MEMO

TO: Michael Thomas
San Luis Obispo Regional Water Quality Control Board

FROM: Ron Rimelman, Project Manager, Tetra Tech, Inc.
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DATE: October 30, 2002

SUBJECT: Drift and Plume Abatement – Morro Bay Power Plant (**Revised**)

Tetra Tech, Inc. has been asked to provide further analysis of the subjects of drift and salt deposition, which could become important concerns within the community of Morro Bay, if cooling towers are given serious consideration as an alternative to the existing once through cooling system at the Morro Bay power plant.

Summary

Modern cooling towers are constructed with drift elimination equipment in place; and although additional drift reduction may be possible by relatively inexpensive means, the degree of additional drift reduction is likely small and very difficult to verify. At the Morro Bay plant, if seawater was used for makeup, cooling tower drift would likely cause some visible salt deposition in the nearby community. The impacts of drift, beyond causing aesthetic concerns, is difficult to predict, however, and, if cooling towers are given serious consideration as an alternative means of cooling at the power plant, modeling to predict patterns of deposition should be performed.

Discussion

Drift

Tiny water droplets carried out of an open recirculating cooling system are called drift. Drift is important because it contains all of the dissolved and suspended solids that are present in the recirculating cooling water. If drift droplets land on an automobile or vegetation, for example, and the water evaporates, the solids are left behind, causing a small blemish or even corrosive conditions. Drift is distinguished from a cooling tower plume, which is caused by the condensation of water vapor out of the highly saturated air that exits a cooling tower. Cooling tower plumes do not carry the dissolved and suspended solids present in cooling water, because solids remain behind, when cooling water evaporates. Cooling tower plumes may cause visual impacts, fogging, or icing in cold weather climates but do not result in the deposition of salts – a phenomenon that is attributed to drift.

Cooling towers are generally constructed with drift elimination technology in place; and manufacturers of large cooling towers generally provide systems that have drift "losses" as low as .001 percent of the recirculating cooling water rate. Field verification of drift below this level is very difficult and not reliable.

Based on .001 percent of the recirculation rate, the amount of drift from an open recirculating, wet cooling system can be estimated at approximately 1 gallon per 100,000 gpm of recirculating cooling water. Seawater makeup will be approximately 3.0 percent solids (30,000 mg/l), so that the solids content of drift can be conservatively estimated at .25 pounds per 100,000 gpm of recirculating cooling water, when seawater is used for makeup. This is a conservative figure because, in an open, wet cooling system, as pure water is being evaporated to dissipate heat, dissolved and suspended solids are left behind in the cooling water and are present in higher concentrations than in makeup water. Operation of the wet cooling system at 1.2 to 1.5 cycles of concentration would result in .3 to .4 pounds per minute of solids leaving the cooling system in drift per 100,000 gpm of recirculating cooling water.

The cooling tower alternatives presented for Morro Bay would use a total cooling water recirculation rate of approximately 250,000 gpm, so that the amount of solids carried from the cooling system via drift could range from .75 to 1 pounds per minute.

<u>Drift Reduction</u>

Drift elimination in a cooling tower is accomplished using drift eliminators, or baffles, that change the path of air flowing through the tower. When air hits a baffle, it changes direction; but when water droplets hit a baffle, they lose velocity and fall back into the recirculating cooling water flow. One method of improving drift reduction may be to use two passes, rather than a single pass, of drift eliminators in the cooling tower. The amount of additional drift reduction will be, however, difficult to verify. And, any reduction of drift below this range, will not be directly proportionate to the amount of additional drift elimination media that is placed within a cooling tower.

Based on discussions with technical staff of Marley Cooling Technologies, a second pass of drift eliminators may reduce drift below .001 percent of the recirculation rate; however, the degree of drift reduction below this range is verifiable only in controlled conditions and not in the field. And, because water droplets that are still entrained within the air pathway after one pass will be very fine, to a large extent, they will remain entrained in the air pathway and will not be influenced by a change in the direction of air flow created by the second pass of drift eliminators.

One cooling tower manufacturer has suggested to Tetra Tech, Inc. that hybrid cooling system designs, more typically used for plume abatement, will also reduce drift. In such a cooling system, a heat exchanger for dry cooling is placed before or after the wet cooling section but in the air pathway, or parallel to the wet cooling section. Warm, dry air from the dry cooling section is mixed with the highly saturated air exiting the wet cooling section, resulting in less saturation of effluent air, less condensation, and less opportunity for a visible plume to form.

