# An Assessment of the Effectiveness of the US Coast Guard Vessel Traffic Service System


**Safety Study**

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National Transportation Safety Board

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## An Assessment of the Effectiveness of the US Coast Guard Vessel Traffic Service System

National Transportation Safety Board

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

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**Abstract:** This study examined the US Coast Guard vessel traffic service (VTS) system's ability to (1) detect and recognize traffic conflicts and other unsafe situations, (2) provide mariners with timely warning of such traffic conflicts and unsafe situations, and (3) control vessel traffic movements in the interest of safety.

Safety issue areas identified during the study include: (1) variation in the use of Coast Guard VTS authority, (2) inadequate VTS watchstander training and qualification, (3) VTS system limitations, and (4) insufficient safety risk management of VTS areas.

As a result of this safety study, the National Transportation Safety Board makes recommendations to the US Coast Guard, the American Pilots' Association, the American Waterways Operators, and the Radio Technical Commission for Maritime Services.

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# Acronyms and Abbreviations

| | |
|---|---|
| AIS | automatic identification system |
| APA | American Pilots' Association |
| ATC | air traffic control |
| AWO | American Waterways Operators |
| *CFR* | *Code of Federal Regulations* |
| the Coast Guard | US Coast Guard |
| the Corps | US Army Corps of Engineers |
| HCA | high consequence area |
| IALA | International Association of Marine Aids to Navigation and Lighthouse Authorities |
| IMO | International Maritime Organization |
| INS | information service |
| IOP | internal operating procedure |
| ISM | International Safety Management |
| MARAD | US Maritime Administration |
| MISLE | Marine Information for Safety and Law Enforcement |
| NAS | navigational assistance service |
| NSOP | national standard operating procedure |
| NTSB | National Transportation Safety Board |
| OJT | on-the-job training |
| ORM | operational risk management |
| OSHA | Occupational Safety and Health Administration |
| PAWSA | Ports and Waterways Safety Assessment |
| PAWSS | Ports and Waterways Safety System |

| | |
|---|---|
| RTCM | Radio Technical Commission for Maritime Services |
| SMCP | Standard Marine Communication Phrases |
| SOLAS | International Convention for the Safety of Life at Sea |
| TOS | traffic organization service |
| *USC* | *United States Code* |
| VHF | very high frequency |
| VMRS | vessel movement reporting system |
| VTIS | vessel traffic information service |
| VTS | vessel traffic service |
| *VTS NSOP* | *Vessel Traffic Service National Standard Operating Procedures Manual* |

# Key Terms Used in This Report

**Coast Guard VTS system**: the 12 US Coast Guard vessel traffic service centers currently operating in the United States.

**Operator**: the individual(s) providing vessel traffic management services in the vessel traffic service center on a rotating shift within an assigned watch period. The US Coast Guard also refers to these individuals as vessel traffic management specialists.

**Training coordinator**: the individual responsible for developing, implementing, and overseeing the training and qualification process for watch supervisors and operators at a vessel traffic service center.

**VTS area**: the geographical area in which a vessel traffic service center provides vessel traffic management services to vessel traffic service users.

**VTS center**: a shore-based facility that provides vessel traffic management services for a designated vessel traffic service area.

**VTS director**: the individual in charge of the vessel traffic service center and responsible for the safe and efficient movement of all vessel traffic service users operating inside the center's vessel traffic service area.

**VTS *special area***: refers to a portion of a waterway defined within a vessel traffic service area in which special operating requirements apply.

**VTS user**: any vessel, or mariner directing the movement of a vessel, within a vessel traffic service area, that is subject to the Vessel Bridge-to-Bridge Radiotelephone Act, required to participate in a vessel movement reporting system, or required to carry a US Coast Guard approved automatic identification system.

**Watch supervisor**: the individual(s) responsible for vessel traffic management operations in the vessel traffic service center for an assigned watch period. The US Coast Guard also refers to these individuals as supervisory vessel traffic management specialists.

**Watchstander**: refers to watch supervisors and operators as a collective group within the US Coast Guard vessel traffic service system.

# Executive Summary

The US Coast Guard (the Coast Guard) vessel traffic service (VTS) is a shore-based surveillance and communications system with the authority to ensure the safe and efficient movement of vessel traffic in particularly hazardous or congested waterways in the United States. The system's primary mission is to reduce the risk of collisions, allisions, and groundings. To do this effectively, the system must be able to detect and resolve unsafe traffic situations in a timely manner. There are 12 Coast Guard VTS centers that make up the VTS system, and each center is responsible for managing the traffic that operates inside its designated VTS area. Since 1994, participation in this system has been mandatory for most types of power-driven commercial vessels, towing vessels, and dredge platforms while operating inside a Coast Guard VTS area.

During the years 2010 through 2014, an average of 18% of all reportable collisions, allisions, and groundings involving vessels meeting the requirements of a VTS user occurred while they were operating inside a VTS area. The most common causal factor assigned to these accidents by the Coast Guard was inattention errors by the mariners involved, which suggests that an opportunity exists for the VTS system to further reduce the risk of these types of accidents by taking a more proactive role in traffic management. In this study, the National Transportation Safety Board (NTSB) examined the Coast Guard VTS system's ability to (1) detect and recognize traffic conflicts and other unsafe situations, (2) provide mariners with timely warning of such traffic conflicts and unsafe situations, and (3) control vessel traffic movements in the interest of safety.

**Why the NTSB Did This Study**

The Coast Guard is responsible for the oversight and management of navigation safety in the United States. The VTS system plays an important role in this process, as it is the only navigation safety component that involves direct interaction between mariners and the Coast Guard. Since the Coast Guard implemented its *Vessel Traffic Service National Standard Operating Procedures Manual (VTS NSOP)* in 2009, the NTSB has investigated six major commercial vessel accidents inside VTS areas, half of which resulted in a hazardous materials release. All of these accidents occurred under conditions that called for VTS action, but such action was not taken or the need for action was not recognized. NTSB findings from these accidents suggested that the VTS system may not be effectively meeting its goal of reducing collisions, allisions, and groundings.

Between 2010 and 2014, collisions, allisions, and groundings inside VTS areas resulted in 2 fatalities, 179 injuries, and more than $69 million in damage to vessels, facilities, infrastructure, and the environment. Therefore, the focus of this study was to assess the effectiveness of the Coast Guard's VTS system to improve maritime safety in the United States. Although NTSB investigations have often identified areas of concern at individual VTS centers, the extent to which such concerns exist across the entire VTS system had never been formally evaluated. As the Coast Guard's 12 VTS centers have been operational for at least 10 years, the NTSB believes that now is an appropriate time to evaluate the need for safety improvements across the VTS system.

The NTSB used a combination of quantitative and qualitative data sources and associated analytical methods to assess the effectiveness of the VTS system. The NTSB analyzed accident and vessel movement statistics and waterborne freight movement data for each VTS area, and used a questionnaire, site visits, and interviews to characterize the workforce and operations within the 12 VTS centers. In addition, industry associations, safety committees, and local waterway stakeholders provided comments and feedback on their experiences as users of the system. Finally, the NTSB conducted a comprehensive review of Coast Guard VTS statutory and regulatory requirements; national and local operating procedures; and personnel training, certification, and qualification standards; and it also collected similar information regarding vessel traffic management systems in Canada and Europe.

**What the NTSB Found**

The Coast Guard has not developed a standard method for measuring the collective safety performance of all 12 VTS centers as a VTS system. As a result, there were no standardized public data or statistics available for assessing the system's overall effectiveness. The Coast Guard *VTS NSOP* manual provides general requirements and guidance in key areas involving personnel, operations, and equipment; however, VTS directors largely interpret how to implement these requirements based on local conditions at the 12 VTS centers. There were inconsistencies in the collection and use of traffic, incident, and near miss event data by the centers, and few best practices or minimum standards of effectiveness that were being shared and consistently applied across the Coast Guard VTS system.

Although the VTS system has sufficient authority to manage vessel traffic, many watch supervisors and operators expressed reluctance to exercise their full authority and direct a vessel. This study found widespread variation in the understanding of Coast Guard VTS authority within the 12 VTS centers and across the VTS system, which has resulted in the inconsistent application of that authority over time. Decisions regarding how and when to exercise VTS authority have been influenced by local stakeholders, economic considerations, and varying management practices at the 12 VTS centers. Moreover, the Coast Guard's training and qualification process for its watch supervisors and operators has not ensured a consistent understanding and application of VTS authority, and this problem has been exacerbated by the regular turnover of active duty personnel, which creates ongoing staffing and experience deficits in the VTS system's workforce.

The Coast Guard has long recognized the importance of safety risk management, but it has not been applying continuous risk assessment processes to its 12 VTS areas. Current procedures for the collection and quality control of activity and incident data do not support effective quantitative assessments of risk and safety performance within each VTS area or across the VTS system. Subsequently, these data are not regularly analyzed to identify and mitigate adverse safety trends, which has made it difficult (and in some cases impossible) to make statistically valid assessments of how well VTS centers are achieving their goal of reducing collisions, allisions, and groundings within their respective VTS areas.

## Recommendations

As a result of this safety study, the NTSB makes recommendations to the Coast Guard, the American Pilots' Association, the American Waterways Operators, and the Radio Technical Commission for Maritime Services.

# 1 Introduction

The US Coast Guard (the Coast Guard) vessel traffic service (VTS) is a shore-based surveillance and communications system with the authority to ensure the safe and efficient movement of vessel traffic in particularly hazardous or congested waterways. The National Transportation Safety Board (NTSB) has investigated several recent marine accidents that occurred under conditions that called for effective VTS action, but such action was not taken or the need for action was not recognized (NTSB 2016a, 2016b, 2015b, 2012a, 2012b, 2011, 2009). This study examines the effectiveness of the Coast Guard VTS system to improve maritime safety in the United States.

## 1.1 Study Goal

The goal of this study was to evaluate the effectiveness of the Coast Guard VTS system by assessing its ability to (1) detect and recognize traffic conflicts and other unsafe situations, (2) provide mariners with timely warning of such traffic conflicts and unsafe situations, and (3) control vessel traffic movements in the interest of safety.

## 1.2 Coast Guard VTS System

### 1.2.1 History of VTS Regulatory Authority

On January 18, 1971, two tankers, the *Arizona Standard* and the *Oregon Standard*, collided just west of the Golden Gate Bridge and released about 800,000 gallons of bunker fuel into the San Francisco Bay in California. The accident occurred in a dense fog at 1:40 a.m. The NTSB determined that the probable cause of the collision was the "failure or inadequacy of four different systems or subsystems, any one of which could have prevented the collision had it functioned adequately" (NTSB 1971). Among the systems listed in the report as inadequate was an experimental traffic information service. To provide this service, Coast Guard operators used land-based radar to monitor the waterway and broadcast information to participating vessels regarding the position and general movement of vessels. Vessel participation was voluntary, and Coast Guard operators did not have the authority to direct vessel traffic.

The NTSB cited three critical shortcomings that prevented the experimental traffic information service from intervening and warning the two vessels of their dangerous proximity to each other: (1) the decision of the *Oregon Standard* not to guard the service's designated very high frequency (VHF) radio channel, which prevented its participation; (2) the prohibition of the Coast Guard operators from providing direction to vessels; and (3) the Coast Guard's lack of authority to regulate vessel traffic. As a result of its investigation, the NTSB issued the following recommendation to Congress:

> Enact legislation such as the proposed "Ports and Waterways Safety Act of 1971" (H.R. 8140) which would provide explicit statutory authority for the U.S. Coast Guard to establish and operate marine traffic regulation systems in the congested port waters of the United States. (M-71-15)[1]

In 1971, Congress enacted the Vessel Bridge-to-Bridge Radiotelephone Act, Public Law 92-63, to ensure that specific categories of vessels would be equipped to communicate with other vessels and with shore on a radio frequency dedicated to the exchange of navigational information.[2] The following year, the Ports and Waterways Safety Act, Public Law 92-340, authorized the Coast Guard "to establish, operate, and maintain vessel traffic services and systems for ports, harbors, and other waters subject to congested vessel traffic." As a result, the Coast Guard began establishing its VTS system throughout the United States. Figure 1 provides a historical time line of the development of the VTS system.

Initially, there was no consistent standard for vessel participation, reporting, or operations within the system. However, on October 13, 1994, the Coast Guard's VTS regulatory authority became effective under Title 33 *Code of Federal Regulations* (*CFR*) Part 161, "Vessel Traffic Management." The national VTS regulations provide a common set of vessel traffic management rules and geographic descriptions of each Coast Guard VTS area. Although the new rules afforded certain exemptions, they made participation mandatory for vessels—

- subject to the Vessel Bridge-to-Bridge Radiotelephone Act,[3]
- required to participate in a vessel movement reporting system (VMRS),[4] or
- equipped with a required type-approved automatic identification system (AIS).[5]

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[1] The NTSB classified Safety Recommendation M-71-15 "Closed—No Longer Applicable" following passage of the Ports and Waterways Safety Act in 1972. This recommendation and all NTSB recommendations referenced in this report as well as relevant excerpts of associated correspondence are available via the NTSB safety recommendations database at http://www.ntsb.gov/safety/safety-recs/_layouts/ntsb.recsearch/RecTabs.aspx.

[2] The commonly used vessel bridge-to-bridge radio frequencies in the United States are VHF channels 13 (156.65 MHz) and 67 (156.375 MHz). These channels are also referred to by the Coast Guard and by mariners as the intership navigation safety frequency or the vessel-to-vessel frequency.

[3] All power-driven vessels of 65 feet or more in length (while navigating); every vessel of 100 gross tons and upward carrying one or more passengers for hire (while navigating); every towing vessel of 26 feet or over in length (while navigating); and every dredge and floating plant engaged in or near a channel or fairway in operations likely to restrict or affect navigation of other vessels except for an unmanned or intermittently manned floating plant under the control of a dredge. The requirements of the act were incorporated in 33 *CFR* 26.03.

[4] All power-driven vessels about 131 feet or more in length (while navigating); towing vessels about 26 feet or more in length (while navigating); or vessels certificated to carry 50 or more passengers for hire (when engaged in trade). For additional information, see 33 *CFR* 161.16.

[5] AIS Class A carriage requirements apply to self-propelled vessels 65 feet or more in length (engaged in commercial service); towing vessels 26 feet or more in length and with more than 600 horsepower (engaged in commercial service); any self-propelled vessel certificated to carry more than 150 passengers; any self-propelled vessel engaged in dredging operations in or near a commercial channel or shipping fairway in a manner likely to restrict or affect navigation of other vessels; and any self-propelled vessel engaged in the movement of certain dangerous cargo or flammable or combustible liquid cargo in bulk. For additional information, see 33 *CFR* 164.46.

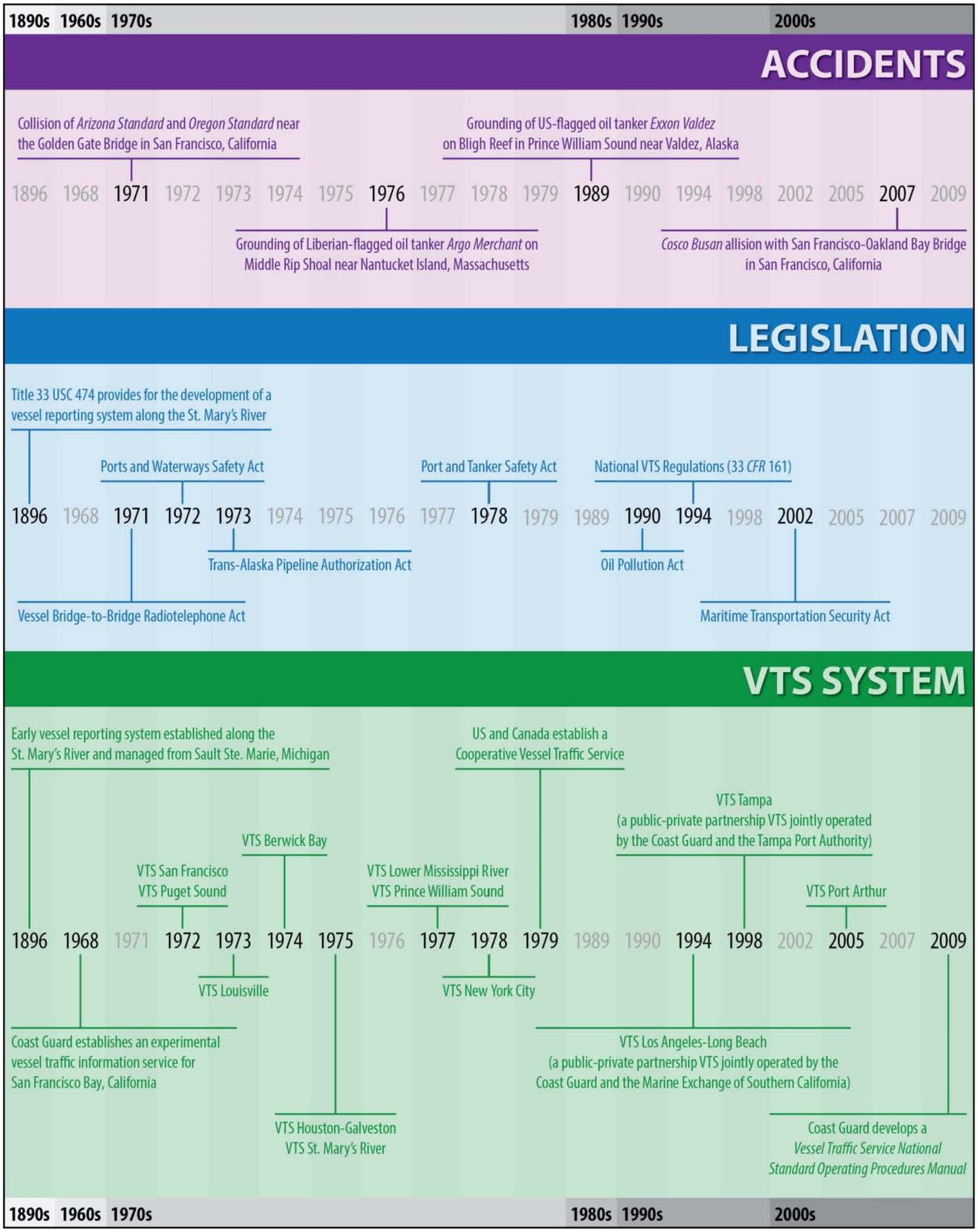


**Figure 1.** Time line of Coast Guard VTS system development in the United States (1896-2009), highlighting selected accidents, legislation, and VTS system components

These criteria encompass most power-driven commercial vessels about 65 feet or more in length; towing vessels about 26 feet or more in length; vessels 100 gross tons and upward carrying one or more passengers for hire; and dredge or floating plants of any type (33 *CFR* 26.03, 161.2, 161.16, 164.46).

### 1.2.2 Coast Guard VTS System Organization

The Coast Guard VTS system consists of operating procedures, personnel, and equipment organized inside VTS centers. The primary mission of these centers is to reduce the risk of collisions, allisions, and groundings; protect lives and property; and prevent environmental damage (33 *CFR* 161; Coast Guard 2011a, 1997).[6] Today, the Coast Guard's VTS centers manage vessel traffic at 12 locations across the United States (see figure 2).[7]

The Coast Guard provides three types of services from its VTS centers: Information Service (INS), Traffic Organization Service (TOS), and Navigational Assistance Service (NAS) (Coast Guard 2011a). The INS consists of hydro-meteorological data, traffic updates, and other information broadcasted to participants transiting a VTS area. The TOS provides advance planning of vessel movements; it also enforces speed restrictions and navigation rules. The NAS provides navigation information when mariners request it or when a VTS center determines intervention is necessary. The NAS enhances onboard navigational decision making during critical moments and monitors the effects (IALA 2012a, 2012b; IMO 1997).

Traffic watches within VTS centers are typically managed in 12-hour shifts. The watches are maintained 24 hours a day, 7 days a week. Depending on staffing levels, a watch usually consists of a supervisor and one or more vessel traffic management specialists, commonly referred to as operators. Supervisors oversee traffic management operations in the VTS center. They are responsible for managing the operators and for ensuring the overall quality of the traffic watch. Based on its size and complexity, a VTS area may be subdivided into multiple traffic sectors with an operator responsible for monitoring each sector. At the time of this study, half of the Coast Guard's VTS areas had multiple traffic sectors.[8]

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[6] A collision is the impact of two moving vessels. An allision is the striking of a moving vessel against a stationary object. A grounding is the unintentional impact of a vessel with the bottom or side of a waterway.

[7] The Coast Guard VTS system consists of VTS Prince William Sound in Valdez, Alaska; VTS Puget Sound in Seattle, Washington; VTS San Francisco in San Francisco, California; VTS Houston-Galveston in Houston, Texas; VTS Port Arthur in Port Arthur, Texas; VTS Berwick Bay in Morgan City, Louisiana; VTS Lower Mississippi River in New Orleans, Louisiana; VTS Louisville in Louisville, Kentucky; VTS St. Mary's River in Sault Sainte Marie, Michigan; VTS New York City in Staten Island, New York; VTS Los Angeles-Long Beach in San Pedro, California; and VTS Tampa in Tampa, Florida. Each VTS center is typically collocated with (or in close proximity to) a Coast Guard Sector Command Center or Marine Safety Unit. The Tampa Bay Port Authority and the Marine Exchange of Southern California operate two of the centers as a private-public partnership with the Coast Guard.

[8] VTS Louisville, VTS Berwick Bay, VTS Los Angeles-Long Beach, VTS St. Mary's River, VTS Tampa, and VTS Prince William Sound have VTS areas that consist of a single traffic sector (this means one operator is responsible for the whole VTS area). VTS Houston-Galveston, VTS Lower Mississippi River, VTS New York City, VTS Port Arthur, VTS San Francisco, and VTS Puget Sound have VTS areas that consist of multiple traffic sectors.


