July 25, 2017

Certified Mail-Return Receipt Requested

Ms. Heidi Hollenbach, AQD District Supervisor
Michigan Department of Environmental Quality
State Office Building
350 Ottawa, Ave. NW
Grand Rapids, MI 49503

Dear Heidi Hollenbach:

Holland Board of Public Works hereby submits one hard copy of the **Maintenance and Inspection Plan** for the cooling towers as required by PTI# 107-13E, for EUCOOLTWR, **at ORISPL #50093, SRN# P-0465,** Holland Energy Park.

An electronic copy is available upon request.

If you have any questions regarding this submittal, please contact me at ph# 616-355-1210, jvisscher@hollandbpw.com.

Sincerely,

Judy N. Visscher
Environmental Regulatory Specialist

Cc: Mike Radakovitz, HBPW
Ted Siler, HBPW
Dan Nally, HBPW

Holland Board of Public Works

Holland Energy Park

Maintenance and Inspection Program for the Cooling Towers (EUCOOLTWR)

Prepared 7/24/17 by JNV

Introduction

Holland Board of Public Works (HBPW) received Permit to Install (PTI) No, 107-13E for the installation and operation of a natural gas-fired combined heat and power (CHP) plant known as Holland Energy Park (HEP). PTI No. 107-13E includes requirements to submit a Maintenance and Inspection Plan under Special Condition (SC) III.1 for HEP's cooling towers, identified as EUCOOLTWR, within 180 days of initial startup.

EUCOOLTWR is a three-cell, wet mechanical draft cooling tower with plume abatement by a dry heat exchanger. Particulate in water droplets will be controlled with drift eliminators.

Purpose

The purpose of this Maintenance and Inspection Plan is to document preventative maintenance tasks and inspection frequencies that will prevent malfunctions and/or failures that result in pollutant emissions above any applicable emission limitation.

Maintenance and Inspection Plan

HBPW will use the attached excerpt from the SPX Cooling Technologies Operations and Maintenance Manual for SPX Job # WU1/112.000002, in particular the "Inspection and Maintenance Schedule" provided on page 23. As we gain experience with operating the plant and the cooling towers, we will amend the plan accordingly, as best assures that EUCOOLTWR will maintain compliance with the emission limits specified in PTI# 107-13E, or subsequent permits.

