



EvapTech, Inc
A wholly owned subsidiary of Evapco, Inc

EvapTech, Inc

8331 Nieman Road
Lenexa, KS 66214
Phone: 913.322.5165
Fax: 913.322.5166
www.evaptech.com

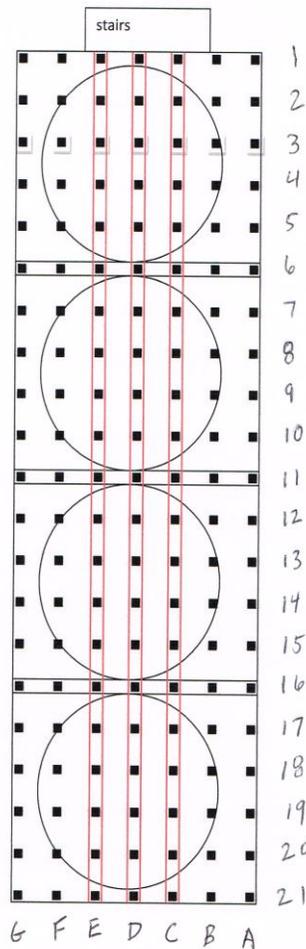
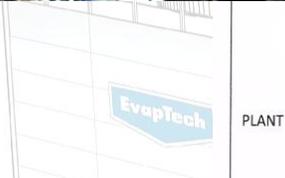
INSPECTION RECOMMENDATION LOCATOR:

- **Structure**
- **Fan Stacks**
- **Casing**
- **Distribution System**
- **Fill & Drift Eliminators**
- **Mechanical Equipment**
- **Tower Access**
- **Fire Protection System**
- **Base Line Status Test**



❖ **Structure:**

- All ties and/or girt lines under the fan area in the plenum area of the tower are in poor and failing condition. The three (3) double 2 x 8 girt lines at C, D and E (in the longitudinal direction – SEE SKETCH BELOW) should be replaced from one end of the tower to the other. All the 2 x 6's at the fan deck level, above the 2 x 8's in the transverse direction, under the fan area, should be replaced as well. Plenum structure area above the drifts, exposed to direct sunlight, is a major concern for wood deteriorating - areas should be replaced.



- In addition to deteriorating members in the plenum area under the fans, there is sufficient evidence of iron rot from old sprinkler hanger hardware on many of the 2 x 8, 4 x 4, and 2 x 6.



- The fan deck is not the original deck. None of the seams are staggered. Plywood under the mechanical support – **motor side has not been replaced.**



- The cooling tower water was treated at the air inlet with a chemical to help prolong the life of the members. Due to this, access to the structure under the fill was non-accessible. Visual inspection did show that the structure seemed to be in fair condition. Should fill media replacement occur, it is highly recommend to further inspect the structure. Louvers were added to the tower to prevent further water splashout – louvers are in good condition with some slight leaks in the corners.

❖ **Fan Stacks:**

- 28' diameter – 18' tall stacks are in good shape. Hardware should be checked occasionally for tightness – several locations @ loose hardware were found.



❖ **Casing:**

- Casing is in fair condition. Areas throughout where exterior gel-coat is worn off exposing fibers throughout. Some leaks are evident, especially at bolt connections on the end walls.



❖ Distribution System:

- The distribution system is in good condition. There are no issues with the fiberglass main header or the 4" PVC lateral spray arms. Nozzles are snap-in style – some are glued and some are held in with tie wraps or radiator clamps. There are about 4 – 6 nozzle with broken splashplates in each cell. Evidence of not a complete radial water pattern has been noticed on the top of the fill. Monitoring of the system is recommended.



