

Cooling Off

State Investigations Show Reductions in Cooling Tower Emissions

Three years ago, GHASP reviewed 12 state investigations of cooling water towers in the Houston area conducted by the Texas Commission on Environmental Quality (TCEQ) in 2002 and 2003. We found that measured emissions exceeded the permitted, grandfathered, or otherwise accepted rate by 138%.¹ In reviewing 20 investigations conducted roughly a year later, GHASP found that measured emissions were about 76% less than the accepted rate. In other words, TCEQ investigations indicate that in 2002-03 cooling towers were emitting far more than expected, but in 2004-05, they were emitting less than expected.

The improvements may be due in part to new cooling tower regulations² adopted by the TCEQ in 2003, and modified in 2004, as part of a regulatory initiative to tighten controls on all stationary sources of highly reactive volatile organic compounds (HRVOCs) in the Houston area. In the past, cooling tower monitoring was conducted as part of leak detection and repair programs, and the frequency of monitoring varied greatly.

The new regulations require that by December 31, 2005, facility operators implement continuous monitoring of volatile organic compound (VOC) concentrations in the water of cooling towers in HRVOC service. Because more cooling towers are being monitored regularly or continuously, it is possible that an increasing number of emissions estimates submitted by industry to government agencies are based on actual monitoring data rather than on a standard calculation method. Thus, it is easier for the operator to determine if the facility is actually in compliance and more difficult for it to hide violations. The tighter controls on HRVOCs also include a site-wide emissions cap of 1200 pounds of HRVOCs per hour (lbs/hr), regardless of whether the emissions come from cooling towers, flares, process vents, pressure relief valves, or any combination thereof.³

This apparent turnaround suggests that many chemical plants and refineries made the necessary improvements in anticipation of the new regulations. It also indicates that the TCEQ may be taking a stronger stand in enforcing the rules. However, the TCEQ needs to address some problems that continue to affect permitting and enforcement of cooling

tower emissions. In several instances, investigators suspected that cooling towers were polluting at rates higher than allowable limits, yet operators were not issued notices of violations. This situation can be traced to permits that fail to adequately specify emission limits and to inadequate investigation efforts. In addition, the 2004-05 investigations focused on facilities not yet investigated, but the TCEQ did not follow up on the 2002-03 investigations of cooling towers with the highest volume of emissions. Therefore, we cannot determine conclusively if the worst emitters have improved. Finally, these new regulations apply only to cooling towers in HRVOC service, so facilities not in HRVOC service, which could have as great or even a greater impact on ozone formation, may suffer from the same inadequate monitoring and control of cooling tower emissions as before.

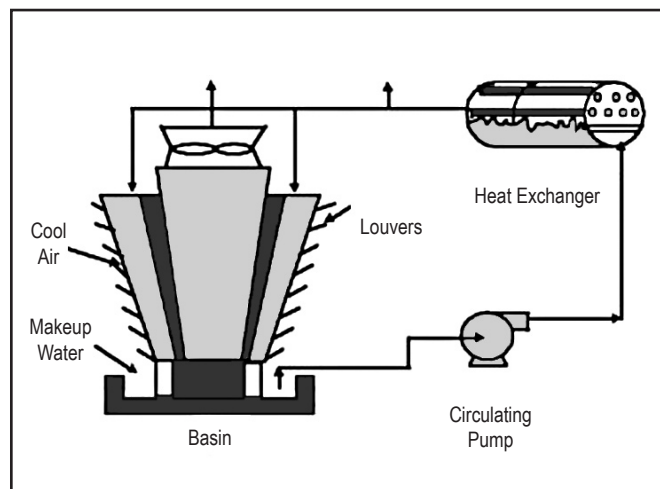
Background

Cooling towers are used in a variety of industrial applications, some of which have little or no air emissions of concern. For instance, cooling towers at power plants remove heat from water circulating through the steam condenser. The dramatic plume sometimes seen rising from a power plant cooling tower is water vapor, which should be benign. Although some industry representatives describe cooling tower emissions at chemical plants and refineries as benign, this is not true. In these applications, heat exchangers serve as the interface between the recirculating water from the cooling tower and the hot process chemical stream. Since the process stream is normally at a higher pressure than the cooling water stream, leaks of chemicals into the water can develop through metal corrosion, cracking, or seal failure. Leaked lower-molecular-weight chemicals will be stripped out of the recirculating water, and exit with evaporated water in the vapor plume.

