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The Houston Barge System

A Brief Review of Operations and Opportunities

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Table of contents

CHAPTER 1

Introduction

The air quality of the Houston area is impacted by a multitude of point and non-point sources of pollution. Assessing the cumulative impact of industrial activity on the air shed is made more difficult because Houston has a diverse industrial base, with many types of emissions that are not regularly encountered in other cities. Houston's refineries, chemical processing facilities, and traffic are all substantial sources of pollution. The contributions of emissions from the freight sector to total air quality, however, are not well understood. Freight movement is central to Houston's economy and the freight that moves through the Port of Houston is vital to the U.S. economy.[1] In 2007, the Houston region's total freight was estimated at 761 million tons, and is estimated to increase to 1.2 billion tons by 2035.[2] Houston relies on all major modes of freight transportation and is a major hub for trucking and rail. Yet, it is maritime freight driven by the Port of Houston and the many other maritime facilities along the Houston Ship Channel that most definitively characterizes Houston's freight system.

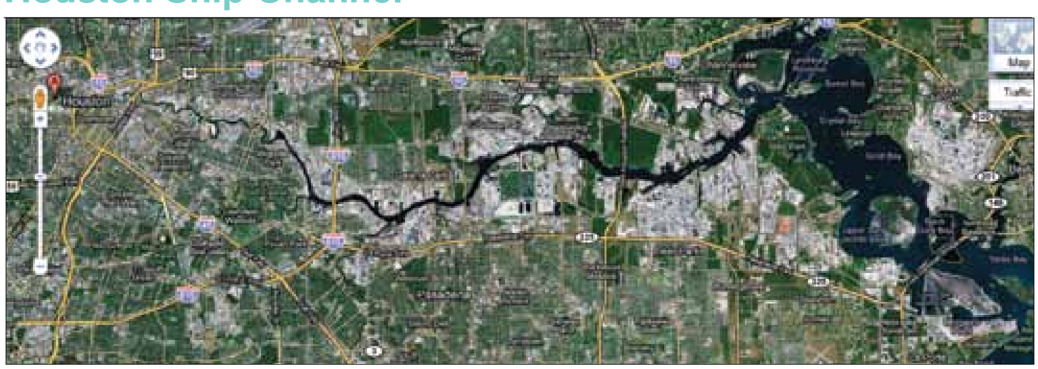
In 2007, the Houston region's total freight was estimated at 761 million tons, and is estimated to increase to 1.2 billion tons by 2035.

Development of the Houston Barging System

The early economic development of Texas was stymied by an almost complete lack of navigable rivers at a time when waterways were the only viable means of transporting goods to market. The Texas economy showed great potential for exports, yet most of the state was landlocked and frozen out of the dynamic trading economies that were developing in states along the Mississippi River. Texas had one port capable of handling oceangoing vessels, located on the relatively inaccessible island of Galveston; it was difficult to envision Houston ever rivaling nearby New Orleans without a port located within a major urban center.

In this context, it is easy to understand why the efforts to develop the Houston Ship Channel, on what had been a modest stream leading to the San Jacinto River, are almost as old as the state itself. Barge traffic remains the oldest extant mode of freight transportation in the Houston area.

FIGURE 1
Houston Ship Channel



Barges and other shallow water vessels formed the entirety of the traffic on the Houston Ship Channel from the mid-1800s until the channel was made sufficiently deep to accommodate oceangoing vessels following the First World War. Many of the terminals and docking positions currently used for barge traffic have existed, in some form, for two centuries, and barge traffic is unlikely to recede from the Houston freight profile in the foreseeable future.

Today, the Houston Ship Channel represents a unique feature of the region's geography with global access to the largest petrochemical complex in the nation. This manmade waterway carries far more cargo through the heart of the city than could be handled by trucks or trains. The channel allows vessels to deliver goods to many different locations within the urban area, including facilities located close to downtown. This access provides substantial benefits and when compared to other forms of transportation, maritime transportation is incredibly efficient from the perspective of energy consumption and associated emissions. Nevertheless, for the over-6 million people who live in the Houston metropolitan area, the sheer volume of maritime transport that occurs within the Houston region results in a substantial amount of pollution that directly affects the health and environment of the local community.