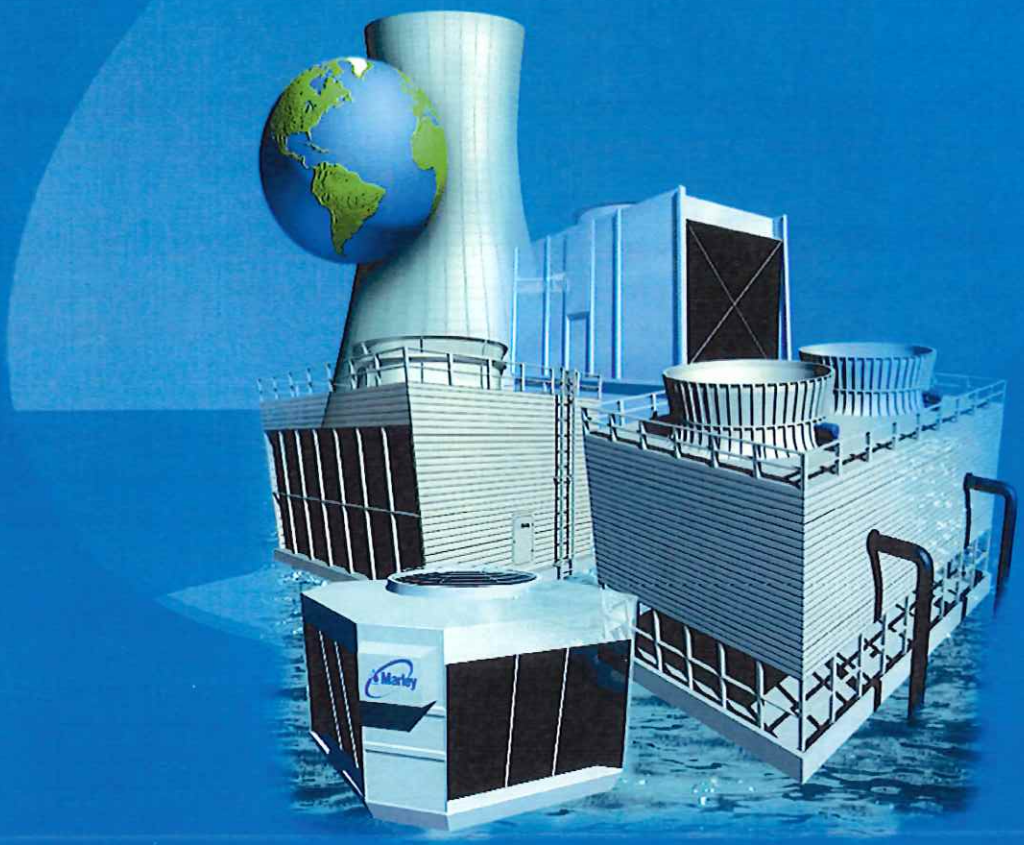
00PAA00AC001

Operations and Maintenance Manual

Holland Board of Public Works Combined Cycle

Holland, MI

SPX Job # WU1/112.000002



SPX Cooling Technologies, Inc.
7401 West 129th Street
Overland Park, Kansas 66213

SPX
COOLING TECHNOLOGIES

maintenance

Tower Maintenance

⚠ Warning

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

Well-maintained equipment gives the best operating results and the least maintenance cost. SPX recommends setting up a regular inspection schedule to insure effective, safe operation of the cooling tower. Use the schedule on page 17 to obtain continuously good performance with the least tower maintenance. See **Cooling Tower Inspection Check List** in this manual. Keep a continuous lubrication and maintenance record for each cooling tower.

HOT WATER DISTRIBUTION SYSTEM–Keep the circulating water and distribution system (piping and nozzles) clean and free of dirt, algae, and scale. Algae and scale may clog nozzles, eliminators, fill, and piping, and may collect on the equipment served thus reducing its performance.

An access hatch in the fan deck with ladder to an intermediate platform provides means for inspection of the plenum area above the eliminators. Removal of an access hatch at the plenum level allows access to the spray chamber for inspection and maintenance of the nozzles and top of fill. Provide surface protection before walking on the fill.

DRIFT ELIMINATORS–Eliminators should be kept clean.

⚠ Warning

Do not walk or step on the eliminators without planking and safety harness.

Cooling Range	Number of Concentrations						
	1.5X	2.0X	2.5X	3.0X	4.0X	5.0X	6.0X
5° F (2.78° C)	.78	.38	.25	.18	.11	.08	.06
10° F (5.56° C)	1.58	.78	.51	.38	.25	.18	.14
15° F (8.33° C)	2.38	1.18	.78	.58	.38	.28	.22
20° F (11.11° C)	3.18	1.58	1.05	.78	.51	.38	.30
25° F (13.89° C)	3.98	1.98	1.32	.98	.64	.48	.38
Multipliers are based on drift of 0.02% of the circulating water rate.							

COLD WATER COLLECTION BASIN (supplied by others)–Inspect collection basin occasionally for leaks and repair if necessary. Keep cold water outlets clean and free of debris. Makeup and circulating water controls must operate freely and maintain the desired water quantity in the system.

maintenance

DRIVE SHAFT–Check drive shaft alignment and condition of couplings every six months. See the *Drive Shaft User Manual* for correcting misalignment, balancing, or replacing parts.