❖ Fill Media & Drift Eliminators:

- A main focus of the inspection is to value the condition of the fill tiers, removing packs from various layers and notice any clogging or fouling that may have occurred. The cells maintain 4½ tiers of fill media, 4 tiers of 1' depth and the top tier ½' depth. As a reference, a typical module of 1' x 1' x 8' will weigh approximately 24 lbs. Packs removed (from top to bottom) from Cell 3 & 4 are as follows:
 - Tier 1 (top) 6" pack – good condition = 12 lbs.
 - Tier 2 – 1' pack – slight plugging, heavy solids forming = 30 lbs.
 - Tier 3 – 1' pack – plugging, heavy solids = 33 lbs.
 - Tier 4 – 1' pack – 20% of module plugging, heavy solids = 39 lbs.
 - Tier 5 – 1' pack – flutes restricted, serious plugging = 70 lbs.





- The PVC drift eliminators are in fair condition. A few areas were noticed where there are gaps and/or broken modules. Estimated that there are about 12 modules per cell (1' x 8') to be replaced.



❖ Mechanical Equipment:

- Mechanical equipment supports are in very poor condition in all cells; Cells 1 & 2 is in the worst condition. Major scaling, rusting and scaling of the steel are evident directly under the fan and gear reducer.



- Mechanical Alignment, Fan Pitch, Blade Tracking, and Blade Tip Clearance:

MECHANICAL ALIGNMENT				
	CELL # 1	CELL #2	CELL #3	CELL #4
ALIGNMENT @ GEAR				
Top	-0.006	+0.0085	0	0
Right	0	+0.022	+0.007	+0.008
Bottom	+0.002	0	+0.018	+0.007
Left	+0.0115	-0.016	+0.005	-0.009
ALIGNMENT @ MOTOR				
Top	+0.007	0	-0.002	-0.002
Right	0	-0.005	0	-0.014
Bottom	0	+0.005	0	0
Left	+0.002	+0.005	+0.001	+0.006
FAN BLADE PITCH ANGLE				
BLADE 1	9°	8°	9°	9°
BLADE 2	9°	9°	10°	9°
BLADE 3	9°	9°	9°	9°
BLADE 4	9°	9°	9°	9°
BLADE 5	9°	9°	9°	9°
BLADE 6	9°	9°	10°	9°
FAN BLADE TIP CLEARANCE				
BLADE 1	3/4"	7/8"	1 1/4	1 1/2
BLADE 2	7/8"	7/8"	1 1/4	1 1/2
BLADE 3	7/8"	7/8"	1 1/4	1 1/2
BLADE 4	3/4"	7/8"	1 1/4	1 1/2
BLADE 5	7/8"	7/8"	1 1/4	1 1/2
BLADE 6	3/4"	7/8"	1 1/4	1 1/2
FAN BLADE TRACKING				
BLADE 1	0	0	0	0
BLADE 2	+5/8	+1/8	-1/2	+1/2
BLADE 3	0	+1/8	+1/4	0
BLADE 4	+5/8	0	-1/2	+1/4
BLADE 5	+1/8	-1/8	+1/8	-1/2
BLADE 6	-1 3/8	-1/8	0	0

- Fan assemblies are in fair condition. A major problem is that there is a fair amount of scaling and solids adhering to the individual blades. The amounts realized would cause the fans out of balance due to weight, and create vibration; customer has verified that the fans do shake quite a bit. Recommend cleaning blade solids, re-balancing when completed. The fan blade hardware is in poor condition and should be highly monitored for replacement.



- Gear reducers are in fair condition, however all attachments, such as probes, heaters, fittings, etc. are in poor condition; rusted badly. All cells show evidence of leaks from the pinion seals and upper gaskets in the gear casings. Cleaning and painting the casing is recommended, along with gaskets seals, filter assemblies and heaters. NOTE: the lash and bearing play are good in all 4 gears, with a little more gear lash in Cell 4.





- Motors and drive shafts are in good operable condition. Drive shafts had some solid build-up and should be routinely cleaned. Shaft guards are rusted and should be replaced.



❖ Tower Access:

- The original ladder was replaced with fiberglass – good condition. Stair tower treads are showing wear. One of the stringers on the stair does have a fairly large crack – should be addressed immediately for safety reasons. So movement in the stair towers – additional bracing should be investigated.



