The Triangle Papers

EPA Headquarters, Federal Triangle, Washington, DC

Volume 1, Issue 1
April, 2005

The purpose of The Triangle Papers is to facilitate improved Preventative Maintenance (PM) programs. Issues that are considered timely or critical are presented for informative purposes , discussion, action and as a catalyst for improvement.

The Systems Connection: - Chemical Water Treatment

One Depends of The Other

All of the components of the Heating, Ventilation and Air Conditioning Systems (HVAC) are interconnected with each other to form a complete and workable operating system. The performance of each unit of the HVAC systems is dependant on the proper operation of all of the individual components.

For instance, even if an Air Handler is operating as it was designed, but the Chiller is not operating properly, the space will not be cooled to the desired temperature. The entire purpose of the Air Handler, which is to provide adequate comfort conditions to the occupants, is negated even though the Air Handler is performing as it should.

If just one component of the System fails to do its job due to poor maintenance, the entire System can fail to perform as intended.

The following are descriptions of typical problems created by poor, inadequate or improper maintenance procedures. The effects on the System as a whole and on other individual components are described.

Water, Water Everywhere

One of the most critical Operating and Maintenance (O&M) deficiencies found at the EPA Headquarters buildings is the Water Treatment Program of the various open and closed loop water systems. These systems consist of the chilled water, condenser water, hot water heating and Glycol heating loops.

Inadequate or improper water treatment creates multiple and severe problems in the HVAC systems.

Several problems with the Water Treatment Program have been uncovered during the evaluation. Some of the problems are common to both the East-West and the North-South buildings. Some problems are unique to only one set of buildings. This article will describe common findings that can affect the Systems in both sets of buildings.

Testing ... 1, 2, 3

A key factor in the success of the Water Treatment Program are consistent and accurate testing procedures. There are three separate testing agencies responsible for performing tests of the chemical treatment of the various HVAC water systems.

Chemical analysis needs to be performed weekly and monthly

Monthly testing is done by the Chemical subcontractor. Each set of buildings has a separate Chemical sub-contractor. A written report of the findings is provided to the Operating and Mainte-

nance Contractor and to GSA.

Weekly tests are supposed to be performed by the building O&M staff. These tests are not conducted on a consistent basis. Test results are not always available.

A third set of tests is performed by a GSA testing facility. Copies of these tests are not readily available on site.

Testing needs to be performed by skilled personnel, capable of assessing problems and recommending immediate solutions

To be effective, all testing must be done on a consistent basis by qualified technicians.

To derive the benefits of the testing procedures, the test results must be reviewed by competent people who understand the meaning and significance of the information contained in the test reports.

The results can then be translated into recommendations for modifications to the Water Treatment Program. The information can also be used to determine if any changes or repairs to other system components are required.

The testing of the Water Treatment Program is not consistent and the test results are not readily available. The results of the testing are not being reviewed by competent technicians. As a result, little to no corrective action is being taken to ensure the Water Treatment Program is effective in protecting the various water systems.

The testing of the condenser water for the East-West building has shown that the chemical concentrations have been consistently low for over a year.

Low chemical concentrations can be the result of improper feed that does not provide adequate chemical flow to meet the system requirements.

However, the most common cause of low chemical concentrations is excess loss of water from the systems. This can be due to leaks in the piping system. In the closed loop systems, there are no readily apparent or visible leaks. Further assessment may determine that excess water pressure is building up in these systems, causing pressure relief valves to discharge water, therefore causing extreme make-up water requirements.

In the case of condenser water, one of the main causes can be from excess bleed due to faulty or improperly set controls. A known major cause in the East-West condenser water loop is overflow of the tower basin due to faulty or misadjusted make up water controls. This has already resulted in using an overabundance of chemicals at higher than necessary costs.

Insufficient chemical concentrations over a long period of time creates a potential for severe problems in the water systems. Any system that has improperly treated water flowing through it is subject to serious damage. Scale and corrosion are the major problems.

Typical Effects of Oxidation and Corrosion

(Example shown is not from EPA buildings)

Not So Cool Chiller

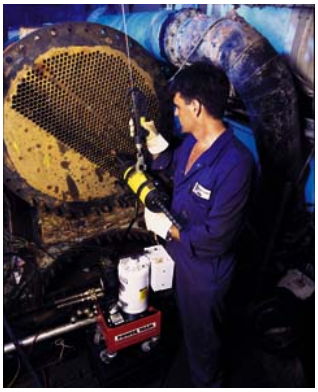
Scale in the chiller heat exchanger tubes has a significant impact on chiller performance. Heat transfer is drastically reduced. This will reduce chiller capacity. In severe cases the chiller may not provide enough cooling capacity to meet the cooling load.

The chiller will operate at a high refrigerant pressure that may be severe enough to cause it to shut down on its safety controls, resulting in total loss of cooling.