ELECTRIC MOTOR–Lubricate and maintain each electric motor in accordance with the manufacturer's instructions. If repair work is necessary, contact the nearest representative of the motor manufacturer. See Warranty Section of *Marley Electric Motors User Manual.*

FAN–Inspect fan blade surfaces every six months. For detailed maintenance information, refer to *Marley Fan User Manual.*

GEAREDUCER–Make weekly and monthly oil checks. Inspect internal parts during seasonal oil change. Refer to the *Geareducer User Manual* for detailed maintenance instructions.

DRY DAMPERS–Inspect linkages, adjust and lubricate as needed.

VENT DOORS–Inspect linkages and bearings, adjust and lubricate as needed.

PAINTING–Periodically clean and, if necessary, recoat all metal parts subject to corrosion.

Water Usage and Treatment

BLOWDOWN–Blowdown, or bleed-off, is the continuous removal of a portion of the water from the circulating system. Blowdown is used to prevent the dissolved solids from concentrating to the point where they will form scale. The amount of blowdown required depends upon the cooling range (the difference between the hot and cold water temperatures), the composition of the make-up water (water added to the system to compensate for losses by blowdown, evaporation and drift). and the amount of condensed water returned from the ClearSky heat exchanger modules. The following table shows an approximate amount of blowdown required to maintain different concentrations with various cooling ranges—these numbers are reduced by the % of condensed water at a given weather condition:

BLOWDOWN–% OF CIRCULATING RATE

EXAMPLE: 7000 GPM circulating rate, 15° cooling range. To maintain 4 concentrations, the required blowdown is .38% or .0038 times 7000 GPM which is 26.6 GPM.

If tower is operated at 4 concentrations, circulating water will contain four times as much dissolved solid as the make-up water, providing none of the solids form scale or are otherwise removed from the system.

maintenance

The blowdown quantity is normally and most easily achieved using a bleed value activated by a measurement of the water's dissolved solids. In this way, no exact calculation of blowdown GPM is required on an ongoing basis.

CHEMICAL TREATMENT–Chemical treatment is required to control biological growth in the cooling tower fill, basins, and piping. In most cases chemical treatment of the circulating water is not required if adequate blowdown is maintained. In most cases, however, chemical treatment is required to prevent scale formation and corrosion. Sulfuric acid or one of the polyphosphates is most generally used to control calcium carbonate scale. Various proprietary materials containing chromates, phosphates or other compounds are available for corrosion control. When water treatment chemicals are required, the services of reliable water treating companies should be obtained.

Slime, a gelatinous organic growth, and algae, a green moss, may grow in the cooling tower or heat exchangers. Their presence can interfere with cooling efficiencies. Proprietary compounds are available from water treating companies for the control of slime and/or algae; however, compounds which contain copper are not recommended. Chlorine and chlorine containing compounds are effective algaecides and slimicides. If used, chlorine should be added as intermittent (or shock) treatment only as frequently as needed to control the slime and algae. Chlorine and chlorine containing compounds should be added carefully since very high levels of chlorine may occur at or near the point of entry into the circulating water system.

FOAMING–Heavy foaming sometimes occurs when a new tower is put into operation. This type of foaming generally subsides after a relatively short period of operation. Persistent foaming can be caused by the concentrations of certain combinations of dissolved solids or by contamination of the circulating water with foam-causing compounds. This type of foaming can sometimes be minimized by increasing the blowdown, but in some cases foam depressant chemicals must be added to the system. Foam depressants are available from a number of chemical companies.

MAINTENANCE OF FILL PERFORMANCE

⚠ Caution

Owner must keep water clean by treatment, screening, or filtering to avoid the possibility of fill clogging and loss of thermal performance.