❖ Fire Protection System:

- The fire protection system is fed by a 6" water line pipe attached to the longitudinal face of the cooling tower. The pipe was attached with uni-strut and bolted through the columns along the casing wall. The original bolts have rusted substantially and pipe supports within are in danger of falling. The rusting of the bolts has created a considerable amount of iron rot in the structural columns as well as handrail posts creating safety concerns.



Additionally there are a number of pipe hangers that have fallen and are showing significant corrosion. Stainless steel fasteners should be considered. Note of smaller lines on the system are inactive – they should be removed.



❖ **Base Line Status Test:**

- The cooling tower test will be conducted in accordance with the Cooling Technology Institute (CTI) Acceptance Test Code for Water-Cooling Towers ATC-105. This test code provides details as to how a cooling tower is to be tested, what test instrumentation is to be used - acceptable test condition, and how the results are to be interpreted. The test measures the following parameters:
 - *Hot water temperature*
 - *Cold water temperature*
 - *Wet-bulb temperature*
 - *Circulating water flow rate*
 - *Fan power*
 - *Make-up and blow-down temperature and flow (where applicable)*

The cooling tower owner or his representative is responsible for preparing the cooling tower prior to the test. Test preparation normally includes the following:

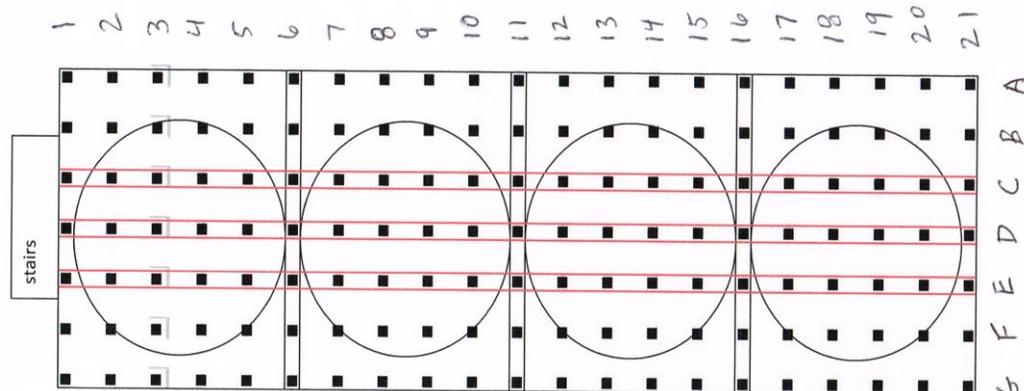
- ✓ Installation of pitot taps for water flow measurement

- ✓ Provide information as to the diameter of the circulating water piping at the water flow measurement location so that an appropriate sized pitot tube will be available
- ✓ Provision of a safe means of access to the pitot taps such as scaffolding or a man lift
- ✓ Provision of electric power (110 VAC) for operation of certain instruments
- ✓ Installation of thermometer taps on the water inlet and outlet of the cooling tower
- ✓ Provision of an electrician or other qualified person for access to MCC to take fan motor power readings
- ✓ Provision of all work permits and safety clearance as required to conduct the test
- ✓ Provide performance curves and other tower design information as required
- ✓ Provision of make-up and blow-down instrumentation or isolation where required.
- ✓ The tower owner must also insure that the test is conducted at a time when plant operating conditions, tower condition, and weather are suitable for testing.
- ✓ For acceptance purposes, the test shall be conducted within the following limitations and variations from design shall not be exceeded:
 - Wet-bulb temperature +/- 15° F
 - Range +/- 20%
 - Circulating water flow +/- 10%
 - Wind velocity average 10 miles per hr.
 - one-minute duration 15 miles per hr.

