NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF MARINE SAFETY
WASHINGTON, D.C.

HAZARDOUS MATERIALS GROUP FACTUAL REPORT

A. ACCIDENT INFORMATION

NTSB Accident No.:	**DCA15MM017**
Accident Type:	Collision
Location:	Houston Ship Channel (HSC), Upper Galveston Bay at buoys 89 and 90 in the vicinity of Morgan's Point.
	Lat 29-40.35N, Long 94-58.74 W 51.6′ N, longitude 93° 56.4′ W
Vessel No. 1:	Liberian-registered bulk carrier *Conti Peridot,* IMO No. 9452634
Owners No. 1:	Conti Peridot Shipping Ltd.
Vessel No. 2:	Danish-registered chemical tanker *Carla Maersk,* IMO No. 9171503
Owners No. 2:	A.P. Moller – Maersk A/S
Date:	March 9, 2015
Time:	12:30:45 Central Daylight Time (CDT)[1]

B. HAZARDOUS MATERIALS GROUP

Group Chairman:

Muhamed El-Zoghbi
Hazardous Materials Group Chairman
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

C. ACCIDENT SUMMARY

For a summary of the collision, refer to the Accident Summary Report in the docket for this investigation.

[1] All times in this report are local CDT in Houston, TX.

Figure 1: Accident location in the Houston Ship Channel and vessel travel directions.

D. VESSEL INFORMATION

The *Carla Maersk* is a double hull chemical tanker with an overall length of 599.9 feet, breadth of 105.6 feet, gross tonnage of 29,289, and deadweight tonnage of 44,999. The vessel was built in 1999 and its flag state is Denmark. The vessel is owned and operated by Maersk Tankers A/S (A.P. Moller-Maersk A/S) of Copenhagen, Denmark. The vessel is authorized to carry chemical products listed on the International Certificate of Fitness[2] and petroleum crude oil. The *Carla Maersk* is outfitted with 20 cargo tanks (10 port and 10 starboard) with a total cargo capacity of 52,736.4 m^3 and 10 water ballast tanks (5 port and 5 starboard) that are arranged in protective locations between the cargo tanks and the ship's hull.

Attachment 1 - Carla Maersk - General Arrangement Plans (FOUO)
Attachment 2 - Carla Maersk - Capacity Plan (FOUO)
Attachment 3 - Sections of Carla Maersk Integrated Contingency Plan
Attachment 4 - Carla Maersk USCG Vessel Detail Information

[2] International Certificate of Fitness –Chemical Carrier; issued by to Det Norske Veritas (DNV) on August 25, 2014; expires November 13, 2018. The vessel is also authorized a sub-category to transport crude oil.

E. HAZARDOUS MATERIALS INVOLVED IN THE ACCIDENT

According to the bill of lading signed by the Master of the *Carla Maersk*, the vessel was carrying 216,049.41 barrels[3] (9,074,075 gallons) of methyl tert-butyl ether (MTBE) which is designated by the US Department of Transportation (DOT) as a hazardous material when transported in commerce. The domestic commercial transport of MTBE is subject to the regulatory requirements of the Hazardous Materials Regulations (HMR) in Title 49 of the Code of Federal Regulations (CFR).

If all or part of a shipment of hazardous materials is made by vessel to, from, or within the United States, the HMR allows the shipment to be made in accordance with the International Maritime Dangerous Goods (IMDG) Code[4], provided certain provisions are satisfied).[5] These provisions are found in 49 CFR 171.25. [6] International maritime shipments of MTBE are subject to the IMDG Code when transported on vessels, such as the *Carla Maersk*, covered by the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.

Table 1 provides information about the hazardous materials on the *Carla Maersk*.

Table 1: Summary of hazardous materials information.

UNITED NATIONS IDENTI-FICATION NUMBER	HAZARDOUS MATERIAL PROPER SHIPPING NAME	HAZARD CLASS OR DIVISION	PACKING GROUP	CHEMICAL ABSTRACTS SERVICE (CAS) NUMBER
2398	Methyl tert-butyl ether	3 - Flammable Liquid	II	1634-04-4

According to the IMDG, instructions T7 with provision TP1 are applicable to MTBE transportation.

Attachment 5 - Carla Maersk Bill of Lading

General Description[7]

MTBE is manufactured by the chemical reaction of methanol and isobutylene. MTBE is produced in large quantities (peak production was 78.9 million barrels in the US in 1999; however, production has been declining since 1999 with 2004 production at approximately 48.1 million barrels)[8] and is almost exclusively used as a fuel additive in motor gasoline. It is one of a group of chemicals commonly known as "oxygenates" because they raise the oxygen content of gasoline. At room temperature, MTBE is a volatile, flammable, and colorless liquid that mixes with water.

[3] Barrels at 60 degrees Fahrenheit.
[4] The IMDG Code contains regulations applicable to the transport of dangerous goods by sea.
[5]http://phmsa.dot.gov/portal/site/PHMSA/menuitem.6f23687cf7b00b0f22e4c6962d9c8789/?vgnextoid=1a9077cccd658110VgnVCM1000009ed07898RCRD&vgnextchannel=f4264d7c0c738110VgnVCM1000009ed07898RCRD&vgnextfmt=print
[6] One must also consult 171.22 and 171.23 to ensure that a shipment made in accordance with the IMDG Code is acceptable for transportation within the United States.
[7] http://www.epa.gov/mtbe/faq.htm
[8] EPA Report 815-R-08-012, Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2).

Uses and Applications[9]

MTBE had been used in US gasoline at low levels since 1979 to replace lead as an octane enhancer (helps prevent engine "knocking"). Between 1992 and 2005, MTBE had been used at higher concentrations in some gasoline to fulfill the oxygenate requirements set by Congress in the 1990 Clean Air Act Amendments. Oxygen helps gasoline burn more completely, reducing harmful tailpipe emissions from motor vehicles. Most refiners chose to use MTBE over other oxygenates primarily for its blending characteristics and for economic reasons.

At least 25 states passed laws banning or limiting the use of MTBE, with effective dates ranging from 2000 to 2009. MTBE use in gasoline has generally been phased out in the US; however, it is still used in gasoline in foreign countries.

Physical/Chemical Properties

The IMDG describes the properties of MTBE as follows:

> Colourless liquid. Flashpoint: below -17^{o}C c.c. [closed cup]
> Explosive limits: 1.7% to 8.4%. Boiling point: 55^{o}C. Immiscible with water.

According to the Computer-Aided Management of Emergency Operations (CAMEO)[10] database and the Texas Petroleum Company (TPC) Material Safety Data Sheet (MSDS), MTBE is a colorless liquid with a distinctive anesthetic-like or turpentine-like odor. Vapors are flammable, heavier than air, and narcotic. The vapors may travel across the ground and reach remote ignition sources causing a flashback fire danger. Contrary to the IMDG description, CAMEO states that MTBE is miscible (mixes) in water. Generally, MTBE is reported as slightly soluble in water.

MTBE has a boiling point of 127.9°F, a specific gravity of 0.745 (H_20 = 1.0), a vapor density of 3.1 (Air = 1.0), a solubility by weight of 4.8 % by weight at 68°F, and an auto-ignition temperature of 435°F. It is incompatible with strong oxidizing agents.

According to an EPA regulatory determination report, MTBE dissolves easily in water and does not "cling" to soil very well; thus, it migrates faster and farther in the ground than other gasoline components. The report also states that MTBE does not degrade (breakdown) easily and is difficult and costly to remove from ground water. MTBE is generally more resistant to natural biodegradation than other gasoline components. According to the EPA, some monitoring wells have shown little overall reduction in MTBE concentration over several years which suggests that MTBE is relatively persistent in ground water. In contrast, studies of surface water (lakes and reservoirs) have shown that MTBE volatilizes (evaporates) relatively quickly.

MTBE is generally considered not bio-accumulative or persistent in the environment.

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[9] EPA Report 815-R-08-012, Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2).
[10] http://cameochemicals noaa.gov/chemical/7091

Routes of Exposure and Target Organs

The primary routes of exposure are inhalation, skin and eye contact, and ingestion. The potential health impacts include:

- Direct contact with the eyes can cause eye irritation.
- Prolonged or repeated skin contact can result in defatting and drying of the skin which may cause skin irritation and dermatitis (rash).
- Inhalation of vapors may cause drowsiness and dizziness. High concentrations can cause severe central nervous system depression (including unconsciousness).
- Swallowing may cause stomach cramps and diarrhea.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established an exposure Threshold Limit Value (TLV)[11] of 50 parts per million (ppm).

Emergency Response Guidance

Hazardous materials guidance to assist first responders in making initial decisions upon arriving at the scene of a transportation incident involving hazardous goods is contained in the Emergency Response Guidebook (ERG).[12] The ERG states, "It is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in the incident, and protecting themselves and the general public during the initial response phase of the incident." The ERG defines the initial response phase as "that period following arrival at the scene of an incident during which the presence and/or identification of dangerous goods is confirmed, protective actions and area securement are initiated, and assistance of qualified personnel is requested."

The ERG specifies the protective actions and isolation/evacuation distances for the safety of responders and the public. It instructs responders to become familiar with the guidebook and its content before an emergency, to approach the incident from upwind, and to stay clear of all spills, vapors, fumes, smoke and suspicious sources.

The ERG numbered guide for MTBE is Guide 127, Flammable Liquids (Polar / Water-Miscible). The ERG advises responders, as an immediate precautionary measure, to isolate the spill or leak area for at least 50 meters (150 feet) in all directions. For large spills, responders are instructed to consider an initial downwind evacuation of at least 300 meters (1000 feet). The isolation distance is increased to ½ mile if a fire is involved. Guide 127 cautions responders that these flammable liquids have very low flash points. All ignition sources (no smoking, flares, sparks or flames in immediate area) need to be eliminated. All equipment used when handling these products must be grounded. A vapor suppressing foam may be used to reduce vapors.

Community Exposure Guidance

The National Advisory Committee for the Development of Acute Exposure Guideline Levels for Hazardous Substances (AEGL Committee), which is managed by the Environmental Protection

[11] 8-hour time weighted average occupational exposure.
[12] The latest edition published in 2012. The prior edition was published in 2008.

Agency (EPA), developed guidelines to help both federal and local authorities, as well as private companies, deal with emergencies involving chemical spills. The development of Acute Exposure Guideline Levels (AEGLs) is a collaborative effort of the public and private sectors worldwide. AEGLs are intended to describe the risk to humans resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals. These levels can be used for emergency planning and response activities related to the accidental release of hazardous substances and general public exposures.

According to the EPA, the AEGLs differ from regulatory permissible exposure limits (PELs) in that "they are based primarily on acute toxicology data and not sub-chronic or chronic data."[13] The guidance does not reflect the effects that could result from frequent or occupational exposures. Unlike most occupational exposure levels, AEGLs factor in exposure effects to the elderly and children.

There are three AEGL levels (one through three) that are defined based on the expected health effects on the public. An AEGL-1 is the airborne concentration, expressed as parts per million or milligrams per cubic meter (ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

An AEGL-2 is the airborne concentration, expressed as ppm or mg/m^3, of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

An AEGL-3 is the airborne concentration, expressed as ppm or mg/m^3, of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Table 2 –AEGLs for MTBE.