**Figure 2.** The 12 Coast Guard VTS centers in the United States

Figure 3 shows the layout of a traffic watch inside a Coast Guard VTS center. Operators monitor traffic using an array of sensors and equipment, including a series of networked radar, closed-circuit television cameras, VHF marine band radios, and AIS data to compile an accurate and continuous traffic image of their VTS area. The AIS is the main surveillance technology used by operators; this system relays information, such as vessel name, location, cargo, and destination to other vessels nearby and to operators at a VTS center. VHF radio is the primary tool used by operators to communicate with mariners transiting a VTS area. Operators use designated VTS radio frequencies to provide traffic updates and advisories, to check in with vessels when necessary, and to verify passing arrangements between vessels. Each operator's workstation also has a radio tuned to the local bridge-to-bridge radio frequency that broadcasts continuously into the room.[9] Operators and supervisors monitor this frequency to hear radio communications between vessels operating in the VTS area.

[9] VTS Louisville and VTS Prince William Sound use the bridge-to-bridge radio frequency as their VTS frequency as well.

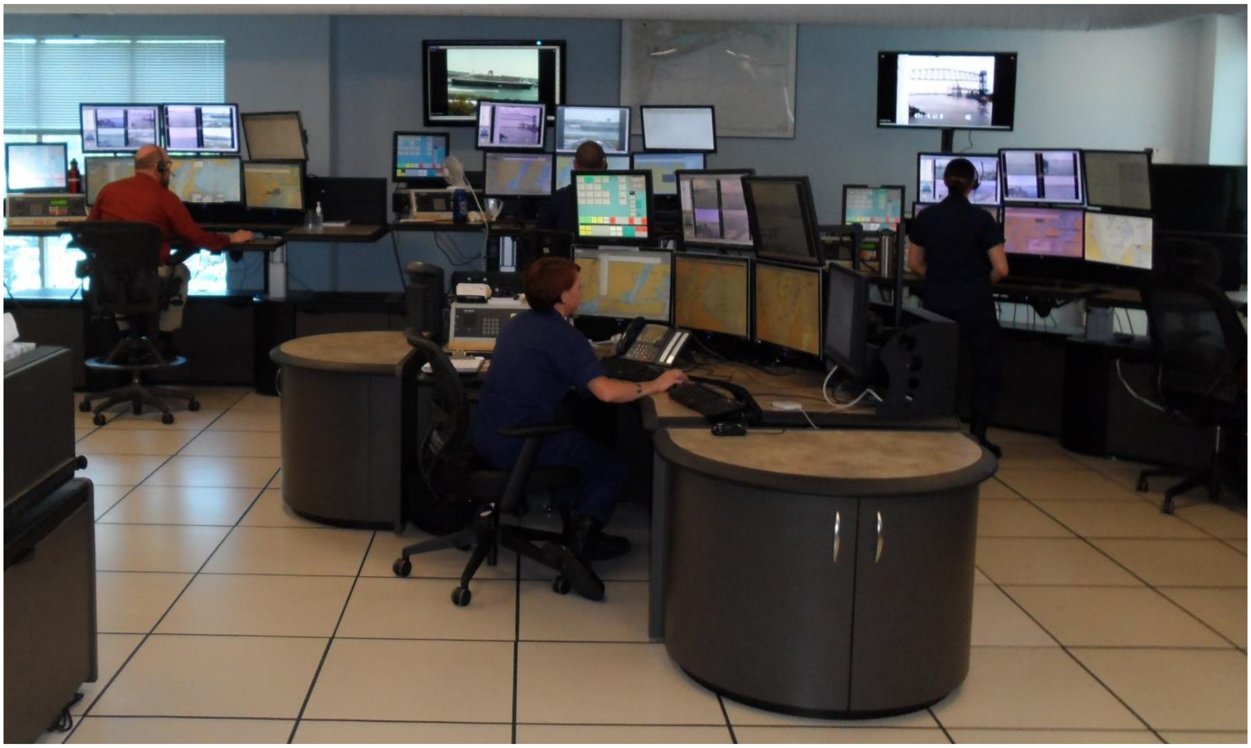

**Figure 3.** Example of a VTS center watchfloor showing supervisor and operators at workstations

Most operators use a vessel traffic information management system called the Ports and Waterways Safety System (PAWSS). This system is designed to help them collect, evaluate, and disseminate navigation safety information to vessels. The PAWSS integrates radar, AIS data, and other sensor data into a common display and assists the operator with monitoring and responding to developing traffic situations.[10] The operator's display shows the vessel movements in near real-time on a geographic outline of the ports and waterways making up the VTS area. Shoreline, piers, and other associated infrastructure are included in the outline. Operators are able to display the navigational track lines of vessels to assist them with various time-space management tasks. There are also different rules-based alarms and other features to help alert operators to specific types of situations (for example, a developing collision).

Coast Guard VTS centers use these advanced surveillance and communications capabilities to manage vessel traffic along critical segments of the US Marine Transportation System. VTS areas account for a small portion of this system that includes about 12,000 miles of coastline and 25,000 miles of commercially navigable waterways that link hundreds of ports, intermodal cargo terminals, and other related infrastructure across the United States (DOT 2014). These complex waterways are shared by a variety of vessels carrying cargo and passengers. Each year, about 8,000 foreign-flagged vessels make more than 60,000 port calls to distribute

[10] Although operators generically used the term PAWSS to refer to the traffic information management system in their VTS center, not all of the centers used the same software and system architecture. In addition, one VTS center observed during this study still tracked vessels manually, using radios, a movement board, and cameras.

commodities, merchandise, and other consumer goods into this system. In addition, more than 180 million ferryboat commuters and another 6 million cruise ship passengers share these waterways with tankers, bulk carriers, tugs, and barges transporting hazardous cargo (DOT 2015, 2014).

According to Title 33 *United States Code (USC)* Sections 1221-1236 and 2704, the Coast Guard is responsible for the oversight and management of navigation safety in the United States. The main components of navigation safety include the navigation rules and regulations, aids to navigation, and VTS centers. Professional mariners are expected to be proficient in the application of navigation rules and regulations. Aids to navigation (for example, buoys and beacons) mark navigable channels, waterways, and obstructions to help mariners determine their location, get from one place to another, and stay out of danger. These aids to navigation function in a manner similar to road signs, traffic lights, and stop signals on land. A VTS center is the only navigation safety component that involves active and direct interaction between waterway users and the Coast Guard.

## 1.3 Previous NTSB Research and Accident Investigations

For years, the NTSB has recognized the need for proactive vessel traffic management in congested waterways. In 1972, the NTSB published a special study on alternative measures for preventing marine collisions, which was prompted in part by its findings from the accident involving the *Arizona Standard* and *Oregon Standard* (NTSB 1972, 1971). The study found that mariners needed more effective tools to deal with increasingly complex vessel traffic and congested waterways. As a result, the NTSB made three recommendations supporting the establishment of mandatory shore-based traffic control systems to be operated by the Coast Guard.[11] The study also found that the United States was lagging behind other countries in the development, implementation, and evaluation of shore-based collision avoidance measures. In 1981, the NTSB conducted another study addressing the marine collision problem, which reassessed the leading causes of collisions and the overall effectiveness of the prevention measures implemented between 1970 and 1980 (NTSB 1981). The 1981 study did not result in recommendations specifically related to the Coast Guard's VTS system (NTSB 1981).

Today, Coast Guard VTS centers have the authority and the means to detect unsafe situations, alert those involved of the potential danger, and help mitigate risk. However, the NTSB continues to investigate accidents where VTS supervisors and operators on duty at the time of the accident did not detect or recognize a developing vessel conflict inside their traffic area, or did not effectively use their authority to intervene and prevent the accident (NTSB 2016a, 2016b, 2015b, 2012a, 2012b, 2011, 2009). Significant VTS issues from these investigations, most of which occurred within the past decade, are discussed in more detail in section 3, "Safety Issues," of this report. The NTSB accident reports that provide more detail about these investigations are available as separate publications on the NTSB website at [www.ntsb.gov](http://www.ntsb.gov).

[11] NTSB Safety Recommendations M-72-1 and -2 to Congress were classified "Closed—No Longer Applicable," and Safety Recommendation M-72-3 to the Coast Guard was classified "Closed—Acceptable Action."

# 2 Methodology and Data Sources

The NTSB used a combination of quantitative and qualitative data sources and associated analytical methods in this study to assess the effectiveness of the Coast Guard VTS system to improve maritime safety in the United States.[12] Accident and vessel movement statistics, and waterborne freight movement data were used to characterize vessel accidents and activity. Individual VTS center rosters and activity reports were used to characterize the overall Coast Guard VTS workforce and operations. The NTSB supplemented these recorded data with a survey of watchstanders (that is, VTS supervisors and operators), site visits and interviews at each of the 12 VTS centers, and discussions with waterway stakeholders and industry associations.[13] The NTSB also conducted a comprehensive review of the applicable statutory and regulatory requirements, oversight procedures, national and local operating procedures, and watchstander training, certification, and qualification standards. Finally, the NTSB reviewed similar information regarding vessel traffic management systems in Canada and Europe and international guidelines, recommendations, and best practices for VTS centers provided by the International Maritime Organization (IMO) and the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

## 2.1 Quantitative Data

In this study, the NTSB analyzed marine accident and activity data from several sources. Accident data from the Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database were used to characterize the number of marine accidents occurring annually throughout the ports and waterways of the United States.[14] The Coast Guard uses the MISLE database to store information collected during its investigations of vessel and waterfront facility accidents, marine pollution incidents, and law enforcement activities throughout the United States. Only some of those data are available to the public. In support of this study, the Coast Guard's Office of Investigations and Analysis provided an additional dataset of marine accident records for 2010 through 2014 to supplement the publicly available MISLE data. The supplemental dataset included additional information related to recent accidents involving the collision, allision, or grounding of vessels meeting VTS user vessel characteristics, including cases that are still under investigation and not yet publicly available.[15] To estimate accident rates,

[12] An expanded discussion of the methods and data used in this study is available in the public docket for this safety study, DCA15SS001, at http://dms.ntsb.gov/pubdms/search/hitlist.cfm?docketID=58688&CFID=518337&CFTOKEN=77b74ed9a34a307e-F8BC0E93-9217-BE65-2E886F480FEF7C46.

[13] The term watchstander is used throughout the remainder of this report when referring to Coast Guard VTS supervisors and operators as a collective group. In those instances where the distinction between supervisors and operators must be maintained, the report uses those terms.

[14] The Coast Guard MISLE database contains data related to marine accident investigations reportable under 46 *CFR* 4.03 and pollution investigations reportable under 33 *CFR* 153.203. Publicly available tables from the MISLE database can be accessed at https://homeport.uscg.mil/mycg/portal/ep/home.do.

[15] In addition to including information about open cases, the supplemental dataset provided by the Coast Guard's Office of Investigations and Analysis included details of any resulting pollution, any hazardous

incident data were compared to waterborne traffic and freight movement data provided by the US Army Corps of Engineers (the Corps) Navigation Data Center and information regarding commercial vessel calls in US ports and terminals provided by the US Maritime Administration (MARAD).[16]

### 2.1.1 Historic US Waterborne Traffic and Accident Trends

Waterborne traffic and freight movement data published by the Corps Navigation Data Center, presented in figure 4, provide an indication of vessel traffic in US ports and waterways from 2003 through 2012.[17] As illustrated in the graph, the total waterborne freight movements increased slightly from 2003 to a high of about 2.6 billion short tons in 2006. Freight movements then dropped to a low of 2.2 billion short tons in 2009, consistent with the US economic recession between 2007 and 2009 (DOL 2012). Freight movements returned to levels similar to 2003 during the remaining 3 years with about 2.3 billion short tons in 2012.

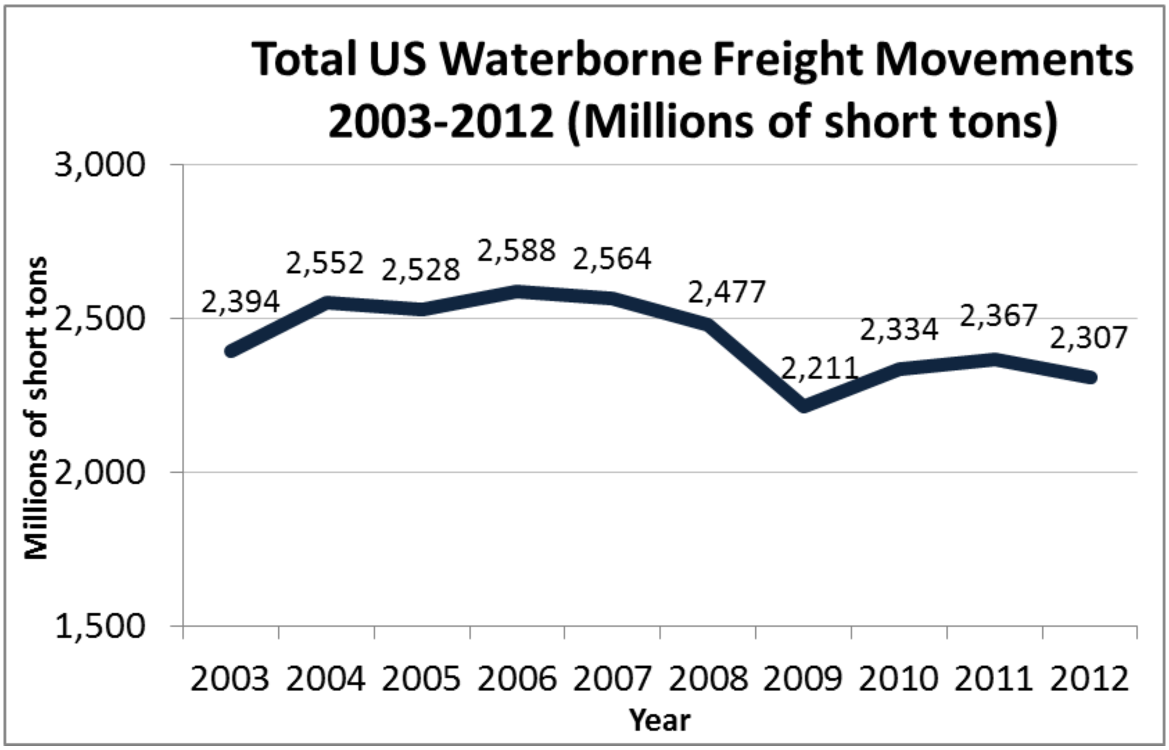


**Figure 4.** Total US waterborne freight movements 2003-2012 in millions of short tons

conditions that existed at the time of the event, any hazardous cargo carried by the vessels involved, and any improper vessel operation identified as a factor in the event.

16 Annual reports of the Corps Navigation Data Center datasets are available for public download at http://www.navigationdatacenter.us/wcsc/wcsc.htm. MARAD port call datasets are available for public download at http://www.marad.dot.gov/resources/data-statistics/.

17 Freight movement data are not a direct measure of all vessel movements. Rather, the data provide an indication of general trends in waterborne traffic. See Waterborne Commerce of the United States, National Summaries of Domestic and Foreign Waterborne Commerce, Table 1-1, http://www.navigationdatacenter.us/wcsc/wcsc.htm.

Vessel port call data published by MARAD, illustrated in figure 5, provide a more direct measure of vessel movements between 2003 and 2012.[18] These data are calculated from privately owned, oceangoing merchant vessels over 10,000 deadweight tons arriving at a US port or terminal.[19] The data show that vessel port calls generally increased over the period, with a decrease in activity from 2007 through 2009 similar to that seen in the freight movements.

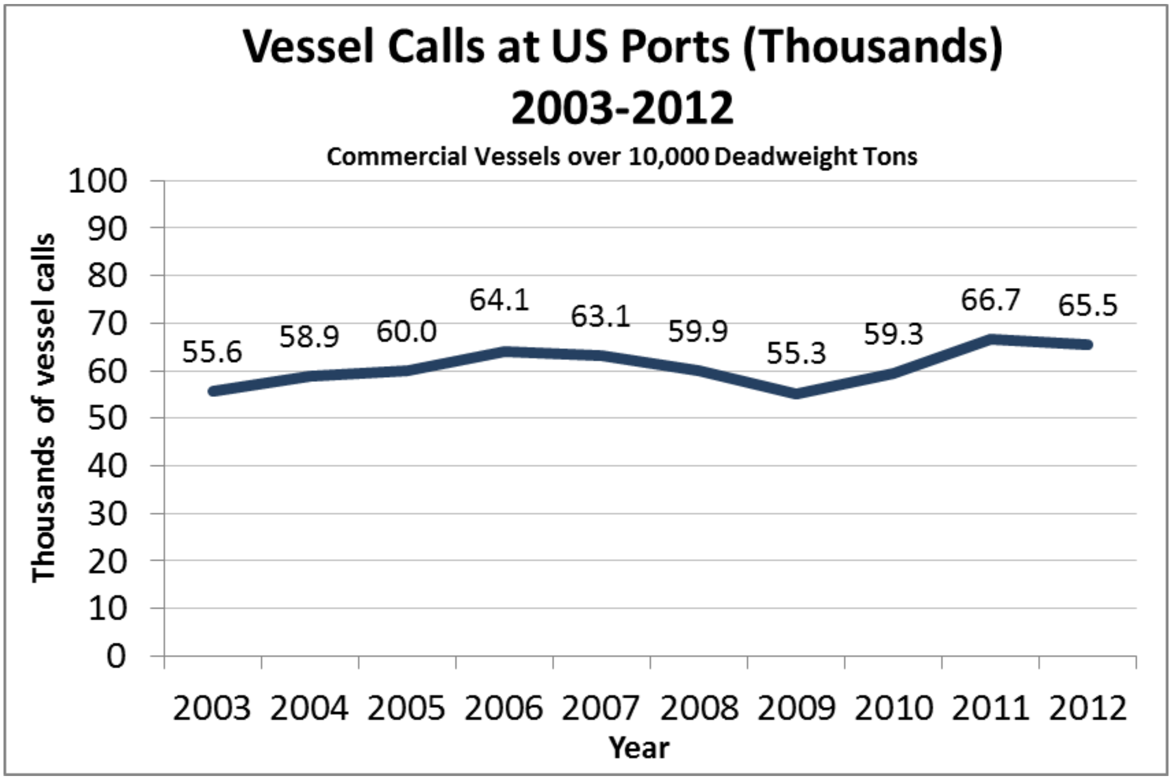


**Figure 5.** Vessel calls at US ports 2003-2012 in thousands of port calls

[18] MARAD collects and publishes summary data for privately-owned, oceangoing merchant vessels of all flags of registry calling at ports and selected ports/terminals within the contiguous United States, Hawaii, Alaska, Guam, and Puerto Rico. Though MARAD strives to provide the most accurate information on vessel activity in the United States, these numbers may vary from statistics collected by port authorities and terminal operators. See the 2002–2012 *Total Vessel Calls in U.S. Ports, Terminals and Lightering Areas Report* at http://www.marad.dot.gov/resources/data-statistics/.

[19] Deadweight tonnage is a measure of the total weight (in metric tons) of cargo, fuel, fresh water, supplies, and crew that a vessel can carry when immersed to its load line.

As illustrated in figure 6, the total number of marine accidents each year fluctuated between 2003 and 2012, following a pattern similar to that of freight movements and vessel port calls.[20] Accidents increased to a high of 6,014 in 2007, then decreased to a low of 4,987 in 2009 as activity decreased. The annual accident total in 2012 was similar to the total in 2003 and did not exhibit a substantial change over the 10-year period.

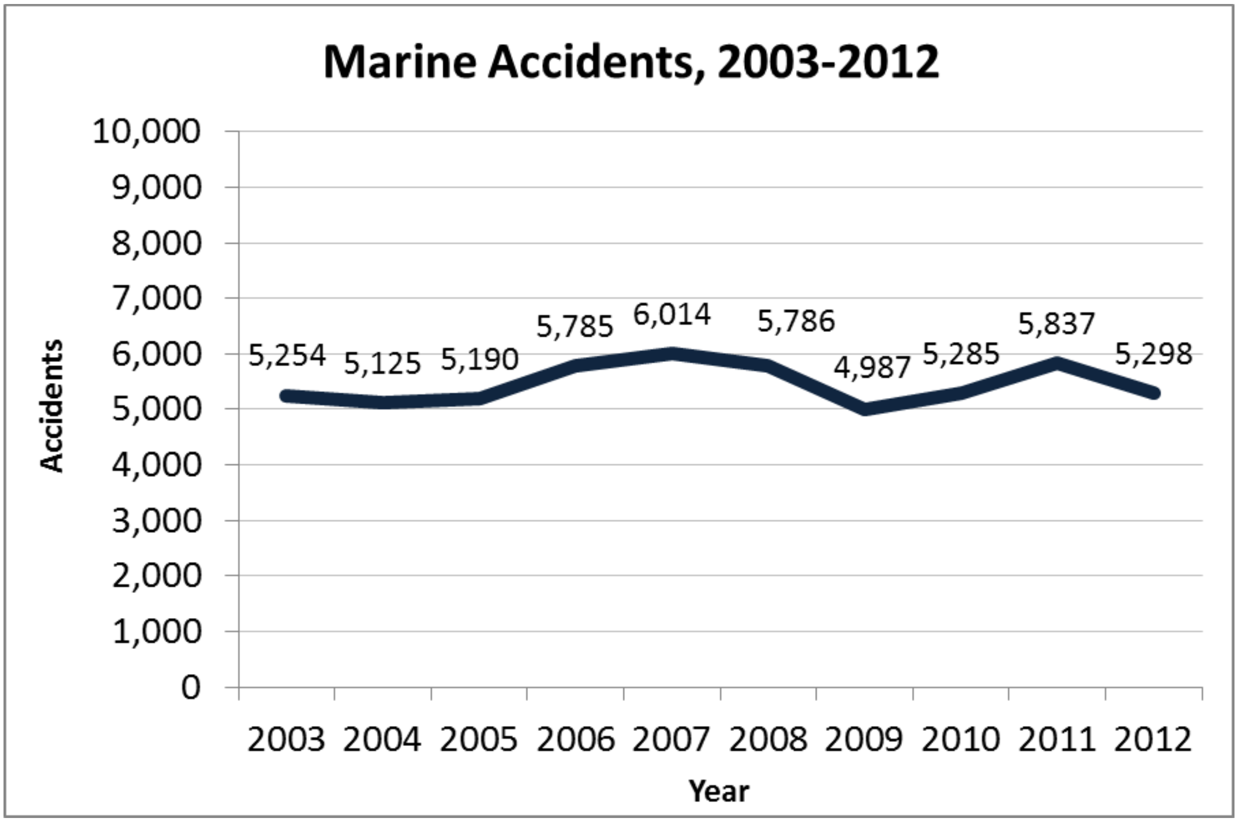


**Figure 6.** Coast Guard reported marine accidents 2003-2012

[20] US Department of Homeland Security, US Coast Guard, Office of Investigations and Analysis data as reported by the US Department of Transportation, Bureau of Transportation Statistics, http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_02_45.html. Accidents in this table include the number of accident cases reported to the Coast Guard in accordance with the marine casualty reporting requirements of 46 *CFR* Part 4.05-1. The regulation specifies a number of different occurrence types that must be reported to the Coast Guard. Some examples include occurrences that affect a vessel's maneuverability or fitness for service; result in property damage in excess of $25,000; result in loss of life or injuries requiring professional medical treatment; or result in significant harm to the environment.