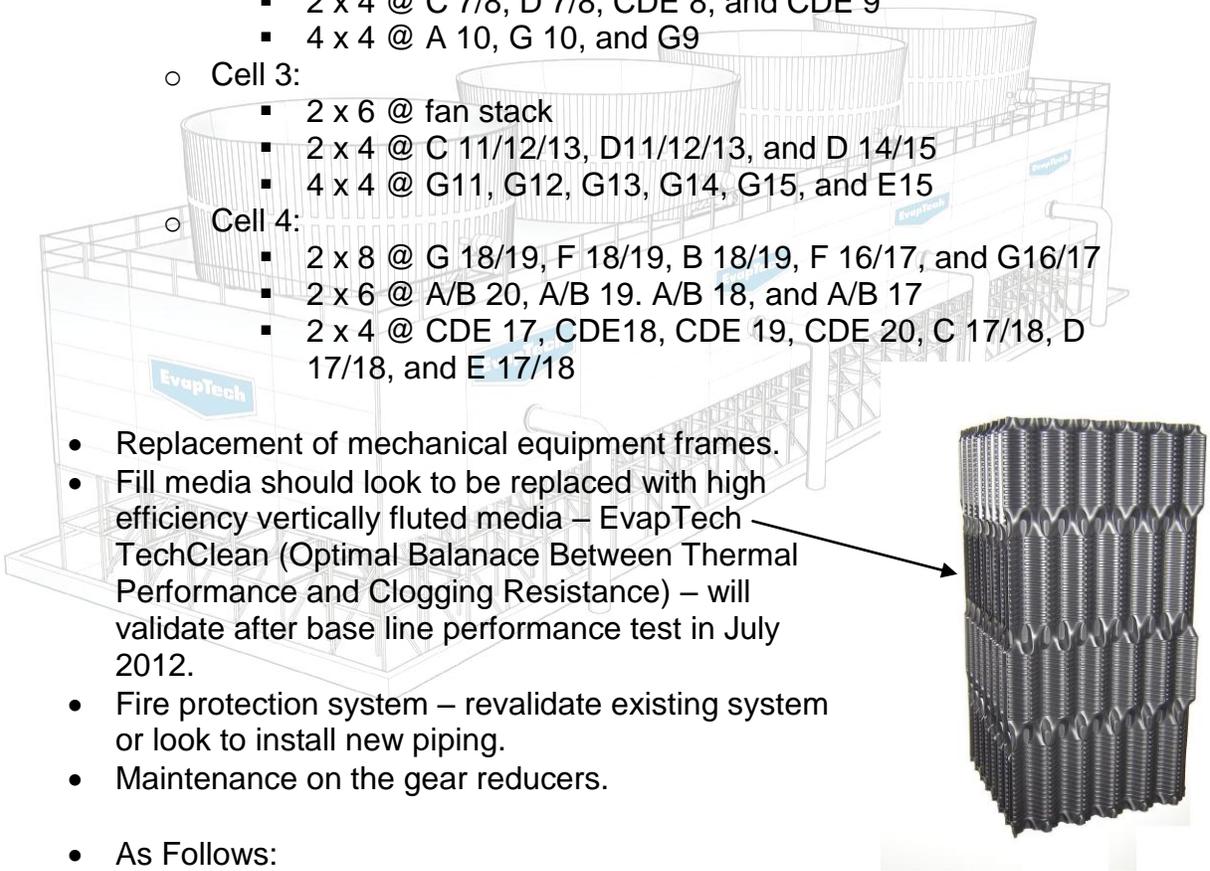
A final report including all raw data and capability calculations will be issued within a reasonable time. Any deviations from the requirements of ATC-105 will be noted in the report.

❖ **Recommendations:**

- Structural replacement (focusing on the plenum area) based on layout below (inclusive of hardware):