CHAPTER 2

Characterizing the towing industry

The essential distinction between a barge/tug and a ship is that the engine (tug or towboat) is separable from the load while the engine of a ship is integrated into the hull.

Most barge/tug operations cannot be operated in the open ocean as they lack the stabilization necessary to navigate open water. The term towboat, also known as a pushboat, refers to vessels that push barges through the water. This is the most common vessel type within the Houston area. The term tugboat most commonly refers to vessels that use a cable to pull cargo through the water. In addition to traditional inland tugs and tows, oceangoing barges have the capability of operating either on the inland river system or on the open ocean. These vessels are larger in size but rarer in number than river barges. The essential distinction between a barge/tug and a ship is that the engine is separable from the load while the engine of a ship is integrated into the hull. For this reason, there is a multitude of different ways in which barges and tugs can be combined.

The following is the breakdown of tug vessels registered and domiciled within the Houston area:

- 872 towboats/pushboats
- 27 tugboats
- 61 oceangoing tugs

In developing strategies to reduce emissions from barge/tug operations, it is important to examine evaporative emissions from barges as well as combustion emissions from tugs. Most recent research has focused either on evaporative emissions from barges or diesel combustion emissions; however, both sources represent potential long-term air quality challenges and as such, this report addresses them in tandem. The report also describes some of the unique features and history of the towing industry that should be taken into consideration in addressing emissions improvements. As the towing industry within the Houston area constitutes almost one quarter of the 4,000 tug and towboats in the United States, actions taken within Houston towing industry are likely to have national ramifications.

Profile of vessel movements

Data collected from the Port of Houston shows that in each of the four quarters of 2009, approximately 30,000 tug movements were recorded within the Houston region, with the highest number of movements in quarter four and the lowest in quarter one, but without substantial variation between quarters. For a given quarter, there were over 700 unique tug vessel movements on the Channel. In 2009, 1,074 unique tug vessels were calculated to have completed at least one trip within the region. This can be designated as the “fleet” serving the region. It can be noted that theoretically any tug can serve the Houston area, even those that are primarily based in other areas of the country. Nevertheless, by comparing the vessel call signs over successive quarters, the data indicate that the profile of vessels within the region remains quite stable.

Barges move very slowly, so it may seem counterintuitive that most barge movements in the Houston area are only an hour or two in length. This is a result of strategic decisions regarding location made by Houston industries in an effort to minimize the distance traveled in transporting their products. Data from the fourth quarter of 2009 showed that the average trip length in the Houston region was slightly more than two hours. This means that within the quarter, towboats spent 65,000 hours in transit. The in-transit emissions do not represent the totality of the emissions from tugs, however, as the vessels also generate emissions when docked.

CHAPTER 3

Air quality impacts—the big picture

Combustion emissions

The International Maritime Organization (IMO) freely admits that the standards set for ship emissions were deliberately set at "very modest" levels in order to gain universal acceptance from treaty signatories.

The 2007 Houston Air Emissions inventory released by the Port of Houston Authority classifies air emissions from the marine sector into two categories; oceangoing vessels (OGVs) and harbor vessels. By far the biggest source of marine pollution in the Houston region comes from the large oceangoing vessels. While there are some international guidelines for the fuels used by these vessels and the conditions of their engines, they are in general less tightly regulated than vessels of domestic origin. For example, the bunker fuel used in ocean transport is of international origin and often of a lower standard than what would be permitted to be sold in the United States.[3] Regulations on international vessels are in their early stage and are governed by the international treaty known as the International Convention for the Prevention of Pollution by Ships (MARPOL) that covers both the prevention of accidental releases as well as pollution from routine operations. It was not until 2005 that Annex VI of the treaty covering air emissions from ships entered into force after having been ratified in 1997. Air pollution represented the last major ship pollutant subject to regulation. The International Maritime Organization (IMO) freely admits that the standards set for ship emissions were deliberately set at "very modest" levels in order to gain universal acceptance from treaty signatories.[4] Furthermore, the standards apply only to newly constructed vessels.