Potential Causes of Fill Clogging:

- Bacteria and/or Slime Growth—Can control with chlorine or non-oxidizing biocides.
- Suspended materials—Trash, etc.
- Scale—Can be sulfates, silicates, carbonates, or oxides. Scaling effects can be accentuated by suspended muds.
- Algae and/or Slime—Can control with chlorine or non-oxidizing biocides.

maintenance

Possible Sources of Scale:

- Calcium Sulfate—From make-up and sulfates produced by sulfuric acid for pH adjustment. Calcium sulfate should be kept below 1000 ppm expressed as $CaCO_3$.
- Calcium Carbonate—Generally will not form scale in the cooling tower if carbonate scaling does not occur in the condenser.
- Exceptions: If make-up water contains surplus free carbon dioxide, scaling may be inhibited in the condenser, but may occur in the tower fill because of CO_2 stripping.
- Silicates and Oxides—Silica scale is virtually impossible to remove. Silica scale is unlikely if SiO_2 is held below 150 ppm. Oxides, such as iron oxide, can coat all parts of the system if soluble iron is present in concentrations above 0.5 ppm. Iron oxides do not usually develop into thick scales but can accentuate the development of other scales.

MAINTENANCE OF CLEARSKY PVC HEAT EXCHANGERS

Fouling

- Dust may accumulate in the dry air ducts over time causing reduced heat transfer.

⚠ Caution

Do not use high pressure washing equipment on ClearSky PVC heat exchangers.

- Low pressure washing from a municipal or similar water supply system using a hose with a spray nozzle on a shower setting is recommended. Do not spray a jet stream directly on the PVC ClearSky heat exchangers. Spray water at the top of the ClearSky heat exchangers.

Leaks

- Water should not be allowed to accumulate in the dry air ducts (except when cleaning). Evaporation of water in the dry ducts will reduce plume abatement. Furthermore, in cold climates ice accumulation may cause damage.
- Leaks at casing and or flashing should be resealed.
- Leaks in the PVC heat exchange tubes may be sealed with an adhesive. PVC cement is not recommended because it may soften the plastic. In the event that the source of the leak can not be identified, the wet path of that tube should be plugged. A closed cell flexible foam that can be inserted and removed is recommended.

maintenance

Spare Parts

SPX Cooling Technologies manufactures and maintains a stock of replacement parts for all cooling tower mechanical equipment. Shipment of these parts are normally made within ten days after an order is received. If emergency service is necessary, contact the local Marley representative for assistance.

To prevent prolonged shutdown periods in case of damage to the mechanical equipment, it is suggested that the following parts be carried in the owner's stock:

- One fan assembly.
- One Geareducer assembly.
- One drive shaft assembly.
- Be sure to furnish the tower serial number when ordering parts.

Seasonal Shutdown Instructions

Tower–Drain all tower piping.

During shutdown, clean the tower and make any necessary repairs. Apply protective coating as required to all metal parts. Particular attention should be given to mechanical equipment supports, drive shaft and drive shaft guards.

Mechanical Equipment

Geareducer (shutdown for 3 months or less).

1. Each month, drain water condensate from the lowest point of the Geareducer and its oil system. Check oil level and add oil if necessary. Operate to recoat all interior surfaces with oil.
2. At start-up, drain water condensate and check oil level. Add oil if necessary. Refer to *Geareducer User Manual* for maintenance and lubrication instructions.

Geareducer (shutdown for 3 months or more).

1. If the motors have space heaters, operate mechanical equipment one hour each month.
2. If the motors do not have space heaters, operate mechanical equipment one hour each week.

3. At startup, operate mechanical equipment one hour or until oil is warm, then shut the equipment down. Drain the oil and refill with new oil. Refer to Geareducer Manual for instruction on changing oil. Refer to *Downtime Instruction Manual* for downtime exceeding six months.

Electric Motors

1. Do not start motor without determining that there will be no interference with free rotation of the fan drive.
2. Refer to the *Marley Motor User Manual.*
3. If shutdown period is longer than seasonal, contact your Marley sales representative for additional information.

ClearSky Plume Abatement System

Close dry dampers to prevent foreign objects from entering the dry ducts.

Cooling Tower Cleaning

⚠ Warning

Any evaporative-type cooling tower must be thoroughly cleaned on a regular basis to minimize the growth of bacteria, including Legionella Pneumophilla, to avoid the risk of sickness or death. Service personnel must wear proper personal protective equipment during decontamination. Do NOT attempt any service unless the fan motor is locked out.