### 2.1.2 VTS Area Traffic and Accidents

The Corps and MARAD vessel traffic and freight movement data were compared with VTS area boundaries and port location data to generate estimates of waterborne traffic for the major ports located inside VTS areas. As illustrated in figure 7, annual waterborne freight movement totals for those ports were generally similar for the years 2010 through 2014.

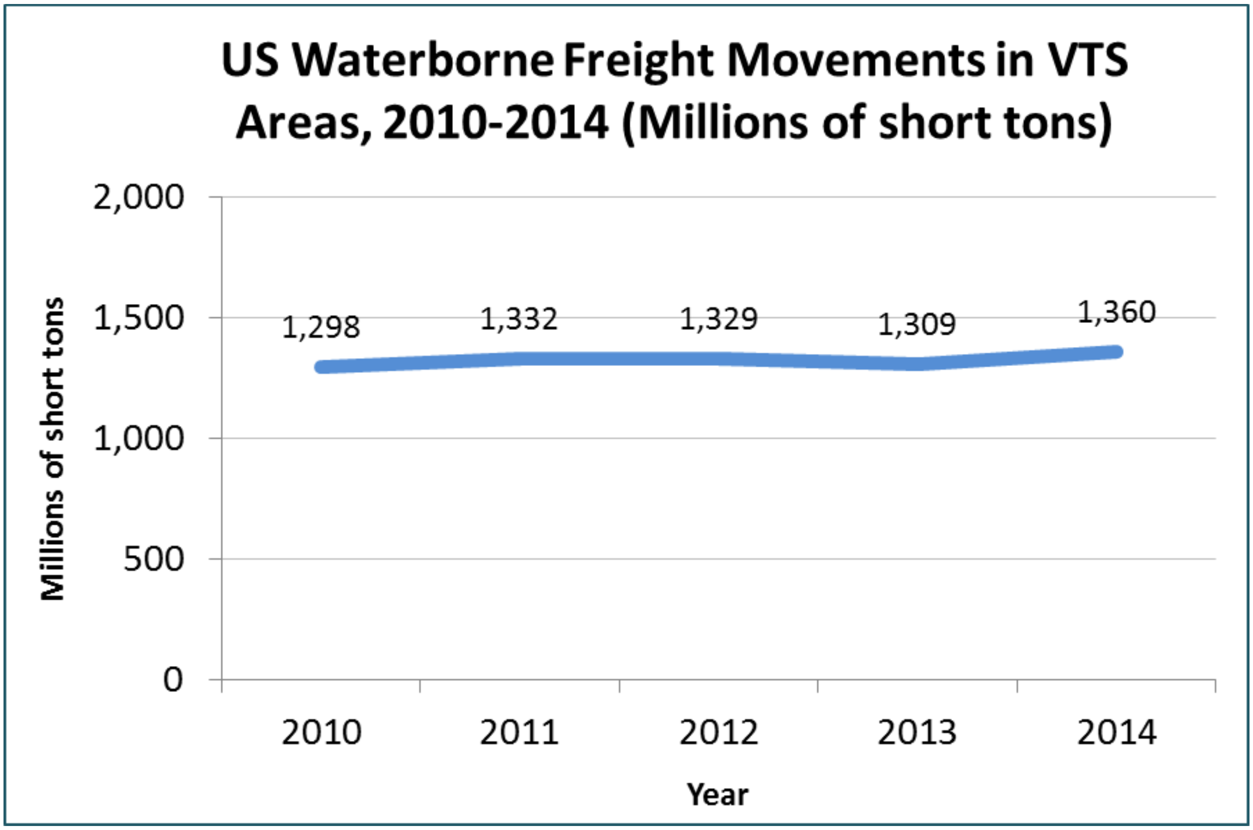


**Figure 7.** US waterborne freight movements 2010-2014 associated with VTS areas in millions of short tons

Figure 8 illustrates the MARAD vessel traffic data for major ports located inside VTS areas.[21] These data are from the calendar year 2013, which are the most recent data available for this report. As the chart shows, nearly half (48%) of all port calls in VTS areas by vessels over 1,000 gross tons were made by tankers.[22] Container and bulk cargo vessels were the next most common with each accounting for about 18% of all large vessel calls in VTS areas in 2013.

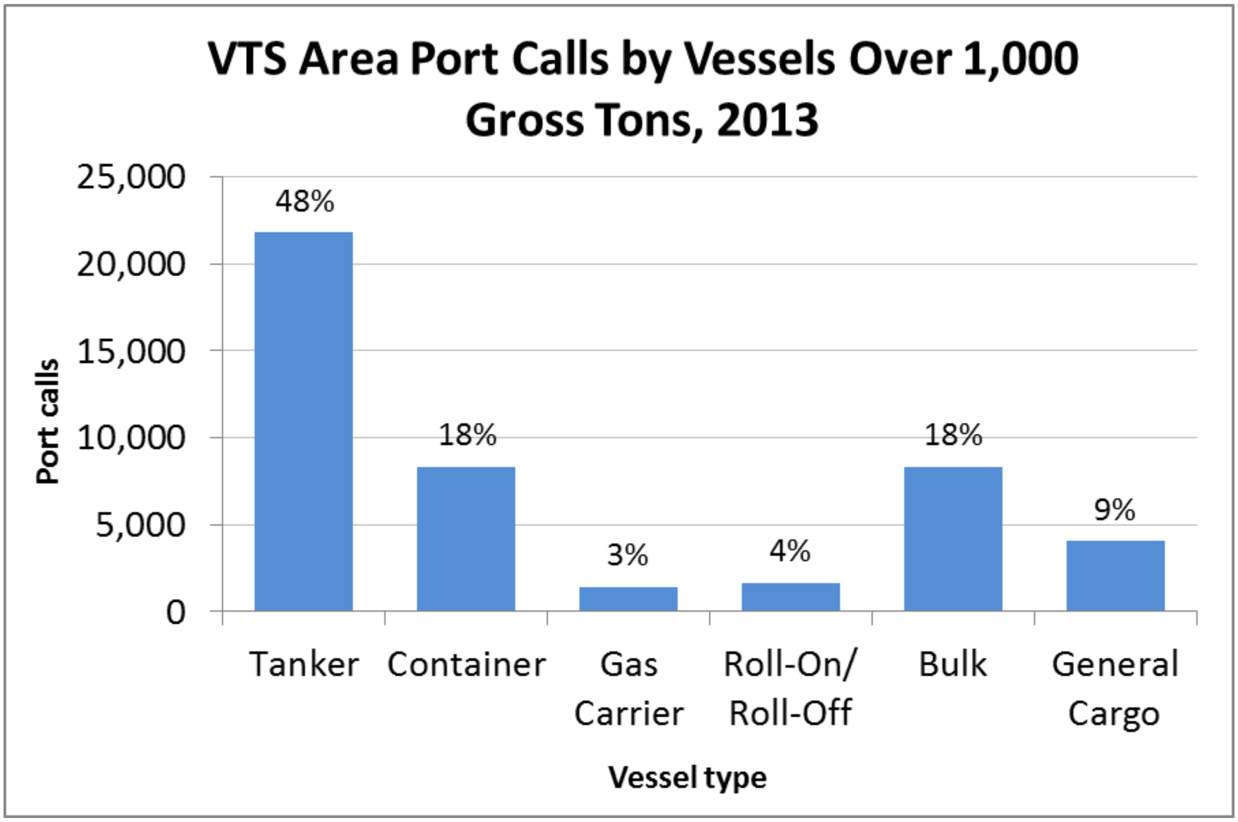


**Figure 8.** 2013 port calls in VTS areas by vessels over 1,000 gross tons

[21] These data include all privately-owned, oceangoing merchant vessels of all flags of registry over 1,000 gross register tons calling at ports and selected ports/terminals within the contiguous United States, Hawaii, Alaska, Guam, and Puerto Rico during 2013.

[22] Gross tonnage is a function of the volume of all of a vessel’s enclosed spaces measured to the outside of the hull framing. It is not a measure of weight.

### 2.1.3 Supplemental MISLE Data

The Coast Guard's Office of Investigations and Analysis provided additional marine accident records for 2010 through 2014 to supplement the publicly available MISLE records.[23] The supplemental records included both open and closed accident investigation records involving vessels meeting the size and operational requirements for VTS participation (that is, at least a VTS user). Position information in the supplemental MISLE records was compared with the geographic boundaries of the 12 VTS areas to identify accidents that occurred within the navigable waterways of a VTS area.[24] The Coast Guard identified a total of 4,782 records in MISLE that met the study search criteria. Of those, the NTSB was able to identify 857 that occurred within the geographic boundaries of a VTS area.

As illustrated in figure 9, the total number of collisions, allisions, and groundings decreased annually from 2010 through 2014. The number of those accidents that occurred in VTS areas also decreased slightly. On average, 18% of all reportable collisions, allisions, and groundings involving vessels meeting the requirements of a VTS user occurred while they were operating inside a VTS area. The most common causal factor assigned to these accidents by the Coast Guard was inattention errors by the mariner(s) involved. Inattention was cited as a cause in an average of 35% of all MISLE collision, allision, and grounding cases inside VTS areas with causal information, which suggests that an opportunity exists for using VTS to further reduce these accidents.

[23] (a) Additional information provided with the public MISLE dataset indicated that during 2013 and 2014 there were more than 550 open Coast Guard investigations of accidents resulting in injury/death and several thousand open investigations of vessel damage and pollution events that had not yet been released. Consequently, NTSB requested additional information from the Coast Guard, including data regarding cases currently under investigation, to provide a more timely characterization of the number of collisions, allisions, and groundings involving vessels meeting the VTS user participation requirements. (b) The Coast Guard's most recently established VTS center in Port Arthur, Texas, began operations in 2005. The NTSB chose to focus the quantitative data analyses in this study on the 5 years from 2010 through 2014 to ensure that all VTS centers were well-established and had been operational for at least 5 years.

[24] VTS areas were defined using the coordinates specified in 33 *CFR* Part 161 and the VTS user manuals to create shapefiles in ArcMap 10.2. Coordinate data in the MISLE database were compared with the resulting shapefiles to identify incidents inside the VTS area boundaries. Incidents with coordinates corresponding to locations on land, or more than 1 kilometer from the boundary of a VTS area were excluded from analysis. Incidents with coordinates corresponding to streams, lakes, wetlands, or other bodies of water within the geographic bounds of a VTS area but non-navigable by commercial vessel traffic were also excluded from analysis.

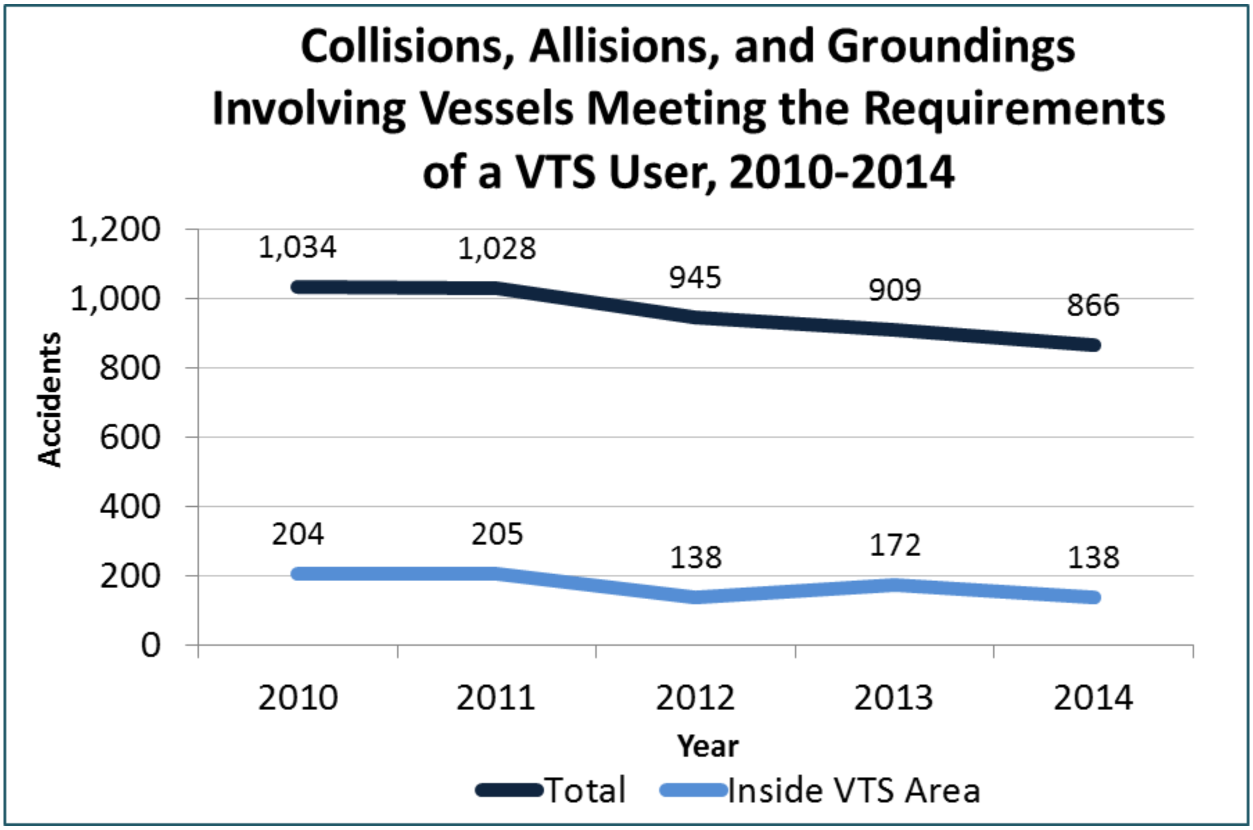


**Figure 9.** Collisions, allisions, and groundings involving vessels meeting the requirements of a VTS user, 2010-2014

Additional information in the supplemental MISLE dataset case files was used to assess the injuries and damage that resulted from collisions, allisions, and groundings in VTS areas. As shown in table 1, these accidents typically did not result in large numbers of fatalities, but people were injured during the event or exposed to hazardous cargo.[25] More often, these accidents resulted in extensive property and environmental damage and associated financial losses.[26] Table 1 shows that the damage resulting from collisions, allisions, and groundings inside VTS areas during 2014 was noticeably greater than the preceding 4 years despite the smaller number of total accidents that year.

[25] For example, the NTSB investigation of a vessel collision in the Houston Ship Channel on March 22, 2014, found that crewmembers suffered inhalation injuries when responding to the resulting oil spill (NTSB 2015b).

[26] In addition to the direct damage and associated costs, these incidents typically result in vessel traffic disruptions or waterway closures that may cost many millions of dollars. Hazardous cargo releases may also have prolonged environmental impacts.

**Table 1.** Injuries and damage resulting from collisions, allisions, and groundings involving VTS users inside VTS areas, 2010-2014

| Year | MISLE Cases | Fatalities | Injuries | Vessel Property Damage | Facility, Cargo, and Other Property Damage | Total Property Damage |
|---|---|---|---|---|---|---|
| **2010** | 204 | 0 | 58 | $5,580,895 | $11,102,401 | $16,683,296 |
| **2011** | 205 | 0 | 11 | $5,080,579 | $5,439,454 | $10,520,033 |
| **2012** | 138 | 0 | 4 | $5,121,891 | $2,719,520 | $7,841,411 |
| **2013** | 172 | 2 | 102 | $5,511,769 | $4,445,119 | $9,956,888 |
| **2014** | 138 | 0 | 4 | $8,132,602 | $16,219,606 | $24,352,208 |
| **2010-14 Total** | 857 | 2 | 179 | $29,427,736 | $39,926,100 | $69,353,836 |

### 2.1.4 VTS Monthly Activity Reports

The NTSB also analyzed VTS monthly activity reports from the 12 VTS centers. Each VTS center is required to record and maintain statistics detailing its monthly operations such as vessel transits, incidents, near misses, waterway controls, and VTS interventions (Coast Guard 2011a).[27]

[27] See section 3.4.3 of this report for a discussion about the definition of near miss.

### 2.1.5 Reported VTS Area Movements

Each VTS center is required to record intra- and inter-port transits of all participating vessels. Transits should be recorded separately for each vessel category of tanker, freighter, tug/tow, ferry/passenger, cruise ships, public, and other vessels (such as recreational boats or fishing vessels).[28] Each VTS center should also report the total number of transits that occurred in the port during the month. Table 2 includes the total vessel transit data provided by each VTS center for the years 2010 through 2014.

**Table 2.** Coast Guard VTS monthly activity report movement data, annual totals, 2010-2014

| VTS Area | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| Berwick Bay | 57,485 | 56,385 | 64,643 | 65,039 | 62,159 |
| Houston-Galveston | 235,685 | 230,301 | 247,026 | 235,374 | 241,238 |
| Los Angeles-Long Beach | 26,626 | 27,737 | 26,359 | 24,940 | 26,223 |
| Louisville | 1,093 | 3,170 | 1,173 | 1,081 | 1,346 |
| Lower Mississippi River[a] | 179,818 | 186,706 | 177,535 | 180,566 | 188,771 |
| New York City[b,c] | 421,618 | 420,738 | 425,568 | 409,560 | 412,311 |
| Port Arthur | 52,898 | 56,107 | 56,567 | 58,819 | 62,248 |
| Prince William Sound | 22,255 | 12,769 | 7,104 | 6,860 | 6,849 |
| Puget Sound[c] | 222,308 | 229,816 | 235,476 | 234,862 | 232,447 |
| San Francisco[c] | 120,718 | 135,141 | 123,374 | 128,505 | 131,391 |
| St. Mary's River[c] | 61,532 | 61,043 | 61,329 | 60,996 | 60,955 |
| Tampa | 8,747 | 9,337 | 9,481 | 9,028 | 8,852 |
| Total Reported VTS Area Vessel Movements | 1,410,783 | 1,429,250 | 1,435,635 | 1,415,630 | 1,434,790 |

[a] The Lower Mississippi River total includes the sum of New Orleans and 81 Mile Point movements.

[b] New York City reported movement data only include VMRS users, not all VTS users.

[c] Includes ferry movement data.

[28] Examples of public vessels include vessels operated by the Coast Guard, the US Navy, the US Army, the Military Sealift Command, the National Oceanic and Atmospheric Administration; foreign navy vessels; and state, city, or county government vessels (such as police and fire/rescue).

### 2.1.6 VTS Reported Incidents

Each VTS center is also required to record the number of incidents per month in its VTS area in the following categories: allision, collision, grounding, pollution, near miss, vessel casualties, anchorages, and any other event category considered notable by the VTS watch supervisor.[29] Table 3 includes all of the VTS centers' reported annual incident totals for 2010 through 2014 in the categories of collision, allision, and grounding.

**Table 3.** Coast Guard VTS monthly activity report collision, allision, and grounding incident data, annual totals, 2010-2014

| VTS Area | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| **Berwick Bay** | incomplete[d] | 6 | 7 | 7 | 5 |
| **Houston-Galveston** | 49 | 48 | 48 | 35 | 30 |
| **Los Angeles-Long Beach[a]** | Incident type not reported | | | | |
| **Louisville** | 2 | 2 | 2 | 0 | 0 |
| **Lower Mississippi River** | 37 | 67 | 48 | 75 | 59 |
| **New York City[b]** | 17 | 32 | 27 | 19 | 19 |
| **Port Arthur** | 25 | 13 | 27 | 15 | 32 |
| **Prince William Sound** | 2 | 1 | 0 | 0 | 0 |
| **Puget Sound** | 4 | 6 | 3 | 10 | 4 |
| **San Francisco** | incomplete[d] | 8 | 2 | 10 | 2 |
| **St. Mary's River** | 9 | 9 | 7 | 2 | 6 |
| **Tampa[c]** | No incident data reported | | | | |

[a] VTS Los Angeles-Long Beach monthly activity report data included all incidents and do not specify collisions, allisions, and groundings.

[b] VTS New York City monthly activity report incident data were populated from Coast Guard MISLE records.

[c] VTS Tampa monthly activity reports did not include incident data.

[d] The data from 2010 were incomplete for VTS Berwick Bay and VTS San Francisco.

[29] Not all of these incidents will meet the MISLE reporting requirements.