At present, the international shipbuilding industry is concerned primarily with manufacturing large Post-Panamax vessels, vessels that may transport as many as 10,000 20-foot equivalent units, or TEUs. Most of the Post-Panamax vessels require deep draft waterways (50 feet or more) when fully loaded. As the Houston Ship Channel is too shallow to accommodate many of the Post Panamax ships, the new build standards adopted by the IMO will have a less significant impact on the fleet of vessels serving Houston than major load centers like the Ports of Los Angeles and Long Beach. Recently, however, the Port of Houston has been able to accommodate vessels with capacity of over 8,000 TEUs. These vessels can be accommodated by Houston's comparatively shallow channel by not loading the ships to full capacity.[5]

Distinct from oceangoing vessels, tug and towboats are considered Harbor Vessels, and thus their emissions are characterized independently, meaning that they are not subject to the same regulations as the larger, oceangoing ships.[6] Thus, despite the fact that as of 2007, combustion emissions from harbor vessels were estimated to account for only around 1% of total maritime emissions for the Houston area for pollutants such as NO_x and carbon monoxide, it is over this modest segment of maritime emissions that the Houston region has the most direct influence.

While some of these harbor vessels operate entirely within the protected waterways of the Houston Ship Channel, many others use a manmade system of protected waterways, called the Gulf Intracoastal Waterway which stretches from the Texas-Mexico border to Florida. Thus, the range of these vessels is not limited to one harbor. This also means that the fleet serving the Houston region is dynamic and includes some vessels that are not domiciled in Houston but

While tow operators frequently rebuild the engines on the boats, these engines are often rebuilt to their original standards, meaning that newer and less polluting designs are not incorporated routinely on new builds.

may serve markets anywhere within the contiguous inland waterway network, even stretching as far north as Minnesota. In addition to the Port of Houston Authority, there are more than 150 private industrial companies located along the Houston Ship Channel that directly or indirectly utilize barge transportation. Given that Houston is one of the principal barging markets in the United States, the small role played by barge emissions says more about the magnitude of total emissions from all sources than it does about the potential significance of barge emissions for human health in the region.[7]

While large, oceangoing vessels are regulated under international law, harbor vessels are regulated through a different regulatory framework. One specific regulatory provision of note is the Jones Act. The Jones Act, passed in 1920, requires that all vessels engaged in domestic maritime trade within the United States be constructed in the United States. The act was originally designed to protect U.S. shipbuilding in the belief that a substantial deterioration of shipbuilding capacity would lead to a diminishment of naval power and thereby produce a threat to national security. Yet, the comprehensiveness of the law makes it applicable even to small inland vessels which make deliveries between domestic locations. As a result, this law has wide-ranging impacts on proposals to improve emissions through fleet modernization.

The impact of this provision on emissions is two-fold. On the one hand, the Jones Act makes tug and barge vessels operating in U.S. domestic waters easier to regulate than international oceangoing vessels, yet because the United States currently has very tight shipbuilding capacity and high cost associated with new builds, barge operators have not had incentive to turn over their fleet with the same frequency as other modes. For this reason, the average age of towboats operating within the Houston region and the rest of the country is quite high. While tow operators frequently rebuild the engines on the boats, these engines are often rebuilt to their original standards, meaning that newer and less polluting designs are not incorporated routinely on new builds. And as is the case with all diesel engines, tow engines are extremely long lived. For this reason, every old polluting engine that is replaced by a new engine without modern emissions controls represents a missed opportunity for realizing future air quality improvements.

In addition to the fact that marine engines have a very infrequent turnover rate, they have been regulated for a far shorter period of time than other types of engines like trucks. This is likely a result of the fact that historically, smaller marine diesel engines were designed first for land-based applications and then modified for marine use through a process called marinization.[8] In 1999, however, EPA issued the marine engine rule, one of the first pieces of legislation to tackle emissions from tug engines.[9] This rule established engine standards on the basis of engine displacement rather than engine power.[10] The law introduced Tier 2 engine standards, based on the same criteria used for on-road engines. In 2008, there was a further tightening of emission standards for tug engines, though these regulations only applied to new vessels entering service. Given that the turnover process for these vessels is gradual, it will be some time before these new regulations have a substantial impact on reducing the combustion emissions of the fleet.