Exposure Period	AEGL-1	AEGL-2	AEGL-3
10 minutes	50 ppm	1,400 ppm	13,000 ppm 🔥🔥
30 minutes	50 ppm	800 ppm	7,500 ppm 🔥
60 minutes	50 ppm	570 ppm	5,300 ppm 🔥
4 hours	50 ppm	400 ppm	2,700 ppm 🔥
8 hours	50 ppm	400 ppm	1,900 ppm 🔥

Lower Explosive Limit (LEL) = 16,000

🔥Indicates value is 10-49% of LEL. Safety consideration against explosions must be taken into account.

🔥🔥Indicates value is 50-99% of LEL. Extreme safety consideration against explosions must be taken into account.

(NAC/NRC, 2013)

The American Industrial Hygiene Association (AIHA) also developed guidelines for community emergency response to potential releases of airborne substances. Emergency Response Planning Guidelines (ERPGs) are air concentration guidelines for single exposures to agents and are intended

[13] http://www.epa.gov/opptintr/aegl/pubs/aeglapp html

for use as tools to assess the adequacy of accident prevention and emergency response plans, including transportation emergency planning, community emergency response plans, and incident prevention and mitigation.

There are three ERPG levels (one through three). An ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor. The ERPG-1 identifies a level which does not pose a health risk to the community, but which may be noticeable due to slight odor or mild irritation. In the event that a small non-threatening release has occurred, the community could be notified that they may notice an odor or slight irritation, but that concentrations are below those which could cause unacceptable health effects.

An ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. At air concentrations above an ERPG-2, there may be significant adverse health effects, signs, or symptoms for some members of the community which could impair an individual's ability to take protective action. These effects might include severe eye or respiratory irritation, muscular weakness, CNS impairments, or serious adverse health effects.

An ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects. The ERPG-3 level is a worst-case level above which there is the possibility that some members of the community may develop life-threatening health effects.

Table 3 provides ERPG information published for MTBE.

Table 3 - ERPGs for MTBE.

Chemical	ERPG-1	ERPG-2	ERPG-3	
Methyl tert-Butyl Ether (MTBE) (1634-04-4)	50 ppm	1,000 ppm	5,000 ppm	LEL = 16,000 ppm

Indicates that odor should be detectable near ERPG-1.

Indicates value is 10-49% of LEL. (AIHA, 2013)

Attachment 6 - CAMEO Report on MTBE
Attachment 7 - MTBE Material Safety Data Sheet (MSDS) from Carla Maersk
Attachment 8 – Kinder Morgan MTBE Material Safety Data Sheet (MSDS)

F. PRE-ACCIDENT EVENTS

Hazardous Materials Shipper's Actions - Shipment Preparation

Prior to the departure of the *Carla Maersk* on March 9, 2015, it was loaded with MTBE at two (2) terminals (Kinder Morgan Terminal in Galena Park[14] and a Texas Petroleum Company Terminal).

[14] Kinder Morgan Galena Park Terminal, 906 Clinton Drive, Galena Park, TX 77547

According to the Master of the *Carla Maersk*, the vessel is loaded using a closed loop system with the vapors captured and flared off.

On February 27, 2015, the vessel was loaded with 31,000 barrels of MTBE at the Galena Park Kinder Morgan Terminal. The remaining approximately 185,000 barrels were obtained from Texas Petroleum Company (TPC).

The MBTE transported by the *Carla Maersk* was shipped by Lukoil Pan Americas LLC to Petróleos de Venezuela, S.A. (PDVSA) in Venezuela.

Lading Volumes and Capacity

During loading operations at the TPC Terminal, there was a dispute between the *Carla Maersk* Chief Officer and the loading terminal regarding the actual volumes loaded on the vessel. According to the *Carla Maersk* cargo report, the vessel was loaded with a total of 216,519.4 barrels (9,093,798 gallons) of MTBE. The Chief Officer signed the cargo report; however, he annotated that the loading terminal refused to sign it and handwrote a disputed total quantity of 216,044.1 barrels (9,073,852.2 gallons), instead of 216,519.4 barrels. The NTSB obtained the letters of protest (LOP) that were lodged by the Chief Officer for numerous issues which included a complaint about the inability to obtain a shore loading figure. The final bill of lading provided by Lukoil Pan Americas states that the vessel was transporting 216,049.41 barrels (9,074,075.00 gallons).

All cargo tanks, except for the port and starboard number 1, 2, and 10 cargo tanks, were loaded with MTBE. The two port cargo tanks (numbers 3 and 4), in the vicinity of the impact zone, contained a total of 30,174.9 barrels (1,267,345.8 gallons) of MTBE.

According to IMDG provision TP1which is applicable to bulk packaging of MTBE and special provision TP1 in 49 CFR 172.102[15], the maximum degree of filling is calculated using the following:

4.2.1.9.2. The maximum degree of filling (in %) for general use is determined by the formula:

$$\text{Degree of filling} = \frac{97}{1+\alpha(t_r - t_f)}$$

4.2.1.9.4. In these formulae, α is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (t_f) and the maximum mean bulk temperature during transport (t_r) (both in °C). For liquids transported under ambient conditions, α could be calculated by the formula:

$$\alpha = \frac{d_{15} - d_{50}}{35 d_{50}}$$

in which d_{15} and d_{50} are the densities of the liquid at 15°C and 50°C, respectively.

[15] Applicable to MTBE based on Table in 29 CFR 172.101.

4.2.1.9.4.1. The maximum mean bulk temperature (t_r) shall be taken as 50°C except that, for journeys under temperate or extreme climatic conditions, the competent authorities concerned may agree to a lower or require a higher temperature, as appropriate.

Based on NTSB calculations, the lading in the port and starboard cargo tanks 3 and 4 did not exceed the maximum degree of filling (in %) prescribed by the IMDG (Section 4.2.1.9.2) or the HMR.

Table 4: Lading volumes of MTBE in cargo tanks 3 and 4 (port and starboard).[16]

CARGO TANK	GSV[17] (m^3)	GSV (m^3) CAPACITY LIMIT	DEGREE OF FILLING (AT LOADING TEMP)	APPROX. MAXIMUM DEGREE OF FILLING (IMDG 4.2.1.9.2)[18]	GSV BARRELS
COT3P	2,332.5	2,633.5	89.2%	92.3%	14,681.0
COT3S	2,306.2	2,626.9	88.5%	92.3%	12515.1
COT4P	2,461.7	2,771.4	89%	92.3%	15493.9
COT4S	2,455.0	2,764.8	89.2%	92.3%	15451.7

Attachment 9 - Kinder Morgan Bill of Lading
Attachment 10 - Kinder Morgan Filling Procedures (FOUO)
Attachment 11 - Carla Maersk Cargo Report
Attachment 12 - TPC Carla Maersk Letters of Protest
Attachment 13 - TPC Response Memo to NTSB

Inert Gas System (IGS) for Cargo Tanks

An inert gas system (IGS) is a system that supplies the cargo tanks with a gas or mixture of gases to create an oxygen deficient environment so combustion cannot occur within the cargo tanks. The *Carla Maersk* was equipped with a nitrogen IGS for its cargo tanks.

[16] Numbers based on *Carla Maersk* Cargo Report.
[17] Gross Standard Volume.
[18] Calculated based on TPC density information.

Figure 2: IGS controls and operational log in *Carla Maersk* Cargo Control Room.

US regulations for gas inerting systems are found in 46 CFR 32.53. These regulations apply to crude oil or product carriers, not a chemical carrier. Chemical tankers constructed before July 1, 1986, carrying flammable cargoes other than crude oil or petroleum products are not required to have an IGS.[19] If the vessel was constructed on or after that date, no inerting is required provided the following:

(1) The individual tank(s) involved do not have a capacity exceeding 3000 m^3;
(2) The individual nozzle capacities of the tank washing machines do not exceed 17.5 m^3/hr; and
(3) The total throughput for all the machines in use in a tank does not exceed 110m^3/hr.

US regulations are not applicable to the *Carla Maersk*. Only IMO and Class rules apply. At the time of the accident, the Det Norske Veritas AS (DNV), Rules for Classification of Ships – Chemical Carriers (Part5, Chapter 4) stated:

> A 100 Application
> 101 Chemical tankers of deadweight in excess of 20 000 tons having individual cargo tanks exceeding 3,000 m3 or cargo tanks fitted with washing machines with a nozzle capacity exceeding 17.5 m3/h or a total through put per tank of 110 m3/h shall be fitted with an inert gas system complying with the rules in Ch.3 Sec.11, if the vessel is intended for carriage of chemicals with flash point not exceeding 60°C.

The IMO's Maritime Safety Committee at its ninety-third session in May 2014 approved amendments to SOLAS and the Fire Safety Systems Code to mandate the use of inert gas on new oil tankers of below 20,000 dead weight tonnage (dwt) and new chemical tankers. The amendment

[19] Navigation and Vessel Inspection Circular (NVIC) No. 2-88, March 1988.

states:

5.5.1.1. For tankers of 20,000 tonnes deadweight and upwards constructed on or after 1 July 2002 but before 1 January 2016, the protection of the cargo tanks shall be achieved by a fixed inert gas system in accordance with the requirements of the Fire Safety Systems Code, as adopted by resolution MSC.98(73), except that the Administration may accept other equivalent systems or arrangements, as described in paragraph 5.5.4.

5.5.1.2. For tankers of 8,000 tonnes deadweight and upwards constructed on or after 1 January 2016 when carrying cargoes described in regulation 1.6.1 or 1.6.2, the protection of the cargo tanks shall be achieved by a fixed inert gas system in accordance with the requirements of the Fire Safety Systems Code, except that the Administration may accept other equivalent systems or arrangements, as described in paragraph 5.5.4.

The DNV Rules for Classification of Ships – Chemical Carriers[20] (Part5, Chapter 4) were updated in July 2015 and reflect the changes above.

G. BRIEF DESCRIPTION OF DAMAGE TO CARGO TANKS

The *Carla Maersk* was struck on its port side. The impact area included port cargo tanks 3(COT3P) and 4 (COT4P) and port water ballast tanks 2 and 3. Cargo tank COT4P was breached and MTBE was discharged into the water. *Carla Maersk* crew completed emergency ballast and cargo transfer operations to correct a port list that was approximately 10 degrees.[21]

Figure 3: Collision of the *Conti Peridot* and the *Carla Maersk*.

[20] https://exchange.dnv.com/servicedocuments/dnv/
[21] According to the Port of Houston Authority Fire Department and the Captain of the *Carla Maersk*.

Figure 4: *Carla Maersk* hull damage caused by the *Conti Peridot*.
(*Courtesy of Port of Houston Authority Fire Department*)

According to an Assistant Fire Chief (Assistant Chief #1) of the Port of Houston Authority Fire Department who was on Fireboat 2, the *Carla Maersk* port list was corrected at 13:22 on March 9, 2015. Also, according to the Assistant Chief #1, he observed a product “pouring” or “flowing” out of a breach in the *Carla Maersk* that was approximately 2 feet above the water line. The fire department provided the NTSB with thermal scan images taken of the hull of the *Carla Maersk*. See Figure 5.