This operating condition will result in premature failure of the equipment or frequent and high repair costs. Early replacement of a chiller could cost $500,000 to $750,000 or more. High energy consumption and costs will also take place.

Corrosion can destroy the steel end bells or heads of the chiller condensers. In severe cases the results of corrosion can be holes in the condenser heads creating leaks.

Chillers need to be opened up to have their tubes inspected, and to have their tubes brushed. Excessive tube wear can cause expensive tube replacement, or even tube breaches.



The steel tube sheet within the condenser can also be severely corroded. In extreme cases the steel can become so pitted around the copper condenser tubes that water can leak into the refrigerant system. This is a major and costly repair that requires the chiller to be out of service for long periods of time.

Pay The Piper

Corrosion in the interior of the condenser water piping can seriously reduce the pipe wall thickness or even cause holes in the piping. Premature replacement of condenser water piping within an existing building is very expensive. In some cases the cooling systems cannot be operated while the piping is being replaced.

Cut-away section of pipe showing internal corrosion. (Example shown is not from EPA buildings.)

Corrosion can also create a heavy buildup of rust and other deposits within the condenser water piping. This condition will restrict water flow in the systems. Reduced water flow through the chiller condenser can also cause high operating pressures, which may cause the chiller to shut down.

The orifices of gauges and other instruments can become plugged causing them to be inoperative or inaccurate.

Scale and corrosion within the chilled water piping system creates other problems. Particles of scale or rust can be circulated in the chilled water loop. These particles can become lodged in control valves and affect operation of the controls.

The Tower of Rubble

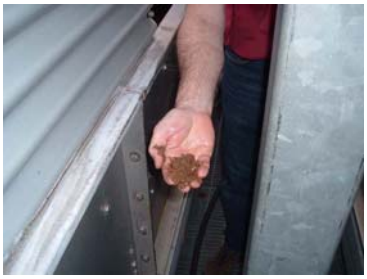
Improper water treatment can also cause severe damage to the cooling tower structure, Galvanized metal Cooling Towers, like those installed in EPA Headquarters at the Federal Triangle, are the most affected by poor water treatment.

North-South cooling tower, showing tower overspray creating rust and corrosion.

The metal structures are damaged by rust and corrosion. In advanced stages the structural members of the tower are weakened. The bottom of the basin can rust through creating leaks with loss of water and chemicals. Constant exposure to chemicals can also cause roof damage.

Calcium and other deposits will collect on the “Fill Elements” and “Drift Eliminators”. This can affect air flow through the tower reducing the cooling capacity of the Tower.

East-West cooling tower, showing rusted scale and particulates from the bottom of the sump.



Rust and corrosion particles as well as calcium buildup on the spray and distribution nozzles will reduce water flow. This condition contributes to

reduction of cooling capacity. If the distribution nozzles become severely restricted, the Hot Deck Reservoir will overflow. This also causes loss of water and chemicals.

Loose debris created by particles of rust, corrosion or calcium deposits will collect in the Cooling Tower basin. The debris will migrate to the intake screen and clog the screen. This will restrict water flow to the chillers.

East-West cooling tower, showing sump strainer covered in debris and scale.

Loose debris in the system will clog pump strainers. Pump impellors can also become worn. Both conditions will reduce water flow in the systems.

Reduced water flow, or condenser water that has not been cooled to design conditions, will affect Chiller operation. The Chiller will operate at high refrigerant pressures and its capacity will be reduced. In extreme conditions the Chiller will shut down on safety lockout.

History is Repeating Itself

In April of 2005, GSA employed a contractor to drain the East-West chilled water closed loop system, to remove glycol. After replacing thousands of gallons of water, the system was left untreated. After six weeks, it remains untreated.

In May of 2005, GSA plans to drain the East-West open loop condenser water system, to remove glycol. Continued assessment may indicate cross contamination between the closed and open loop systems.

Both of these systems require immediate and effective chemical water treatment.

Truth and Consequences

The truth is that the Chemical Water Treatment Program is one of the least understood or respected of the HVAC system components. The term “Chemical” introduces an air of mystery that is supposed to be understood by only the select few who provide the chemicals.

The truth is that the Chemical Water Treatment Program affects more components of the HVAC systems than almost any other single segment of the system.

The truth is that a poor or inadequate Chemical Water Treatment Program can cause the most damage to the overall HVAC systems.

The truth is that the O&M team staffs (contractor and GSA) in all buildings are inadequately trained to perform the required testing, interpret the results and implement timely and effective solutions.

The truth is that a poor Chemical Water Treatment Program will result in higher than normal energy costs, water costs and chemical costs.

The truth is that spillage of chemicals on the roof may cause premature failure of sections of the roofing systems.

Overflow of cooling tower water onto East-West roof..

The truth is there are **serious consequences** if the purpose of the Chemical Water Treatment Program is not upheld. Every major piece of equipment in the HVAC Systems will experience rapid degradation and premature failure. The financial impact of this degradation and failure could easily cost **Millions of Dollars**.