### 2.1.7 VTS Area Collision, Allision, and Grounding Rates

The Coast Guard's VTS monthly activity reports do not include measures of risk, but the NTSB used the available vessel movement and incident data to calculate a collision, allision, and grounding incident rate for each VTS area. As shown in table 4, the overall incident rates remained generally similar for the years 2010 through 2014. The incident rates were higher for VTS areas characterized by a river or a confined channel than for VTS areas primarily characterized by open and deep water. Although these rates reflect general differences in accident risk between waterways, the rates cannot be used to assess the performance of the VTS system due to differences in the collection and reporting of vessel movement and incident data by the 12 VTS centers.

**Table 4.** VTS area collision, allision, and grounding incident rate per 1,000 transits calculated annually from available VTS monthly activity report data, 2010-2014

| VTS Area | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| Berwick Bay | incomplete[a] | 0.11 | 0.11 | 0.11 | 0.08 |
| Houston-Galveston | 0.21 | 0.21 | 0.19 | 0.15 | 0.12 |
| Los Angeles-Long Beach | Rate could not be calculated[b] | | | | |
| Louisville | 1.83 | 0.63 | 1.71 | 0.00 | 0.00 |
| Lower Mississippi River | 0.21 | 0.36 | 0.27 | 0.42 | 0.31 |
| New York City | 0.04 | 0.08 | 0.06 | 0.05 | 0.05 |
| Port Arthur | 0.47 | 0.23 | 0.48 | 0.26 | 0.51 |
| Prince William Sound | 0.09 | 0.08 | 0.00 | 0.00 | 0.00 |
| Puget Sound | 0.02 | 0.03 | 0.01 | 0.04 | 0.02 |
| San Francisco | incomplete[a] | 0.06 | 0.02 | 0.08 | 0.02 |
| St. Mary's River | 0.15 | 0.15 | 0.11 | 0.03 | 0.10 |
| Tampa | Rate could not be calculated[b] | | | | |

[a] The incident data from 2010 were incomplete for VTS Berwick Bay and VTS San Francisco.

[b] Rates could not be calculated due to missing incident data.

### 2.1.8 Analysis of VTS Activity, Incident, Intervention, and Near-Miss Data

The NTSB sought to analyze safety trends and VTS performance within and across the ports and waterways served by the Coast Guard VTS system using the activity, incident, intervention, and near-miss data recorded from operations at the 12 VTS centers. Although the VTS centers are required to record these data, the NTSB found that the VTS monthly activity report data were neither complete nor consistent enough to support such analyses. The lack of standardized vessel movement and incident measures precluded the calculation of incident rates for all VTS areas. Seven of the 12 VTS centers were recording data on waterway controls and VTS interventions, and 5 of the 12 were recording data on near misses.[30] The VTS monthly activity reports also lacked sufficient position data to support geographic analyses of incidents, near misses, interventions, or vessel traffic.

### 2.1.9 Quantitative Data Limitations

Historical accident and movement data do not provide sufficient detail to support a comprehensive analysis of Coast Guard VTS system effectiveness. Analyses of these data do not reflect the unique characteristics of vessel traffic, waterway configuration, or weather. These analyses also do not identify accident causes or mitigation efforts. Finally, analyses of the available data do not provide insights about local waterway user and stakeholder concerns. To overcome these data limitations, the NTSB collected qualitative information by conducting a survey of Coast Guard VTS watchstanders, site visits, and interviews.

## 2.2 Qualitative Data

The NTSB collected a variety of qualitative information to examine Coast Guard VTS program management, stakeholder experiences with the overall Coast Guard VTS system, and the workforce and operations at the 12 Coast Guard VTS centers. Specifically, the NTSB—

- developed and administered an online questionnaire to qualified watchstanders;
- interviewed Coast Guard VTS program managers;
- conducted study visits and observed day and evening watchfloor operations at all 12 Coast Guard VTS centers;
- interviewed Coast Guard VTS directors, training coordinators, watch supervisors and operators, and support personnel;
- attended the National VTS Certification Course at the Maritime Institute of Technology and Graduate Studies in Linthicum Heights, Maryland; and

[30] The monthly activity report data from VTS Berwick Bay, VTS New York City, VTS Port Arthur, VTS Prince William Sound, VTS Puget Sound, VTS San Francisco, and VTS St. Mary's River contained at least one measure of VTS controls, interventions, or special vessel handling. VTS Louisville, VTS Lower Mississippi River, VTS Port Arthur, VTS Prince William Sound, and VTS Puget Sound included near-miss events in their monthly activity report data.

- met with and received feedback from professional associations, harbor safety committees, marine exchanges, pilots, port authorities, and other local waterway stakeholders.

These sources provided insight into how each VTS center was organized; the size and demographics of the workforce; operator and supervisor training and proficiency; the equipment and technologies used to monitor traffic and detect unsafe situations; and the strategies used to intervene and resolve potential vessel conflicts. The Pilots' Association for the Bay and River Delaware Vessel Traffic Information Service (VTIS), at Cape Henlopen, Delaware, also provided additional information about non-federal traffic and information services in the United States.

### 2.2.1 VTS Watchstander Questionnaire

The NTSB used a questionnaire to obtain data on the work experiences and opinions of active duty and civilian VTS watchstanders from the 12 Coast Guard VTS centers.[31] The questionnaire covered topics related to the training, certification, and qualification of watchstanders; vessel traffic management and standard operating procedures; VTS facilities and equipment; and local waterway and traffic characteristics. The questionnaire also solicited basic demographic information from respondents including age, work location, and employment experience. Survey participation was voluntary and responses were confidential. No personally identifiable information was collected and only aggregate results are presented in this study.

The questionnaire was administered as a web-based survey from the end of May to the beginning September 2015. All responses were received by September 4, 2015. A total of 164 VTS watchstanders (95 civilian and 69 active duty Coast Guard personnel) completed the questionnaire.[32] The overall proportion of questionnaire respondents was about 58% civilian and 42% active duty. The watchstanders represented all 12 of the Coast Guard's VTS centers.

The total number of questionnaire responses; the proportion of respondents identifying themselves as either active duty or civilian (and the proportion of supervisors and non-supervisors within these two groups); and the distribution of responses received from each VTS center was compared to watchstander rosters provided by the Coast Guard for the period of May to September 2015. Based on the rosters provided by each VTS center, there were an estimated 264 qualified VTS watchstanders during the questionnaire period, of those, 57% were civilian and 43% were active duty.

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[31] A copy of the questionnaire is provided in the appendix of this report.

[32] An additional 28 questionnaires were started but not completed. Partially completed questionnaires were excluded from study analyses.

Given the proportionate distribution of respondents, combined with the high overall questionnaire response rate of nearly two-thirds (62%) of qualified watchstanders, the questionnaire was considered to be representative of the Coast Guard VTS watchstander population.[33] Figure 10 summarizes the number of qualified watchstanders who were offered the questionnaire and the distribution of responses received from each VTS center.

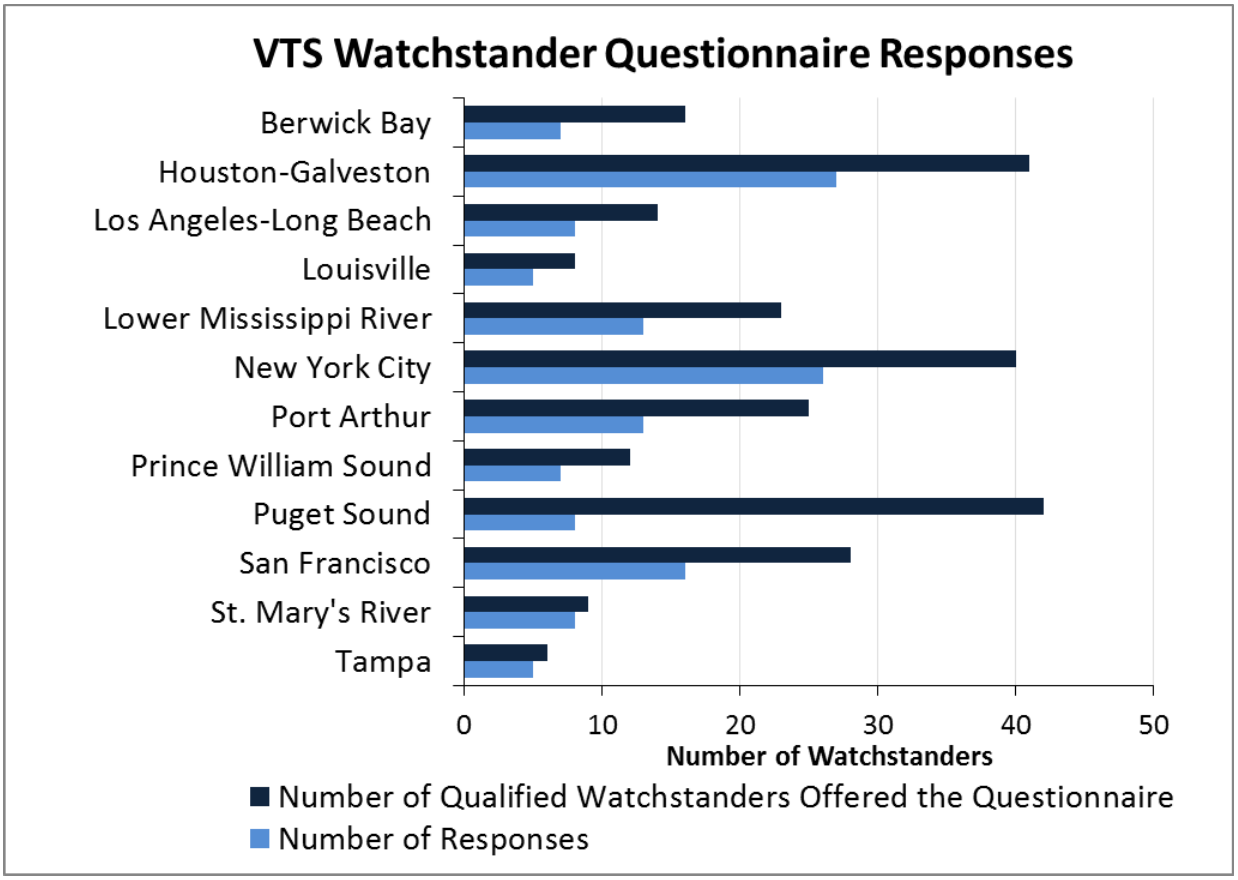


**Figure 10.** Study questionnaire responses by Coast Guard VTS center

[33] Due to the high annual turnover rate of active duty personnel, the distribution of questionnaire respondents may be different each year. Therefore, the questionnaire represents a 2015 cross section of the Coast Guard VTS system.

### 2.2.2 VTS Center Site Visits and Interviews

The NTSB visited a total of 14 vessel traffic facilities in North America. These visits included the 12 Coast Guard VTS centers and 1 VTIS center in the United States and 1 Marine Communications and Traffic Services center in Victoria, British Columbia, Canada.[34] The NTSB observed the watchfloor at each of these facilities, spending several days observing each Coast Guard VTS center during day and evening watches, as well as during watch shift changes. In addition, the NTSB interviewed an IALA VTS committee representative and a senior advisor for the Port of Rotterdam VTS in the Netherlands.

The NTSB conducted informal interviews with the VTS directors at all 12 of the Coast Guard's VTS centers. In addition, semistructured interviews were conducted on site at these facilities with 90 qualified watchstanders who volunteered to participate in the study. The interview topics focused on how operators and supervisors perceived their authority and capability to control vessel traffic movements. They were asked to give specific examples of unsafe traffic situations and the steps they took to intervene and resolve them. Many of the watchstanders provided additional insight into the limitations of the equipment they use to detect hazards, the types of information that would prompt them to interact with and influence traffic, and how they communicate that information to pilots and other mariners.

The NTSB also interviewed training coordinators on topics related to new watchstander indoctrination and qualification, recurrent training, and professional development. Electronics support personnel provided insight into the technical limitations of the sensors and equipment used by watchstanders to monitor and interact with vessel traffic. Marine exchange and port authority personnel who work at the Coast Guard's public-private partnership VTS centers and pilots who serve as VTS advisors were also interviewed about their perspectives concerning the Coast Guard VTS system.

[34] The Pilots' Association for the Bay and River Delaware VTIS is located at Cape Henlopen, Delaware.

# 3 Safety Issues

The NTSB identified four safety issue areas in this study: (1) variation in the use of Coast Guard VTS authority, (2) inadequate VTS watchstander training and qualification, (3) VTS system limitations, and (4) insufficient safety risk management of VTS areas.

## 3.1 Variation in the Use of Coast Guard VTS Authority

### 3.1.1 VTS Program Oversight

The Coast Guard is divided into two area commands, the Atlantic Area and the Pacific Area, which are further divided into a total of nine district commands. Each district is divided into operational units known as sectors. Individual ports and waterways are commanded by a captain of the port who is responsible for enforcing port safety and security and marine environmental protection regulations within their respective areas.[35] Finally, each VTS center has a director who is responsible for the overall management and operations of that center. VTS directors maintain daily oversight of traffic management operations, administrative and budget issues, staffing, training, internal operating procedure (IOP) manuals, and maintenance (Coast Guard 2011a).

VTS directors primarily work with their local chain-of-command, but they also work with VTS program management as needed to ensure alignment with Coast Guard headquarters (Coast Guard 2011a). The VTS program is managed from Coast Guard headquarters, in Washington, D.C., by the Chief of the Office of Navigation Systems who is also designated as the competent authority for VTS in the United States. Headquarters management tasks include program-wide issues such as VTS system and regulatory requirements, staffing and training standards, sensors and equipment, and funding.

The Coast Guard VTS program has developed general standards and guidance in key areas involving personnel, operations, and equipment. The *Vessel Traffic Service National Standard Operating Procedures Manual (VTS NSOP)* also provides VTS directors with the flexibility to interpret how to implement these requirements, based on local conditions (Coast Guard 2011a). As a result, VTS program management and VTS directors reported that there are few best practices or minimum standards of effectiveness that are shared and consistently applied by all 12 VTS centers. The NTSB recognizes that VTS centers must have the flexibility to adapt their operations to local traffic and waterway conditions; however, VTS centers must also be able to consistently and reliably provide information, traffic organization, and navigational assistance services. During interviews, VTS directors and watchstanders identified the application of authority, communication with users, and watchstander training as common elements that should be standardized across the VTS system.

[35] Captain of the port delegation of authority is specified at 33 *CFR* 1.01-30. The captain of the port is an active duty member of the Coast Guard.

In its comprehensive 1994 report *Minding the Helm*, the National Research Council Committee on Advances in Navigation and Piloting concluded that in the face of regional and global economic competition and safety and environmental concerns, the loosely integrated management of US waterways systems needed to be tightened. Despite the significant differences between the marine and aviation operating environments, the committee identified aviation examples that could serve as long-term goals for port and waterway safety management. Examples included a system-wide operating concept; universal procedures, protocols, and operating language; pre-planned routes; vigorous training requirements; professional controller staff; and a near-miss reporting system (NRC 1994). The NTSB found that the Coast Guard has not yet achieved these goals, and similar safety management concerns remain.

### 3.1.2 VTS Authority to Direct Vessel Movements

The Coast Guard has a national regulatory framework, policies and instructions, and infrastructure to support the use of its VTS system. Today, the Coast Guard has primary federal responsibility for ensuring safety on the navigable waterways of the United States. The agency performs its navigation safety mission by enforcing federal laws and regulations intended to prevent damage to or loss of any vessel, bridge, or other related structures. The Coast Guard is authorized to control or limit the use of waterways and establish vessel restrictions or other navigation requirements. A VTS center is the means by which the Coast Guard actively interacts with traffic to improve the safety and efficiency of vessel movements in particularly confined or busy waterways.

Title 33 *CFR* Part 161, “Vessel Traffic Management,” requires that specific categories of commercial vessels participate in the Coast Guard VTS system. A VTS center may issue different types of measures and directions to enhance navigation safety within the boundaries of its VTS area. These measures are typically used to designate temporary vessel reporting points or operating requirements, establish specific routes to be followed, and enforce speed restrictions. During periods of traffic congestion, restricted visibility, adverse weather, or other hazardous conditions, more assertive measures are also authorized, such as specifying the time of entry, movement, or departure for vessels transiting (or attempting to transit) the VTS area (33 *CFR* 161.11). At any time, regardless of conditions, a VTS center may direct or otherwise control the movements of participant vessels to provide for the safety of ports, waterways, and the environment (33 *CFR* 160.5, 1.01-30). Despite the Coast Guard’s clear regulatory authority to direct vessel movements, nearly all of the watchstanders interviewed during this study indicated that they are prohibited from directing a vessel’s course or speed. All but one of the IOP manuals reinforced this inconsistent interpretation of Coast Guard VTS authority.

According to the *VTS NSOP*, it is Coast Guard policy that VTS directions are normally given in the form of a desired outcome (for example, slow down, proceed to anchorage, or do not proceed past a specific point) (Coast Guard 2011a). Pilots and other mariners must comply with all measures and directions issued by a Coast Guard VTS center, provided that they can do so safely, without endangering persons, property, or the environment (33 *CFR* 161.1, 161.12).[36]

[36] This is similar to the authority and responsibility of an aircraft pilot when interacting with air traffic control (ATC). According to 14 *CFR* 91.3, “The pilot in command of an aircraft is directly responsible for, and is the final

This interpretation of vessel control is also consistent with international guidelines, which recommend that final decisions concerning the actual maneuvering of a vessel should be left to the vessel's master (IALA 2012b; IMO 1997).

Based on its review of the Coast Guard's statutory and regulatory authorities, and watchfloor observations conducted at all of the Coast Guard's VTS centers, the NTSB believes the Coast Guard VTS system has the authority, infrastructure, and technology to direct the movements of specific commercial vessels operating inside VTS areas (33 *USC* Sections 1221-1236; 33 *CFR* 160, 161). Further, the NTSB believes that the Coast Guard is the appropriate authority to manage the operation of waterway navigation safety systems such as VTS.

### 3.1.3 *Monitor*, *Inform*, *Recommend*, and *Direct*

The Coast Guard's VTS watchstanders are trained to apply their authority by using four vessel traffic management activities (Coast Guard 2011a). These activities, from the least to the most assertive level of traffic management are *monitor*, *inform*, *recommend*, and *direct*. In practice, they can be implemented in any order (for example, a traffic watch may have to direct a vessel away from an immediate hazard without first attempting to *inform* or *recommend*). The *VTS NSOP* defines the four levels and provides the following guidance:

> ***Monitor***: the use of surveillance, communications equipment, and other resources to collect, organize, display, and analyze information.
>
> ***Inform***: the use of communication resources to disseminate information that vessel operators, shore-side facilities, and other organizations use to facilitate vessel traffic movements, safety, and security. It is essential that the information provided is timely, relevant, and accurate.
>
> ***Recommend***: the use of communication resources to highlight particular information or recommend particular actions to vessel operators, shore-side facilities, and other organizations. Recommendations usually are given to resolve miscommunications or otherwise call attention to particular circumstances, hazards, or conflicts when there is doubt that appropriate action is being taken.
>
> ***Direct***: the use of communication resources to direct a course of action when necessary. A VTS center may direct the movement of vessels to minimize the risk of collision or damage to property or the environment, and to promote compliance with navigation regulations. Other forms of directions include designating temporary reporting points or procedures, establishing traffic routes to be followed, enforcing exclusion areas or speed restrictions, or relaying an order from the Coast Guard's captain of the port. Directions to

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authority as to, the operation of that aircraft." Although pilots are required to comply with all ATC instructions, if an emergency exists, the pilot may operate the aircraft contrary to those instructions, even in an area where traffic control is exercised. After the emergency has been resolved, the pilot must notify ATC of the deviation as soon as possible (14 *CFR* 91.123).

> vessels are normally given in the form of a desired outcome. VTS center IOP manuals will provide detailed procedures for the employment of VTS directions.

These traffic management activities are intended to facilitate orderly and predictable vessel movements and balance waterway safety and efficiency.

NTSB accident investigations have identified situations in which Coast Guard VTS watchstanders recognized that a hazardous situation or condition existed but did not effectively intervene and direct the vessel (or vessels) involved. On November 7, 2007, the M/V *Cosco Busan* allided with the fendering system at the base of the Delta tower of the San Francisco-Oakland Bay Bridge. The accident occurred in restricted visibility conditions similar to the *Arizona Standard* and *Oregon Standard* collision in 1971. VTS San Francisco called the pilot aboard the *Cosco Busan* on the radio when it noticed that the vessel appeared to be deviating significantly from its intended route between the towers of the bridge. The VTS operator monitoring the traffic sector asked the pilot "what are your intentions," to which the pilot confirmed that he still intended to transit the bridge span (NTSB 2009). After this exchange, there was no further communication between the VTS center and the pilot until after the allision. The VTS center never informed the *Cosco Busan*'s pilot or master of the potential danger. During the NTSB's interviews at VTS San Francisco, the watch supervisor on duty at the time of the accident indicated that the watchstanders continued to monitor the *Cosco Busan*'s movements in the moments leading up to the allision (NTSB 2009).

The NTSB determined that the probable cause of the *Cosco Busan* allision was the pilot and master's "failure to safely navigate the vessel in restricted visibility" (NTSB 2009). A concurrent investigation by the Inspector General of the US Department of Homeland Security acknowledged that VTS San Francisco had the authority to keep the *Cosco Busan* at the pier for safety reasons, due to the restricted visibility conditions; however, the watchstanders did not have a procedure or clear guidelines for when or how to exercise that authority (DHS 2008). As a result of its investigation, the NTSB issued the following safety recommendation to the Coast Guard:

> Provide Coast Guard-wide guidance to vessel traffic service personnel that clearly defines expectations for the use of existing authority to direct or control vessel movement when such action is justified in the interest of safety. (M-09-3)

Although the NTSB classified Safety Recommendation M-09-3 "Closed—Acceptable Action" following the Coast Guard's development of its *VTS NSOP*, similar concerns about VTS authority have reemerged as a safety issue. Most recently, in March 2015, the NTSB investigated a collision between the bulk carrier *Conti Peridot* and the chemical tanker *Carla Maersk* in the Houston Ship Channel, where it learned that VTS Houston-Galveston had broadcast a fog advisory and even attempted to alert each individual vessel operating in its traffic sectors of the deteriorating visibility conditions in the hour leading up to the accident. VTS Houston-Galveston had specific procedures for directing vessels to discontinue their transit in restricted visibility whenever the watch supervisor believed conditions were unsafe (Coast Guard 2012a). Moreover, pilots had stopped boarding vessels due to the weather. Yet, in this and other accident investigations, the NTSB has found that Coast Guard VTS centers have not exercised their authority to direct vessels to discontinue transit during restricted visibility.

