

# Smoke in the Water

## Air Pollution Hidden in the Water Vapor from Cooling Towers – Agencies Fail to Enforce Against Polluters

Chemical plants and refineries in Texas release three times more pollution than they report to the state, far more than their permits are intended to allow. Yet because of grandfathered plants, weak permits and other problems with the state's air quality regulations, there has not been a single enforcement action resulting from the discovery of 14 cooling tower leaks.

In mid-2001, new scientific findings demonstrated that chemical plants and refineries are reporting only a small fraction of their actual pollution releases. Because these companies are reporting such inaccurate data, the state uses pollution estimates that are six times higher than the reports made by companies when studying Houston's smog. Essentially, Houston-area chemical plants and refineries are reporting less than 20% of their emissions of volatile organic compounds (VOCs).

Either industrial companies don't know where this pollution is coming from, or they aren't telling. The state's environmental scientists have funded research efforts that target leaks from plant equipment (fugitives), emissions from flares and leaks into cooling tower water. Beginning in June 2002, environmental agency investigators began unannounced inspections of cooling towers, using the best available monitoring equipment.

The investigations reveal that cooling towers are leaking air pollution at a phenomenal rate. Investigators measured an annual pollution rate from cooling towers of 2.3 million pounds of VOCs (table 1). The importance of this emission rate becomes clearer when compared to the 4.9 million pounds of *total reported* VOC emissions from these same nine facilities.

Even though studies on cooling tower emissions have been underway for about two years, environmental agencies have failed to stop these pollution releases. Instead, these investigations demonstrate that the state does little more than complain about pollution leaks.

The state needs to expand funding for air quality inspections, and aggressively enforce permit conditions and regulations to deter sloppy management of cooling tower leaks. The state should also require cooling towers at chemical plants and refineries to install pollution control devices rather than relying on problematic leak detection and repair programs. If the state will not act, the US Environmental Protection Agency must intervene.

### Worst Leak: Butadiene from Texas Petrochemicals

Because butadiene made up a large part of a leaks from Texas Petrochemicals, and appears to be the most hazardous leak found by an investigation. The measured butadiene leak rate was 2.9 times greater than the maximum emission rate, as listed in an application for a voluntary emissions reduction permit (VERP). Texas Petrochemicals has not yet received a permit for its grandfathered pollution sources.

Butadiene is a known cause of leukemia, and state environmental officials noted that butadiene is a problem in this area in a July 2001 memo. The nearby Milby Park monitor measured a mean butadiene level of 3.2 ppb during 1997-2002, enough to cause an added leukemia risk of 245 in a million.

Cooling Tower Emissions	Rate (lbs/yr)
VOCs: Maximum (proposed rate)	44,150
VOCs: Measured	572,248
Butadiene: Maximum (proposed rate)	8,124
Butadiene: Measured	23,389

### Texas Petrochemicals Facility Emissions

VOCs: 2001 Toxic Release Inventory	195,089
Butadiene: 2001 Toxic Release Inventory	134,746

Sources: Maximum emissions rates from Texas Petrochemicals VERP Application (#46307). Measured emissions from City of Houston Bureau of Air Quality Control Investigations #17886, #26455 and #254540. TRI data from US Environmental Protection Agency website.

**Table 1: Monitored cooling tower emissions often exceed allowable rates and reported facility emission rates**

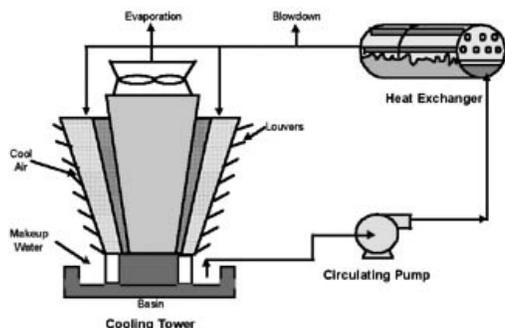
		Total Reported Emissions	Cooling Tower Emission Rate	
		(lbs of VOCs) 2001 Toxic Release Inventory	(lbs of VOCs per year) Measured Emission Rate	Accepted Emission Rate
Texas Petrochemicals	Houston	195,089	<b>572,248</b>	81,126
Shell	Deer Park	968,943	<b>515,000</b>	50,149
ExxonMobil	Baytown	1,206,646	<b>495,915</b>	351,797
Enterprise Products	Mont Belvieu	34,030	<b>373,096</b>	32,598
Crown Central	Pasadena	352,536	<b>264,264</b>	28,698
Chevron Phillips	Cedar Bayou	624,977	34,803	113,503
Union Carbide	Texas City	1,172,001	29,872	113,267
Valero Refining	Houston	259,692	14,742	26,858
ExxonMobil	Houston	126,740	6,321	39,770
<b>Total</b>		<b>4,940,654</b>	<b>2,306,262</b>	<b>837,767</b>