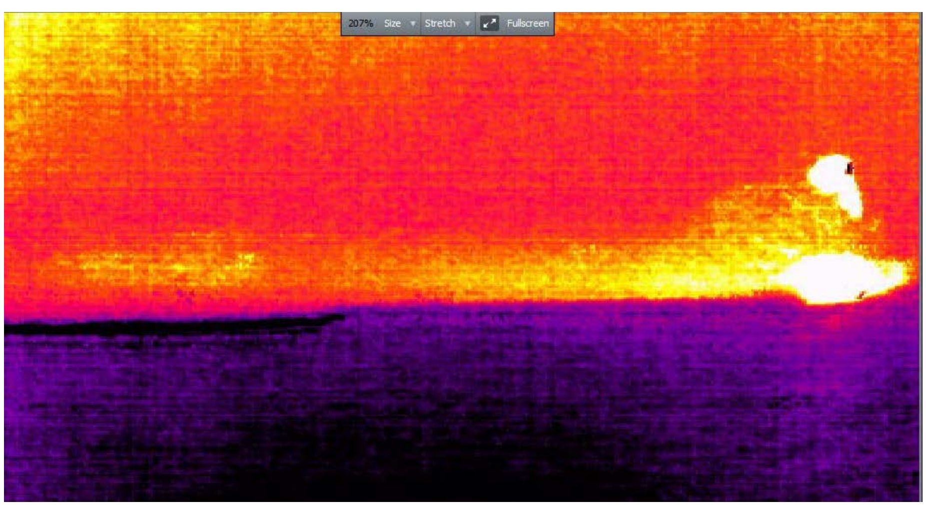

Figure 5: Thermal scan image of damage to *Carla Maersk*.
The two light areas on the right-side indicate location of product flow/breach.
(*Courtesy of Port of Houston Authority Fire Department*)

A sheen was observed on the water as a result of the rupture of hydraulic lines on the vessel. USCG small boats were on station at the border of the visual sheen edge due to MTBE flammability concerns.

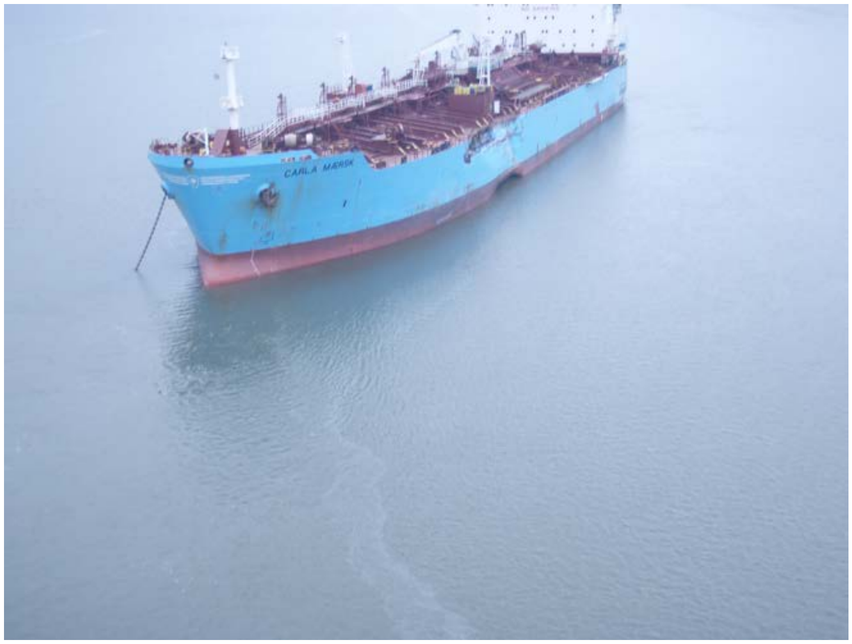

Figure 6: *Carla Maersk* with sheen on the water and damage to the hull on March 10, 2015. (*Courtesy of USCG*)

Figure 7: *Carla Maersk* with extended sheen on March 10, 2015. (*Courtesy of USCG*)

Figure 8: Sheen on water of the HSC on March 10, 2015. (*Courtesy of USCG*)

The thermal survey scan of the *Carla Maersk* indicated potentially two breaches. The DNV survey report of the post-collision condition of the *Carla Maersk* states:

> 4. Following an internal inspection carried out by an ROV [remotely operated vehicle] inside Cargo Tank 4 Port, two holes were found in the inner longitudinal bulkhead in way of Fr. 71, one being of oval shape 260 x 125mm and the other of elongated shape 360 x 35mm.

The *Carla Maersk* reported 27 people on board (including the pilot). The *Conti Peridot* reported 25 people on board (including the pilot).

The *Conti Peridot* sustained damages primarily to the bow of the vessel. It had a crushed bulbous bow with a breach above the waterline.

Figure 9: Damage to the *Conti Peridot*.
(Courtesy of Port of Houston Authority Fire Department)

Both vessels anchored near the location of the collision and remained under power. The HSC was closed in the vicinity of the collision and a safety zone was quickly established.

Attachment 14 – DNV Survey Statement – Survey of Hull Damage to Carla Maersk
Attachment 15 –Survey Statement - Narrative Annex - Hull Damage and Repairs - 2015-07-13 - Miami

H. SPILL PLANS

Central Texas Coastal Area Contingency Plan

The Central Texas Coastal Area Contingency (CTCAC) plan outlines the areas strategies for coordinated responses to the discharge, or threat of discharge, of oil or hazardous substances, in predesignated inland and coastal zones. The plan was established and coordinated by the USCG, Texas General Land Office (TGLO), Environmental Protection Agency (EPA), Texas Commission on Environmental Quality (TCEQ), Bureau of Safety and Environmental Enforcement (BSEE), and Texas Railroad Commission (TXRRC). The CTCAC plan in effect at the time of the accident was approved on March 22, 2013, and updated in July 2014. This plan covers the navigable waters of the Captain of the Port (COTP) Houston-Galveston area of responsibility.

In accordance with Section 311 of the Clean Water Act (CWA), as amended by the Oil Pollution Act of 1990, the Federal On-Scene Coordinator (FOSC) is delegated authority to ensure the effective and immediate removal of a discharge and mitigation or prevention of a substantial threat of discharge of a hazardous substance. The USCG assumes the role of FOSC for oil discharges and hazardous substance releases into or threatening the coastal zone.

Based on the National Contingency Plan (NCP), the COTP has been designated as the local hazardous materials responder for releases into or threatening the coastal zone. The COTP will remain the FOSC and make notifications to the NRC and assist in the coordination of response efforts. If the incident is beyond the capabilities of the local responders, the COTP/FOSC will exercise the Area Contingency Plan (ACP) and will initiate the formation of the Incident Command System (ICS).

According to the CTCAC[22] plan:

> The master of a vessel, facility manager, or designated representative is responsible for the safety of the crew and vessel and should initiate response actions in accordance with the vessel's fire plan. The presence of responding agencies does not relieve the master/manager of command or transfer the master's or manager's responsibility for overall safety of the vessel. The master/manager should not countermand any orders given by the supervisors of responding organizations in the performance of their activities unless the action taken or planned clearly endangers the safety of the vessel, crew, or passengers. The master of the vessel or facility manager will utilize his resources to control the release until such time as he is relieved of

[22] Section 7130 – Vessel Master Responsibility

Also, according to the plan, TCEQ is the State On-Scene Coordinator (SOSC) and designated as lead State agency for hazardous materials releases, as described in Texas Water Code, Section 26.264 and 26.266.[23]

According to the CTCAC plan, operational response will be based on the following tactical priorities:

- Safety: Ensure safety of responders, victims, and public. If possible, approach from upwind, upgrade, and upstream.
- Isolation and Deny Entry: Attempt to restrict access to incident site. Position barricades or perimeters as available to identify the hot zone.
- Notifications: Ensure proper notifications have been made to all concerned parties.
- Identification and Hazard Assessment: Attempt to determine the nature and extent of the hazard present. Utilize as many sources as are available to assure the most accurate assessment possible. All further response actions will be based on this identification and hazard assessment.
- Conduct a risk analysis prior to initiating any response activities.
- Personal Protective Equipment: Determine the appropriate level of personal protective equipment to respond to the incident. Ensure responders are trained in the use of such equipment in accordance with prescribed OSHA requirements found in 29 CFR 1910.
- Containment and Control: Determine the containment and control actions necessary to mitigate the specific incident at hand. "No Action" may be an appropriate control method.
- Protective Actions: Determine the need to recommend evacuation or shelter-in-place of the local populace which may be affected.
- Decontamination and Cleanup: Conduct decontamination and cleanup of affected areas and response equipment to prevent the spread of contamination.
- Disposal: Dispose of the recovered Hazardous Materials and any other residue, such as cleaning water or solutions used in the decontamination and cleanup process.

Carla Maersk Approved USCG Response Plans and Integrated Contingency Plans

The *Carla Maersk* vessel response plan (VRP) # 11402, submitted to meet the requirements of the Federal Water Pollution Control Act as amended by the Oil Pollution Act of 1990 (33 Code of

[23] State requirements for response to a HAZMAT release are also described in Chapter 30 of the Texas Annotated Code, Sections 327.5 and 335.8

Federal Regulations art 155, Subparts D and I), was approved by the USCG on October 11, 2012. The plan's approval remains valid until April 22, 2018.

According to the USCG approval letter, the *Carla Maersk* is authorized to operate in the Houston-Galveston Port Zone.

According to the Maersk Integrated Contingency Plan (all ships), the Master shall appoint a single Emergency Party. The following personnel are to be members of the Emergency Party:

- Chief Officer
    - Team leader (Spill Officer) for oil spill or emergency on deck, within cargo or accommodation spaces.
- Second Engineer Officer
    - Team leader (Spill Officer) if incident is within machinery spaces.
- First Assistant Engineer Officer/Bosun
- Three Ratings

The responsibilities of the Emergency Party include:

- Team Leader: Determine the source/cause of the discharge, take steps to mitigate the discharge, and estimate the manpower and equipment needs to deal with the spill.
- Emergency Contingency Plans are intended to familiarize the ship's crew with different circumstances and the types of response required for specific emergencies.
- For an oil spill situation, the Emergency Party will normally be split into two spill teams, augmented as necessary from the stand-by/first aid party.

The *Carla Maersk* Integrated Contingency Plan provides the crew with considerations in performing initial damage assessments. They are as follows:

- Are any tanks penetrated above the waterline?
    - Does the colliding vessel have a bulbous bow?
- If so, expect to find below-waterline penetration in the ship's hull.
    - Is any oil spilling at present?
- If so, ascertain an estimate of the quantity of oil in the water and its orientation with respect to the ship (flowing in what direction, etc.).
- If the vessels are dead in the water and interlocked, is it more prudent to the safety of the vessels that they stay interlocked?
- If separation of the vessels is advisable, will such separation increase the size or likelihood of a spill?
    - Will sparks associated with separation of the vessels risk fire or explosion in the cargo?
- Is there any danger of fire or explosion aboard either vessel and, if so, is there danger that fire can spread to the other vessel?
- Are the vessels of greater danger to traffic in the area if they remain interlocked?
- If one vessel has reduced buoyancy from serious damage below the waterline is there a danger of her sinking if separated from the interlock?
- If the vessels are separated, can own vessel maneuver after separation?

When performing secondary damage assessments, the crew is instructed to:

- Determine the extent of damage;
- Visually inspect as much external and internal structure as is accessible;
- Sound all tanks;
- Compare tank soundings with loading ullages to check for leakage;
- Sound all compartments and void spaces to ensure integrity; and
- Take draft readings and reporting the ship's trim and list configuration.