Operators of evaporative cooling equipment, such as water cooling towers, should follow maintenance programs which will reduce to an absolute minimum the opportunity for bacteriological contamination. Public Health Service officials have recommended that "good housekeeping" procedures be followed, such as: regular inspections for concentrations of dirt, scale, and algae; periodic flushing and cleaning; and the following of a complete water treatment program including biocidal treatment.

Visual inspection should take place at least once a week during the operating season. Periodic flushing and cleaning should be done at least twice a year. Nozzles should be checked for clogging. Drift eliminators, and easily accessible fill surfaces should be cleaned by use of a moderate-pressure water nozzle, being careful not to cause physical damage. A reliable water treatment program should be installed and maintained.

troubleshooting

Trouble	Cause	Remedy
Motor Will Not Start	Power not available at motor terminals	1. Check power at starter. Correct any bad connections between the control apparatus and the motor. 2. Check starter contacts and control circuit. Reset overloads, close contacts, reset tripped switches or replace failed control switches. 3. If power is not on all leads at starter make sure overload and short circuit devices are in proper condition.
	Wrong connections	Check motor and control connections against wiring diagrams.
	Low voltage	Check nameplate voltage against power supply. Check voltage at motor terminals.
	Open circuit in motor winding	Check stator windings for open circuits.
	Motor or fan drive stuck	Disconnect motor from load and check motor and Geareducer for cause of problem.
	Rotor defective	Look for broken bars or rings.
Unusual Motor Noise	Motor running single-phase	Stop motor and attempt to start it. Motor will not start if single-phased. Check wiring, controls and motor.
	Motor leads connected incorrectly	Check motor connections against wiring diagram on motor.
	Ball bearings	Check lubrication. Replace bade bearings.
	Electrical unbalance	Check voltages and currents of all three lines. Correct if required.
	Air gap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
	Cooling fan hitting guard	Reinstall or replace fan.
Motor Runs Hot	Wrong voltage or unbalanced voltage	Check voltage and current of all three lines against nameplate values.
	Overload	Check fan blade pitch. See Fan Service Manual. Check for drag in fan drive train as from damaged bearings.
	Wrong motor RPM	Check nameplate against power supply. Check RPM of motor and gear ratio.
	Bearings overgreased	Remove grease reliefs. Run motor up to speed to purge excessive grease.
	Rotor rubs stator bore	If not poor machining, replace worn bearing.
	Wrong lubricant in bearings	Change to proper lubricant. See motor manufacturer's instruction.
	One phase open	Stop motor and attempt to start it. Motor will not start if single-phased. Check wiring, controls and motor.
	Poor ventilation	Clean motor and check ventilation openings. Allow ample ventilation around motor.
	Winding fault	Check with Ohmmeter
	Bent motor shaft	Straighten or replace shaft.
	Insufficient grease	Remove plugs and regrease bearings.
	Deterioration of or foreign material in grease	Flush bearings and relubricate.
	Bearings damaged	Replace bearings.
	Incorrect fan blade pitch	See Fan Service Manual for blade pitching instructions.
	Voltage too low at motor terminals because of line drop	Check transformer and setting of taps. Use higher voltage on transformer terminals or reduce loads. Increase wire size or reduce inertia.
Motor Does Not Come Up To Speed	Broken rotor bars	Look for cracks near the rings. A new rotor may be required. Have motor service man check motor.