Sources: Investigation Reports (Texas Commission on Environmental Quality, Region 12 and City of Houston, Bureau of Air Quality Control). US Environmental Protection Agency, 2001 Toxic Release Inventory.

## Cooling Tower Investigations

Cooling towers are used in a variety of industrial applications, some of which are environmentally benign. For instance, cooling towers at power plants are used to remove heat from water circulating through the steam condenser. The dramatic plume of vapor rising from a power plant cooling tower should be relatively benign.

Figure 1: Cooling Tower



Source: Puckorius & Associates Inc.

Although cooling towers at chemical plants and refineries have also been described as benign, this has never been true. Heat exchangers, the interface between the cooling tower water and the hot process chemicals, may develop leaks through corrosion, cracking or seal failure. Even a small leak of a chemical at high pressure can have a significant impact on air quality.

Because cooling towers at chemical plants and refineries have been thought to be relatively benign, the prevailing method of controlling leaks is "leak detection and repair." The frequency of monitoring varies considerably. Even if a significant leak is detected, a repair may be deferred until the next plant shutdown, which may be months away. Until last year, environmental agencies did not make intensive unannounced inspections of cooling towers.

Of approximately 280 cooling towers at seventy-five major chemical plants and refineries in the Houston region, inspectors investigated 53 cooling towers at nine

facilities. Not every cooling tower was checked at some facilities. The first investigation began in June 2002 and efforts continued through at least June 2003. (More investigations may be underway; only nine reports were publicly available in September 2003.) Other than one scheduled follow-up, investigations were unannounced, and included a review of company records and sampling of cooling tower water to check for leaks.

These investigations verified that the "benign" steam coming from chemical plants and refineries often includes hazardous air pollutants. Unfortunately, the investigations also demonstrated that the enforcement threat is nonexistent. Even though over one-third of the investigated cooling towers were leaking, in only one instance did an agency officially note an "area of concern" regarding a leak. **Not a single investigation resulted in a "notice of violation" for an air pollution leak.**

Environmental investigators said they did not issue "notice of violation" letters in response to leaks because:

- Four leaking cooling towers were **grandfathered** and the investigators could not determine an enforceable emission limit;
- Company representatives found that **leaks were allowed by permit** terms at six cooling towers – typically an emission limit for an individual tower was superseded by some other permit term; and
- **Evidence problems** such as conflicting data mistakes by the agency and other technical issues resulted in inconclusive findings at nine cooling towers with apparent leaks.

In total, these 19 leaking units were responsible for 95% of the measured VOC emissions from the 53 cooling towers monitored during these investigations.

In several instances, the investigating agency issued an "area of concern" letter regarding inadequate monitoring, and ExxonMobil (Baytown) received two "notice of violation" letters. These actions may improve the leak repair programs at the affected facilities.

Table 2: Reasons for lack of enforcement action against companies with leaking cooling towers

Facility	City	Cooling Tower Emissions VOCs (lbs/yr)	Reason for Lack of Enforcement Action (by percent of estimated emissions)			
			Acceptable Emissions	Grandfathered	Leak Allowed by Permit	Evidence Problems
Texas Petrochemicals	Houston	572,248	< 1 %	100 %	-	-
Shell	Deer Park	515,000	< 1 %	-	74 %	26 %
ExxonMobil	Baytown	495,915	8 %	-	55 %	37 %
Enterprise Products	Mont Belvieu	373,096	2 %	-	98 %	-
Crown Central	Pasadena	264,264	2 %	-	-	98 %
Chevron Phillips	Cedar Bayou	34,803	100 %	-	-	-
Union Carbide	Texas City	29,872	100 %	-	-	-
Valero Refining	Houston	14,742	20 %	48 %	-	32 %
ExxonMobil	Houston	6,321	100 %	-	-	-
<b>Total Cooling Tower Emissions</b>		<b>2,306,262</b>	<b>5 %</b>	<b>27 %</b>	<b>44 %</b>	<b>25 %</b>
<b>Number of Cooling Towers</b>		<b>53</b>	<b>34</b>	<b>4</b>	<b>6</b>	<b>9</b>

Sources: Investigation Reports (Texas Commission on Environmental Quality, Region 12 and City of Houston, Bureau of Air Quality Control).