According to the collision plan within the Maersk contingency plans, crews are instructed as follows:

- Limited damage: concentrated in one or two tanks for example, with the impact on stress and stability taken into account, consideration should be given to internal transfer of cargo away from the damage.
- Considerable damage is such that the quantitative determination of the cargo transfer cannot be computed on board, the Master shall inform the vessel operator or the designated damage stability and hull stress information resource providing them with all necessary data to make the damage stress and stability calculations.
- Transferred contents can be directed to slack tank(s) on board, ashore or to lighters as is most feasible.
    - If the head in the leaking tank cannot be eliminated by removal of contents or the leak is not otherwise plugged, it will continue to flow until a hydrostatic balance between sea level and the tank is achieved.
- If the locale of the leak is not obvious, location of affected tanks can most readily be identified by comparing existing ullages with the loading ullages, noting substantial variations between the two.
- If it is suspected that leakage is from the bottom or lower shell plating of a tank, leakage can also be stopped by reducing the level in the tank and pumping water into the tank to provide a water bottom buffer cushion under the tank contents to block further leakage.

SVITZER Salvage Americas certified that the *Carla Maersk* Pre-Fire Plans, required by 33 CFR 155.4035(b)(2), has been reviewed and found acceptable, and that they agree to implement the Pre-Fire Plan for use in mitigating a potential or actual fire.[24]

According to the SVITZER Salvage Americas Consent Letter, they certify that upon notification of an incident requiring salvage and/or firefighting response by the client or their authorized representative, SVITZER Salvage Americas agrees to and is capable of providing, and intends to commit to providing, the services listed in 33 CFR 155.4030(a) through 155.4030(h). These services will be provided, to the best of SVITZER Salvage Americas capability, within the planning response timeframes listed in 33 CFR Table 155.4030(b), for the COTP zones specifically listed in the client's VRP.

[24] Certified in February 2013.

SVITZER Salvage Americas, in accordance with the Oil Pollution Act of 1990 (OPA-90) and the California Code of Regulations, Title 14, certifies that Maersk Tankers A/S, as Plan Holder, has ensured the availability of the required personnel and equipment capable of responding to a maritime emergency requiring salvage, lightering, or firefighting within the required response times and in the specific Geographic Regions listed in the VRP for the covered vessel(s) which include the *Carla Maersk.*

Gallagher Marine Systems maintains the Vessel Response Plans for A.P. Moller-Maersk A/S. On April 16, 2014, Gallagher Marine Systems sent the USCG change #42 for Maersk Tankers A/S Integrated Contingency Plan, Vessel Response Plan #11402, to update the Official Number and Gross Tonnage for the vessel *Carla Maersk.*

Attachment 16 – Carla Maersk VRP
Attachment 17 - Change #42 to VRP
Attachment 18 - Carla Maersk Pre-Fire Plan

I. EMERGENCY RESPONSE

Unified Command Structure

At approximately 15:00, on March 9, 2015, a Unified Command (UC) was established with its incident command post situated at the City of La Porte Emergency Operations Center.[25] The incident commander was the Qualified Individual (QI) for Gallagher Marine Systems who acted on behalf of the responsible party Maersk Tankers A/S. The Federal On-Scene Coordinator (FOSC) was the Captain of the Port (COTP) and commanding officer of USCG Sector Houston-Galveston. The State On-Scene Coordinator (SOSC) was the Texas Commission on Environmental Quality (TCEQ). The Local On-Scene Coordinators (LOSC) were the City of La Porte Emergency Management Coordinator and a representative from the Port of Houston Authority. Together, these organizations formed the UC. The actions of the incident commander were subject to the concurrence and oversight of the FOSC, SOSC, and the LOSC. Other agencies or organizations that staffed the incident command included the National Oceanic and Atmospheric Administration (NOAA), Wildlife Response Services LLC, Center for Toxicology and Environmental Health (CEH), Horizon Environmental, and Titan Salvage.

The UC was comprised of the following sections: Operations, Planning, Logistics, and Finance. On March 10, 2015, the COTP gave the NTSB a briefing at the UC about the incident and the subsequent emergency response. After this briefing, NTSB investigators were not allowed at the UC throughout the entire on-scene portion of the investigation despite several requests. A USCG official stated that the NTSB's presence could have a negative impact on their operations and would have a "chilling effect" on the cooperation and open discussion among the UC members. During the NTSB on-scene investigation, the USCG provided a liaison who was responsible for communicating NTSB issues to the UC.

The National Incident Management System (NIMS) provides a consistent nationwide template to enable federal, state, tribal, and local governments, nongovernmental organizations, and the private

[25] 3001 N. 23rd Street, La Porte, Texas 77571.

sector to work together to prevent, protect against, respond to, recover from, and mitigate the effects of incidents regardless of cause, size, location, or complexity in order to reduce the loss of life and harm to the environment. According to NIMS, a UC is "an application of the ICS [incident command system] used when there is more than one agency with incident jurisdiction or when incidents cross political jurisdiction. Agencies work together through the designated members of the UC, often the senior person from agencies or disciplines participating in the UC, to establish a common set of objectives and strategies and a single Incident Action Plan (IAP)."

According to the National Response Team Unified Command Technical Assistance Document, "[t]he UC is a structure that brings together the Incident Commanders of all major organizations involved in the incident in order to coordinate an effective response, while at the same time allowing each to carry out their own jurisdictional, legal, and functional responsibilities."

The USCG Incident Management Handbook, published May 2014, states that an Intelligence/Investigation Section could be created in the UC. According to Chapter 9 of the USCG Handbook, the primary function of the Investigation Section Chief (ISC) "…is to conduct an investigation to determine the cause(s) of the incident and guide appropriate agency enforcement options." Additionally, the handbook explicitly mentions the NTSB as a potential member of the UC. On page 9-3 of the handbook it states:

> Deputy ISCs may be from the same organization as the ISC or from an assisting organization. Deputy ISCs – Marine Casualty may include members from the National Transportation Safety Board (NTSB), Bureau of Safety and Environmental Enforcement (BSEE), Chemical Safety Board, Occupational Safety and Health Administration (OSHA), and/or the vessel's international flag state.
>
> A marine casualty investigation in accordance with ref (d) requires greater autonomy and less integration of the I/I [Intelligence/Investigation] Section. Because the vessel or facility owner (sometimes designated as the "Responsible Party" under ref (c)) is often a member of the Unified Command and integrated throughout the response organization. Since the Responsible Party may have some liability for the marine casualty or be the subject of a criminal investigation, the investigative portion of the I/I Section must maintain an appropriate level of autonomy from the Unified Command to ensure sensitive investigative information is not shared with the Responsible Party.
>
> Under these circumstances the I/I Section should be established as a Section, with the ISC as a member of the General Staff, and integrated as much as possible into the incident management team without compromising the investigation.
>
> Integration includes proper check in with RESL [Resource Unit Leader]; coordination with the Operations Section regarding access to the incident scene; use of Logistics Section supported facilities, safety equipment, facilities, communications equipment, and transportation; and cost documentation by the Finance/Admin Section.

During an interview with the NTSB,[26] the COTP was asked if he was aware of federal NIMS guidance that allows for the creation of an investigative section in the UC. The COTP answered:

> I am aware of it. I would not -- I would disagree with characterizing the NIMS as such. The NIMS is a tool kit appropriate to the needs of the Unified Command. I was not conducting an investigation so I did not stand up the investigation

During this interview, the Deputy Staff Judge Advocate for the 8th Coast Guard District raised a general objection to the NTSB questioning and stated:

> I know there was a big concern from the part of the Coast Guard of potential chilling effect in real time on discussions in the Unified Command.
>
> For my purpose today, I guess I'm concerned with kind of the second order chilling effect to the extent that …[the COTP] is asked or shares information about pre-delivery of decisions that occurred in the Unified Command. I wouldn't want to create a situation where in future Unified Commands that …[the COTP] may stand up that folks will be hesitant to come forward to share information that …[the COTP] would need to know about in order to respond to potentially another incident like this.

The COTP was asked if he believed an investigative section was necessary at this incident. The COTP stated:

> I wasn't conducting an investigation. I was responding and my priorities were such that I was not -- at the incident command post-- I was not concerned with that element.

The COTP also stated during the interview:

> To give a little bit broader answer... when we took the notification, I was immediate assured, because I was here, that the initial investigative action had been initiated and I did not feel a need to bring that into the command post for actually many of the same reasons that we discussed previously. I knew an investigation was occurring and I didn't need to have it in the command post I guess is probably the most correct way to say what I'm trying to say.

Unified Command Actions

The UC developed the following overall and strategic objectives for the incident[27]:

- Safety of the public, responders, and the crew;
- Continuous air monitoring and map air quality readings;
- Stop air plume from ship;
- Monitor whether MTBE is on the surface, find and map;

[26] NTSB interview conducted on September 29, 2015.
[27] From ICS 202 – Incident Objectives.

- Protect natural resources from surface contamination;
- Keep public informed on protective measures;
- Initiate assessment for salvage on Maersk vessel (damage and cleaning) prior to moving;
    - Continue salvage on Maersk vessel (damage and cleaning) prior to moving
- Perform assessment and move Maersk vessel to lay berth;
- Perform assessment and move *Conti Peridot* vessel to lay berth;
- Recover and Rehabilitate Injured Wildlife;
- Locate anchor and mark location/remove;
- Open the waterway and restore commerce.

The UC priorities[28] were as follows:

- People (Life Safety);
- Incident Stabilization;
- Environment (Protection);
- Assets;
- Reputation.

A modified shelter-in-place order was put into effect for the City of Morgan's Point and the Barbours Cut Terminal (BCT) on the first day of the incident. Shortly into the incident, the Port of Houston Authority evacuated the BCT. The Mayor of Morgan's Point implemented additional protective measures for his community and a partial evacuation of the City of Morgan's Point took place. Residents were not required to leave; however, they were not allowed to return if they left. Two schools, a primary and a post-secondary school, were affected by the incident. Students were sheltered-in-place, but school buses were to take students home as their school day ended.

The UC established a safety zone that included a large portion of the HSC and the surrounding waterways. See figures 9 through 10.

[28] From ICS 202A – Command Direction.

Figure 10: Map showing the location of the vessels, the safety zones, and location of air monitoring on March 10, 2015, at 02:30.

