5.3 Once-Through Cooling

Applicability

This BMP is intended for those industrial water users that circulate water from a lake or bay to remove heat generated from industrial equipment and mechanical devices such as heat exchangers, condensers, or process equipment. Water is consumed in the process by forced evaporation on the lake or bay. In addition a number of facilities with cooling lakes or ponds supplement the dependable yield of the plant reservoir by pumping water from another water source such as a lake or river.

Description

Cooling involves the removal of process energy in the form of heat. This BMP centers on the practices for optimizing the water-use efficiency of the once-through cooling systems and the makeup to the cooling reservoir from other sources.

The Environmental Protection Agency ("EPA") defines once-through cooling as water passed through the main condensers in one or two passes for the purpose of removing waste heat. This definition would also apply to other types of large heat exchangers that utilize cooling water to remove heat in one or two passes. Typically, large volumes of water at ambient temperatures are pumped from one arm of a lake or bay, through the heat exchange equipment where heat is transferred, and then are discharged to another arm of a lake or to a separate bay system. After the warm water is discharged to the receiving water body, heat is liberated from the once through cooling water primarily by evaporating a small portion of the total volume pumped. The cooled water then circulates back to the plant intake where it is again pumped back through the plant to provide cooling. For cooling reservoirs, the natural evaporation from the pond surface must also be made up or replenished.

Once-through cooling is the favored choice for cooling needs in electric power plants and many other large facilities such as petrochemical complexes, primarily for overall economical, operational, and reliability factors. Alternatives to once-through cooling in large facilities are recirculating evaporative cooling towers, dry cooling by induced air flow, and combination wet/dry (hybrid) cooling systems. Because of the significant amounts of capital investments and variability of operating expenses associated with each, cost effectiveness decisions on the type of cooling process to be used will generally be made during the planning and development of new facilities.

Water efficiency measures that should be implemented for existing once-through systems include:

1) sizing of pumps with cooling equipment to optimize heat transfer,
2) proper maintenance and repair of pipelines, intake and discharge structures, and
3) optimization of heat loading to the system.

For those plants that have an additional makeup supply to the cooling reservoir, the plant must carefully balance the makeup requirements to the cooling lake with the need to pump the additional water from the other sources. The cooling ponds should be optimally sized for efficient cooling with consideration for minimization of evaporative losses. For plants on cooling lakes that do not supply potable water, the use of alternative make-up water sources such as treated wastewater or reuse of water from other processes should be considered. At coastal locations, the use of saline water should be evaluated to provide complete or partial cooling for high heat load areas of the plant or as a replacement for higher quality water.

Implementation

After identification of water-cooled equipment, implementation should consist of the following actions:

1) Perform an equipment efficiency evaluation on each water-cooled system to optimize the effective heat transfer to the cooling water which thereby results in the optimum amount of cooling water being force evaporated.
2) Replacement or upgrades of small water-cooled systems with equipment using alternative cooling modes such as air-cooling or non-aqueous systems to reduce the heat load placed on the cooling reservoir.
3) Evaluate the cooling pond makeup requirements to optimize the amount of water required to be pumped to the plant reservoir.
4) Evaluate alternative sources of cooling pond makeup water such as reclaimed water from mining activities, wastewater from other industrial facilities, or wastewater from publicly owned treatment works.
5) Operation of the water-cooled processes and equipment in an efficient manner at all times. This includes maximization of external air-cooling opportunities, optimization of heat exchange equipment, use of solenoid valves or other methods for shutting down of systems when not in use, proper sizing of pumping equipment including consideration for variable speed drives, and keeping all structures and equipment maintained in optimal operating condition.
6) For industrial facilities located adjacent to coastal areas, consider utilizing saline water as a cooling source. Typically such a decision would be made during the design phase for a new process unit.

Schedule

If the water user chooses this BMP, the following is a recommended schedule:

1) The industrial water user should identify water cooled equipment and complete an efficiency evaluation in a timely manner. Evaluations of very large or complex systems should be completed within twelve (12) months of beginning this BMP.
2) The industrial water user should upgrade identified systems within a normal planning and budget cycle to implement the BMP in order to achieve the

maximum water efficiency benefit in a reasonable time frame. For changes implemented over multiple budget cycles, changes should be implemented in a progressive manner to increase efficiency.

3) Once-through cooling systems should be operated optimally at all times following the guidelines of this BMP.

Scope

To accomplish this BMP, the industrial water user should do the following:

1) Industrial water users with one facility, or several facilities with the same or very similar industrial processes, should perform an efficiency evaluation and perform upgrades or replacements as outlined in Section D.
2) For industrial water users with multiple facility sites, or multiple industrial processes, a progressive implementation schedule should be followed, implementing the BMP in successive facilities until all facilities have been evaluated and conservation measures implemented.
3) Cost effectiveness considerations may result in partial implementation of this BMP at one or several of a large number of facilities.

Documentation

To track this BMP, the industrial water user gathers and maintains the following documentation and can utilize industry accepted practices:

1) Number of once-through cooled devices or systems and description of the process the cooling is used for, type of cooling process, and water use stream;
2) System design requirements for cooling including temperature, volume, and duration of flows (hr/day);
3) Where meters exist, the daily water use records for each system as appropriate for make-up water, discharge, and flow through the system. If discharge permits are held, these records should be kept in conformance with the requirements of the Texas Commission on Environmental Quality or other appropriate regulatory authorities.
4) Written details and records of all facility replacements, modifications, and upgrades of cooling systems made to meet the requirements of this BMP; and
5) Details of alternate water sources opportunities considered.

Determination of Water Savings

Water savings should be calculated based upon a quantified water balance for the entire cooling lake and plant water use systems. Changes in cooling lake volumes resulting from historic inflows, surface evaporation, forced evaporation, return flows from plant operations, seasonal differences in evaporative demand, seepage, and rainfall contributions to the water in storage should all be evaluated in the water balance analysis. Based on this analysis the industry should optimize the amount of makeup water needed to properly operate their reservoir. While it is recognized that each site will have unique circumstances for water conservation, opportunities may exist to reduce surface evaporation or percolation losses from the lake and increase potential return flows from the plant. These water saving opportunities should be included as terms in the water balance.

Cost-Effectiveness Considerations

The industrial water user should determine the cost effectiveness to implement each identified replacement or equipment upgrade in its once-through cooling facilities or operations, utilizing its own criteria for making capital improvement decisions. A cost effective analysis under this BMP should consider not only the capital costs of any equipment or process changes and improvements, but also the one-time costs of any feasibility studies, water quality sampling and testing, and regulatory costs. Additional ongoing costs to be considered may include staff and labor, chemical and treatment costs, additional costs or savings in energy use, purchased water supply costs, and potential savings in wastewater treatment costs.

References for Additional Information

1) The Electric Power Research Institute ("EPRI"), a non-profit energy research consortium which provides science and technology-based solutions to the energy industry, has conducted or has several ongoing projects that address water use, water availability, and water utilization.
2) The U.S. Department of Energy's Office of Fossil Energy has ongoing research in multiple aspects of water management issues for industry. www.fossil.energy.gov/programs/powersystems/
3) *Process Cooling & Equipment,* monthly magazine published by BNP Media focuses specifically on cooling equipment, materials and supplies used during the manufacturing process. http//www.process-cooling.com
4) *Water Efficiency Guide for Business Managers and Facility Engineers*, State of California Department of Water Resources, October 1994.