## Grandfathered Cooling Towers

Grandfathered cooling towers have three problems: old, leaky heat exchangers; ineffective leak detection and repair programs; and unknown emission limits.

Grandfathered cooling towers at **Texas Petrochemicals (Houston)** were the leakiest and most hazardous units investigated (see table 1 and front page box). For instance, one cooling tower was leaking during each of the three investigation visits, over a three month time period (BAQC Report 26455). Texas Petrochemicals either couldn't or wouldn't get the leaks fixed.

While Texas Petrochemicals has a leak detection and repair program, the program appears fairly haphazard, as demonstrated by two anecdotes from the investigation.

- Texas Petrochemicals' engineer was misinformed about how cooling water flows to the towers, misleading investigators in two separate instances. The correct configuration was not established until January 2004. As a result, over one-half of the cooling water was never monitored by investigators.
- Investigators discovered that the company wasn't finding leaks because its sampling device was plugged. The agency avoids plugged sampling devices by calibrating before each investigation.

This approach to leak detection seems as outdated as the cooling towers, built in the 1940s and 1960s.

Because the cooling tower systems predate the Clean Air Act, they are grandfathered and have not been required to obtain air pollution permits. In response to legislation encouraging voluntary permit applications, Texas Petrochemicals applied for a permit in November 2000.

The draft permit suggests that Texas Petrochemicals will be asked to do no more than monthly monitoring to update its cooling tower systems. At the time of the investigations it appeared that no progress had been made in updating this aging equipment.

Until Texas Petrochemicals receives its permit, the towers will continue to lack enforceable emission limits. Although its leaking cooling towers are grandfathered, Texas Petrochemicals would be required to obtain a permit and update its pollution control technology if its emissions have grown since the plant was grandfathered. Agency staff requested these "grandfathered emission limits" twice, but Texas Petrochemicals did not respond.

**Valero Refining (Houston)** also has leaky grandfathered cooling towers. Although one grandfathered unit was leaking during the investigation, the investigation report contains relatively little information about the grandfathered cooling towers. Perhaps investigators did not have much interest in further inquiry because they had learned from the prior Texas Petrochemicals investigation that they lacked authority to compel repair of a leaking grandfathered cooling tower.

## Cooling Tower Permits Allow Leaks

*"It is stated in the [Enterprise Products (Mont Belvieu)] permit that cooling tower emissions are estimate only and should not be considered as a maximum allowable emission rate (MAER). . . . Therefore, the Region does not have a means to enforce the emissions for this cooling tower."* (TCEQ Investigation Report 10823)

One Enterprise Products cooling tower's emissions were measured at a rate that is 11 times greater than the "estimate" included in its permit, but investigators found that the permit could not be enforced. It appears that the state's air quality permits can allow unlimited air pollution without enforcement consequences.

**Shell (Deer Park)** used a similar technique to evade enforcement. The state measured cooling tower emissions at a rate 10 times greater than the permit's hourly emission "estimate," concluding that, "the hourly emissions [limits] were exceeded during the hours that the sampling was conducted by the agency."

However, a Shell representative rebuffed the agency, claiming that, "since the permit states that monitoring shall be conducted once a month, [Shell's] monitoring data for the month of January did not indicate exceedance of an internal limit." In other words, Shell disregarded the agency's findings in favor of its own (more favorable) monitoring data.

A third problem is that many companies are relying on outdated or discredited leak detection methods. Investigators found that five of the nine facilities were using inadequate leak detection methods, and either made an informal recommendation to the company to update its method, or issued a formal "area of concern" letter. While these facilities are likely to improve their leak detection efforts, for this enforcement strategy to succeed, every single facility would need to be visited by investigators to determine if their approved leak detection method is actually sufficient to identify leaks.

Essentially, Texas issues air pollution permits with holes that allow cooling towers to pollute with few restrictions. One part of the problem is that the state is failing to follow its own permit guidance.