Evaporative emissions

The issue of evaporative emissions from barges operating within the Houston Ship Channel grew in prominence following consistent reports of elevated benzene levels from the Lynchburg Ferry air quality monitor starting in 2003. The emissions were determined to have originated from a barge cleaning facility near the air monitoring location. Due in part to operational improvements made by the barge industry, benzene levels have been falling since 2005 and the levels are currently below threshold values.[11] The Lynchburg Ferry monitor is situated precisely on the Houston Ship Channel and captures emissions from ship and barge traffic. Tank barges that are improperly sealed can emit benzene as well as other air toxics, yet the exact contribution of barge emissions to the air toxics in the region is currently unknown.

95% of emissions, according to the model utilized by ERG, are released during the movement of empty barges.

A recent study commissioned by the state environmental agency, the Texas Commission on Environmental Quality (TCEQ), the state environmental agency and completed by Eastern Research Group (ERG), attempted to determine the cumulative impact of evaporative emissions from barges, principally volatile organic compounds (VOCs) but also hazardous air pollutants (HAPs) and highly reactive volatile organic compounds (HRVOCs).[12] Rather than direct measurements, the report used a sophisticated modeling approach to profile the emissions that likely emanate from barges in the Houston region principally due to so called "breathing losses," which refers to the release of gases from the top of the barge when evaporative pressure has built up inside the tank. Breathing losses can result in a significant amount of localized emissions if there is a high density of barges within a small area. This can happen during an industry practice known as "fleeting." Fleeting refers to an activity whereby barges are tethered together in a type of docking station arrangement. The barges are hotelled in a specific location where they wait for the most favorable market conditions under which to sell the specific petrochemical commodity that they are carrying.

In an effort to estimate these evaporative emissions from barges, ERG adapted a model developed by EPA. Known as the "TANKS" model, this model was originally used to estimate similar emissions from storage tanks that hold gasoline and other petroleum-based products. Recognizing that there were relevant differences between the operating characteristics of above-ground tanks and barges, ERG noted that there were a number of variables aside from the type of cargo being carried that impacted the likelihood of the release of significant emissions. Evaporation within a tank barge causes a build-up of pressure that must be released when the pressure exceeds the pressure rating threshold of the barge. Some barges are pressurized with a pressure rating greater than 1 PSI. These barges can accommodate sustained buildups of pressure without releasing gases into the atmosphere. The longer the barge is in transit, the greater the pressure.

The study also confirmed that the vast majority of barge trips in the Houston region are short in duration and, in fact, analogous to local truck delivery times. This means that most of the barge cargo in transit in the Houston area does not result in barge pressures that generate substantial evaporative emissions, even in the summer months when the rate of evaporation is higher due to the increased ambient temperature. One of the study's most striking findings is that in the Houston area, 95% of evaporative emissions, according to the model utilized by ERG, are released during the movement of empty barges. This phenomenon is a result of higher pressure levels within the tank that is generated from the evaporation of the residual product due to the greater vapor space within the tank.[13]

Aside from the routine evaporative emissions that may occur from general barge transit, exceptional emission events are an additional source of evaporative emissions. Exceptional emission events occur when an abnormally large amount of pollution is released on a particular journey, sometimes due to a malfunction of the barge itself. In addition, evaporative emissions can result during transfer of volatile products such as benzene during the loading or unloading process. There are a number of techniques used to account for significant evaporative emissions of VOCs from barges. One common method is a mass balance analysis, a technique that involves precise measurement of the weight of the cargo at the beginning and end of transport. While this technique does not directly document the release of evaporative emissions as they occur, any difference in product volume between the starting and ending volume can be used to estimate fugitive VOC emissions.[14]

In addition to empirical mass balance tests, advanced infrared technologies such as the IR camera have been used to capture fugitive emissions from barges. The advantage of this technique is that it can identify leakages occurring in real time. The precision, however, with which these cameras are able to measure the density of emissions plumes is extremely limited and therefore, the cameras cannot quantify the amount of emissions being released.[15] Infrared cameras can, however, demonstrate when and where emissions are occurring. For this reason, they are used by some barge operators to determine the location of leaks.

