



Cooling Tower Inspection Methodology

Pre-Inspection Assessment – Prior to the commencement of the detailed inspection, the towers to be inspected will be subject to an external visual assessment to determine their “inspectability” including:

1. condition of the cell isolation valves
2. determination of the cell(s) in the worst condition and/or cells that will be the focus of the inspection
3. accessibility of the cells and planking requirements

The Pre-Assessment will be conducted by the EvapTech representative(s) in conjunction with Customer’s safety coordinator for the project and will identify all potential safety and health hazards associated with the work and identify how each hazard will be eliminated or controlled. Note: Since portions of the inspection may be conducted from outside the cooling tower, and require that some casing be removed, and if any Asbestos casing is still present on the towers, provisions must be made to assure proper handling of the Asbestos.

Based on the Pre-Inspection Assessment, the detailed Inspection Work Plan will be finalized in terms of schedule and sequence of cells to be inspected as defined in the Inspection Criteria defined below. Included in the final Inspection Work Plan will be the listing of equipment, planking, and safety provision required to conduct the inspection.

Basis of T&M Estimates – The T&M estimates provided in EvapTech’s proposal do not represent “Not to Exceed” values. The proposed inspection process and T&M estimates are based on the following criteria:

1. Customer will be able to isolate one cell and continue fan operation for a minimum of six (6) hours to dry the structure and at a time based on the inspection sequence defined in the Final Inspection Work Plan.
Note: Since the inspection activity will be performed in the winter months, it is critical that the distribution valves can be completely closed to isolate the cell from all water. This is critical not only in terms of personnel safety, but also to assure there is no ice accumulation that could contribute to additional stress on the cooling tower structure.
2. Customer will provide a hole watch for the entire duration of the inspection.
3. Customer will be responsible for removal, handling and disposal of any asbestos materials.
4. A factor is included to allow for down time, availability of equipment, lost efficiency due to winter climate and/or fogging of the cooling tower and other contingencies.
5. If any tower to be inspected is so hazardous that the inspection cannot be performed safely, Customer will provide whatever protective equipment or remedial repairs required which may add significantly to the estimated man hours and duration required to complete an inspection of the tower and will be in addition to estimated inspection cost included in EvapTech’s proposal.



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6. EvapTech's T&M estimates do include Customer required safety training; drug screens; background check; or daily security check.

Inspection Methodology – EvapTech's recommended Inspection Methodology will employ a series of Inspection Teams. The overall responsibility for execution of the inspections will be assigned to EvapTech's Engineering Manager (John Ahern) who will serve as the Customer Inspection Program Manager (See profile included in the proposal). The on-site responsibility to oversee the inspections will be provided by a professional engineer as the On-Site Coordinator under subcontract to Ragland, Alderman & Associates, Inc. (See profile attached). The individual inspectors including the on-site coordinator will be trained by John Ahern prior to the commencement of the inspections and John Ahern will also be on-site during the first week of the inspection and as required during the duration of the inspections.

EvapTech proposes two distinct teams to perform different scopes of inspection. Team A will focus on cooling tower structures and internal components including fill and drift eliminators and will be comprised of the On-Site Coordinator and a second engineering technician also under subcontract to Ragland, Alderman & Associates, Inc. Team B will be comprised of 4 people under subcontract to Associated Insulation Services, Inc and focus on cooling tower mechanical components and on non-mechanical components, including decking, distribution piping, casing and access equipment (e.g. stairs, ladders, handrails, platforms, etc.). Team B will also support Team A, by performing preparation work including removing fill, eliminators, casing, planking the fan opening, etc.

Deliverable – Using the EvapTech Inspection Form (attached), the detailed results of the inspection will be recorded. The results of the inspections will further be summarized and reported in an Access Database (prototype input form attached). The database will also include priority of repairs or tower replacement, recommended time period by which repair or replacement should be completed, and recommended schedule for next inspection. The database will be a deliverable to Customer and can be populated with data from inspections performed by other contractors.

The EvapTech proposal does not include specific mapping of specific members that require replacement with the exception of mechanical equipment components. Rather, the reporting database will identify general scope of materials and components to be replaced including recommended repairs by component, member size and estimated unit quantity. The later is a more common inspection practice than mapping.

EvapTech has the staff and technology to perform Predictive Analysis on not only the physical condition of the tower, but also the serviceability of the tower, including mechanical and thermal performance evaluations such as, estimating current performance, predicting the impact of performance upgrades and sizing of replacement towers. EvapTech utilizes the services of Jean-Pierre Libert, Principal of ANEMOS Consulting Engineers, LLC. Mr. Libert is under exclusive contract to EvapTech and is



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renowned as a cooling tower thermal performance expert. **EvapTech can provide rates for such services, however the T&M Estimates do not include any costs for these services.**

Inspection Criteria – The Inspection Matrix indicates the number of cells of each component that will be subjected to detailed inspection. In order to perform the inspection on the fill area structure, the fill, eliminators and/or sections of casing will be removed from one complete bay, full height and full air travel (both sides of double flow crossflow towers) in the cell being inspected to allow access for detailed inspection of the structural members.