Even a small leak of a toxic air pollutant at high pressure can have a significant impact on air quality. Yet because these cooling tower emissions were erroneously considered benign or trivial, repairs of even significant cooling tower leaks have sometimes been deferred until the next plant shutdown, which could be months away.

Prior to 2002, these leaks largely avoided regulatory scrutiny because agency investigators did not make intensive unannounced inspections of cooling towers. Since then, however, environmental investigators have inspected almost half of the approximately 280 cooling towers at 75 major chemical plants and refineries in the Houston area. The first

Figure 1: Cooling Tower



Source: Puckorius & Associates Inc.

set of investigations began in June 2002 and continued through June 2003. The second set began in April 2004 and continued through April 2005. Typically, investigations were unannounced, and included a review of company records and sampling of cooling tower water. Not every cooling tower was checked at some facilities visited by investigators, though.

From an air quality perspective, the most significant concern with cooling tower water is the concentration of VOCs that will vaporize from the water. Also, to effectively analyze the contaminants, the sample must be concentrated 50-fold. So field investigators today most often use the El Paso Method to measure cooling tower leaks. Generally, this involves air stripping a sample of cooling tower water to transfer the volatile contaminants to the air, and then measuring the concentration of those contaminants in the air.

During a field investigation, if the field measurement and material balance calculations indicate the cooling tower emission rate at the time of inspection is greater than the permit allows, the investigator collects an air sample for a complete analysis by gas chromatography (GC) in a laboratory. Violation notices, generally, are issued only if the GC analysis indicates that the VOC concentration exceeds a permit limit.

Apparent Improvements in Emissions

For this report, we compared the 2002-03 investigations (Table 1) reviewed for our earlier report to the 2004-05 investigations (Table 2). We added information from several 2002-03 investigation reports that was not available at the time of our original report. We also show measurements of VOCs in lbs/hr, rather than in pounds per year.

In the table, the "Accepted Rate" is a baseline number based on a widely-used method for calculating an accepted or expected emission rate, while the "Measured Rate" is an estimate based on measurements by the investigators. To determine the "Compliance Rate" for a given facility, we added the measured rates for the cooling towers that appear to be in compliance with permit conditions, and then compared this rate to the total measured rates for all of the cooling towers investigated at the facility.

The difference between the two sets of investigations is dramatic. However, with one exception (Chevron Phillips Chemical Co. Cedar Bayou Plant),⁴ the plants investigated in 2004-05 are different from the ones investigated in 2002-03. In 2002-03, only 6 of the 12 plants investigated (50%) were determined to be in full compliance with permit limits, and the aggregated compliance rate of all the cooling towers covered by these investigations was only 6%. In 2004-05, 17 of the 20 plants investigated (85%) were determined to be in full compliance with permit limits, and the aggregated compliance rate was 29%.

As shown in Table 3, the measured rate of VOC emissions from the cooling towers investigated in 2002 and 2003 was more than double the accepted emission rate, while in the 2004 and 2005 investigations, the measured emission rate was only 20% that of the accepted emission rate. Thus, we estimate that from 2002-03 to 2004-05 there could have been as much as a 90% reduction in VOC emissions from cooling towers at chemical plants and refineries in the Houston area. But this needs to be confirmed by follow-up investigations at those plants having high emissions in 2002 and 2003.

Issues with TCEQ Investigations

In our first report, we raised several issues with the TCEQ related to the control of leaks from cooling tower systems. Based on our review of the 2004-05 investigations, several issues remain.