Best management practices[16]

With the aim of reducing the preventable release of VOCs from barges, the American Waterway Operators (AWO), a national association of barge professionals, has developed an inventory of best management practices (BMPs) in conjunction with the Chemical Transportation Advisory Committee (CTAC), the Louisiana Department of Environmental Quality (LDEQ) and the Texas Commission on Environmental Quality (TCEQ). The matrix of BMPs developed is intended to be distributed to shore tankering companies; shipyard/cleaning vendors; terminals/facilities; and cargo inspectors/surveyors.[17]

These practices have been assumed to be effective in preventing leaks from occurring and/or rapidly identifying them if they do occur. They are classed according to four criteria:

- Area/item
- Potential issue of concern
- Proposed best practice
- Responsible party

In basic terms, the areas refer to the physical parts or components of the barge that can be compromised or that may directly result in vapor releases or contribute to releases. Issues of concern refer to specific problems that can occur with each of these components. A proposed best practice can be a preventative check, the use of a particular material or a preferred operational technique. The intent of the AWO in developing these BMPs is for its membership to incorporate them into their operations in order to control and reduce emissions from tank barges without the necessity of additional federal or state regulation.[18]

While the BMPs have been around for a number of years, there have been limited data to verify the effectiveness or implementation rate across the industry. New efforts using the latest IR camera technology are underway by regional stakeholders to help assess the efficacy of these BMPs.

CHAPTER 4

Operational characteristics and profile of vessel movements of Houston barges

In the report commissioned by the TCEQ and completed by ERG, it was estimated that the average cruising speed for barge trips was 5-6 miles per hour. The average speed for the most common types of barge moves, those that are less than one hour, however, were estimated to be only 2.5 nautical miles per hour due to the fact that most of the time the tow barge spends in transit is actually spent docking or undocking.[19] On a per mile basis, this indicates that these very short trips generate greater emissions than the longer trips in which the vessels can maintain a greater average speed (See Table 1 on page 10)

One difficulty in quantifying the total emissions from tugs is that the size of the engines used by the Houston towing industry varies from 400 to 6,000 horsepower. Table 2 on page 10 indicates the following breakdown of main engine brake horsepower for vessels registered in the Houston market.

A common sized tow serving the Houston Ship Channel is around 900 horsepower and can easily consume between 150,000–200,000 gallons of diesel fuel per year. The amount of pollution generated by each engine depends largely on the age of the engine; older engines not only lack emissions controls, but they also become less efficient as they age.

Even if policy were developed to encourage a rapid shift to modern engines, it is unlikely that there is sufficient industrial capacity to build at the production levels of the early ’80s.

Profile of Houston tow engine model years

Figure 2 on page 11 shows the breakdown of engine ages for towboats serving Houston, exclusive of rebuilds. The age profile demonstrates the very long life-span of tow engines and suggests how this history influences the current state of the towing industry in the Houston area. As an example, severe overcapacity caused by a surge in vessel construction during the late 1970s and early 1980s came to a crashing halt during the oil crisis (see Figure 2 on page 11), and many tug manufacturers did not escape the dramatic fall off that occurred during the mid-1980s. For this reason, even if policy were developed to encourage a rapid shift to modern engines, it is unlikely that there is sufficient industrial capacity to build at the production levels of the early ’80s. The larger towing companies are currently in the process of acquiring newer vessels and scrapping the oldest in their respective fleet, yet it will be years if not decades before the capacity glut of the 1970s and early 1980s is expunged.

Approximately 10% of the vessels currently in service in the Houston area are reported to have been re-engined, of which 23 were re-engined in the 1980s, 50 re-engined in the 1990s, and 49 re-engined since 2001. The conclusion is that re-engining has thus far only modestly improved the vessel age profile given that very few engines have been re-engined since emission controls went into effect. Even with these modest totals for the industry as a whole, only a small number of companies have engaged in the repower efforts.