troubleshooting

Trouble	Cause	Remedy
Wrong Rotation (Motor)	Wrong sequence of phases	Change any two of the three motor leads.
Geareducer Noise	Geareducer bearings	If new, see if noise disappears after one week of operation. Drain, flush and refill Geareducer. See Geareducer User Manual. If still noisy, replace.
	Gears	Correct tooth engagement. Replace badly worn gears. Replace gears with imperfect tooth spacing or form.
Unusual Fan Drive Vibration	Loose bolts and cap screws	Tighten all bolts and cap screws on all mechanical equipment and supports.
	Unbalanced drive shaft or worn couplings	Make sure motor and Geareducer shafts are in proper alignment and "match marks" properly matched. Repair or replace worn couplings. Rebalance drive shaft by adding or removing weights from balancing cap screws. See Drive Shaft User Manual.
	Fan	Make certain all blades are as far from center of fan as safety devices permit. All blades must be pitched the same. See Fan User Manual. Clean off deposit build-up on blades.
	Worn Geareducer bearings	Check fan and pinion shaft endplay. Replace bearings as necessary.
	Unbalanced motor	Disconnect load and operate motor. If motor still vibrates, rebalance rotor.
	Bent Geareducer shaft	Check fan and pinion shaft with dial indicator. Replace if necessary.
Fan Noise	Loose fan hub cover	Tighten hub cover fasteners.
	Blade rubbing inside of fan cylinder	Adjust cylinder to provide blade tip clearance.
	Loose bolts in blade clamps	Check and tighten if necessary.
Insufficient Cold Water Plume	Tower operating in plume abatement mode	See ClearSky Operation Logic Diagram on page 10.
	Insufficient dry air	Close vent doors and incrementally open dry dampers. See ClearSky Operation Logic Diagram on page 10.
	Duty more difficult than design	Tower will plume. Configure for maximum plume mode. See ClearSky Operation Logic Diagram on page 10.

SAFETY FIRST–The tower has been designed to provide a safe working environment while either operating or shut down. The ultimate responsibility for safety rests with the Operator and Owner. When flow to the tower is shut off or when portions of the tower require maintenance, temporary safety barricades may be required around openings, and other safety precautions such as safety harnesses should be utilized where appropriate for compliance with OSHA regulations and standards and good safety practices.

Routine periodic maintenance must be performed on all personnel access and material handling accessories in accordance with the following schedule:

	Ladders, Stairways, Walkways, Handrails, Covers, Decks and Access Doors	Davits, Derricks, and Hoists
Inspect for General Condition	Semi-annually	Semi-annually
Inspect and Repair for Safe Use	Yearly	
Inspect and Repair Before Each Use		As Required

inspection checklist

Date Inspected _____ Inspected By _____

Owner _____ Location _____

Owner's Tower Designation _____

Tower Manufacturer _____ Model No. _____ Serial No. _____

Process Served by Tower _____ Operation: Continuous ☐ Intermittent ☐ Seasonal ☐

Design Conditions GPM _____ HW _____ °F CW _____ °F WB _____ °F

Number of Fan Cells _____

Condition: 1—Good 2—Keep an eye on it 3—Needs immediate attention

	1	2	3	Comments
Structure				
Casing Material _____				
Structural Material _____				
Fan Deck Material _____				
Stairway? ____ Material _____				
Ladder? ____ Material _____				
Handrails? ____ Material _____				
Interior Walkway? ____ Material _____				
Cold Water Basin Material _____				
Water Distribution System				
Distribution System _____				
Header Material _____				
Manifold Material _____				
Branch Arms _____				
Nozzles—Orifice diameter _____ inches				
Heat Transfer System				
Fill _____				
Inlet Face of Fill _____				
Eliminators _____				
ClearSky Heat Exchangers _____				

Use this space to list specific items needing attention: _____

inspection checklist

Condition: 1—Good 2—Keep an eye on it 3—Needs immediate attention

Mechanical Equipment

1	2	3	Comments

Gear Drive Units

Manufacturer _____ Model _____ Ratio _____

Oil Level: Full ❑ Add Immediately ❑ Low, check again soon ❑

Oil Condition: Good ❑ Contains Water ❑ Contains Metal ❑ Contains Sludge ❑

Oil Used—type _____

Seals _____

Back Lash _____

Fan Shaft End Play _____

Any Unusual Noises? No ❑ Yes ❑ Action Required: _____

Drive Shafts

Manufacturer _____ Material _____

Fans

Manufacturer _____ Fixed Pitch ❑ Adjustable Pitch ❑

Diameter _____ Number of Blades _____

Blade Material _____

Hub Material _____

Hub Cover Material _____

Blade Assembly Hardware _____

Blade Tip Clearance _____" min. _____" max.