Instead, VTS centers have deferred to mariners to make such decisions (NTSB 2016a, 2015b, 2009).

The NTSB examined the IOP manuals for all of Coast Guard's VTS centers and discovered that traffic management authority and the use of *monitor*, *inform*, *recommend*, and *direct* are not being applied consistently across the VTS system. According to these manuals, the most assertive level of VTS traffic management (*direct*) typically involves some type of geographic or area-based measure or a vessel-specific direction to control the movement of one or more vessels. The decision to use such measures or directions is made on a case-by-case basis—depending on the hazard present—to minimize the risk of an accident or to promote compliance with navigation regulations. Yet, 38% of all operators indicated that they did not have the authority to control the movement of a vessel without first seeking a supervisor's approval. In contrast, at some Coast Guard VTS centers, the NTSB noted that the use of *direct* was a daily part of traffic management. In those locations, the VTS center had been established for the specific purpose of enforcing one-way traffic through challenging navigation areas or for imposing the order of vessels proceeding through a particular section of waterway.[37]

Variation in the use of *direct* (and the willingness to exercise such authority) was also noted from watch to watch inside the same VTS center. For example, during interviews, many of the watchstanders described their use of *monitor*, *inform*, *recommend*, and *direct* as an escalating checklist of involvement where each step justified the next. In their descriptions there appeared to be a strong bias against directing vessel movements. Most watchstanders stated that their role was largely advisory in nature and some of them indicated that it was important not to bother or interfere with the mariner's work aboard the vessel. A number of them stated that if they did not follow the order from the least (*monitor*) to the most assertive level (*direct*), that it might be perceived by a pilot or master as the Coast Guard challenging their authority or telling them how to operate their vessel. As part of this study, the NTSB provided an opportunity for waterway stakeholders to comment on their experiences with the Coast Guard VTS system. In response, the American Pilots' Association (APA) provided the NTSB with comments from its members indicating that Coast Guard VTS centers should "provide the necessary information to the mariner without being intrusive or distracting" (APA 2015). The APA also emphasized that on particularly busy waterways, the focus should be on "<u>providing smarter information to the mariner, not just more information</u>."[38]

The NTSB has observed during this study that the Coast Guard and mariners share the same perspective that VTS centers should be as non-intrusive as possible to pilots and vessel masters. In practice, however, the interpretation of what constitutes non-intrusive vessel traffic

[37] For example, the VTS Lower Mississippi River watchstanders use *direct*, as well as red/green traffic control lights, to regulate the movement of vessels and enforce one-way traffic through particularly difficult navigation areas whenever the Mississippi River reaches 8 feet on the Carrollton gage. VTS Berwick Bay uses *direct* to control the movements of thousands of vessel transits per month in the vicinity of the Morgan City railroad bridge. VTS Louisville uses *direct* nearly every day it operates, to enforce one-way traffic through the area between Towhead Island and Portland Canal. VTS Louisville only operates when the McAlpine upper gage of the Ohio River is 13 feet or higher.

[38] Emphasis is in the original letter submitted by the APA, which is available in the public docket for this safety study, DCA15SS001, at http://dms.ntsb.gov/pubdms/search/hitlist.cfm?docketID=58688&CFID=518337&CFTOKEN=77b74ed9a34a307e-F8BC0E93-9217-BE65-2E886F480FEF7C46.

management varies across the 12 VTS centers. After the *Cosco Busan* allision, in 2007, when the Coast Guard was asked why VTS San Francisco only made one attempt to communicate with the pilot in the time leading up to the accident, the Coast Guard pointed out that its watchstanders are trained “not to distract the pilot with interruptions during any critical maneuver” (CRS 2008).

The Coast Guard’s authority to direct or otherwise control the movement of vessels is being interpreted and applied differently by watchstanders within and across the 12 VTS centers. A brief introduction to the definition and use of *monitor, inform*, *recommend*, and *direct* is taught during the initial certification of watchstanders. More in-depth practice with how and when to apply these different levels of traffic management does not occur until trainee watchstanders go through the final qualification process at their respective VTS center. The NTSB concludes that there is widespread variation in the interpretation of Coast Guard VTS authority within the VTS centers and across the VTS system, which results in inconsistent application of that authority. The NTSB recommends that the Coast Guard revise and align 33 *CFR* Part 161, the *VTS NSOP*, VTS center IOP manuals, and training curricula, as necessary, to ensure that VTS authority is consistently applied across the Coast Guard VTS system.

## 3.2 Inadequate VTS Watchstander Training and Qualification

Watchstander training and qualification is conducted in multiple phases to establish the minimum knowledge, skills, and abilities required to work in a Coast Guard VTS center. The typical program includes attendance at the National VTS Certification Course, which is held at the Maritime Institute of Technology and Graduate Studies in Maryland, and completion of a final qualification process developed and administered locally by the trainee’s VTS center.

Since 2004, the Coast Guard has required all new trainees to complete the National VTS Certification Course. This requirement must be met within 1 year of their assignment or employment with a VTS center (Coast Guard 2011a). The course provides a general introduction to VTS regulations, navigation rules, and basic traffic management concepts. Most of the material is presented in a classroom environment with some additional exercises conducted using simulators.

The final qualification process for watchstanders varies across the 12 VTS centers. In general, they are expected to complete some combination of individualized one-on-one training, self-study, practical exercises, and ship rides, along with watchfloor on-the-job training (OJT). The majority of watchstanders finish the qualification process by passing a knowledge exam and a series of performance evaluations. The final qualification process takes about 1 to 6 months.

Maintaining an adequate number of qualified watchstanders has been a significant challenge across the Coast Guard’s VTS system. Active duty personnel make up 43% of all watchstanders, and each year up to one-third of them transfer in and out of the system (Coast Guard 2007). A number of VTS directors and training coordinators expressed concern that the high rate of turnover creates recurring shortages of qualified watchstanders and places a heavy workload on those watchstanders assigned to mentor new trainees.

### 3.2.1 VTS Simulator Training

During interviews, VTS watchstanders estimated that it took about 1 to 2 years after initial qualification before they were truly proficient at standing traffic watches. Among the reasons cited was the time it normally takes to be exposed to the broad range of traffic patterns and unsafe situations that can develop inside a VTS area. VTS simulators have been used to develop watchstander skills by exposing trainees to many different types of traffic scenarios in a compressed period of time. IALA also recommends the use of simulator training to develop the practical skills, knowledge, and level of competence necessary to be an effective watchstander rather than wait until they experience increasingly complex traffic situations in actual daily operations (IALA 2013, 2009a, 2009b). IALA's Guideline No. 1027 "Simulation in VTS Training at Training Institutes and VTS Centers" further recommends using simulation to complement other training methods and techniques for assessing watchstander competence and proficiency (IALA 2005).

The Coast Guard has begun to provide VTS simulator training to introduce watchstanders to some of the skills needed for the safe and effective handling of vessel traffic. The National VTS Certification Course offers blocks of instruction where trainees work scenarios in a simulated VTS center. The Maritime Institute of Technology and Graduate Studies offers an array of simulators capable of running complex traffic, environmental conditions, and other training scenarios. Some VTS centers have also started to develop in-house traffic simulation capabilities (using desktop computers), as well as relationships with local maritime training facilities to build and run traffic simulations for their watchstanders.

Most watchstanders stated that the National VTS Certification Course was adequate as an introduction to the Coast Guard VTS system, but they consistently identified the VTS simulator exercises as one of the weaknesses of the course. The most frequently cited problems were the lack of realism, inadequate use of radar and AIS data on the simulated VTS display, and not enough time at the simulated VTS operator position. When asked what changes would enhance the simulations, they stated that the simulation exercises should bring together the key concepts from the class lectures such as the navigation rules, the four levels of vessel traffic management, and radio communication. Most watchstanders stated that more time should be allotted for practicing how to apply these concepts, and some expressed concern that they were not able to practice at least one scenario that covered when and how to use *recommend* and *direct*.

The NTSB observed the National VTS Certification Course in August and September 2015. VTS simulations were conducted over 4 days in 3.5-hour blocks of instruction. The scenarios covered basic communication procedures, how to record vessel information into a track data card, and a few different applications of traffic management concepts. The simulated operator display did not replicate the most common display types used in the Coast Guard's VTS centers. Two trainees at a time participated in the VTS watchstander simulation. One trainee took the role of the VTS operator interacting with the simulated vessel traffic, and the other trainee assisted by monitoring and panning the cameras along the simulated waterway.[39]

[39] This division of labor was inconsistent with how traffic operators perform their job inside a Coast Guard VTS center. VTS centers have one operator working each traffic sector, and that operator is responsible for

Other class members operated the vessel simulators that made up the different traffic scenarios. A typical scenario ran for 20 to 30 minutes before the trainees changed positions. In total, each trainee spent about 10 hours operating the vessel simulators and 1.5 hours at the VTS operator position. In contrast, IALA recommends about 100 practice hours of VTS simulator exercises for operator trainees to achieve a basic level of competence (IALA 2009a, 2005).[40]

VTS simulation can be used in introductory and refresher training to provide targeted practice using the navigation rules and to improve the skills needed to apply these rules in a variety of traffic configurations (for example, high volume crossing areas) and environmental conditions (for example, restricted visibility). Realistic simulations provide opportunities to teach VTS watchstanders effective strategies for detecting, recognizing, and resolving unsafe traffic situations with no risk to mariners. Finally, the pace and complexity of simulator training scenarios can be adjusted to progressively develop watchstander competency and proficiency. The NTSB concludes that the Coast Guard is not using realistic and sufficient VTS simulation training exercises, which would improve competency and proficiency among all watchstanders across the VTS system. The NTSB recommends that the Coast Guard incorporate additional training that emphasizes realistic VTS simulation exercises, including detecting and responding to unsafe traffic situations, in its initial training and proficiency requirements for all VTS watchstanders in the Coast Guard VTS system.

### 3.2.2 On-the-Job Training

Most VTS watchstanders were satisfied with the qualification process at their VTS center, but many operators were frustrated with the OJT portion of the process. Operators repeatedly stated the following concerns about OJT during study interviews:

- inconsistencies in the teaching abilities and expectations of mentors,
- interpretations of traffic management concepts and approaches that varied across mentors and watch sections, and
- the use of recently qualified watchstanders as mentors.

According to the training manuals and materials reviewed for this study, mentor checks and approvals are the most common performance evaluation tool used during the OJT phase at most of the VTS centers. Due to the importance of these mentor checks, several operators stated that they often found themselves adapting their traffic watch practices to the personal preferences of each mentor rather than trying to meet a defined standard. The NTSB found that although the Coast Guard's VTS program provides a minimum set of topic areas, it does not have a common standard for administering OJT. Variations in the content and duration of operator OJT are

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monitoring and interacting with all of the information displays, communications systems, surveillance cameras, and other equipment at their work station.

[40] The Port of Rotterdam VTS has new trainee operators complete a 6-month national certification course followed by a 6-month OJT process at the trainee's assigned VTS center. During an interview with the NTSB, the Port of Rotterdam's senior VTS advisor estimated that VTS operator trainees spend more than 3 months practicing different traffic scenarios in a VTS simulator while attending the national course.

permitted because the process is designed and carried out locally by different training coordinators, and other designated individuals, at each VTS center (Coast Guard 2011a).

Coast Guard VTS centers do not require watchstanders to complete instructor training before serving as a mentor for OJT. Three of the 12 centers required newly qualified watchstanders to stand watch for a specified period of time to be eligible to mentor OJT. This minimum requirement varied from 2 months to 1 year. However, study interviews at some of these centers identified examples where the stated minimum was not always followed, and newly qualified watchstanders were being assigned as mentors to new trainees during OJT. Interviewees expressed concern that less experienced mentors could not provide adequate instruction for new trainees.

The NTSB concludes that the quality of OJT provided to trainees has been inconsistent because the Coast Guard does not require a minimum level of VTS operator work experience or instructor training as a prerequisite for all OJT mentors. The NTSB recommends that the Coast Guard require standard OJT mentor selection criteria, including appropriate VTS operator work experience levels and instructor training requirements, for all OJT mentors.

### 3.2.3 Watch Supervisor Qualification

Watch supervisors play a critical role in determining what constitutes a hazardous condition or developing unsafe situation inside a VTS area. At 6 of the 12 VTS centers, the operators must have their watch supervisor's approval to issue a VTS measure or direction. However, the NTSB found that at some VTS centers supervisors have limited or no experience working as an operator. Nearly a quarter (22%) of all watch supervisors and more than a third (38%) of active duty supervisors indicated that they had never worked as an operator.[41]

VTS training coordinators commented during interviews that there are no formal guidelines or standards for the initial training and certification of Coast Guard VTS watch supervisors. Although the Coast Guard has considered adding a watch supervisor certification course to its national VTS training program, it has not yet created or required one (Coast Guard 2011a). The NTSB reviewed IALA recommendations and training materials and spoke with VTS directors, policy advisors, and other experts in Canada and Europe to determine how VTS systems outside the United States selected and prepared new watch supervisors. IALA has recommended the use of an accredited training and certification process for new supervisors to ensure that they meet a common standard of competency (IALA 2013, 2009b). VTS experts at the Port of Rotterdam, Netherlands, and Victoria, Canada, indicated during interviews that specialized training for new watch supervisors is most effective when used to build upon the core knowledge and skills obtained by completing a VTS operator course, and that supervisors should be selected from qualified VTS operators.

Because watch supervisor guidance and approval are critical to the VTS operators' application of Coast Guard VTS authority to direct vessel traffic, similar qualification

[41] In total, five of the eight VTS centers that have active duty supervisors expected them to complete the certification and qualification requirements of an operator as part of their supervisor qualification.

requirements are warranted. The NTSB concludes that because the Coast Guard does not require all of its VTS watch supervisors to achieve a VTS operator qualification or meet a minimum operator work experience requirement prior to selection, the Coast Guard cannot ensure that all of its watch supervisors are proficient in operator knowledge and skills, including detecting and recognizing traffic conflicts and other unsafe situations. Therefore, the NTSB recommends that the Coast Guard require all VTS watch supervisors to achieve a VTS operator qualification and complete a minimum work experience requirement as an operator before serving as a supervisor.

## 3.3 VTS System Limitations

VTS watchstanders provided some examples in which they were able to identify unsafe situations and intervene to prevent an accident. One such positive example is described below. However, this study also identified several systemic issues that decrease the likelihood of proactive intervention and limit the potential of the VTS system.

### 3.3.1 Proactive Traffic Management

On January 1, 2016, a tug with two tank barges parted its lines sometime before dawn and went adrift into one of the busiest and most confined sections of the Sabine-Neches Channel. The crew aboard the tug was asleep at the time of the incident and unaware that they were drifting across the channel. About 5:30 a.m., the tug and its barges were detected inside the North Sector of VTS Port Arthur (Texas). While performing a waterway scan using a smaller chart scale (done every 20 minutes on watch), the VTS operator responsible for the North Sector noticed a minimized AIS symbol on his display screen that appeared to be out of place in the channel. He determined the name of the tug (from its AIS data) and attempted to contact the crew by VHF radio. When the tug's crew did not respond, the watch supervisor looked up the owner's information in the vessel database at VTS Port Arthur. The supervisor tracked down the owner (located in Louisiana) and requested the tug master's cell phone number, which he then used to make contact with the master on board the tug. Once aware of the situation, the master removed the tug and barges from danger.

The NTSB obtained the above narrative describing this near miss, along with similar examples of proactive traffic management, from activity data collected by VTS Port Arthur. When asked about strategies used to detect traffic anomalies, watchstanders at this VTS center stated that they used an explicit standard of effectiveness for all traffic management activities (*monitor*, *inform*, *recommend*, and *direct*).[42] These standards were also integrated into the operators' training and qualification process, and written down for reference inside the IOP manual at VTS Port Arthur. In addition, watch supervisors and operators had specific instructions to always "look for opportunities to add greater value to waterway safety" (Coast Guard 2012b). This proactive approach also included the more assertive levels of traffic

[42] For example, the VTS Port Arthur's guidance for effective monitoring states that "Operators are expected to be aware of all vessel traffic or large hazards on the waterways. Operators shall scale down the Geo display at least every 20-minutes and scan for un-acquired moving contacts in or near designated channels and fairways. All moving or potentially hazardous radar contacts will be acquired, tracked, and whenever possible, identified" (Coast Guard 2012b).

management (for example, *direct*). Some VTS center IOP manuals emphasize the importance of issuing a vessel directive when in the interest of safety. For example, the VTS Port Arthur IOP manual reminds its personnel that although the decision to direct or otherwise control a vessel's movement is largely based on judgment, there is a responsibility to impose controls when the situation requires immediate action to resolve a hazard and restore traffic safety (Coast Guard 2012b). This emphasis on the VTS center's responsibility to intervene was not clearly articulated in all of the VTS center IOP manuals.

### 3.3.2 VTS Intervention and Navigational Assistance

According to the Coast Guard, all of its VTS centers listed in 33 *CFR* 161 are organized and equipped to provide INS, TOS, and NAS (Coast Guard 2011a). (See section 1.2.2 of this report for a description of each service type.) TOS and NAS are the more proactive levels of service, intended to closely manage traffic and provide vessels with an added safeguard in the event that a mariner fails to detect or recognize a developing unsafe situation.

There are, however, inconsistencies in the delivery of these services that may be confusing to mariners that operate in multiple VTS areas. The NTSB, during its evaluation of the IOP manuals for each Coast Guard VTS center, noted that the only services provided on a continuous basis were INS and TOS. More than half (60%) of the VTS centers listed in 33 *CFR* 161 indicated in their operating procedures that they only provided NAS at the request of a vessel operator, thus implying that NAS may not be initiated by the VTS center when navigation safety issues or other types of hazardous conditions are detected. This interpretation is not consistent with the Coast Guard's *VTS NSOP*, which clearly states that NAS "is designed to assist the on-board navigational decision-making process and is provided at the request of a vessel, or when deemed necessary, by the VTS" (Coast Guard 2011a).

The majority of VTS operators (77%) that participated in this study stated that they had the best overall traffic picture within their VTS area. Several operators and supervisors pointed out that dangerous situations involving vessel traffic or waterway conditions often develop outside the immediate visual cues and references used on board a vessel by the pilot, master, or bridge team. Further, when asked to identify sources of error affecting safety in their VTS areas, about three-quarters of watchstanders (74%) cited the pilot's or master's failure to recognize a developing unsafe situation. Overall, watchstanders identified poor vessel-to-vessel communication and the failure of pilots or masters to recognize a developing unsafe traffic situation as the two most common types of error with the potential to cause an accident in VTS areas.

During interviews, many VTS operators described proactive traffic management as a continuous process that involved searching for early signs that a routine transit may be progressing into a dangerous waterway or navigation safety situation, anticipating problems, and providing timely information that mariners can use to avoid danger. Others emphasized that sharing information and awareness with mariners sufficiently provided for waterway safety, because mariners were competent professionals capable of operating their vessels in accordance with the navigation rules and regulations. These VTS operators often referred to themselves as "a buoy with a voice" and stressed that information—once acknowledged by the mariner—should not be repeated unless the mariner requests clarification or an update.

The practice of providing navigational assistance only when requested by a mariner is inconsistent with the Coast Guard VTS operators' recognition that they have the best strategic view of vessel traffic and the reported frequency of problems resulting from mariners failing to recognize the early signs of a developing unsafe situation. This practice also limits the effectiveness of the primary safety benefit of the Coast Guard VTS system, that is, the ability to proactively intervene and prevent accidents by warning vessels of unsafe situations. The Coast Guard's *VTS NSOP* provides clear guidance to its watchstanders that the VTS system has the authority and the responsibility to provide navigational assistance (including specific warnings to individual vessels) whenever an unsafe situation is detected and intervention is deemed necessary by a VTS center (Coast Guard 2011a). However, the conflicting guidance in several VTS center IOP manuals and conflicting statements from VTS watchstanders during study interviews indicate that not all VTS watchstanders share a common understanding of this responsibility. Therefore, the NTSB concludes that because the Coast Guard gives VTS watchstanders inconsistent guidance about their responsibility to provide navigational assistance whenever an unsafe situation is detected, watchstanders may be reluctant to provide this service. Therefore, the NTSB recommends that the Coast Guard modify its *VTS NSOP*, VTS center IOP manuals, and training curricula, as necessary, to ensure that VTS watchstanders share a common understanding of how to identify and respond to situations requiring navigational assistance.

During study interviews, some VTS watchstanders mentioned that they may be reluctant to proactively intervene when they are unsure whether they are observing a potential unsafe situation. This is particularly true of less experienced watchstanders who are less confident of their knowledge in contrast to the experienced mariners they are monitoring. Watchstanders stated that some pilots and other mariners do not like to communicate with VTS centers, and may seek to embarrass them or call attention to their misunderstanding on the radio if they incorrectly identify a potential unsafe situation or question a mariner. One of the interviewees offered the following observation regarding the reluctance of VTS watchstanders to intervene and direct a vessel in response to a potential unsafe situation:

> God, what if I direct? What if I do this, and then the – it's just the fear of it, just the true fear of what if I'm wrong? I don't think people are thinking I'm going to lose my job or I'm going to have to pay money or I'm going to get sued or I'm going to go to jail. I don't think people think -- or at least I don't think like that. But you're thinking, I don't want to be embarrassed. I don't want to make the wrong call…

Study interviews and NTSB accident investigations indicate that VTS watchstanders have reacted quickly and assertively to direct traffic away from potential hazards in response to accidents or pollution events. In such cases, the unsafe situation is clearly defined. In order to respond proactively to prevent accidents, watchstanders must be able to identify developing situations with similar speed and accuracy. This may be particularly difficult when hazards are ambiguous or not clearly defined, such as unsafe situations resulting from communication problems between mariners.