TABLE 1

Barge transit time distribution for the Houston area

TRIP LENGTH (HRS)	LOADED TRIPS	AVG HOURS	AVG MILES	AVG SPEED (NAUTICAL MPH)	AVERAGE SHIPMENT SIZE (BARRELS)
1	15,908	0.68	1.7	2.50	43,039
2	4,060	1.59	6.5	4.09	39,788
3	1,392	2.55	13.4	5.25	30,966
4	547	3.46	19.4	5.61	27,108
5	245	4.46	25.2	5.65	26,682
6	206	5.58	31.3	5.61	26,372
7	794	6.43	37.6	5.85	38,060
8	157	7.56	42.1	5.57	56,197
9	2,600	8.74	51.1	5.85	49,530
10	95	9.55	50.9	5.33	75,609
11	187	10.67	60.6	5.68	34,535
12	71	11.51	65	5.65	28,778
13	2,332	12.27	70.3	5.73	41,087
14	702	13.56	77.6	5.72	48,953
15	7,848	14.48	83.5	5.77	51,974
16	1,429	15.49	89.6	5.78	50,984
17	329	16.38	93.6	5.71	45,336
18	52	17.4	95.3	5.48	31,527
19	0	0	0	0.00	0
20	0	0	0	0.00	0
21	0	0	0	0.00	0
22	5	21.29	121.3	5.70	29,197
23	0	22.6	131.1	5.80	72,828
24	20	23.37	136.6	5.85	37,241
25	45	28.29	161.9	5.72	46,265

Source: Reprinted from Eastern Research Group, *Barge Emissions Report: Final Report*. Prepared for the Texas Commission for Environmental Quality. August, 2010.

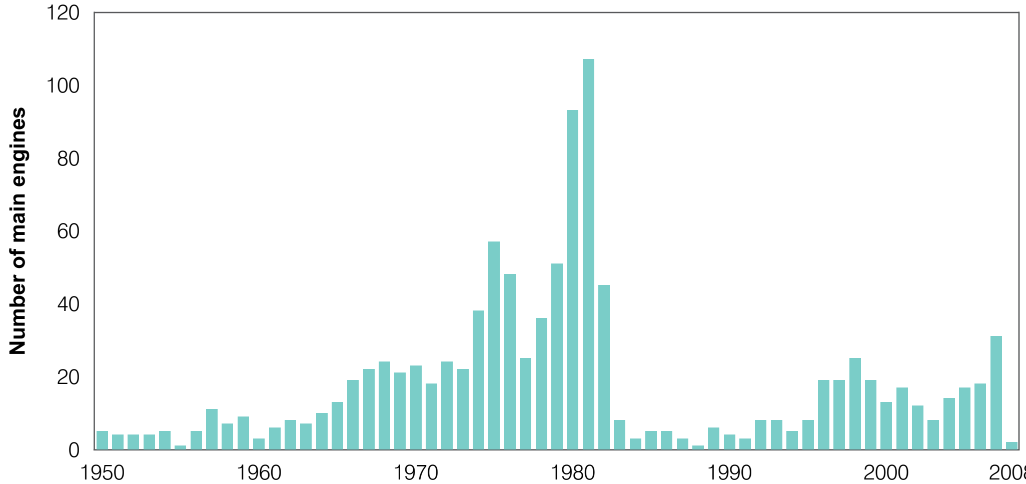
TABLE 2

Breakdown of Houston towboats by horsepower

HORSEPOWER	NUMBER OF TOWBOATS
> 500	124
500–1000	341
1001–1500	170
1501–2000	165
< 2001	168

FIGURE 2

Profile of tow main engine model years active in the Houston area



It should be noted that while vessel engines are commonly rebuilt, there is a distinction between a rebuild which essentially restores the engine to its original state and a re-engine in which the engine is truly new and takes on the emission profile of the best available technology from the year it was re-powered. The process of rebuilding engines has grown so precise that there is little to no disadvantage, from a reliability standpoint, to the operator in having an engine rebuilt as opposed to purchasing a new engine.[20] Nevertheless, rebuilt engines can be less efficient and thereby incur additional fuel costs.

Emissions from tow engines primarily come from the main engines which are used to propel the vessel as well as from the auxiliary engines which are used to provide other essential ship functions. While the main engines are the largest consumers of fuel, auxiliary engines are more intensively utilized as they function even when the vessel is docked. It is not uncommon for auxiliary engines to log more than 7,000 service hours per year. For this reason, they tend to wear out somewhat more quickly and require rebuilds or re-engining more frequently than main engines. Furthermore, it is less technologically complicated to retrofit an older ship with a new auxiliary engine as compared to a new main engine. Therefore, auxiliary engines are a natural target for efforts to improve overall emissions performance.