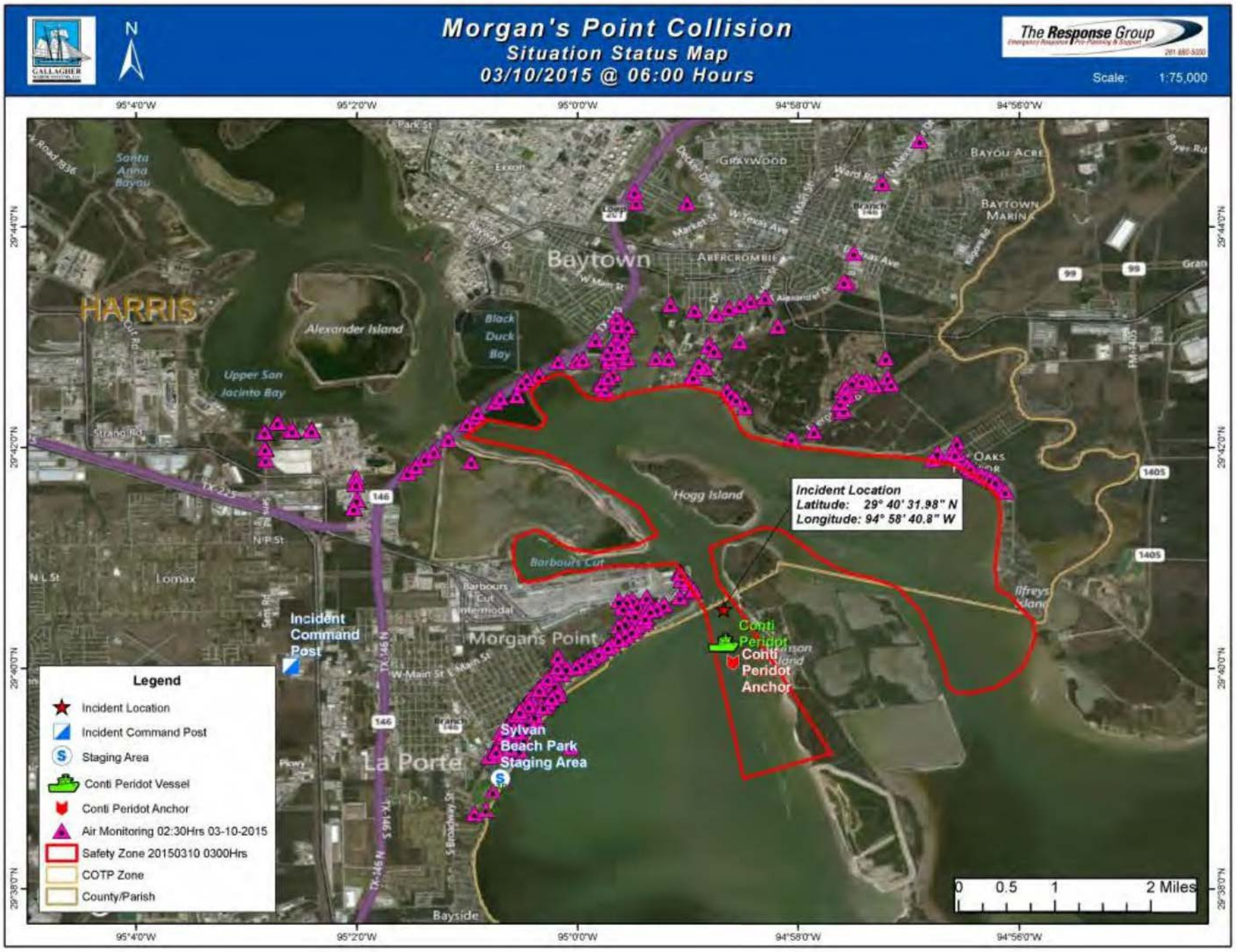

Figure 11: Map showing the location of the vessels, the safety zones, and location of air monitoring on March 10, 2015, at 0600.

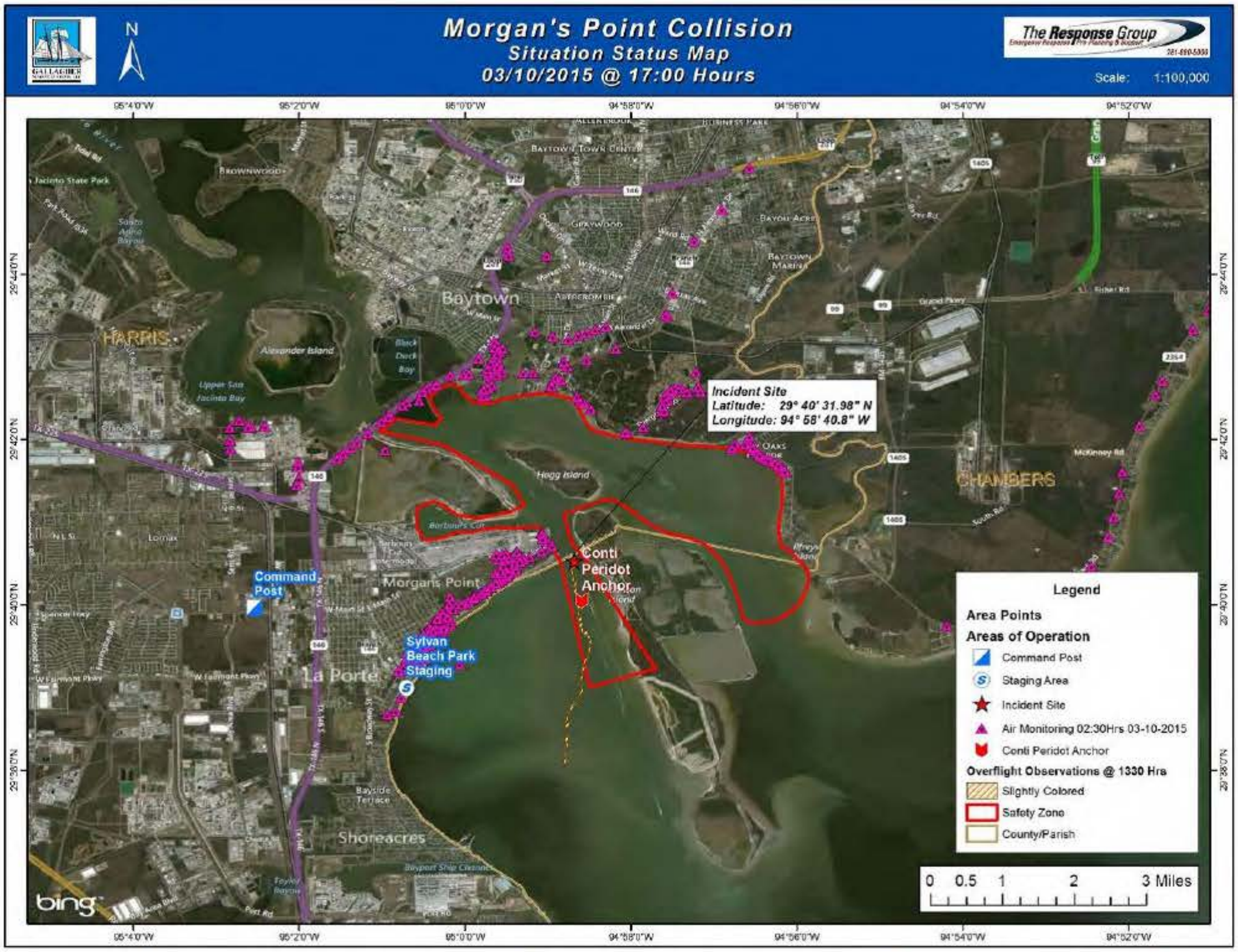

Figure 12: Map showing the location of the vessels, the safety zones, the movement of the sheen on the water, and location of air monitoring on March 10, 2015, at 01700.

Weather conditions on the day of the accident included rain, drizzle, low clouds/low ceiling/fog.

The UC coordinated air monitoring and public safety messaging. Media reports were highlighting the shelter-in-place orders and concerns regarding toxicity. Several chemical terminals in the BCT area had voluntarily self-evacuated; however, air monitoring in the area confirmed that they were not at toxic levels. Between 14:19 on March 9 and 05:00 on March 10, 2015, the following air monitoring data was collected by CTEH on land locations around the accident location:

Instrument	Analyte	Number of Readings	Number of Detections	Average of Detections	Range of Detections
Gastec 141L	Ethyl acetate	5	0	NA	< 5 ppm
MultiRAE	LEL	439	0	NA	< 1 %
	VOC	517	13	5.24 ppm	0.1 - 20 ppm

Both vessels were directed to remain anchored in place until a determination could be made regarding their ability to safely transit and a suitable lay berth was identified for each.

At approximately 16:00 on March 9, 2015, the shelter-in-place order was lifted; however, BCT remained closed as a precaution.

At approximately 17:00, a USCG team embarked the *Carla Maersk* to conduct an assessment. The vessel reported that three damaged port cargo tanks had been emptied (product transferred to other cargo tanks) and potentially little to no cargo was discharged into the water. The strong odor was believed to be coming from the residual product left in the tanks. The wind was blowing from the southeast and vapors were being detected in the northwest area. The wind direction was expected to shift to the west at approximately 23:00. This would blow vapors toward the upper Galveston Bay over open water. According to air monitoring results, there appeared to be no apparent drift of the plume.

The *Carla Maersk* still had a fully functional nitrogen IGS and crew were directed to flood the cargo tanks and three damaged ballast tanks with nitrogen. During the collision, the *Conti Peridot* lost its port anchor and a Port of Houston Authority fireboat was tasked to search for it using its side scan sonar capabilities.

On March 10, 2015, all members of the UC were present with the exception of TCEQ and the owner's representative from the *Conti Peridot*. Both vessels remained anchored in the vicinity of the collision site. The waterway remained closed and a Safety Zone remained in effect. Air monitoring teams along the shore were not reporting concentrations of vapors that were of concern.

By 10:55 on March 10, 2015, all the formal members of the UC had been designated, and seven objectives were identified for execution beginning the following morning. The USCG team aboard the *Carla Maersk* reported that 3 ballast tanks and 2 cargo tanks were ruptured on the port side. There were 300 metric tons not specifically accounted for; however a significant amount of MTBE was believed to be in the ballast tanks. A sheen (one mile long by one-half mile wide) was reported in the vicinity of the *Carla Maersk.*

Salvage personnel arrived on scene and began investigating ways to inhibit vapor leaks. The Gulf Strike Team was launched and assisted with air monitoring.

The UC planned on moving the *Conti Peridot* to the City Docks to offload cargo. The operations to stabilize vapors and cargo on *Carla Maersk* were commenced and the vessel was to be moved to the Barbours Cut Basin the following day.

Water samples were collected from the HSC and analyzed for MTBE/VOC concentrations. Three samples were collected south of the collision location and 2 north of it. MTBE was detected in all the samples. The sample collection locations and the analytical results are provided in attachment 21.

Based on a review of onboard cargo loading, a total of 2,100 barrels (88,200 gallons) of MTBE were unaccounted for; however, due to MTBE miscibility with water and volatility, that volume could not be confirmed.

The Safety Zone was still in place. Land based air monitoring showed no signs of MTBE vapors. A salvage plan was developed that included the use of AFFF (foam) and the placement of a soft patch (tarp) over the damaged area to decrease residual product vapor. Once that was completed, a damage assessment and ROV hull inspection was completed to determine if the vessel could be moved to Barbours Cut.

On March 11, 2015, the *Conti Peridot*, with the assistance of two tugs, weighed anchor and moored at City Dock 21, outside of the Safety Zone. The salvage plan for the *Carla Maersk* was finalized and approved by the UC. The plan execution began. Air monitoring continued with 570 air monitoring events being recorded with no detectable traces of MTBE off the *Carla Maersk*. AFFF was applied periodically as a vapor blanket to stabilize the breached tanks and the soft patch application was completed.

On March 12, 2015, the HSC was reopened for traffic and the *Carla Maersk* was safely transited to the BCT turning basin awaiting further plans of action.

On March 14, 2015, lightering operations began onboard the *Carla Maersk* in the BCT turning basin. This phase of the operation involved:

- Offloading of cargo to barge #1, from tanks 1 and 10.
- Offloading product/water mixture from damaged tank COT4P to barge #2.
- Washing down wing ballast tanks 2 and 3.

The *Carla Maersk* crew was fully occupied during this operation. Additionally, the UC had substantial concerns about the release of hazardous vapors and was continuing air monitoring for a potential release of hazardous vapors, which would require stopping operations and possibly evacuating the port.