*"The [US EPA emission factors] are very general and should be replaced by actual test data from the tower once it is in operation. Specifically, the VOC concentration in the water . . . should be determined so that an emission rate can be calculated."* (TCEQ Technical Guidance RG-108)

None of the nine cooling tower investigations indicated that "actual test data" had been used to calculate an emission rate to replace the use of the US EPA emission factors. None of the nine reports described any enforceable emission limit for a cooling tower used by a chemical plant or refinery.

## Evidence Problems Hamper Investigations

Even if air pollution permits had enforceable emissions limits, there are problems with the state's investigation methods. Sometimes the state doesn't follow proper procedure in handling evidence, but more often the state relies on the data that is most favorable to the company in determining whether a permit "limit" is exceeded.

Investigators measure contaminants in cooling tower water using a two-step process. First, they take a direct measurement of the total VOC concentration. If that measurement is above the permit "limit," then a sample is drawn into a canister for later laboratory analysis. Investigators will not take further action unless both monitoring methods indicate a sufficiently large leak.

In the case of **Crown Central Petroleum (Pasadena)**, the onsite measurement indicated a large leak. However, the agency lost essential documentation and was unable to use the laboratory sample. The agency determined that the "cooling tower should be remonitored," but more than a year later it appears that there has not been any further investigation or other action to address the leak.

Another problem is that laboratory analysis finds less pollution leakage than the onsite measurements – on average, 54% less. The TCEQ has not determined why laboratory analysis usually finds lower leak rates, but there are several possible explanations.

- The onsite measurement method cannot easily be customized for the varying mixes of pollutants in each sample. This could result in either an under- or an overestimated leak rate.
- Because the canisters are not analyzed until several days after the investigation, unstable pollutants may decay or react in the canister, resulting in an underestimate of the leak.
- The laboratory analysis may not be set up to detect every important pollutant (for example, formaldehyde). Pollutants measured onsite may be entirely missed in the laboratory.

For example, during the **ExxonMobil (Baytown)** investigation, onsite monitoring indicated that 9 of the facility's 21 cooling towers were leaking. Because ExxonMobil has a single emission limit covering all 21 towers, individual cooling tower leaks are allowed. The agency's onsite monitoring measured a release of 39 lbs/hr of VOCs, compared to the "flexible permit" cap of 29 lbs/hr. However, the laboratory only measured 20 lbs/hr, well below the permit cap.

It seems most likely that the laboratory analysis is incomplete, although it is also possible that onsite measurements routinely overestimate leak rates. Because investigators assume that the laboratory analysis is correct, the public is not assured that large pollution leaks are being corrected.

## Recommendations to Improve Enforcement

The nine cooling tower investigations demonstrate that there are major problems with leaking heat exchangers, the state's permitting, and the state's investigation techniques. The overall impression is that many companies are not proactively adopting the best technology to detect leaks and make repairs, let alone investing in equipment that is less prone to leak.

**Industrywide investigations** are needed to identify problems and press for corrections. Every chemical plant and refinery cooling tower in the Houston region should get a complete investigation as soon as possible.

Because the Texas Legislature limits the staff of the Texas Commission on Environmental Quality, it is probably beyond the current capacity of the commission to implement this recommendation. The US Environmental Protection Agency should assist with these extraordinary inspections.

**Enforceable emission limits** are needed in cooling tower permits and regulations. Permits that are under review should be written to include such provisions. Old permits should be reopened if there are problems with their enforcement. The state is studying new strategies for regulating cooling towers. Any new regulations must be written to ensure that they can actually be enforced.

**Improved investigation methods** are needed to ensure that the effort put into investigations and improved permits is not wasted. Where there is strong evidence that a leak exists, but one sampling method does not support that finding, an immediate follow-up investigation should occur. Environmental investigators should not give the benefit of the doubt to the company, but should pursue further evidence when there is doubt.

**Known technology** would help reduce pollution from cooling towers, and should be installed immediately. Companies could replace old, leaking heat exchangers, install spare back-up exchangers to avoid plant shutdowns for leak repair and test methods to extract pollution that has leaked into cooling tower water before it evaporates into the air we breathe.



The Galveston-Houston Association for Smog Prevention (GHASP) is a community-based environmental organization dedicated to improving the quality of our region's hazardous air through public education, participation in the state and federal planning process, and active advocacy in appropriate venues.

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