An additional, but smaller category of engine emissions comes from the barges themselves. Some tanker barges have on-board engines that are used to unload product, by means of a small diesel generator. These engines represent another opportunity for modernization, yet they are less essential than auxiliary engines given that they only function while the barge is unloading.

The common thread for all three engine categories is that their average age is older than diesel engines for comparative transportation modes such as truck or rail. Barging has been, since the 1980s, a remarkably stable industry with essentially the same fleet size in operation. This stability, however, leads to substantial inertia in terms of fleet modernization and has so far significantly hindered the industry's ability to modernize engines as quickly as other modes.

CHAPTER 5

Air quality improvement strategy: Clean Vessels for Texas Waters

The barging industry relies on a relatively limited number of tugboats to move an extraordinary amount of cargo. Because each tug is utilized so extensively, the replacement of even a single tug engine with a comparable Tier II certified engine can have significant air quality benefits.

The barging industry relies on a relatively limited number of tugboats to move an extraordinary amount of cargo. Because each tug is utilized so extensively, the replacement of even a single tug engine with a comparable Tier II certified engine can have significant air quality benefits. While some engines have been upgraded through natural retirement, the long life of diesel engines combined with the ability of tow operators to rebuild engines to their original standards without pollution control equipment means that the rate of improvement in emission reductions for the fleet is exceedingly slow. Until now, it has been difficult for tow operators to take advantage of incentive programs such as the Texas Emissions Reduction Plan (TERP), which has upgraded a large number of diesel engines from road and rail sources, because many towboats do not qualify for funding. TERP funding requires that the engine being replaced with a TERP grant operate in areas that are designated as non-attainment, meaning an area that does not comply with federal clean air standards. Since most towboats spend some portion of their time in areas that are in attainment, they are not normally eligible for TERP funding. As the towing industry can only compete with other modes as long as its capital asset base is lean and its service area is flexible, it is difficult for towboats to guarantee that their operation will be limited to a specific geographic area. In contrast to TERP grants, a new class of federal air quality improvement grants awarded under the Diesel Emission Reduction Act (DERA) has greater potential to improve the fleet of towboats operating not only in Houston but around the country. Houston has been a key beneficiary of the DERA program in the last several years. The Port of Houston Authority and the Houston-Galveston Area Council (H-GAC), the Houston regional planning organization, have been awarded several million dollars in recent years to reduce diesel emissions.

Cognizant of the unique air quality opportunities presented by improvements to the towing fleet, H-GAC recently attempted to secure DERA funding for the towing community. In partnership with Bay Houston Towing Co. (Bay Houston), G&H Towing, J.A.M. Marine Services (JAM), Environmental Defense Fund (EDF), and Port of Houston Authority (PHA), H-GAC identified main engines in tugboats in the Houston area that could be upgraded to Tier II standards. The applicants looked for engines that would likely receive rebuilds within the immediate future and that were otherwise in good physical condition. Three vessels owned and operated by the participating tug companies were identified that met the criteria for this program. On June 22, 2011, the U.S. Environmental Protection Agency recommended that the project be fully funded to the requested amount of $991,041. The funding, awarded through the National Clean Diesel Assistance program, will be used to replace a total of seven engines, including three twin engine main pairs along with one auxiliary engine. It is projected that the engine replacements will generate 620 tons of nitrogen oxide (NO_x), 59 tons of carbon monoxide (CO), and 6.6 tons of particulate matter (PM) reductions in seven years by repowering (re-engining) high-emitting, old tugboat and harbor craft engines with new, cleaner engine technology. The reductions in emissions are based on the age and emissions performance of the existing engines. The main engines operate between 2,750-3,500 hours per year, or between eight and ten hours a day, 365 days a year. In order to qualify for participation, the vessels are required to spend 75% of their operating hours within EPA Region 6 waters. Region 6 includes the states of Arkansas, Louisiana, New Mexico, Oklahoma and Texas. Most importantly, for the purposes of this grant, Texas and Louisiana are the two states that form the critical origin-destination pair for inland waterway shipments, given that the vast majority of traffic on the Gulf Intracoastal Waterway operates on the stretch between Corpus Christi and New Orleans.[21] The limitation to Region 6 is therefore a logical delineation that ensures that emission reductions from participating vessels will benefit the Houston region while giving barge operators sufficient flexibility to utilize these vessels for a number of different routes without compromising eligibility for the program. Table 3 shows a profile of the vessels selected for the funding award and the engines that will be replaced.