The navigation rules and regulations provide clear guidance on vessel navigation such as meeting, crossing, and overtaking; narrow channel operations; responsibilities between vessels;

and the conduct of vessels in restricted visibility to prevent conflicts and collisions (Coast Guard 2014a). Professional mariners are required to demonstrate proficiency in the navigation rules and regulations by passing a Merchant Mariner Credentialing Rules of the Road examination. Coast Guard personnel responsible for controlling the safe movement of a vessel as officer of the deck or as coxswain must demonstrate proficiency in these regulations by completing initial and recurrent Coast Guard Deck Watch Officer examinations (Coast Guard 2015a).

According to Coast Guard VTS program officials, VTS watchstanders must know the navigation rules and regulations to effectively monitor traffic, understand the obligations of the vessels involved, and confidently intervene when an unsafe situation is identified. However, most VTS watchstanders do not have experience as a mariner or Coast Guard deck watch officer, and are not required to demonstrate that level of proficiency in the navigation rules and regulations.[43] Therefore, VTS watchstanders may not be confident in their ability to identify vessel conflicts or potential collisions—such as which vessel has the right of way in various crossing situations—resulting from a mariner's misinterpretation or violation of navigation rules and regulations. Similarly, a VTS watchstander may misinterpret a vessel operation as unsafe and respond inappropriately thereby damaging their credibility with the VTS users. The NTSB concludes that some Coast Guard VTS watchstanders lack confidence applying the navigation rules and regulations when unsafe situations are detected because they do not have sufficient knowledge of or proficiency with the rules and regulations. Therefore, the NTSB recommends that the Coast Guard ensure that VTS watchstanders are trained in and demonstrate proficiency with the navigation rules and regulations by passing the Coast Guard Deck Watch Officer exam, the Merchant Mariner Credentialing Rules of the Road exam, or another appropriate knowledge test.

### 3.3.3 Vessel-to-Vessel Communications

The navigation rules and regulations guide mariner decision making and provide a framework for how vessels should meet, cross, or overtake in different navigational situations and waterway conditions (Coast Guard 2014a). In addition, the bridge-to-bridge radio frequency is used by mariners on commercial vessels to coordinate these vessel interactions in advance. Yet, when asked to identify the types of error with the greatest potential to lead to an accident inside a VTS area, 87% of VTS watchstanders cited vessel-to-vessel communication errors.

Watchstanders are required to monitor the bridge-to-bridge radio frequency at all Coast Guard VTS centers. By monitoring this radio frequency, watchstanders may be able to identify and help resolve miscommunications between vessels. During study visits, the NTSB observed that watchstanders typically have the bridge-to-bridge radio frequency continuously broadcasting from a speaker at their individual workstations. However, the majority of watchstanders use headphones to help concentrate their attention on the VTS frequency for their assigned traffic sector. The NTSB observed this practice across the Coast Guard VTS system.

[43] At the time of this study, the most common background for new active-duty watchstanders was Coast Guard Operations Specialist. Operations Specialists are primarily assigned to shore-based command centers or aboard large cutters, and they typically serve in watchstander positions. When serving aboard a vessel, they assist in the operation of tactical, navigation, and communication systems.

During interviews, a number of watchstanders reported being unable to fully attend to the bridge-to-bridge radio frequency, and many of them expressed concerns about missing vessel passing arrangements and other important navigation safety information.

In March 2014, during its investigation of the collision between the bulk carrier *Summer Wind* and the towing vessel *Miss Susan* in the Houston Ship Channel, the NTSB found that VTS operators were not effectively guarding the bridge-to-bridge radio frequency. The frequency was being broadcast on the watchfloor, but the VTS operators were wearing headphones and did not hear the communications between the mariners regarding the traffic conflict and developing risk of collision. The NTSB found that the VTS center did not effectively follow its stated procedure to guard the bridge-to-bridge radio frequency. The NTSB also found that, in the minutes leading up to the collision, the VTS center was not maintaining an effective watch, which diminished the watchstanders' ability to recognize a developing risk of collision and warn the vessel operators involved (NTSB 2015b).

During investigations of two additional accidents in March 2015, the NTSB found that the VTS watchstanders did not hear the passing arrangements made by the vessels on the bridge-to-bridge radio frequency (NTSB 2016a, 2016b). In both cases, the VTS center only became aware of the situation after being notified by mariners that a collision had occurred in the Houston Ship Channel. The NTSB concludes that the Coast Guard's current method of monitoring vessel communications on the bridge-to-bridge radio frequency is inadequate to identify unsafe situations in VTS areas, particularly during periods of low visibility or high traffic volume. The NTSB recommends that the Coast Guard conduct or sponsor research, with input from appropriate subject matter experts, to develop more effective procedures or methods for monitoring vessel communications on the bridge-to-bridge radio frequency to identify and address developing unsafe situations in VTS areas. The NTSB further recommends that once the research recommended in Safety Recommendation M-16-11 is completed, the Coast Guard should revise its *VTS NSOP*, VTS center IOP manuals, and training curricula, as necessary.

### 3.3.4 Pilots' Perceptions of VTS Watchstanders

Many of the pilots and other mariners that participated in this study indicated that they thought it would be an unsafe practice to take shore-based vessel maneuvering orders from a Coast Guard VTS center.[44] APA members stated that Coast Guard VTS centers should be largely advisory in nature and focused on providing timely, accurate, and relevant information to mariners. During study interviews, the Coast Guard captain of the port and VTS director at each of the 12 VTS centers stated similar opinions about the role of the VTS system. The APA expressed concern that watchstanders in these facilities do not have the necessary level of professional maritime training, credentials, or experience to take on such a role. The APA also

[44] Although pilots and other mariners in the United States indicated during this study that it would be unsafe practice to take shore-based vessel maneuvering orders from a Coast Guard VTS center, they did not express the same reservations about shore-based pilotage when conducted by a licensed pilot. Internationally, shore-based pilotage is a service provided by pilots on a limited basis and in specific navigation conditions. The practice can be found within some VTS areas in Europe. Examples include Rotterdam, Netherlands, and River Scheldt and London, United Kingdom.

reported that a number of pilot groups were concerned about the frequent turnover of active duty VTS watchstanders (APA 2015).

Study questionnaire responses support the perception by pilots and mariners that watchstanders lack maritime experience. The Coast Guard's VTS watchstanders do not typically have a professional mariner's license or maritime industry work experience. Of the 164 watchstanders that responded to the questionnaire, most (95%) indicated that they had never worked on a commercial vessel prior to being hired at their VTS center.[45] Pilot's perceptions of the effect of frequent turnover on active duty watchstander experience were also supported by the questionnaire responses, with the majority (93%) of active duty operators and supervisors reporting 5 years of work experience or less at a Coast Guard VTS center.

A Coast Guard VTS watchstander must be able to detect and analyze a developing unsafe traffic situation, decide on a desired outcome, and communicate an appropriate traffic advisory, measure, or vessel direction that is clear, unambiguous, and easily understood (Coast Guard 2011a). However, in order for these communications to be effective, mariners must also be communicating with the VTS center on the appropriate radio frequency. In January 2010, during its investigation of the collision between the tankship *Eagle Otome* and the cargo vessel *Gull Arrow* and *Dixie Vengeance* tow, along the Sabine-Neches Canal (Port Arthur, Texas), the NTSB found that the pilots aboard *Eagle Otome* did not alert the VTS center or other vessels in the area that the tankship had begun to sheer bank to bank along the canal (NTSB 2011). The VTS watchstander on duty at the time of the accident told the NTSB that he was unaware the tankship was having a problem until the master of the *Dixie Vengeance* called to report the accident (NTSB 2011).

In study questionnaire responses and during interviews, VTS watchstanders cited examples in which pilots did not respond when hailed on the VTS frequency but did respond when hailed on the bridge-to-bridge frequency. Many watchstanders interpreted these experiences as the VTS center being ignored, underutilized, or not fully accepted by pilots. In its comments to the NTSB, the APA stated that pilots are satisfied with the Coast Guard's VTS system, but at times "VTS provides too much information to vessels" that can be "redundant and frequently unnecessary" (APA 2015). However, the Coast Guard's ability to exchange critical waterway and navigation safety information is undermined when pilots or other mandatory VTS participants do not monitor the Coast Guard VTS radio frequencies.

One approach the Coast Guard has used to improve communication between the VTS center and pilots has been to use pilots as VTS watchstander advisors. Pilots currently serve as advisors inside one Coast Guard VTS center (Coast Guard 2015b). Although the pilots have no authority, they assist the VTS watch supervisors by providing information about piloted vessels operating inside the VTS area and serve as liaisons between the Coast Guard VTS center and the pilot managers and dispatchers, and the pilots working aboard vessels in the area. The

[45] There were three civilian respondents with previous experience as a pilot, and all of them were from VTS Lower Mississippi River, New Orleans, where the Coast Guard has advisor pilots working in the VTS center. Another two civilian respondents indicated that they were or had once been licensed as a master, and one active duty respondent and two civilian respondents had previous work experience as a deck watch officer or mate aboard a merchant (non-military) vessel.

NTSB received positive feedback about this arrangement from the local maritime community and the Coast Guard. The NTSB first recommended the use of pilot advisors to improve the effectiveness and reliability of a Coast Guard VTS center following its investigation of a collision involving the bulk carriers *Irene S. Lemos* and *Maritime Justice* in the Lower Mississippi River (NTSB 1980).[46]

The use of pilots or other professional mariners as advisors is not widespread across the Coast Guard VTS system. The NTSB concludes that cooperation between pilots and Coast Guard VTS watchstanders is often adversely affected by a negative perception of VTS expertise because most VTS watchstanders are not licensed mariners with work experience on commercial vessels. Therefore, the NTSB recommends that the Coast Guard work with the APA and the American Waterways Operators (AWO) to conduct or sponsor research to evaluate and determine the feasibility and benefits of professional mariner representation on the watchfloor at each of the Coast Guard VTS centers, and establish such representation at VTS centers, as appropriate, based on the findings of that research. The NTSB further recommends that the APA and the AWO work with the Coast Guard to conduct or sponsor research to evaluate and determine the feasibility and benefits of professional mariner representation on the watchfloor at each of the Coast Guard VTS centers, and establish such representation at VTS centers, as appropriate, based on the findings of that research.

### 3.3.5 VTS to Vessel Communications

VTS centers rely on radio communication to provide mariners with information, traffic organization, and navigational assistance services. The Coast Guard requires VTS watchstanders to use appropriate radio frequencies and protocols; to communicate in a clear, concise, and timely manner; and to use the English language at all times and under all conditions (Coast Guard 2013a, 2013b). Watchstanders are also required to include the vessel's identity during their communications, even when a local pilot or mariner is operating the vessel. During study interviews, watchstanders regularly cited communication problems with mariners as a concern, and study survey results identified communication problems between mariners (that is, vessel-to-vessel) as the most commonly reported source of unsafe situations. VTS watchstanders provided examples of communication problems with mariners who are non-native English speakers, local mariners who speak with a strong regional accent or dialect, and mariners who use unfamiliar jargon.

During the NTSB's investigation of the *Cosco Busan* allision in 2007, the master of the containership told investigators that he had experience with the VTS phrases from the IMO Standard Marine Communication Phrases (SMCP) because he had heard them used in other VTS locations. The NTSB noted that VTS San Francisco did not use this standardized language in its communications with the *Cosco Busan*, suggesting that the master—who was not a native English speaker—likely did not immediately recognize from VTS San Francisco's conversation

[46] Although NTSB Safety Recommendation M-80-16 was classified "Closed—Unacceptable Action" in 1984, currently, Louisiana river pilots from the Crescent River Port Pilots Association and the New Orleans Baton Rouge Steamship Pilot Association serve as advisors to the Coast Guard's watchstanders at VTS Lower Mississippi River.

with the pilot that the containership was getting dangerously close to the San Francisco-Oakland Bay Bridge (NTSB 2009).

IMO recommends that VTS watchstanders use the IMO SMCP when they encounter problems communicating with mariners to ensure that safety information is received and properly understood.[47] These phrases are typically preceded by one of eight key words, or message markers, to emphasize the content of the communication, including *information*, *warning*, *advice*, *instruction*, *question*, *answer*, *request*, and *intention* (IALA 2012b; Coast Guard 2011a; IMO 2002).[48] The Coast Guard's *VTS NSOP* states that watchstanders must use the IMO SMCP if they experience language difficulties communicating with mariners, and it states that all VTS centers should establish standard message markers and standard wording in their IOP manuals for use when providing navigational assistance in emergency situations, such as recommending or directing vessel movements. However, the Coast Guard's *VTS NSOP* does not require the routine use of the IMO SMCP or message markers (Coast Guard 2011a).

Although many of the VTS watchstanders provided examples of situations when they encountered language problems with mariners, in most of these cases they did not attempt to use the IMO SMCP to resolve the situation. The questionnaire showed that slightly less than half of all operators (48%) and supervisors (46%) reported that they use the IMO SMCP. The study also showed that about half of the VTS centers did not have explicit procedures that required watchstanders to use message markers when issuing directions to vessels or when providing other types of navigational assistance services. One of the 12 VTS centers specified the use of the IMO SMCP and message markers in its IOP manual.[49] Rather than using standardized communications, most watchstanders reported that they try to adopt the local mariners' communication style in an attempt to improve acceptance by VTS users. Several active duty watchstanders mentioned having difficulty adapting to the use of local jargon rather than standard Coast Guard phraseology.

Using message markers, in particular, is considered to be a best practice for ensuring that the purpose of each piece of information contained in a communication is quickly understood by the recipient (IALA 2012b; IMO 2002). In addition to not using message markers, several watchstanders reported that they were reluctant to use the words *recommend* or *direct* when attempting to communicate their concern to a mariner about a potentially unsafe situation. Instead, they described a practice of finding alternative ways of expressing their concern without using those words, such as repeatedly asking mariners to state their intentions, which is a query rather than a warning. The NTSB concludes that the Coast Guard is not enforcing its requirement that VTS watchstanders use standardized VTS phrases and message markers from the IMO

[47] Part A 1/6 of the IMO SMCP consists of more than 100 standard phrases specifically designed for VTS. These phrases are intended to facilitate communications between VTS and mariners; each phrase is typically introduced by one of the eight SMCP message markers. In addition, the IMO "Guidelines for Vessel Traffic Services" recommend that for any message directed to a vessel, VTS watchstanders should use an appropriate message marker, and that the IMO SMCP should be used where practicable (1997).

[48] For example, a communication using message markers would be "*warning*: visibility in the approach channel is less than half a mile; *instruction*: do not enter the fairway" (IALA 2012b).

[49] At this VTS, the message markers and the most commonly used phrases from the IMO SMCP were displayed on the wall of the watchfloor as a quick visual reference for watchstanders.

SMCP, which can lead to miscommunication with mariners during safety critical situations. The lack of standard communication phrasing by all VTS centers may also result in misunderstanding by mariners that operate in more than one VTS area. Therefore, the NTSB recommends that the Coast Guard revise its *VTS NSOP*, VTS center IOP manuals, training curricula, and VTS user manuals, as necessary, to ensure that VTS watchstanders use standard VTS communication phrasing and message markers from the IMO SMCP during radio communications with mariners when appropriate.

### 3.3.6 Tow Size and Configuration Data Accuracy

More than 90% of VTS operators cited sensors and equipment as the source of information they depend on most to identify unsafe or hazardous vessel traffic situations. When asked to identify the tools they used most often, 97% of operators, and 100% of supervisors, cited the AIS.[50] VTS operators use the AIS to monitor the movement of certain types of vessel traffic to promote safety inside VTS areas. Operator displays receive vessel movement data from the AIS, which helps reduce the need for certain radio communications between VTS centers and vessels. In addition, the system helps operators collect, process, and disseminate information to mariners about the overall traffic picture within the VTS area.

All vessels required to have AIS are also required to input and maintain accurate information in all AIS data fields.[51] However, the regulations do not specifically require towing vessels to include the dimensions and configuration of their tows when programming their onboard AIS. As a result, the AIS information displayed to the VTS center and other vessels may be limited to the dimensions of the towing vessel. It is not uncommon on some waterways for a single tow to measure 600 feet in length or more. Mariners operating vessels on the waterway have the benefit of being able to directly observe the size of a vessel's tow (provided visibility is not restricted). Whereas, the Coast Guard's traffic watches rely solely on the information provided by the sensors and equipment available at the VTS center. In these cases, it may not be possible for watchstanders to determine a vessel's size and tow configuration from AIS data, cameras, and other information provided by their traffic displays.

The NTSB has investigated collisions involving towing vessels that have encroached upon shipping channels, but neither of the vessel crews nor the Coast Guard VTS center detected that a hazard existed. Following the August 2011 collision between the tanker *Naticina* and the towing vessel *Alliance* at the intersection of the Texas City Channel and the Intracoastal Waterway, the NTSB determined that the probable cause of the accident "was the encroachment by the master of the *Alliance* and its two barges into the Texas City Channel and into the path of the *Naticina*" (NTSB 2012b). More recently, in March 2014, the NTSB investigated a collision between the bulk carrier *Summer Wind* and the *Miss Susan* tow in the Houston Ship Channel, where it concluded that "consistently entering the complete dimensions of tow configurations for

[50] When asked what additional equipment or technology they would like to have, the most common request from operators was for improved camera coverage and capabilities, such has higher resolution cameras and infrared or low-light capability. The operators reported using cameras to validate what they hear on the radio and see on their operator displays.

[51] See 33 *CFR* 164.46(d)(1)(iv).

individual transits into AIS would alleviate misinterpretation and possible confusion from inaccurate information, and thus enhance safety" (NTSB 2015b).

During interviews with stakeholders, local pilots cited similar concerns about the accuracy of AIS data. A number of pilots working on inland waterways indicated that if they are unsuccessful at getting tow configuration and dimension information from their AIS or from the towing vessels, they rely on the VTS center to provide the information. Although many of the VTS center IOP manuals had a procedure for obtaining tow size and tow configuration information, towing vessel operators are not required to provide information about the dimensions or configuration of their tows when establishing communication with a Coast Guard VTS center.

The AWO provided the NTSB with additional insight into this issue from the towing vessel operators' perspective. A towing operation can move barges to multiple destinations within the same VTS area in different quantities and using different towing configurations. As a result, the overall dimensions of a vessel and its tow may change with each transit. To ensure accuracy, a towing vessel operator would have to correctly enter or update the onboard AIS with the total dimensions of vessel and tow before every transit. Further, if a tow is reconfigured at any time during a transit, the new dimensions would have to be immediately updated in the AIS. Although onboard AIS hardware typically includes a data entry interface, the interface may not easily facilitate routine updates to AIS data fields during vessel operations.

Because tow size and configuration are typically not included in the AIS vessel dimension field, the AIS display does not provide a reliable representation of the true dimensions of the combined vessel and tow for other mariners and for the Coast Guard's VTS centers. Therefore, the NTSB concludes that the Coast Guard may be limited in its ability to detect the potential for collisions, allisions, and groundings in VTS areas when VTS watchstanders do not have accurate information regarding vessel size, tow size, and tow configuration for VTS users engaged in towing operations. Therefore, the NTSB recommends that the Coast Guard work with the Radio Technical Commission for Maritime Services (RTCM) and the AWO to modify regulations, procedures, and equipment standards, as necessary, to ensure that vessels engaged in towing operations broadcast accurate AIS information regarding tow size and tow configuration as well as vessel size. Further, the NTSB recommends that the RTCM and the AWO work with the Coast Guard to modify regulations, procedures, and equipment standards, as necessary, to ensure that vessels engaged in towing operations broadcast accurate AIS information regarding tow size and tow configuration as well as vessel size.

## 3.4 Insufficient Safety Risk Management of VTS Areas

IMO has established international standards for the safe management and operation of ships through the International Safety Management (ISM) Code.[52] The ISM Code establishes safety management objectives and requires ship owners and operators to maintain a safety management system. Effective safety risk management programs apply established system safety principles to support continuous improvement in safety performance. A typical safety risk management program includes formal procedures for identifying hazards, assessing risks, and creating risk controls. Once these controls are established, they are continuously monitored to evaluate their effectiveness and to search for new hazards (DOD 2012).

The Coast Guard has established policy, and associated procedures and responsibilities, for operational risk management (ORM) (Coast Guard 1999). The guidance states that its risk management program includes all Coast Guard missions and daily activities involving any military or civilian personnel. As illustrated in figure 11, the Coast Guard ORM model is a seven-step continuous process that includes detecting hazards, assessing risks, and implementing and monitoring risk controls to support effective, risk-based decision making.[53]

[52] In 1994 the International Convention for the Safety of Life at Sea (SOLAS) adopted the ISM Code as an international standard for the safe management and operation of ships and for pollution prevention. Since 2002, nearly all international shipping was required to comply with the ISM Code. SOLAS is an international maritime safety treaty that establishes minimum safety standards in construction, equipment, and operation for ships flagged by signatory States.

[53] For a more detailed overview of the Coast Guard's operational risk management and risk-based decision-making models, see *Operational Risk Management for Facility and Vessel Inspectors* (Coast Guard 2014b) and *Risk-Based Decision Making Guidelines* (Coast Guard 2016b).