First, in a number of instances, the laboratory GC detected total organic content lower than was measured in the field, and lower than the permit limit, so a violation notice was not issued. These

Table I: 2002-03 Cooling Tower Investigation Findings

2002 – 2003	Plant	Investigation Date	Cooling Tower Emissions (lbs of VOCs per hour)		Compliance Rate
			Accepted Rate	Measured Rate	
	Mobil Baytown Facility (RN102579307)	May 03	55.3	78	8%
	Texas Petrochemicals Houston Facility (RN100219526)	Nov 02	9.3	65.3	0%
	Shell Oil Deer Park (RN100211879)	Jan 03	5.7	58.8	0%
	Enterprise Mont Belview West Complex (RN102323268)	Oct 02	3.7	42.6	2%
	Crown Central	Jun 02	3.3	30.2	2%
	Chevron Phillips Chemical Co. Cedar Bayou Plant (RN103919817)	Jul 02	13	4	100%
	Dow Chemical Formerly Union Carbide Texas City (RN100219351)	Jan 03	12.9	3.4	100%
	Valero Refining Houston Refinery (RN100219310)	Feb 03	3.1	1.7	20%
	ExxonMobil Olefins	May 03	4.5	0.7	100%
	Dixie Chemical Bayport Facility (RN100218486)	Jun 03	0.4	0.1	100%
	Solvay Chemicals Deer Park Plant (RN100216704)	Apr 03	1.1	0	100%
	Sterling Chemicals (RN100212620)	May 03	7.2	0	100%
	Total	2002-2003	119.5	284.7	6%

Table 2: 2004-05 Cooling Tower Investigation Findings

2004 – 2005	Plant	Investigation Date	Cooling Tower Emissions (lbs of VOCs per hour)		Compliance Rate
			Accepted Rate	Measured Rate	
	Equistar Chemicals Channelview Complex (RN100542281)	Mar 05	25.3	17.1	4%
	ConocoPhillips Sweeny Refinery (RN101619179)	Jul 04	7.4	10.3	3%
	ExxonMobil Chemical Baytown Chemical Plant (RN102574803)	May 04	11.9	4.1	100%
	Dow Chemicals	Jun 04	22.7	1.8	49%
	Lyondell Chemical Bayport Plant (RN102523107)	Feb 05	4	1.7	100%
	Equistar Chemicals Channelview Complex (RN100542281)	Apr 04	23.1	1.1	100%
	Celanese Clear Lake Plant (RN100227016)	Apr 04	12.7	0.7	100%
	Equistar Chemicals La Porte Complex (RN100210319)	Mar 05	8.4	0.6	100%
	Dow La Porte Site (RN102414232)	Jul 04	4.4	0.4	100%
	BP Solvay Polyethylene	Jun 04	2.7	0.3	100%
	BP Solvay Polyethylene	Feb 05	1.7	0.2	100%
	Innovene Polyethylene North America (RN100229905)	Mar 05	3.2	0.1	100%
	Sunoco R & M Bayport Polypropylene (RN100229905)	Feb 05	0.6	0	100%
	Total Petrochemicals USA La Porte Plant (RN100212109)	Apr 05	2.9	0	100%
	Equistar Chemicals La Porte Complex (RN100212109)	Apr 04	8.2	0	100%
	Nova Chemicals Bayport Site (RN100542224)	Jul 04	3.5	0	100%
	Basell USA Bayport Plant (RN100216761)	Feb 05	2.8	0	100%
	Lyondell-Citgo Refining (RN100218130)	Mar 05	2.3	0	100%
	Chevron Phillips Chemical Co. Cedar Bayou Plant (RN103919817)	Mar 05	7.5	0	100%
	Equistar Chemicals Chocolate Bayou Complex (RN100210574)	Apr 05	6.8	0	100%
Total		2004-2005	161.9	38.4	29%

discrepancies in analytical results are a major problem which should be addressed by the TCEQ.