The last phase involved moving the *Carla Maersk* to Oil Tanking Facility on March 17, 2015, to offload the remaining product that was not contaminated with water.

Attachment 19 - Incident Action Plans
Attachment 20 - CTEH Air Monitoring Results
Attachment 21 - Environmental Sampling Results -Water

J. IMMEDIATE RESPONSE ACTIONS OF THE *CARLA MAERSK* CREW[29]

After the separation of the two vessels, the *Carla Maersk* began to list to the port side. The Master of the *Carla Maersk* stated in an interview with the NTSB that he assumed this was caused by the breaching and filling of ballast tanks 2 and 3 (which he believed were empty before the collision). The Master called everyone to their muster stations. He radioed the Chief Officer, who was in the

[29] Based on VDR and brief discussion with the crew.

Cargo Control Room (CCR), and expressed concern that the cargo tanks could be breached. He asked the Chief Officer to provide a situation report and instructed him to begin ballasting/cargo movement to balance the vessel. The Master told the NTSB that balancing the vessel was his first priority. He knew that there were several empty cargo tanks on the starboard side to which product could be transferred. The Master provided the pilot, who was communicating with Port of Houston Authority Fireboat 2, the name of the cargo product.

At 12:40, the Master was still uncertain about the condition of his cargo tanks. He noted that the vessel had a 10 degree port list.

At 12:43, the crew was checking soundings/ullage of the cargo tanks and evaluating vessel damage. The Master noted that ballast was escaping from the port ballast tank 3. At 12:44, he was on the phone with the vessel owners and discussed the notification to Gallagher Marine Systems, the qualified individual (QI).

At 12:46, the crew notified the Master that MTBE was leaking from port cargo tank 3. At 12:47, he instructed his crew to transfer cargo from port cargo tank 3 (COT3P) to starboard cargo tank 2 (COT2S). During an interview with the NTSB, the Master stated that the ullage results his crew obtained were not very meaningful and high level ullage alarms had actually sounded due to the vessel list. He stated that it was difficult to adequately assess the actual status of the tanks.

At 12:52, the *Carla Maersk* still had a 10 degree port list and cargo was still being transferred to other tanks to minimize leakage. The Master stated that "[d]uring this time when [the] vessel is leaning, everything is dropping down from the tables." Approximately 45 minutes after the collision, the Master reported that the vessel was righted and no longer listing.[30] He believed that his vessel was now stable and he began focusing on the response to the potential cargo release.

The Master stated that when the port cargo tank levels (in 3 and 4) were reduced to below sea level, the Chief Officer came to the bridge to report that the levels were stabilizing at sea level. The Master wanted water to enter the tanks instead of cargo going out.

Approximately 3 hours after the collision, a USCG speedboat came alongside the *Carla Maersk* and called over VHF radio. The USCG wanted to board the vessel, but high VOC measurements prevented their boarding. The ventilation in the crew areas was on recirculation since they had left the loading terminal, in accordance with Maersk operating procedures. The Master stated that he did not notice any vapors in their accommodation spaces. Later in the incident, air monitoring was performed to ensure no vapor intrusion (See attachment 22).

At approximately 17:00, the Master had a meeting with all the crew to review the MTBE MSDS information. Shortly after this meeting, two USCG officers boarded the vessel. They had vapor detection meters and told the Master that they were detecting VOC measurements in the range of 20 or 30 ppm.

[30] Witness stated that this occurred at 13:22.

The USCG officers and the Master reviewed the cargo loading computer to evaluate cargo and ballast volumes. After reviewing the printed-out ullage reports, the USCG checked the licenses of the *Carla Maersk* officers. The Master told the NTSB:

> And that time, the [USCG] officer, he compared departure total figure for cargo and ballast with the total figure, cargo and ballast, that time. And we had more. And this was assumed to be okay, because we have more. We don't loss. Different balance, but we have more.
>
> The next thing was to -- we explained that the cargo tank, they are inerted. Still inert [gas] is there. The inert [gas system] was working while we're transferring, so we fill up with the nitrogen gas in the cargo tanks while transferring. And the only thing is the ballast tank, of course, its hole, and obviously breach with the cargo tanks.
>
> So the suggestion was -- instruction, I would say, to start inert[ing] the ballast tank, to make it safe, as there was vapors. And of course number two was total smash, so it was not possible. Number 3, we said we can do it if we open the hatch, can lower down with hose and fill up with nitrogen somehow, yeah, we will find out how to do this, because this is not our normal procedure.
>
> Normal procedure is [to] go through -- when ballast tank is total empty -- to go through the filling ballast line from the top, filling this way. But if the tank is half full or full, the inert gas won't go this way. So it was from the top.

To conduct the tank inerting operation, crew members performing this task had to wear self-contained breathing apparatus (SCBA). According to the Master:

> …because we show that our tanks are inerted, still on the pressure of inert [gas]; however, the ballast tanks are open. So the instruction [from the USCG] was to start in at the ballast tank. But once we have the water inside, I explain that we cannot do it as we normally do it, the tank must be empty. So in this case, we have to do something extraordinary, special, go from the vapor line with the hose to the ballast hatch.
>
> They [USCG] want[ed] to stay on board for observing this, and they stay until, I don't know, just before 1800. We commence the inerting of this tank. They disembark. However, shortly after, we get smell and the vapors against us. So close everything, double check everything, and eventually I decide to stop inerting ballast tank because apparently this was causing the vapors -- I thought, at that time -- coming up on deck.
>
> I think, I believe, we start to measure inside accommodation the readings hour by hour, 2000 something, every hour. Send to office hourly reports monitoring this. Whoever must go outside was to have a BA [SCBA] set. We were filling the bottles, because they were consuming the air bottles also during the reading of the inert arrangement -- inerting of the ballast tanks.
>
> At that time, of course, we expected some cargo was leaked, but at that time still -- still was, in my belief, that whatever leaked is in the ballast tanks and the vapors coming from the ballast

tank because of we introduce the inert and push up the vapors up … I stay to, I don't know, 2:00, 3:00, when I went to sleep. There was [a] pilot on board all the time, they shifted.

[At] 2300 came salvage team on board from Titan. We start to discuss this, what we did, where we are, and how to proceed. There was talk about the barge with foam on the way. I went for rest after maybe 3:00 in the morning.

Attachment 22 – Carla Maersk Air Monitoring

Cargo Control Room (CCR)

The CCR is located 4 levels below the bridge. The cargo and ballast pumps are controlled from this room and their contents are displayed on an operator's computer screen. Figures 13 through 18 show the controls/stations in the CCR.

Figure 13: Operator station in the Cargo Control Room with displays for ballast and cargo loads.

Figure 14: Operator station display of ballast tanks.

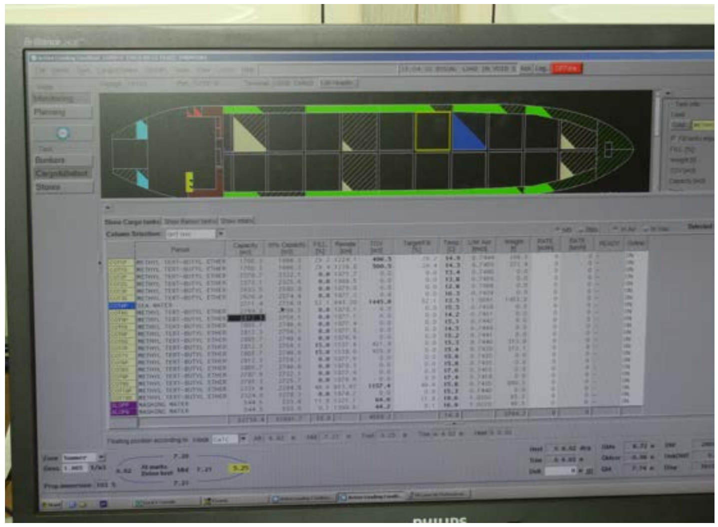

Figure 15: Operator station display of cargo tanks.

Figure 16: Cargo pumping system control panel.

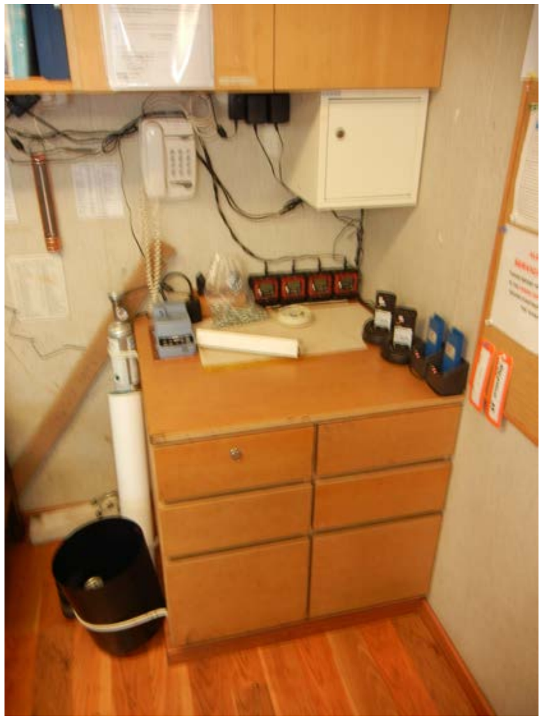

Figure 17: Air monitoring charging and calibration station in Cargo Control Room.

Figure 18: Cargo tank overfill alarm panel in Cargo Control Room.

K. PORT OF HOUSTON AUTHORITY FIRE DEPARTMENT

Background

The Port of Houston Authority Fire Department operates three fire stations strategically located along the HSC. The fire department is capable of fighting marine and land fires. It is also capable of responding to other emergencies throughout the ship channel and its tributaries.

The fire department operates three fireboats, three hazardous materials (HAZMAT) trucks, two class A pumpers and one booster truck to respond to fires, rescue, hazardous materials and oil spills. The current fleet of fireboats includes the Firestorm 70's Fireboat 1, Fireboat 2, and Fireboat 3. These fireboats can act as command centers and high speed response vessels with powerful quad diesel inboard engines to propel the vessels at 45 knots. Four onboard firefighting pumps can produce flow meter results of 13,600 gallons per minute (gpm) at 150 pounds per square inch (psi) and 15,000 gpm at 130 psi, and stream up to 450 feet with a roof mounted Stang monitor. The boats are capable of long range stays at terminal or shipboard fires with quick crew change over.

All firefighters are certified by the state of Texas as Structural Firefighter, Marine Firefighter, HAZMAT Technician, and Emergency Medical Technician (EMT). All their pilots and captains are licensed USCG masters (100 ton masters). The department is comprised of 47 firefighters.

According to the Fire Chief, approximately 50-60% of their incidents/calls involve hazardous materials.

Emergency Response Actions

At 12:43, the fire department received calls regarding an unknown/strong chemical odor at gate 12 (near the administrative building) at Barbours Cut Terminal (BCT). Engine 2 arrived on-scene at 12:48 and initiated a command for the investigation. At 12:51, HAZMAT 2 arrived on-scene. Soon thereafter, a report of a ship collision near Morgan’s Point was received. Dispatch advised that the ship collision could be the source of the odor. Firefighters could smell the odor, but did not detect any readings/measurements on their air monitoring equipment. A fire engine was dispatched shore-side to the ship collision.