**Figure 11.** Coast Guard Operational Risk Management Model (adapted from Coast Guard 2014b)

The Coast Guard ORM model identifies three levels of risk management (Coast Guard 1999):

- **Time-critical**: Personnel employ the time-critical process to consider risk when making decisions in a time-compressed situation. This level of risk management is used during the execution phase of training or operations and in crisis responses.

- **Deliberate**: Deliberate risk management applies the complete process and each step is typically documented. It primarily uses experience and brainstorming to identify hazards and develop controls.

- **Strategic**: Strategic risk management provides the most thorough hazard identification and risk assessment by researching and analyzing available data, testing formally, and tracking hazards associated with the system over the long term. Strategic applications study complex operations' or systems' hazards and associated risks, or those whose hazards are not well understood. Examples of strategic applications may include long-term, complex operational planning and introductions of new equipment, materials, or missions.

Of these three levels of risk management, VTS watchstanders must be trained to employ a time-critical risk assessment process while standing watch. Watchstanders are expected to continuously monitor the waterway, evaluate any developing hazards, and respond as needed to mitigate potential problems. In addition to this day-to-day reactive risk management by watchstanders, VTS centers may work with local waterway users and stakeholders as part of a proactive process, known as a Ports and Waterways Safety Assessment (PAWSA), to evaluate safety risks and possible mitigations for VTS areas.

### 3.4.1 Ports and Waterways Safety Assessment

PAWSA is a formal process for collecting expert inputs to identify risk factors in a particular port or waterway and evaluate potential risk mitigation measures (Coast Guard 2016a, 2001; Merrick and Harrald 2007). Upon request of a sponsor such as the captain of the port, the Coast Guard will convene a select group of local waterway users and stakeholders for a 2-day structured workshop. With the help of a PAWSA facilitator, the waterway users and stakeholders develop a Waterway Risk Model for the port or waterway of interest that includes the causes of waterway casualties and their effects. The model generates risk values from the participants' qualitative assessments in six variable categories of vessel, traffic, navigation, and waterway conditions, and the immediate and long-term consequences of waterway casualties. Users and stakeholders are included in the process to represent the various environmental, public safety, and economic interests in the port, and to encourage support for any resulting risk mitigation efforts (Coast Guard 2016a, 2001; Merrick and Harrald 2007).

The PAWSA process is an example of the deliberate level of risk assessment that relies on "experience and brainstorming to identify hazards and develop controls" (Coast Guard 1999). Although it includes elements of long-term hazard identification and risk assessment indicative of strategic risk assessment, the PAWSA process emphasizes waterway user and stakeholder input and relies on qualitative measures of risk rather than quantitative analyses of recorded data. According to published descriptions of the PAWSA process by the original developers, it was not possible to include objective quantitative measures in the PAWSA model because the Coast Guard did not have a data-collection process to support the researchers' suggested measured values rather than expert input (Coast Guard 2016a; Merrick and Harrald 2007).

The PAWSA process was established in response to congressional defunding of a major Coast Guard VTS development project (known as VTS 2000) in 1996 and criticism from Congress, waterway users, and stakeholders about a perceived lack of user input during the project. The emphasis on qualitative assessment rather than quantitative data analysis is consistent with the Coast Guard's assignment from Congress at the time to cooperate with the maritime community and local organizations. Specifically, the Coast Guard was directed to work with waterway users and local stakeholders to assess the need for safety improvements and identify candidate locations for inclusion in the Coast Guard's VTS system.[54] Thus, the PAWSA process was originally developed to assess the value of establishing a Coast Guard VTS center at a particular port or waterway, rather than a tool for continuous risk management of VTS areas.

Of the 51 PAWSAs conducted between 1999 and 2015, 14 (27%) involved ports or waterways that are currently associated with a VTS area, and 3 of the current VTS areas were the subject of more than 1 PAWSA.[55] As illustrated in figure 12, more than half (55%) of all PAWSAs conducted to date were performed during the first 3 years after PAWSA was developed, indicating that it was used to assess candidate waterways that might benefit from a VTS center after the VTS 2000 project was cancelled, but it has not been used effectively as a continuous risk management tool for VTS areas.

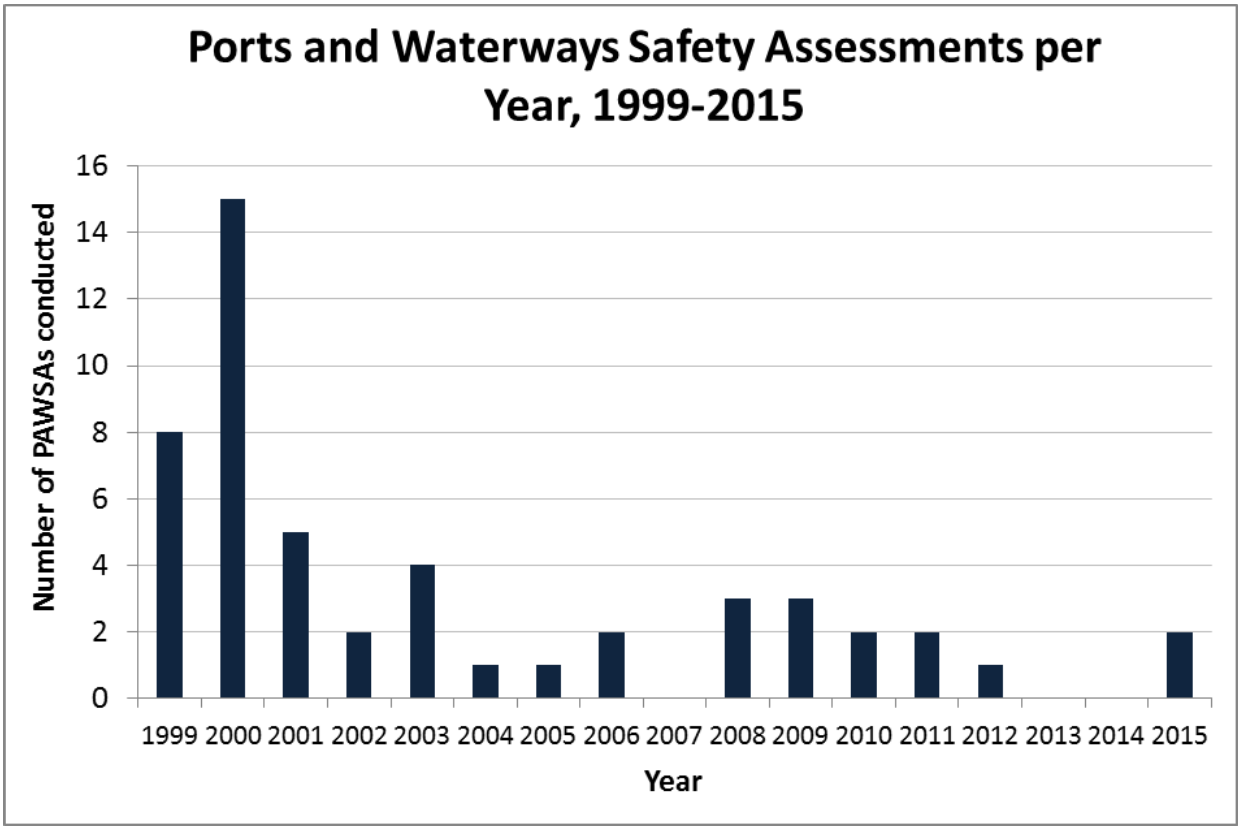


**Figure 12.** Number of Ports and Waterways Safety Assessments conducted in US waterways per calendar year

[54] In September 1996, Congress terminated all VTS 2000 contracts and, through the 1997 Appropriations Act, directed the Coast Guard to analyze future VTS system requirements that minimize complexity and are based upon an open system architecture maximizing use of off-the-shelf technology, to be conducted in cooperation with the maritime community and local organizations affected by the implementation of such systems. See the Department of Transportation and Related Agencies Appropriations Act, 1997, Public Law 104-205, 110, Statute 2951, 2954 (1996).

[55] A PAWSA was conducted for Port Arthur in September 1999, but VTS Port Arthur began operations in 2005.

### 3.4.2 Continuous Risk Management

Effective risk management is a continuous process. The previous graphic depiction of the Coast Guard ORM model (see figure 11) illustrates an iterative process that includes the continuous search for new or unexpected hazards. Whenever new risk controls are established, they must also be continuously monitored to evaluate their effectiveness and to search for new hazards.

Accident investigations are one method for identifying hazards. By investigating the circumstances of these events, VTS centers can identify any safety lapses and establish new policies, technology, or procedural controls to prevent their recurrence. VTS centers can also identify potential safety deficiencies by monitoring their operations for undesired or unexpected circumstances and events that could have resulted in damage or injury but did not. By recording and investigating safety concerns and narrowly avoided accidents, or close calls, VTS centers and their stakeholders could gain insight into hazards and changing risks in their VTS areas before they result in accidents.

The Coast Guard has established the PAWSA process to solicit local stakeholder input and expertise when conducting risk assessments of ports and waterways in the United States. However, the scheduling and locations of PAWSAs conducted since 1999 indicates that the PAWSA process is not being used for continuous risk assessment. Therefore, the NTSB concludes that the Coast Guard is not using its PAWSA process to conduct continuous risk assessments and mitigate adverse safety trends within Coast Guard VTS areas. The NTSB recommends that the Coast Guard develop a continuous risk assessment program to evaluate and mitigate safety risks for each VTS area in the Coast Guard VTS system that includes input from port and waterway stakeholders. The NTSB further recommends that the Coast Guard develop a program for conducting periodic risk assessments of the entire Coast Guard VTS system that includes input from port and waterway stakeholders to evaluate and mitigate system-wide safety risks.

### 3.4.3 Coast Guard Incident Reporting and Monitoring Systems for VTS Areas

The Coast Guard's *VTS NSOP* requires each VTS center to record and maintain statistics detailing its operations (Coast Guard 2011a).[56] VTS monthly activity report statistics are to be used to evaluate local and program-wide resource allocation and policy effectiveness in addition to supporting local waterway risk assessment processes. The Coast Guard VTS program has determined that the following categories of statistics, calculated monthly, provide the data necessary to support the program:

[56] Each VTS is required to record and maintain statistics detailing its operations to evaluate local and program-wide resource allocation and policy effectiveness in addition to supporting local waterway risk assessment processes.

1. Intra- and inter-port transit movements of all participating VTS users, by category of vessel.

2. Transits that required special handling by the VTS center, which may include vessels carrying certain dangerous cargo (as listed in 33 *CFR* 160.203), vessels that require *safety zones*, or other transits of a non-routine nature or handled differently by the VTS center.

3. The number of incidents that occurred during the month in the categories of *allision, collision, grounding, pollution, near miss, vessel casualties, anchorages,* or any other event which is considered notable by the VTS watch supervisor.

4. The number of times that the VTS center intervened or acted to ensure safety in the waterway, including when the waterway or portion of the waterway is closed/restricted, and when the VTS center intervenes with a particular vessel or vessels to address a particular waterway or navigation safety issue.

5. Other support activities, such as gathering information for other Coast Guard mission areas or other federal, state and local organizations.

6. Customer outreach hours spent supporting activities with the VTS user community with regard to VTS operations and interaction with mariners.

7. A narrative description of any concerns and/or comments regarding the VTS center's equipment suite.

8. Any additional information the VTS director deems necessary to amplify information provided above (such as recommendations or vessel directions related to an incident) or to explain any special VTS activities that may have affected or are outside the scope of the monthly statistics.

After reviewing all available VTS monthly activity reports from each VTS center for the years 2010 through 2014, the NTSB found that the inconsistent collection of data on waterway controls, VTS interventions, and vessel near misses could not support the stated goals of evaluating resource allocation, policy effectiveness, and risk assessment processes.

Even among the VTS directors that are still meeting the VTS monthly activity report data collection requirement, there is confusion and disagreement about the definitions of some data categories, such as what constitutes a near-miss incident. Many other industries have successfully implemented safety data analysis programs to manage risk in their operations, and have either addressed or not experienced similar concerns.

A wide range of domains including healthcare, the chemical process industry, firefighting, offshore oil drilling, aviation, and railroads have implemented near-miss reporting programs. All of these programs share similar understanding of the meaning of a near miss or a close call. For example, the railroad *Confidential Close Call Reporting System* managed by the National Aeronautics and Space Administration and the Federal Railroad Administration defines a close call as a condition or event that did not result in an accident but had the potential for more serious safety consequences (NASA 2016). The Occupational Safety and Health Administration defines a near miss as an event in which a worker might have been hurt if the circumstances had been slightly different, and the National Safety Council defines a near miss as an unplanned event that did not result in injury, illness, or damage—but had the potential to do so and only a fortunate break in the chain of events prevented an injury, fatality or damage (OSHA 2016; NSC 2016).

When queried about the VTS monthly activity reports, several VTS directors indicated that there is little emphasis placed on the collection, quality control, or analysis of these transit and incident data within their VTS area. The consensus opinion among these directors was that the data were not being used at Coast Guard headquarters.

Several of the VTS directors and senior program personnel reported that the Coast Guard VTS program stopped requesting these data on a monthly basis about 2002 in favor of annual reporting, and eventually stopped completely. Today, VTS directors are not required to provide regular reports to the VTS program, but they are expected to be able to provide data when requested. As a result, the data are no longer being collected or analyzed in a standardized manner.

In its 1994 report, *Minding the Helm*, the National Research Council Committee on Advances in Navigation and Piloting provided the following observation about the value of data-driven continuing risk assessment for improving the safety of port operations:

> Information is of no practical value unless it is effectively used. A continuing risk assessment program could be established at the national level. The program would draw on information from near-miss reporting; national and worldwide exposure databases; and relevant quantitative risk assessment studies, including those based on modeling performed as part of permit applications and other activities requiring risk assessment and other appropriate safety information. The purpose would be to provide near-term capability to detect trends in shipping that affect marine, public, and environmental safety and U.S. economic interests. The program also would provide essential data for planning improvements to the marine traffic safety system, setting priorities for regulatory initiatives, and determining benefit–cost relationships for possible regulatory requirements and government programs (NRC 1994).

Despite past recommendations for the Coast Guard to establish a continuing risk assessment program, and the *VTS NSOP* requirement to collect the data necessary to support quantitative risk assessment studies, those data are not being consistently recorded for all 12 VTS centers or utilized by the Coast Guard VTS program in general (NRC 1994; Coast Guard 2011a). Consequently, these data are not being used to perform systematic risk assessments inside VTS areas, nor are they being used to conduct comparative analyses and system-wide evaluations across VTS areas. It is also difficult, and in some cases impossible, to make statistically valid assessments of how well the Coast Guard's VTS centers are achieving their goal of reducing collisions, allisions, and groundings within VTS areas. The NTSB concludes that the Coast Guard's collection and quality control of VTS area activity and incident data do not support effective quantitative assessments of risk and safety performance within its

VTS areas. Therefore, the NTSB recommends that the Coast Guard develop or revise, as necessary, its definitions of the activity and incident data collected by VTS centers as necessary to ensure standardized and routine reporting across the entire Coast Guard VTS system. The NTSB further recommends that the Coast Guard establish a program to periodically analyze the activity and incident data collected by VTS centers to assess the safety performance of each VTS center and the entire Coast Guard VTS system.

### 3.4.4 Geographic Analyses of Operational and Incident Data

Watchstanders at the Coast Guard's 12 VTS centers were able to identify locations of potential high risk in their waterway based on anecdotal accounts of vessel traffic patterns and past incidents. However, the NTSB found that neither the individual VTS centers nor the VTS program at Coast Guard headquarters were routinely collecting or analyzing geographic information, and none of the VTS monthly activity reports included sufficient position data to support geographic analyses of near misses, or other incidents requiring VTS intervention. Due to the lack of position information in the VTS monthly activity report data, the NTSB used the coordinate data in the supplemental MISLE dataset provided by the Coast Guard to conduct geographic analyses of recent collisions, allisions, and groundings involving VTS users while operating within a Coast Guard VTS area. The Coast Guard VTS centers could use such analyses to identify high risk areas where risk reduction measures should be implemented.

The NTSB has recently studied the use of data-driven approaches to identifying areas of higher risk along gas transmission pipelines in the United States (NTSB 2015a). Since 2004, pipeline operators have been required to implement management systems consisting of policies, processes, and procedures designed to monitor and ensure the integrity of pipeline segments located within high consequence areas (HCA) (NTSB 2015a; PHMSA 2011). Identifying HCAs for gas transmission pipelines typically involves defining the area along a pipeline that would be impacted if a pipeline ruptured and the gas ignited. Once defined, these areas are assessed for potential impact on population, structures intended for human occupancy, and public use facilities or areas, such as, schools, hospitals, or parks (NTSB 2015a).

Similar information about the population, infrastructure, and the location of residential and public use areas could be used with information collected from VTS centers to assess and manage risk in VTS areas. Yet, the Coast Guard's VTS centers are not routinely using geographic information to identify potential HCAs or assess high risk areas identified by VTS watchstanders and local mariners. Examples from two VTS areas, Houston-Galveston and Lower Mississippi River, are provided below to illustrate the locations of recent incidents along these waterways and provide example geographic analyses that could be used to enhance VTS area risk assessments.[57]

[57] Geographic analyses for all 12 VTS areas are available in the public docket for this safety study, DCA15SS001, at http://dms.ntsb.gov/pubdms/search/hitlist.cfm?docketID=58688&CFID=518337&CFTOKEN=77b74ed9a34a307e-F8BC0E93-9217-BE65-2E886F480FEF7C46.

Figure 13 shows the reported locations of the collision, allision, and grounding incidents involving VTS users in the Houston-Galveston VTS area as identified in the supplement MISLE dataset for the years 2010 through 2014. The VTS area is represented by the darker blue area and the locations of reported events are represented by the red markers.

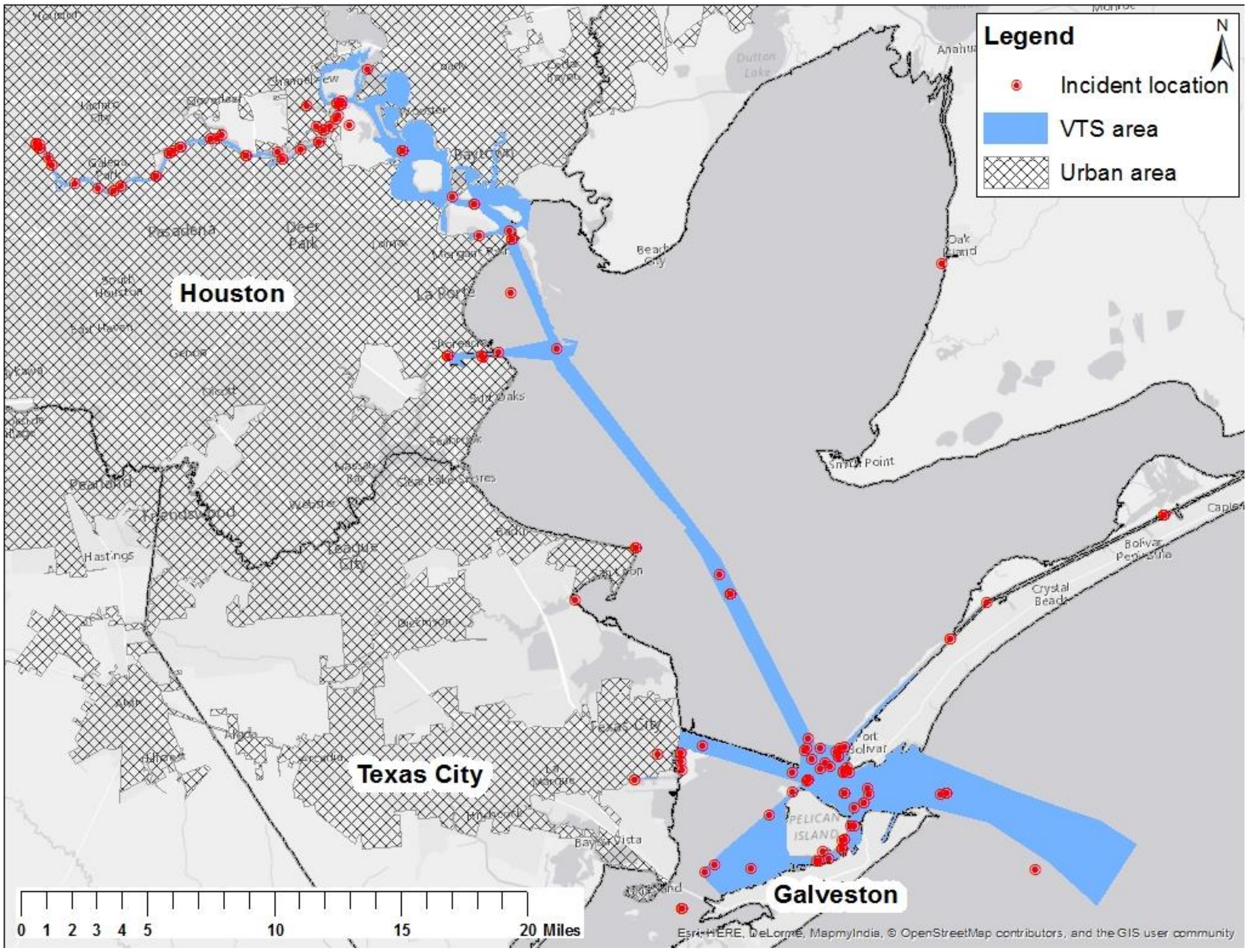


**Figure 13.** Geographic representation of MISLE collision, allision, and grounding incidents 2010-2014 involving VTS users in the Houston-Galveston VTS area in Texas

Incidents can be further analyzed in context with population data, infrastructure, waterway characteristics, AIS data, and vessel traffic information recorded by VTS centers. Such analyses can identify locations that may require additional risk reduction efforts. For example, figure 14 includes the same supplemental MISLE incident data in figure 13, with additional information about population and incident density. Areas with higher population density and historically large numbers of incidents may be considered areas of high risk to be evaluated for possible risk reduction efforts.