TABLE 3

Profile of vessels and engines to be replaced in the Clean Vessels for Texas Waters program

# OF ENGINES	ENGINE TYPE	TYPICAL USE (AVG HRS/YR)	FUEL USE (GAL/YR)	OWNERSHIP	ENGINES	MODEL YEAR	CURRENT AND FUTURE FUEL TYPE
4	EMD 16 645 E6	2,772	65,949	Bay Houston	Main Engines	1988 and 1989	Diesel
2	Cummins KTA-19M	3,500	92,400	JAM	Main Engines	2003	Diesel
1	CAT 3406	4,714	11,785	Bay Houston	Generator Engine	1989	Diesel


Captain Ted (http://www.tugboatinformation.com

William M. Built 1989, owned by Bay Houston and operated by G&H Towing, the *William M* was constructed in 1989 in Louisiana. It has been owned by Bay Houston and operated by G&H Towing since 2005. It is rated at 4000 hp and is classed as a Z-Drive tug. Z Drive tugs have high maneuverability due to fully rotatable propellers and are capable of a number of different types of operations.[22] The Clean Vessels for Texas Waters grant application proposed to replace both the main and auxiliary engines of this Gulf workhorse.


Tigone

Phillip K. The *Phillip K* is an older vessel with a horsepower rating similar to the *William M*, having been originally built in 1976 with a rated horsepower of 3900. The Clean Vessels for Texas Waters grant proposed to replace the main engines on this vessel. As is the case with the *William M,* the *Phillip K* operates at several ports in proximity to the Houston area.

Kristy L, J.A.M. Distribution Source: Tord Avsnes Sele

Kristy L. The *Kristy L* is a 56-ft towboat operated by JAM Distributing, a multi-modal distributor of fuel and lubricants products. It was constructed in 2003 and is very heavily utilized in the Houston area. Absent the grant, the *Kristy L* would likely have received a rebuild of its original 2003 engine in the near future. The replacement with a new Cummins engine will guarantee substantial emissions savings for years to come.

CHAPTER 6

Conclusion

By providing a fuel-efficient and safe form of transportation for heavy industrial products, the barges on the Houston Ship Channel provide a clean alternative for cargo movement that makes the operation of the country's largest petrochemical complex run smoothly. The towing industry has not been the principal focus of air quality improvements in recent years because its contribution to the total air quality problem is significantly less than other sources. Additionally, as all emission types from marine sources on the ship channel are regulated by the Coast Guard and not the TCEQ, there has been little priority given to reducing these emissions as compared to other sources. Nevertheless, due to the small size and consistent operation of the towing industry, it represents one of the most predictable sources of emissions. Investments in modernizing the tug and tow fleet serving the Houston area represent a cost–effective, emissions control strategy that is appropriate for an era of scarce resources. The principal categories of emissions sources from the towing industry are diesel combustion of the marine engines and evaporative emissions from tank barges carrying petroleum-based products. At present, the most effective short-term strategy for reducing emissions appears to be a two-track approach of utilizing strategic investments to replace and modernize diesel engines in the fleet of towboats that serve the Houston area while simultaneously supporting the universal adoption of best management practices for the control of accidental emissions from tanker barges. The engine replacements recently approved for funding represent an effective down payment on a longer term strategy for improving the average age of engines. Because the characteristics of the fleet are known and the turnover rate is low, the opportunity exists to consistently identify the engines that are most in need of replacement and to preemptively quantify the benefits that would result from repowering.

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The Clean Vessels for Texas Waters proposal demonstrates the value and benefits of a successful regional partnership in reducing diesel emissions. Great progress could be made in securing further emission reductions if more effort and resources were devoted to leveraging these types of strategic alliances.

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