, etc.)_____

Fan information (CFM, rotation, diameter, etc.)_____

Bearing sizes (s)_____

Belt size and number of belt_____

Filters size and number of filters_____

Gas or Oil_____ Fuel Nozzle Size_____

Frequency of RWP (Annual, Semi-Annual, Quarterly, Monthly)_____

Name of Person Conducting Inventory_____