Structure:

1. Evaluate wood deterioration, including through-cracks, fractures, or decay in wood members
2. Inspect wood members both visually and by tapping with a hammer to evaluate the softness of wood structural members. Inspectors will probe soft members to evaluate presence or potential for wood rot
3. Evaluate tightness of bolted structural joints.
4. Inspect joint connections
5. Evaluate loading, eccentricity, and buckling of cooling tower columns, particularly under heavy loadings such as distribution piping and mechanical equipment
6. Inspect supporting structure under the fan deck and hot water basins (crossflow) for signs of deterioration and deflection

Fan Deck and Hot Water Distribution Basins:

1. Evaluate general condition of the decking material
2. Identify air and/or water bypass between adjacent panels
3. Identify areas where fan deck panel or fan deck overlay deterioration or delamination creates tripping or other personnel hazards

Distribution System:

1. Inspect iron pipe for corrosion and loss of coating material
2. Examine all supports to insure their integrity for continued service
3. Verify tightness of bolted joints
4. Identify deterioration on PVC or fiberglass pipe including cracks, deformation, indications of potential collapse, inadequate circumferential restraint by pipe supports
5. Inspect bell and spigot joints in PVC pipe for excessive movement, leaks and bulging or blow out of gaskets or O-rings
6. Evaluate valve components for corrosion or signs of wear. In cells being isolated for inspection, operate valve manually through its full operating range and assure that valve shuts completely to isolate the cell from circulating water



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7. Check distribution nozzles for clogging or signs of internal wear and missing nozzles
8. Inspect pipe supports for excessive movement

Fill:

1. Splash fill:
 - a. Identify sagging, broken, missing or misplaced, and decaying splash bars or excessive buildup of scale
 - b. Evaluate condition of fill support grids, attachments to splash bars, attachment of grid itself to supporting structure
2. Film fill:
 - a. Identify areas of buildup of scale, algae, or other contaminants on the surface of the sheets
 - i. If evidence of buildup is identified, packs can be sampled for weight as compared to "as new" weight
 - b. Evaluate erosion, sagging, torn sheets, or evidence of ice damage
 - c. Inspect fill sheets and packs for brittleness, tearing and general degradation

Drift Eliminators:

1. Spot check air passages for build up of scale, algae, or other contaminants and accumulation of debris
2. Evaluate the condition of seals to assure that water can't bypass the eliminators through deteriorated or missing seals
3. Wood blades and frames will be evaluated for rot and decay.
4. PVC cellular eliminators will be inspected for brittleness tearing and general degradation

Casing:

1. Identify cracks, holes or general deterioration, including air leaks between adjoining panels
2. Evaluate tightness and general condition of attaching hardware
3. Inspect access doors for general condition and assure that access doors shut tightly during tower operation

Louvers:

1. Identify missing louvers
2. Evaluate deterioration of the louver materials
3. Inspect for excessive scale buildup or biological growth
4. Evaluate condition of louver support members, and of the connections of louvers supports to the cooling tower frame

Mechanical Equipment:

1. Gear Boxes:



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- a. Check for oil leaks around seals
 - b. Check backlash by rotating the pinion shaft back and forth
 - c. Check endplay and bearing wear by pulling up and down on a fan blade tip
 - d. Inspect outside of the case for deposits which may inhibit cooling.
 - e. Evaluate connecting tightness and general condition of attaching hardware
2. Drive Shaft and Couplings:
- a. Check alignment Inspect for corrosion or other damage on the tube
 - b. Evaluate connections between the tube and the flex elements, coupling halves, motor and gear box shafts
 - c. Inspect metallic flex elements for signs of corrosion or fatigue
 - d. Inspect elastomeric flex elements for excessive wear including cracks, and brittleness
 - e. If tower utilizes an intermediate bearing housing support check alignment of both shafts and tightness and condition of hold-down hardware
3. Fans:
- a. Measure the fan blade pitch angle
 - b. Inspect the blades and hub for indications of corrosion, erosion, or excessive buildup of deposits
 - c. Inspect the surface of fan blades for cracks or other deterioration
 - d. Evaluate the tightness and condition of the hardware attaching the blades to the hub
 - e. Measure tip clearance between fan tips and the fan cylinder using the longest blade
4. Fan Cylinders:
- a. Inspect the overall condition of the material
 - b. Evaluate the tightness of all assembly and hold-down hardware
 - c. Inspect for leaks between stack segments
5. Mechanical Equipment Supports:
- a. Inspect all steel components for corrosion or loss of metal and broken or cracked welds
 - b. Evaluate tightness and condition of connections between the mechanical equipment and the support
 - c. Evaluate the tightness and condition of connections between the support and the tower structure

Stairways, Ladders, Walkways and Handrails:

1. Inspect for presence of wood decay or steel corrosion
2. Inspect for loose or deteriorated treads, handrails, and stringers on stairways and walkways; and deteriorated rungs and rails on ladders
3. Evaluate tightness and condition of all bolted connections on stairways and ladders and between them and the cooling tower structure