Vibration Level _____

Fan Cylinder Height _____

Mech. Eqpt. Support Mat'l _____

Oil Fill & Drain Lines _____

Oil Level Sight Glass _____

Vibration Limit Switches _____

Other Components _____

Motor

Manufacturer _____

Name Plate Data: _____ hp_____ RPM_____ Phase____ Cycle_____ Volts_____

F.L. Amps _____ Frame _____ S.F. _____ Special Info. _____

Last Lubrication—Date _____

Grease Used—Type _____

Any Unusual Noise? No ❑ Yes ❑ Action Required _____

Any Unusual Vibration? No ❑ Yes ❑ Action Required _____

Any Unusual Heat Build-up? No ❑ Yes ❑ Action Required _____

inspection checklist

Actuators – Dry Dampers

Manufacturer _____ Model _____ Ratio _____

Motor Manufacturer _____

Name Plate Data: _____ hp _____ RPM _____ Phase _____ Cycle _____ Volts _____

F.L. Amps _____ Frame _____ S.F. _____ Special Info. _____

Last Lubrication—Date _____

Grease Used—Type _____

Any Unusual Noise?	No ❑	Yes ❑	Action Required _____
Any Unusual Vibration?	No ❑	Yes ❑	Action Required _____
Any Unusual Heat Build-up?	No ❑	Yes ❑	Action Required _____

Actuators – Vent Doors

Manufacturer _____ Model _____ Ratio _____

Motor Manufacturer _____

Name Plate Data: _____ hp _____ RPM _____ Phase _____ Cycle _____ Volts _____

F.L. Amps _____ Frame _____ S.F. _____ Special Info. _____

Last Lubrication—Date _____

Grease Used—Type _____

Any Unusual Noise?	No ❑	Yes ❑	Action Required _____
Any Unusual Vibration?	No ❑	Yes ❑	Action Required _____
Any Unusual Heat Build-up?	No ❑	Yes ❑	Action Required _____

inspection and maintenance schedule

General Recommendations

—more frequent inspection and maintenance may be desirable

	Fan and Fan Guard	Motor	Driveshafts and Guards	Geareducer	Eliminators	Fill	Cold Water Basin	Hot Water Distribution System	Float Valve	Suction Screen	Control Valves	Structural Members	Casing	Fan Cylinder	Stairs, Ladders, Walkways, Doors, Guardrails	Davits, Derricks, Hoists	ClearSky PVC Heat Exchangers	ClearSky Dry Dampers and Vent Doors
1. Inspect for clogging					M	M		W		W							M	
2. Check for unusual noise or vibration	D	D	D	D														
3. Inspect keys, keyways and set screws	S	S	S	S														
4. Make sure vents are open				S														
5. Lubricate (grease)		R									S							R
6. Check oil seals				M														
7. Check operating oil level				D														
8. Check static oil level				M														
9. Check oil for water and sludge				M														
10. Change oil				S														
11. Check fan blade tip clearance	S																	
12. Check water level							D	D										
13. Check for leakage				W		S	S	S									S	
14. Inspect general condition	S	S	S	S	Y	S	Y	S	Y	S	S	S	Y	S	S	S	S	S
15. Tighten loose bolts	S	S	S	S														
16. Clean	R	R	R	R	R	R	S	R	R	R	R						R	
17. Repaint	R	R	R	R														
18. Rebalance	R		R															
19. Inspect/repair for safe use	Y		Y												Y			
20. Inspect and repair before each use																R		

D–Daily W–Weekly M–Monthly Q–Quarterly S–Semiannually Y–Yearly R–as Required

SPX®
WHERE IDEAS MEET INDUSTRY

F400 ClearSky cooling tower

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