At 12:55, Fireboat 2 with Assistant Chief #1 was dispatched to the ship collision (which was close to the fireboat dock at BCT). Assistant Chief #1 observed a large hole in the *Carla Maersk*. Fireboat 2 detected high levels of VOC in the air and the fire department quickly determined that the two incidents were related.

At 12:56, dispatch reported that, according to USCG Vessel Traffic Service (VTS), the product being discharged into the HSC was MTBE, a gasoline additive.

Fireboat 2 headed south in the HSC. It was very foggy with visibility at 0.25 miles. When Fireboat 2 arrived at buoy 89, the firefighters could see the *Carla Maersk* on the right-side of the channel with a “large gash in her side”.

At 12:59, Fireboat 2 was near the *Carla Maersk*. Firefighters observed that both the *Carla Maersk* and the *Conti Peridot* had dropped anchor. The *Conti Peridot* had noticeable damage to the bow of the vessel. The *Carla Maersk* had a noticeable port list. Assistant Chief #1 told the NTSB that product could be seen leaking from a tear in the port side of the *Carla Maersk* approximately 2 feet above the water level near mid-ship. The released product/fluid was seen off-gassing. Vapors could also be seen off-gassing from an area (approximately 300 feet long by 50 feet wide) on the water.

A firefighter donned a SCBA and placed an AreaRae meter outside the wheelhouse enclosure. A VOC measurement of 7,000 ppm was detected. A second meter was set inside the wheelhouse and no VOCs were detected within the enclosure. Fireboat 2 was located due west of the *Carla Maersk* (downwind of the leak). After detecting high VOC measurements in this location, Fireboat 2 backed away from the *Carla Maersk* and moved approximately 1000 feet due south. Air monitoring continued. At the new location, no VOCs were detected. The *Conti Peridot* was approximately 3,000 feet further to the south of this location.[31]

A Hot Zone/Safety Zone was established. Fireboat 2 contacted the Master of the *Carla Maersk* on VHF channel 12, and asked him to verify the product and the amount of product that had been lost. The Houston Pilot aboard stated he was not sure if the product was leaking, but confirmed the product was MTBE. Assistant Chief #1 informed the Pilot that the vessel was in fact leaking.

At 13:01, Fireboat 2 reported to dispatch that the *Carla Maersk* had an extreme port list. They also reported that the *Conti Peridot* appeared stable with no listing at that time.

At 13:07, Assistant Chief #2 (from station 3) was dispatched and assumed command of land operations. Very shortly thereafter, he assumed command of the incident. Dispatch was asked to contact the National Response Center (NRC). Prior to Assistant Chief #2's assumption of command, he had noted an odor at the C7 crew's terminal where he instructed that the air handlers be shut-off. The Fire Chief was in communication with both Assistant Chiefs.

At 13:08, HAZMAT 3 arrived on location and Engine 3 arrived at 14:04. The fire department continued receiving numerous complaints about the chemical odor.

At 13:09, a shelter-in-place order was issued for all of BCT due to the increasing reports of a chemical odor within the terminal. Responders were still uncertain of the extent of the incident.

At 13:22, Fireboat 2 reported that the *Carla Maersk* list had been corrected.

Between 13:17 and 13:42, Fireboat 2 continued to detect VOC readings as high as 331 ppm.

At 13:42, Fireboat 2 provided another report from its location 1,000 feet south of the *Carla Maersk*. Fireboat 2 detected 1,626 ppm of VOC and 4% LEL outside the wheelhouse. No VOC readings were detected within the wheelhouse enclosure.

[31] They were not in the hot zone.

At 13:44, firefighters began detecting VOC readings at the BCT Administrative Building near gate 12. They detected 70.4 ppm of VOC at the Administrative building and 115.7 ppm at the BCT Fireboat Dock. Fluctuating readings from those two locations continued to be collected.

Assistant Chief #2 ordered the evacuation of the BCT at approximately 14:15. This decision was made after consulting the DOT Emergency Response Guidebook and the MTBE MSDS. Individuals were evacuated from the terminal before conditions got worse. The wind was blowing out of the east– placing the terminal in a downwind location of the accident. The wind did not shift until 21:30 when it shifted toward the southeast.

At 14:15, a decision was made to move the Command Post to the Morgan's Point City Hall, approximately 3 miles from the ship collision. La Porte EMS was contacted to respond to an asthmatic patient and a patient experiencing chest pain at the terminal. Assistant Chief #2 also requested a second La Porte EMS unit and an EMS supervisor to report to the Command Post to establish the Medical Branch of the ICS.

At 14:26, the Command Post was moved to the Morgan's Point City Hall because the initial command post was in the hot zone due to elevated VOC readings. Mutual aid resources began to arrive at the new command post. The Port of Houston Authority and the City of Morgan's Point received numerous complaints regarding the chemical odor. Several individuals experienced eye irritation and dizziness, but no one requested treatment or medical transport.

At 14:36, two patients (one for chest pains and one for an asthmatic attack) were transported to the Bayshore Medical Center.

At 14:46, the Fire Chief arrived at the Morgan's Point Command Post. Assistant Chief #2 remained as Incident Commander. La Porte EMS established a Medical Branch. A HAZMAT Branch was tasked with conducting air monitoring operations by land inside of BCT. Assistant Chief #1, onboard Fireboat 2 was designated as the Marine Branch Officer and was tasked with conducting all marine operations. The Port of Houston Authority Police Department Deputy Chief was designated the Law Enforcement Branch Officer and was tasked with conducting traffic control and evacuation operations.

At 15:13, Harris County HAZMAT 1 was on location at the Morgan's Point Command Post. Upon arrival, they were designated as the HAZMAT Branch, and all field units reported to them for air monitoring operations.

At 15:18, the USCG was on location at Morgan's Point Command Post. A Unified Command (UC) was established with USCG COTP in the lead. The UC officially named the incident the Morgan's Point Collision. Representatives from the Port of Houston Authority Police, La Porte EMS, Harris County HAZMAT, La Porte Police, Harris County Sheriff's Department, CTEH, Titan Salvage, and IEC (firefighting) were present. The Morgan's Point Mayor and Police Chief, in addition to the La Porte Emergency Management Coordinator, were present. The UC obtained a weather report from NOAA which documented that the wind direction was east-southeast with a speed of 11.1 knots and wind gusts of 15.9 knots.

At 15:59, schools in Morgan's Point were released and the shelter-in-place order was lifted by the Mayor. CTEH, Harris County HAZMAT 1, and Fireboat 2 conducted air monitoring to investigate and attempt to chart MTBE levels.

At 16:05, due to the increase in number of personnel in the UC, the Command Post was moved to the City of La Porte Emergency Operations Center.

At 16:55, Fireboat 2 drifted to the northwest and detected 7,000 ppm of VOC.[32] At 17:50, Fireboat 2 departed their station in the HSC and went to the BCT fireboat dock. When the fireboat was due west of the *Carla Maersk*, 22,000 ppm of VOC was detected. At the dock, Fireboat 2 detected 1,802 ppm of VOC. Due to the high readings at the dock, Fireboat 2 went to the Bayside Marina.

At 18:04, Fireboat 2 was requested at the BCT fireboat dock to transport the Qualified Individual (QI) to the *Carla Maersk*.

At 18:20, the UC released Harris County HAZMAT; however, air monitoring continued by CTEH and the fireboats. The incident was determined to have occurred in Chambers County, not Harris County. Harris County maintained a representative at the Unified Command due to the impact of the incident on their county.

At 18:29, while approaching the *Carla Maersk*, Fireboat 2 detected 9,000 ppm of VOC approximately 500 feet from the vessel. Fireboat 2 returned the QI to the fireboat dock.

At 18:36, Fireboat 2 staged at the Baytown Marina due to strong readings in the area.

At 20:30, the UC held an Incident Action Plan Meeting.

At 21:29, Fireboat 2 left the Bayside Marina in search of the missing anchor using its side sonar scan in the HSC.

At 22:00, Fireboat 2 returned to the BCT fireboat dock. No VOCs were detected at the dock because the wind direction had already shifted to the southeast (5-6 knots).

On March 10, 2015, an Incident Action Plan (IAP) was developed and approved by the COTP at 06:00.

At 11:00, Fireboat 2 was underway with a Houston Pilot to the *Carla Maersk*. Air monitoring indicated no readings adjacent to the vessel.

At 14:09, Fireboat 2 delivered Titan personnel to the *Carla Maersk*. All air monitoring equipment showed no detectable levels of MTBE.

At 14:46, HAZMAT 2 reported air monitoring was complete within BCT with no detectable levels of MTBE.

[32] Levels will be verified once printouts of AreaRae equipment are provided to the NTSB.

The Port of Houston Authority Fire Department had a total of 13 responders involved in the incident.

Attachment 23 – Port of Houston Authority Police – Fire Incident Table

L. <u>USCG – CAPTAIN OF THE PORT (COTP)</u>

At 12:33, USCG Vessel Traffic Service (VTS) received notification that the *Carla Maersk* and the *Conti Peridot* collided in the HSC. The COTP was notified and he went to VTS. He contacted the Harris County Assistant Chief of Emergency Operations who informed him that they would be providing air monitoring and hazardous materials support to the local jurisdiction of Morgan's Point. The COTP was informed that a UC was being set-up at the Morgan's Point City Hall.

The COTP arrived at the Morgan's Point City Hall at approximately 15:00. He began receiving reports regarding the chemical odor in the area. He worked with members of the UC on establishing community protective measures. At approximately 16:00, the Command Post was moved to La Porte.

The COTP told the NTSB that he did not receive shipping papers from the *Carla Maersk*. He obtained vessel capacity volumes and estimates for quantities released when he dispatched a team of qualified marine inspectors to the *Carla Maersk*. They boarded the vessel and went through the loading and post-collision tankage data. The UC was provided this information and specific volumes that were in COT3P and COT4P. The UC estimated that 2,100 barrels of MTBE were likely released, with a large portion potentially ending up in ballast tank water. A worst case discharge based on the loading capacity of the cargo tanks was used even though it was known that they were not fully loaded.

The COTP told the NTSB that notifications regarding the Safety Zone in the HSC and the hazardous material release were made through the following means:

1. Vessel Traffic Service (VTS) – a broad notification was made through VTS regarding the closure of the HSC.
2. A port-partner alert warning system (Alert and Warning System Enterprise) which makes notifications to all agents, security officers, the Port of Houston Authority, and pilots.[33]
3. Local/municipal notification channels which sent out alerts to residents and provided protective measure guidance.

The COTP stated that the *Conti Peridot* was likely notified about safety measures through their pilot or agent. Notifications were also made through VHF channel 16 (marine safety information broadcast) regarding the MTBE release.

The COTP instructed the *Carla Maersk* to continue pumping inert gas into the tanks because it would help in reducing the flammability and explosive hazard.

[33] http://www.uscg.mil/FF21/AWS-E.asp

M. TEXAS COMMISSION OF ENVIRONMENTAL QUALITY (TCEQ)

The TCEQ is the state's lead agency in spill response to certain inland oil spills (crude oil spills emanating from oil or gas exploration, development, or production facilities are Railroad Commission jurisdiction), all hazardous substance spills (except those from exploration and production facilities), and spills of other substances which may cause pollution or adversely impact air quality in Texas.