In a hybrid design, cooling water travels from the power plant's steam condenser to both the dry and wet sections of the hybrid cooling tower. The amount of open recirculating cooling water flow would be approximately equal to that of a wet cooling system design; i.e., the potential for drift would be approximately the same. The possibility of reducing drift occurs because, when a heat exchanger is placed in the cooling tower, a much larger dry area (plenum area) of the cooling tower is created. This significantly larger plenum area may provide much more opportunity for water droplets to fall back into the recirculating water flow, rather than be carried out of the system as drift. There may be some merit to this suggestion; however, entrained water droplets that have passed the drift elimination section of the cooling tower to reach this point in the system will be very fine and may not separate from the air flow.

Costs of Drift Reduction

Cooling towers can be designed to include a second pass of drift eliminators, and most existing towers can be retrofitted with a second pass. At Morro Bay, the cost of this equipment would be a small fraction of the facility's total costs to retrofit from the once through cooling system to a wet cooling tower design. A second pass of drift eliminators, however, will also have a small negative impact on cooling efficiency; and actual drift reduction, beyond what is achieved by standard drift elimination technology (a single pass of drift eliminators), will be small and difficult to verify.

The cost of a hybrid cooling tower, designed to reduce visible plumes, and incidentally reduce drift, would be approximately two times that of a wet cooling tower system designed for the same thermal load. To use such a design solely for its potential to reduce drift would not be justified, because the potential for a hybrid design to reduce drift below the .001 percent range appears to be theoretical only and difficult to verify in field applications. In its Evaluation of Cooling System Alternatives for the Morro Bay Power Plant of May 2002, Tetra Tech, Inc. has already presented cost estimates for hybrid cooling systems.

Impacts of Drift in the Morro Bay Community

The impacts of drift will be highly site and facility specific and dependant on such variables as cooling system design and operation, local meteorological conditions, and the type and proximity of receptors. And, there is little actual experience using salt water makeup in very large cooling towers. Modeling to project salt deposition patterns can be done, however, if wet cooling with seawater makeup is given further consideration as a feasible cooling alternative for the Morro Bay power plant.

Based on modeling of fresh water cooling tower systems, Tetra Tech, Inc. does believe that the use of cooling towers with seawater makeup at the Morro Bay facility, which is within one half mile of the community, can result in a degree of local salt deposition that will cause aesthetic concerns; i.e., salt deposition will be apparent. The effects on vegetation, automobiles, and the rest of the Morro Bay community are hard to predict. Impacts of drift from cooling systems using freshwater makeup are rarely a concern. However, drift from a cooling system using seawater makeup will have ten times the solids content; and the impacts will be, in theory, ten times as great as a similarly sized system using freshwater makeup. This would be especially true in the location of the Morro Bay power plant, which is located so close to the community.

Besides potential impacts of salt deposition, use of seawater makeup on the scale contemplated at Morro Bay may also cause a change in odors in the near vicinity of the cooling towers. Although such odor would not be harmful and is usually associated with the beach, a change or new odor can raise concerns within the community.

EPA's Position on Drift

Regarding drift, the EPA, in its Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities (EPA-821-R-01-036), states that costs for drift abatement were incorporated into its cost estimates for new cooling towers, as modern cooling towers already utilize advanced materials to minimize drift effects. This view corresponds to the view expressed by Tetra Tech, Inc., above. EPA does not mention a cooling technology as a means to further reduce drift, but mentions only the possibility of acquiring buffer land to minimize the effects of drift, where necessary. For plants projected to use estuarine/tidal water as makeup, when upgrading from once through to cooling tower systems, the Agency concludes that impacts on crops and ornamental vegetation would be minimal. The Agency offered support for this conclusion from the conclusions of NUREG-1437, which summarized examination of eighteen nuclear facilities, the Chalk Point plant, a review of literature, and information provided by natural resources and agricultural agencies, to arrive at the same conclusion. The conclusions of the EPA and of NUREG-1437 appear to focus on effects to crops and ornamental vegetation and do not address potential impacts to more urban receptors.

Plume Abatement

The only reliable means for minimizing plumes associated with cooling towers is to use a hybrid (wet/dry) cooling design. Such a design results in evaporative and non-evaporative heating and a reduction of the relative humidity of air leaving the cooling tower. The effectiveness of such technology for plume abatement at the Morro Bay facility will be dependent on many site-specific variables, including cooling system design and operation and local meteorological conditions. There is considerable experience, however, with hybrid cooling systems, and some degree of plume abatement could be accomplished, with effectiveness being most closely related to local, ambient humidity levels.