- All Cells:
 - 2 x 8's in longitudinal bent lines C, D, and E
 - 2 x 6's in transverse bent lines 2,3,4,5,7,8,9,10,12,13,14,15,18,19, and 20
 - Cell 1:
 - 2 x 8 @ B 1/2, B 3/4, A 3/4, A 6/7, and F3/4
 - 2 x 6 @ A/B 3, C/D/E 1, and CDE 1/2
 - 2 x 4 @ CDE 2, CDE 3, CDE 4, CDE 5, C 1/2, D 1/2, E 1/2, C 3/4, D 3/4, and E 3/4
 - Partition wall C/D
 - 4 x 4 @ C4 and D5
 - Cell 2:
 - 2 x 8 @ B 8/9, G 9/10
 - 2 x 6 @ A/B 10, A/B 8, F/G 8, and F/G 9
 - 2 x 4 @ C 7/8, D 7/8, CDE 8, and CDE 9
 - 4 x 4 @ A 10, G 10, and G9
 - Cell 3:
 - 2 x 6 @ fan stack
 - 2 x 4 @ C 11/12/13, D11/12/13, and D 14/15
 - 4 x 4 @ G11, G12, G13, G14, G15, and E15
 - Cell 4:
 - 2 x 8 @ G 18/19, F 18/19, B 18/19, F 16/17, and G16/17
 - 2 x 6 @ A/B 20, A/B 19, A/B 18, and A/B 17
 - 2 x 4 @ CDE 17, CDE18, CDE 19, CDE 20, C 17/18, D 17/18, and E 17/18
-
- Replacement of mechanical equipment frames.
 - Fill media should look to be replaced with high efficiency vertically fluted media – EvapTech TechClean (Optimal Balance Between Thermal Performance and Clogging Resistance) – will validate after base line performance test in July 2012.
 - Fire protection system – revalidate existing system or look to install new piping.
 - Maintenance on the gear reducers.
-
- As Follows:
 - Typical Inspection & Maintenance Calendar
 - Mechanical Field Procedures & Recommendation



Upon request, pricing can be provided for each selected recommendation

❖ INSPECTION CALENDAR

General Recommendations

—more frequent inspection and maintenance may be desirable

	Fan and Fan Guard	Motor	Driveshaft and Guards	Geareducer	Eliminator	Fill	Cold Water Basin	Hot Water Distribution System	Float Valve	Suction Screen	Control Valves	Structural Members	Casing	Fan Cylinder	Stairs, Ladders, Walkway, Doors, Handrails	Davits, Derricks, Hoists
1. Inspect for clogging					M	M		W		W						
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					
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								
14. Inspect general condition	S	S	S	S	Y	S	Y	S	Y	S	S	S	Y	S	S	S
15. Tighten loose bolts	S	S	S	S												
16. Clean	R	R	R	R	R	R	S	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

❖ **MECHANICAL FIELD PROCEDURES & RECOMMENDATIONS:**

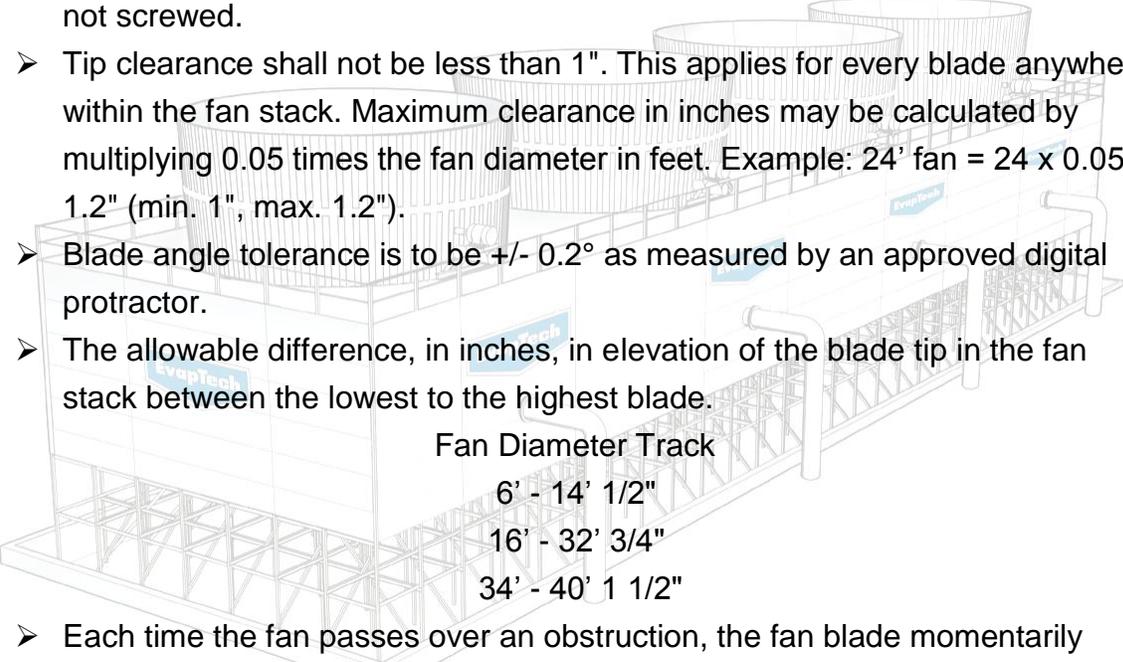
- The screws attaching the junction box and gasket should remain intact to keep moisture from the electrical connections inside.
- Excessive build-up on motor will reduce the ability to dissipate heat through air cooling fans.
- If bearings are not permanently sealed tight, they should be greased regularly. Caution should be taken to avoid over greasing.
- Recommend that the gear box shaft key and motor shaft key be cut as follows:

1. Proper Key Length = Original Key Length + Width of Hub/2. Example: If the gear box arrived with a 6" long key & the gear box side hub is 3 1/2" wide, the proper key length is $6" + 3 \frac{1}{2}"/2 = 4 \frac{3}{4}"$.

- If metal drive shaft and fan is 28 ft. or greater, it has been documented that the drive shaft will bow slightly when stopped in direct sunlight.
- The shaft guards should be attached firmly to the mechanical equipment support to be able to contain the shaft if it comes loose on either side.
- Torque Values:

Bolt Diameter (in.)	Torque Value (foot-pounds)	
	Galvanized Lubricated	Stainless Steel Lubricated
1/2"	80	40
5/8"	160	80
3/4"	280	140
7/8"	450	225
1"	680	340
1 1/8"	970	485
1 1/4"	1360	680
1 1/2"	2370	1185

- The oil line should be of a non-corrosive material such as stainless steel, copper or brass.
- After installing the oil line, fill the oil in the box to the proper level by checking the oil site gauge on the side of the gearbox. Mark this level on the exterior gauge as the stopped or still level. Then with the fan on, mark the gauge as the operating level. Note - the oil level will go down approximately an inch during operation.

- Vent lines must be piped down beside the gear box and outside the fan stack so the air drawn in is not the hot, moist air of the plenum. Note - if the breather line collects water inside, it will lead to a reading error on the oil fill gauge.
 - In storing a gear box for any length of time, prior to or between operations, it should be filled to the top with oil. Normal oil level in operating gear boxes is approximately half full. This is very important - many new gears have been damaged after warehousing because the output bearings were allowed to dry and failed at start-up. DO NOT START gear boxes without draining to operating level - damage will occur and oil will blow the gear box seals.
 - Neoprene or stainless steel edge protectors, glued or stainless steel rivets, not screwed.
 - Tip clearance shall not be less than 1". This applies for every blade anywhere within the fan stack. Maximum clearance in inches may be calculated by multiplying 0.05 times the fan diameter in feet. Example: 24' fan = $24 \times 0.05 = 1.2"$ (min. 1", max. 1.2").
 - Blade angle tolerance is to be $\pm 0.2^\circ$ as measured by an approved digital protractor.
 - The allowable difference, in inches, in elevation of the blade tip in the fan stack between the lowest to the highest blade.
- 
- | Fan Diameter Track |
|--------------------|
| 6' - 14' 1/2" |
| 16' - 32' 3/4" |
| 34' - 40' 1 1/2" |
- Each time the fan passes over an obstruction, the fan blade momentarily unloads due to the disruption of airflow. If the number of times this occurs matches the natural frequency of the fan or the tower, a severe and sometimes damaging vibration problem will be created.