The TCEQ and the Texas Department of Transportation (TXDOT), as provided in 25.264 (f) of the Texas Water Code, have developed a contractual agreement whereby TXDOT personnel, equipment, and materials may be used in state-funded cleanup actions. All expenses and costs resulting from cleanup activities are subject to reimbursement from the Texas Spill Response Fund.

N. NOAA SCIENTIFIC SUPPORT

The National Oceanic and Atmospheric Administration (NOAA) scientific support coordinator (SCC) for USCG District 8 assisted the FOSC at the incident command with cleanup and trajectory analysis. The SCC provided scientific support and guidance, such as predicting the MTBE movement, identifying the potentially affected zones and risk to environmental areas, and developing spill maps. A copy of the initial report developed by the SCC was provided to the NTSB. The initial analysis was based on a worst case discharge estimate of 42,000 barrels of MTBE which is an estimate of the total capacity of 3 cargo tanks.

The report stated the following:

> Product Information:
>
> MTBE is a colorless liquid with a distinctive anesthetic-like odor. It is miscible with water, and has a specific gravity of 0.74. Vapors are heavier than air, and the flash point is low (~18^0F). It poses an explosion and inhalation hazard in confined spaces, and an inhalation hazard for responders at the scene.
> Weather:
>
> Current weather conditions in Houston are rain and fog, with a southeast wind of 10 mph. Showers are expected to continue through tomorrow, with the wind shifting to the north at 10 mph.
>
> Fate:
>
> MTBE is miscible with water, and we anticipate the majority of the product will be in the water column rather than on the surface. Available fate information indicates half-life of MTBE in freshwater is ~ 3days, thus we anticipate the plume from the release could persist on the order of several days to a week. Persistence as a discernable "plume" will be affected by water column mixing and dilution into progressively large volumes of water as it moves toward Galveston Bay. Current weather conditions will likely enhance the tendency of MTBE to partition to the water column.

Trajectory:

With incomplete information regarding amount released, uncertainty is associated with the trajectory estimate. Based on current tidal conditions, we anticipate the plume will progress toward Galveston Bay, with the leading edge reaching the opening to the bay at around 8 am on March 10 (See Figure 1, below). We anticipate the leading edge with be approximately parallel to Seabrook by 8 am, March 11.

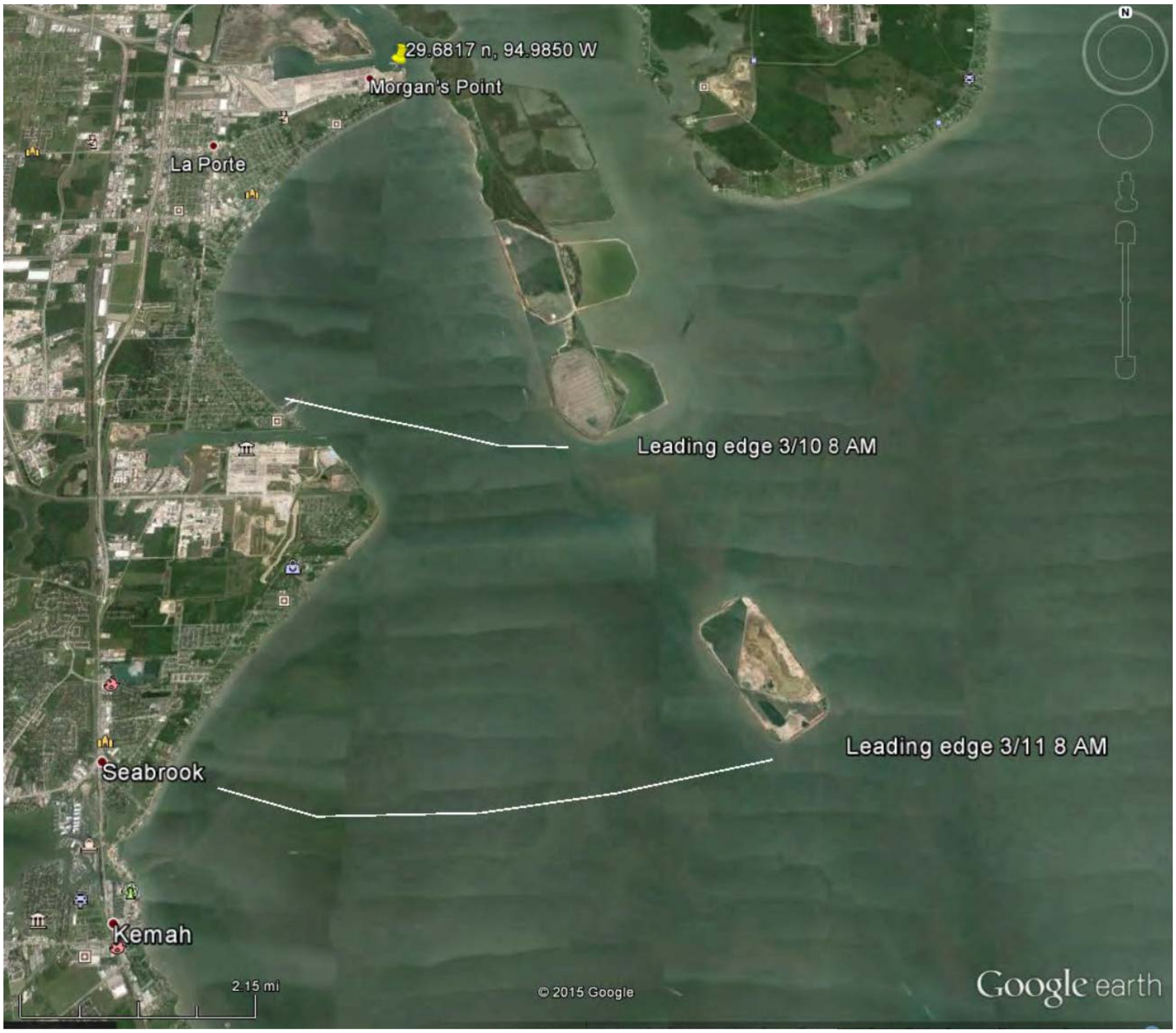

Figure 1 – Leading Edge Estimate Based on Tidal Excursion

Toxicity:

Minimal toxicity data are available for MTBE, but based on what are available for it and a related compound, diethyl ether, it is categorized as practically non-toxic to aquatic life, with LC50s in the 1,000 to 10,000 ppm range. However, given the volume of product potentially released, there may be localized fish kills. Based on solubility in the water column and persistence in the environment, we do not believe it poses a threat to birds or mammals.

Resources at Risk:

Entry point of the release is close to Atkinson Island Wildlife Management Area (State of Texas), and other mid-channel low lying islands inhabited by birds. Bird species known to occur on the islands include species such as American white pelican, black skimmer, brown pelican, Caspian tern, Forster's tern, great blue heron, great egret, gull-billed tern, laughing gull, least tern, roseate spoonbill, royal tern, sandwich tern, and yellow-crowned night heron. Although birds inhabit this area year round, during early March, few species would be nesting. Possible nesting species include great blue heron, great egret, and royal tern. While no listed birds occur on the island immediately adjacent to the spill are, piping plover are shown as occurring on one of the other small islands in the area, and may be present at this time of year.

A range of fish are reported to be present in the bays, including Atlantic sharpnose shark, bull shark, blacktip shark, tarpon, and spinner shark. Some may be present at this time of year, none are spawning or in larval stages. The area is designated Essential Fish Habitat for shrimp, reef fish, red drum, and coastal pelagics.

West Indian manatee and Kemp's ridley turtle, both of which are listed do occur in the bays, but are unlikely to be present at this time of year. Dolphins may also occur in the bay.

Eastern oysters occur in the bay, and there are some oyster leases in the bay area parallel to Seabrook.

Shorelines:

Shorelines on the mid-channel islands are a combination of mixed sand and gravel beaches (ESI 5) and riprap (ESI 6B) on the side of the islands where the incident occurred and where we anticipate the plume will travel. There are some marshy areas on the other side of the islands. Areas along the western side of the bay are predominantly rip-rap and man made structures (ESI 1B).
Given the nature of the product, we do not anticipate there will be much shoreline cleaning required.

Response Recommendations:
We recommend you respond to this product much as you would to a gasoline release.

O. <u>USCG CERTIFICATE OF COMPLIANCE (COC) FOR THE *CARLA MAERSK*</u>

The dates and findings of the USCG conducted COC examinations of the *Carla Maersk* are as follows:

- December 29, 2013 – USCG Sector Texas City – 0 discrepancies noted.
- September 24, 2014 – USCG Sector Houston – 0 discrepancies noted.

- September 20, 2014 – USCG Sector NOLA – 0 discrepancies noted.

A copy of the COC was provided to the NTSB. Additionally, the USCG provided a historical record of discrepancies. The most recent discrepancy occurred in 2013 relating to a records/logs issue that was quickly resolved.

Attachment 24 – USCG Certificate of Compliance for Carla Maersk
Attachment 25 – USCG - Carla Maersk Defect History

P. ACCIDENT INJURIES

The Unified Command reported that 2 individuals (employees at the Port of Houston Authority) were affected by the release. They were taken to the Bayshore Medical Center for treatment.

Q. INTERVIEWS

The following interviews were performed:

- **Captain Brian Penoyer, USCG**
  Captain of the Port (COTP) and Federal On-Scene Coordinator (FOSC)
  March 13, 2015 – Telephone interview (unrecorded)

  Captain Penoyer provided information regarding how the Unified Command was established, the relocation of the Incident Command, and a general description of the operations performed on the first day of the incident. He discussed the assistance provided by the NOAA scientific support coordinator regarding the worst case discharge and trajectory analysis. He also discussed the means alerts were sent out to the vessels and others in the HSC.

- **Chief Bob Royal, Assistant Chief of Emergency Operations**
  Harris County Fire Marshall's Office
  March 11, 2015 – In-person interview (unrecorded) at Marriot Hobby Airport

  Chief Royal and his hazardous materials response team provided support to the incident and conducted air monitoring operations at Morgan's Point on the first day of the incident. Chief Royal explained the complex jurisdictional boundaries and the mutual aid assistance agreements between the local fire departments.

- **Lieutenant [redacted]**
  USCG Marine Inspector, Sector Houston/Galveston
  March 12, 2015 – In-person (unrecorded) at 13411 Hillard Street, Houston, TX 77034

  LT [redacted] explained the Certificate of Compliance examinations performed by the USCG. He provided a Certificate of Compliance for the *Carla Maersk* and a history of defects found on the vessel.

- **Captain Luis Cornelio**
  Master of *Conti Peridot*
  March 14, 2015 – In-person interview (recorded) on the *Conti Peridot*

  Captain Cornelio discussed his immediate actions and observations after the collision with the *Carla Maersk*, specifically focusing on the hazardous materials response and information provided to his vessel. He also discussed observing sheen on the water and smelling a chemical in the air after the accident.

- **Assistant Fire Chief Jason Roberts, Assistant Fire Chief Jeremy Kimich, and Fire Chief William Buck**
  Port of Houston Authority Fire Department
  March 13, 2015 – In-person group interview (recorded) at Port Authority Executive Offices

  Assistant Fire Chief Roberts was the initial incident commander for the emergency response. Assistant Fire Chief Kimich was in-charge of Fireboat 2 and responded to the *Carla Maersk*. Chief Buck was involved in the Unified Command. All were involved in the first 24-hours of the incident emergency response.

Muhamed A. El-Zoghbi
Safety Engineer/Hazardous Materials Accident Investigator