For example, in July 2004, the TCEQ investigated six cooling towers at the ConocoPhillips Sweeny Refinery. Based on the field investigation, one cooling tower (CT-14) appeared to have a leak rate of 9.1 lbs/hour, well above the permit limit of 3.4 lbs/hour. However, the laboratory GC detected only 2.9 lbs/hr of pollutants. According to the TCEQ report, "it is assumed that the cooling tower water most likely contained some heavy organic which the laboratory did not analyze." However, it is unlikely that the field sampling would have stripped out heavy organics from the water – say, those vaporizing at above 140° F. In short, the TCEQ is simply guessing in this case because it does not have the speciated data. Also, TCEQ's own permitting guidance notes that "it is difficult to sample water in the field then to analyze it in the laboratory without some loss of the volatile material. Compounding the problem is the fact that the measurement of interest is the amount of material that volatilizes while the water is in the cooling tower."⁶

Furthermore, TCEQ guidance notes that field measurements are important not only to ensure compliance with emission limits, but also to discover process leaks into the cooling tower water.⁷ The report on the investigation of the Sweeny Refinery notes that refinery staff informed the TCEQ that a leak into CT-14 was detected about two weeks prior to the investigation, but that the refinery staff had not collected any samples or otherwise made any effort to "determine the extent of the leak." In a follow-up investigation, the investigator could have tested the theory that heavy organic material was responsible for the high field measurements and determined whether refinery staff had fixed the leak. TCEQ documents note that the presence of entrained liquids in cooling water indicates a process leak, which may need to be fixed to reduce fugitive emissions as well.

Table 3: Industry Improvements

	Cooling Tower Emissions (lbs of VOCs per hour)	
	2002-03	2004-05
Accepted emission rate (baseline)	119.5	161.9
Measured emission rate	284.7	38.4
Performance ratio	2.4	0.2
Improvement	90%	

Instead of assuming, without apparent foundation, that laboratory measurements indicating no violation are more valid than field measurements indicating a violation, the TCEQ should conduct follow-up monitoring to determine if there is a leak. GHASP has requested explanations for not conducting such follow-up studies, but the TCEQ has not responded. By not issuing a violation notice, the TCEQ signals that the facility is operating properly, when all the TCEQ has determined is that its evidence is inconclusive.

Second, in some cases permit limits for cooling towers are unenforceable as written. For example, Enterprise Mont Belvieu West Complex Permit 20698 authorizes cooling tower emissions without setting a limit to those emissions. In October 2002, a TCEQ investigator measured VOC concentrations in field samples some 25 times that of levels used to calculate a specific cooling tower's contribution to the emissions inventory for the facility. However, because the cooling tower emission rates stated in the permit are "estimate[s] only and should not be considered as a maximum allowable emission rate," the investigator concluded that the TCEQ cannot use the data he collected for enforcement purposes.⁸ Other permits establish limits based on EPA emission factors rather than actual test data. Although TCEQ technical guidance calls for test data to be obtained and used to update the permit once the cooling towers are in operation, this step is routinely neglected.

Third, too few permits impose enforceable emission limits on cooling towers. For example, in the investigation of CT-8 at the ConocoPhillips Sweeny Refinery, a leak rate of 1.15 lbs/hour (well above the permit limit of 0.52 lb/hour) was measured and verified by the laboratory GC analysis. Nevertheless, the TCEQ declined to bring an enforcement action. The permit states that faulty equipment shall be repaired at the earliest opportunity but no later than the next scheduled shutdown of the process unit in which the leak occurs. Thus, a cooling tower may leak until the next unit shutdown, and the company need only report the emissions in its annual emissions inventory. The investigation report does not indicate whether the plant had any opportunity to repair the faulty equipment. Investigators apparently did not ask whether it was technically feasible to take the faulty heat exchanger offline for repair while keeping the plant in operation. Essentially the requirement to repair "at the earliest opportunity" is treated as unenforceable due to vagueness.

Although we highlighted the issue of unenforceable permit limits in our prior report, we are not aware of any systematic effort by the TCEQ to

ensure that every cooling tower has an enforceable permit limit. The lack of enforceable permit limits may be a violation of the federal Clean Air Act.

Further, as noted in our previous report, we were concerned that the TCEQ had not initiated any enforcement actions regarding leaks found at 14 cooling towers during the 2002-03 inspections. The TCEQ finds it difficult to take enforcement action even when it identifies cooling tower leaks.

In a modest improvement, one cooling tower leak found during the 2004-05 investigations is the subject of a current enforcement action. In February 2005, at the Equistar Chemicals Channelview Complex, investigators determined the emission rate from the East Plant Cooling Tower to be 5.54 lbs/hour, exceeding the permit limit of 3.23 lbs/hour.⁹ Furthermore, the plant's cooling tower monitoring program represented a "major deviation" from the terms of its permit. According to TCEQ staff, enforcement of these violations is being pursued as part of a larger case being brought by the EPA and Texas against Equistar Chemicals for a pattern of similar violations at several plants.¹⁰

¹ "Smoke in the Water: Air Pollution Hidden in the Water Vapor From Cooling Towers." GHASP. (October 2003, updated February 2004)

² See 30 Texas Administrative Code (TAC) §§115.760-769 (2004).

³ 30 TAC §§115.722(c) and 115.761(c) (2004).

⁴ In July 2002, the TCEQ conducted an investigation of six cooling towers at the Chevron Phillips Chemical Co. Cedar Bayou Plant in Baytown to determine whether the company was complying with the terms of a claimed permit by rule. In March 2005, the agency revisited two of the six cooling towers after a year-long emissions event, from September 1, 2003 to August 31, 2004.

⁵ TCEQ Investigation 289795, ConocoPhillips Company Sweeny Refinery, RN101619179 (Jul. 6-7, 2004).

⁶ Texas Natural Resources Conservation Commission Air Permits Division, Air Quality Permit Technical Guidance for Chemical Sources: Cooling Towers (Draft Feb. 2001), p. 10.

⁷ Ibid.

⁸ TCEQ Investigation 10823, Enterprise Products Operating LP Belvieu Environmental Fuels, RN102323268 (Oct. 17-21, 2002), p. 4.

⁹ TCEQ Investigation 270126, Equistar Chemicals Channelview Complex, RN100542281 (Apr. 8-19, 2004).

¹⁰ On December 20, 2006, the Texas Attorney General filed suit against Equistar and affiliated companies for unlawful emissions at this and three other Houston-area plants.

Recommendations to Improve Enforcement

Even though the apparent reduction in emissions suggests that chemical plants and refineries have reduced pollution releases from cooling towers, still more reductions are necessary. Problems with TCEQ investigation methods limit the usefulness of the investigations in underpinning effective enforcement.

To improve the effectiveness of its cooling tower investigations, the TCEQ should:

- Conduct follow-up monitoring of cooling towers when laboratory measurements do not confirm field investigation findings, and when emissions rates are well above permitted levels;
- Investigate the reasons for major discrepancies between field measurements and laboratory GC analysis;
- Establish legally enforceable limits on the extent and duration of leaks in the regulations applicable to all cooling towers, superseding the many existing flawed permits;
- Conduct more thorough investigations, particularly with respect to repair and mitigation activities; and
- Focus resources on plants with large cooling towers, historic problems, plants not subject to the more intensive HRVOC regulations, and plants not yet investigated.

The apparent progress in reducing cooling tower emissions demonstrates that when regulators scrutinize industry operations more closely, companies take action to reduce emissions. So we need tighter controls on non-compliant polluters, and certainly more diligent enforcement.



The Galveston-Houston Association for Smog Prevention (GHASP) works to persuade government and corporate officials to prevent smog. GHASP seeks to accomplish its mission by being the most credible advocate for clean air in the Houston region; by supporting efforts to educate the public; and by directly engaging government officials, community leaders, the media and industry on regional air pollution issues.

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