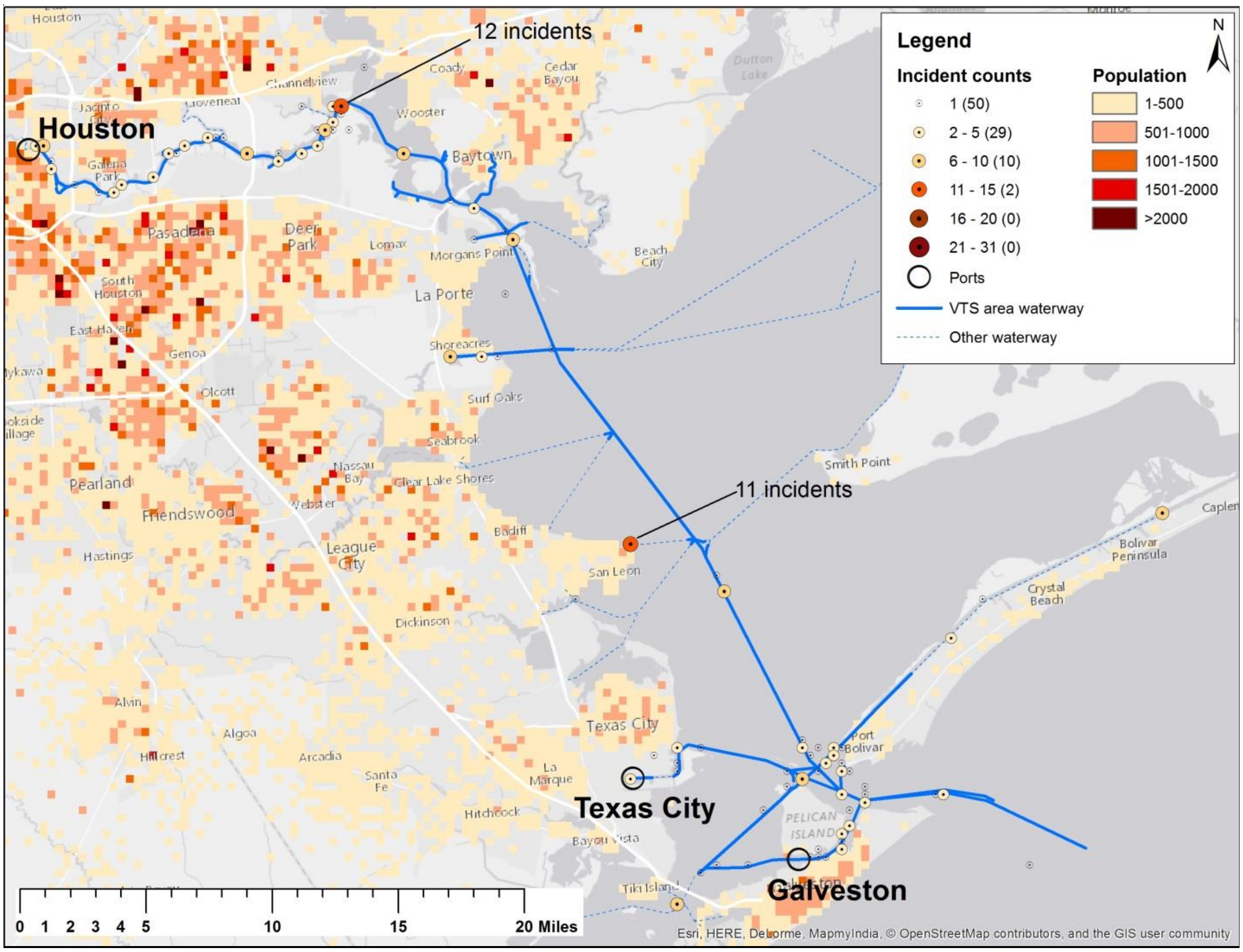


**Figure 14.** MISLE collision, allision, and grounding incidents 2010-2014 involving VTS users in the Houston-Galveston VTS area with additional population density and incident hotspot information

Figure 15 includes a similar geographic representation of the MISLE reported collision, allision, and grounding incidents in the Lower Mississippi River VTS area from 2010 through 2014.

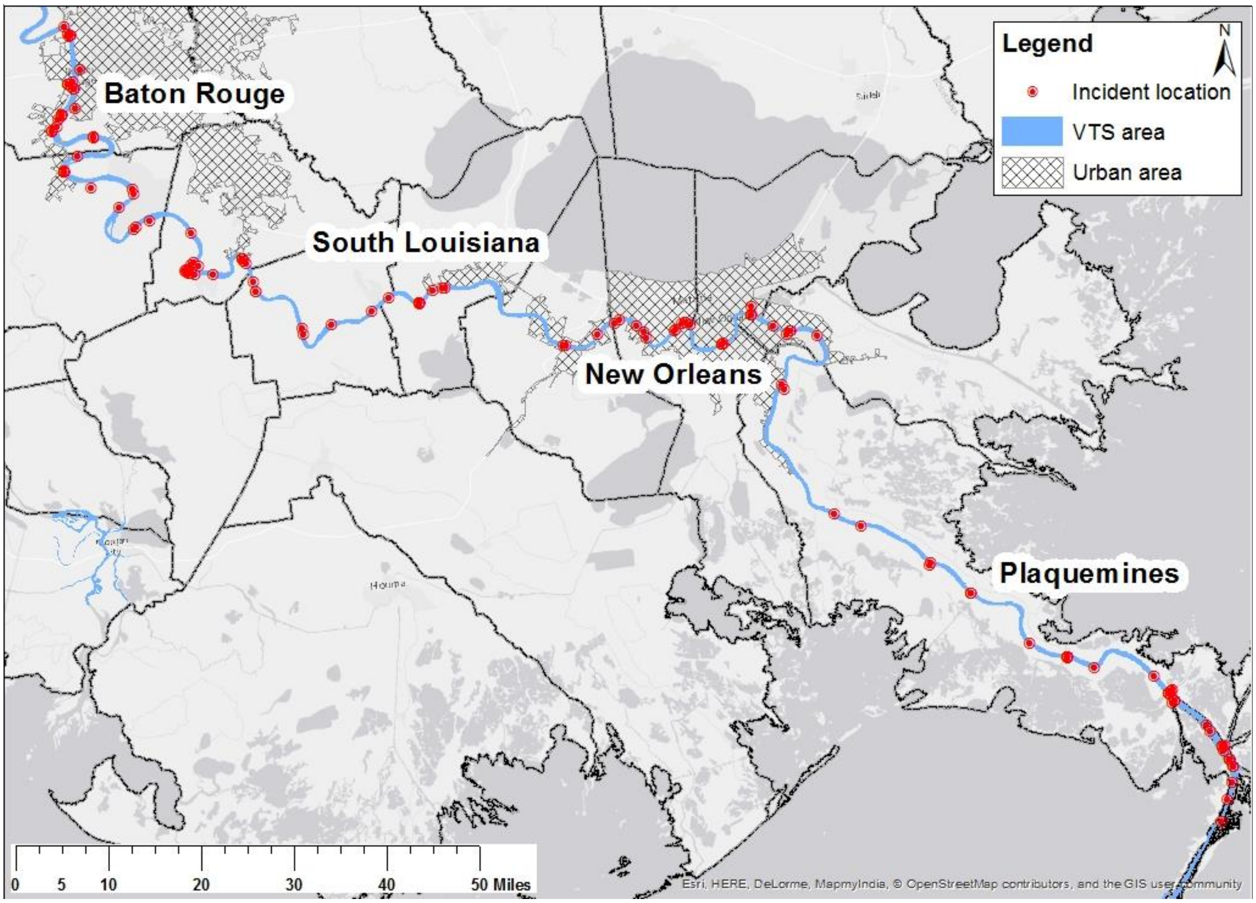


**Figure 15.** Geographic representation of MISLE collision, allision, and grounding incidents 2010-2014 involving VTS users in the Lower Mississippi River VTS area in Louisiana

When incident data are combined with population density, several areas of high risk are evident. As illustrated in figure 16, there are numerous areas of high population density that have experienced multiple collision, allision, and grounding incidents from 2010 through 2014.

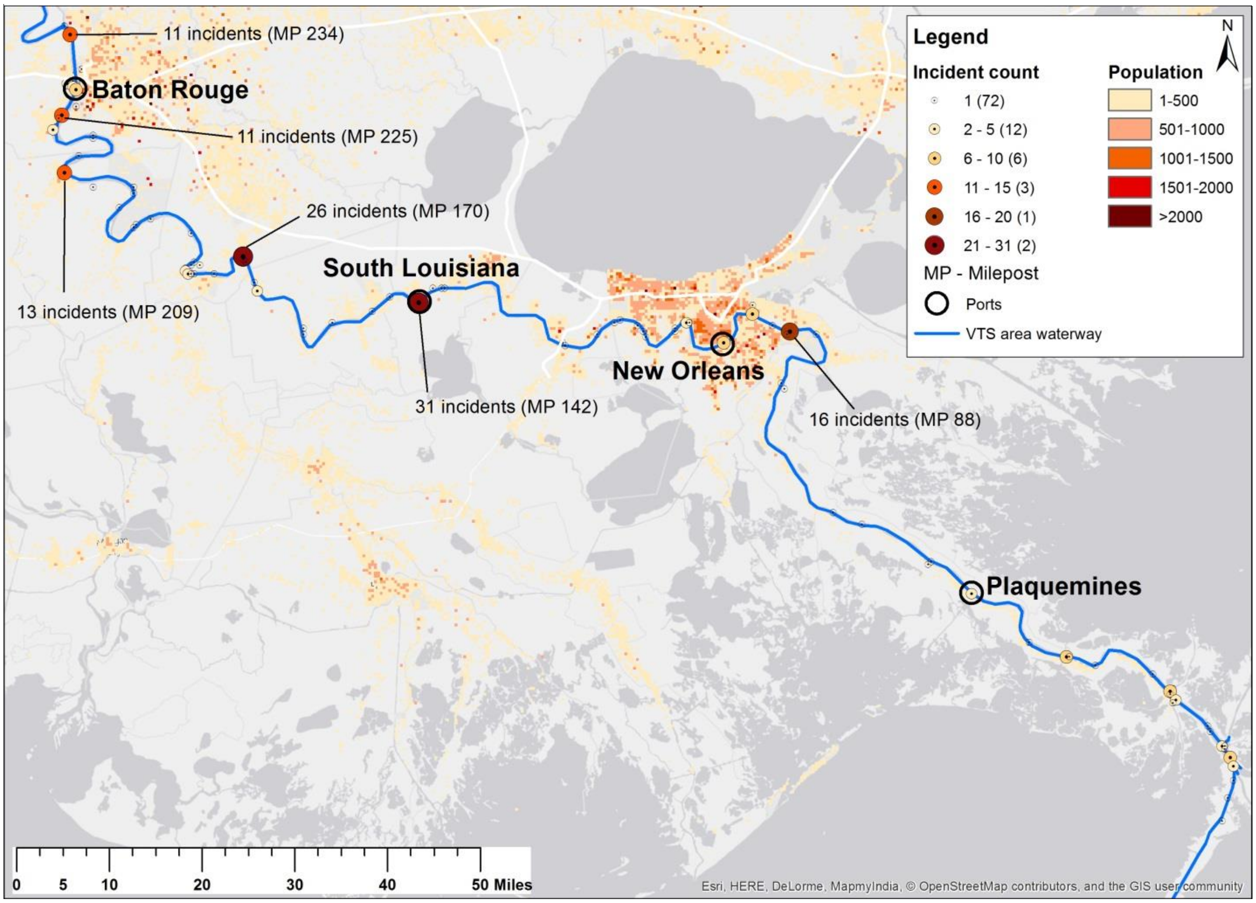


**Figure 16.** MISLE collision, allision, and grounding incidents 2010-2014 involving VTS users in the Lower Mississippi VTS area with additional population density and incident hotspot information

These examples illustrate the value of geographic analyses for identifying areas of high risk. Further, by routinely collecting and periodically monitoring these data, it is possible to identify changes in the prevalence and location of hazardous events, developing trends, and areas for potential risk mitigation. The NTSB concludes that the Coast Guard’s VTS monthly activity report incident data do not include geographic position information, which prevents the Coast Guard VTS program from using geographic analyses to identify and mitigate locations of high risk in VTS areas. Therefore, the NTSB recommends that the Coast Guard revise the VTS monthly activity report requirements to include geographic coordinates for all incident-related data collected by the Coast Guard VTS system.

### 3.4.5 VTS *Special Areas*

On October 29, 2011, the *Elka Apollon*, a Greek-flag tankship, collided with *MSC Nederland*, a Panamanian-flag containership south of the intersection of the Houston and Bayport Ship Channels in the Houston-Galveston VTS area (NTSB 2012a). Based on its investigation of that accident, and the *Naticina* and *Alliance* collision in a different location within the Houston-Galveston VTS area 3 months earlier, the NTSB identified a need for the Coast Guard to improve its ability to mitigate unsafe traffic situations in the Houston Ship Channel (NTSB 2012a, 2012b). The NTSB found that following the *Elka Apollon* accident, VTS Houston-Galveston was able to enhance the safety of the waterway by stopping vessel traffic in the channel until it was clear for safe passage. However, the VTS center did not proactively intervene to prevent the collision. In its report on the *Elka Apollon* accident, the NTSB recommended that the Coast Guard—

> Develop and implement a policy to ensure adequate separation between vessels operating in the Bayport Channel and Bolivar Roads Precautionary Areas and any other similarly configured precautionary areas in the Houston Ship Channel. (M-12-6) [58]

An informal Coast Guard review of the *Elka Apollon* accident proposed a similar strategy by suggesting that the VTS center "become more proactive" in managing vessel traffic (NTSB 2012a). Although the high traffic volume, areas of converging traffic, and width and depth limits of the Houston Ship Channel represent unique hazards, the safety concerns are not unique to that waterway.

The typical means by which VTS centers manage vessel traffic movements is by providing information through radio communications. VTS operators broadcast traffic and navigational information, and transiting vessels in turn make position reports. Despite the available array of AIS data, radar, and cameras, several VTS operators and supervisors interviewed for this study reported a reluctance to direct vessel traffic when they have observed potentially unsafe situations.

As discussed in section 3.1.3 of this report, many watchstanders perceived that *monitor*, *inform*, *recommend*, and *direct* must be applied in an escalating progression of involvement. This reactive application of the Coast Guard's authority can limit the potential effectiveness of the VTS system. Using this approach, by the time an operator is certain of the need to direct a vessel's movements, nearly all opportunities for preventing an accident may have been exhausted due to the maneuvering limitations of large vessels. The Coast Guard, and its VTS system in particular, has multiple tools available to proactively manage vessel traffic, which do not rely solely on VTS watchstander interventions. In addition to managing vessel traffic via radio communications, the Coast Guard and its VTS centers can establish specific operating requirements for areas of a waterway in response to temporary or long-term hazardous

[58] Safety Recommendation M-12-6 is currently classified "Open—Unacceptable Response."

conditions.[59] An example of a traffic management tool is a traffic separation scheme, in which vessel traffic separation is managed through a routing measure similar to traffic lanes. Several stakeholder comments to this study mentioned that a VTS system is particularly effective when established in conjunction with routing measures to organize the flow of vessel traffic.

Another routing measure is the *precautionary area* where ships must navigate with particular caution and within which the direction of traffic flow may be recommended.[60] There are currently 14 separate *precautionary areas* specified in regulation for the Houston-Galveston VTS area, including the areas in which the August 2011 and October 2011 accidents occurred (33 *CFR* 161.35). A large stakeholder company that operates in the Houston-Galveston VTS area provided comments to this study in which it referred to the NTSB's Safety Recommendation M-12-6 from the *Elka Apollon* accident. The operator stated that it supported the NTSB's recommendation to establish additional policy to ensure adequate vessel separation in the *precautionary areas* of the Houston-Galveston VTS area, but noted that it may require additional regulatory action by the Coast Guard to create a VTS *special area* and additional resources to ensure compliance.[61]

A VTS *special area* is a regulatory option used to specify additional vessel operating requirements or restrictions within a defined section of a larger VTS area. The dimensions and additional operating requirements can be tailored to address the unique hazards and demands of the particular location.[62] Unlike a *precautionary area*, these special operating requirements are specific and mandatory rather than a general precaution. Some examples of special operating requirements include bridge-related restrictions enforced by VTS Berwick Bay, entry requirements for the Valdez Narrows in Prince William Sound, and one-way vessel traffic restrictions (controlled via a traffic light) on the Lower Mississippi River during periods of high water.

During study interviews, watchstanders throughout the VTS system were able to readily identify locations they considered to be high risk inside their VTS area, due to unique vessel traffic or waterway characteristics. Currently, there are only four VTS centers using VTS *special areas* to address high risk locations.[63] Watchstanders at these centers reported that the additional operating requirements of a VTS *special area* provided clear and unambiguous procedures for

[59] Examples of other regulatory areas include *security zones* established to prevent damage or injury to any vessel or waterfront facility; to safeguard ports, harbors, or waters; or to secure the obligations of the United States; *safety zones* to limit access for safety or environmental protection purposes, typically in response to a temporary hazard such as an accident; and *regulated navigation areas* are areas that require a higher standard of vessel control than that provided by the navigation rules to preserve the safety of the adjacent waterfront structures, ensure safe transit of vessels, and/or protect the marine environment. For example, the two cooperative VTS locations at Los Angeles-Long Beach and Tampa Bay are established through regulated navigation areas.

[60] A *precautionary area* is a routing measure established in regulation at 33 *CFR* 167.10.

[61] The comments provided by this local stakeholder, and by stakeholders that operate inside other Coast Guard VTS areas, are available in the public docket for this safety study, DCA15SS001, at http://dms.ntsb.gov/pubdms/search/hitlist.cfm?docketID=58688&CFID=518337&CFTOKEN=77b74ed9a34a307e-F8BC0E93-9217-BE65-2E886F480FEF7C46.

[62] VTS *special areas* are established in regulation at 33 *CFR* 161.13.

[63] The four VTS centers are VTS Berwick Bay, VTS Lower Mississippi River, VTS Prince William Sound, and VTS Puget Sound. See 33 *CFR* 161.40, 33 *CFR* 161.55, 33 *CFR* 161.60, and 33 *CFR* 161.65.

managing vessel traffic in areas of increased risk. However, watchstanders at centers that did not have additional traffic management tools, such as routing measures or VTS *special areas*, reported that they must manage locations of increased risk through heightened monitoring and vigilance. This approach places the responsibility on VTS watchstanders to promptly identify unsafe situations and issue directions to resolve them.

When VTS watchstanders direct a course of action as a last resort in response to an unsafe situation, there may not be sufficient time or space for large vessels to make course or speed changes to avoid an accident. Further, the NTSB found that VTS watchstanders are generally reluctant to direct vessel movements, and pilots and other mariners strongly prefer that watchstanders do not issue course or speed commands. The current focus on whether watchstanders should communicate directions to resolve an unsafe situation reflects a reactive rather than a proactive approach to vessel traffic management. In contrast, a continuous risk management program based on measured data would identify high-risk locations within VTS areas that could be addressed through systematic means that reduce the demand on individual VTS watchstanders. Regulatory options such as predefined routing measures and VTS *special areas* provide clear guidance that allows operators and waterway stakeholders to anticipate potential conflicts well in advance of any vessel transit, meeting, or crossing. The NTSB concludes that the Coast Guard has not widely used regulatory vessel traffic management options, such as routing measures and VTS *special areas*, to prevent vessel accidents in areas of demonstrated high risk across the VTS system. Therefore, the NTSB recommends that the Coast Guard establish a program to periodically review each of the 12 VTS areas and seek input from port and waterway stakeholders to identify areas of increased vessel conflicts or accidents that could benefit from the use of routing measures or VTS *special areas*, and establish such measures where appropriate.

# 4 Conclusions

## 4.1 Findings

1. There is widespread variation in the interpretation of US Coast Guard vessel traffic service (VTS) authority within the VTS centers and across the VTS system, which results in inconsistent application of that authority.

2. The US Coast Guard is not using realistic and sufficient vessel traffic service (VTS) simulation training exercises, which would improve competency and proficiency among all watchstanders across the VTS system.

3. The quality of on-the-job training (OJT) provided to trainees has been inconsistent because the US Coast Guard does not require a minimum level of vessel traffic service operator work experience or instructor training as a prerequisite for all OJT mentors.

4. Because the US Coast Guard does not require all of its vessel traffic service (VTS) watch supervisors to achieve a VTS operator qualification or meet a minimum operator work experience requirement prior to selection, the Coast Guard cannot ensure that all of its watch supervisors are proficient in operator knowledge and skills, including detecting and recognizing traffic conflicts and other unsafe situations.

5. Because the US Coast Guard gives vessel traffic service watchstanders inconsistent guidance about their responsibility to provide navigational assistance whenever an unsafe situation is detected, watchstanders may be reluctant to provide this service.

6. Some US Coast Guard vessel traffic service watchstanders lack confidence applying the navigation rules and regulations when unsafe situations are detected because they do not have sufficient knowledge of or proficiency with the rules and regulations.

7. The US Coast Guard’s current method of monitoring vessel communications on the bridge-to-bridge radio frequency is inadequate to identify unsafe situations in vessel traffic service areas, particularly during periods of low visibility or high traffic volume.

8. Cooperation between pilots and US Coast Guard vessel traffic service (VTS) watchstanders is often adversely affected by a negative perception of VTS expertise because most VTS watchstanders are not licensed mariners with work experience on commercial vessels.

9. The US Coast Guard is not enforcing its requirement that vessel traffic service (VTS) watchstanders use standardized VTS phrases and message markers from the International Maritime Organization Standard Marine Communication Phrases, which can lead to miscommunication with mariners during safety critical situations.

10. The US Coast Guard may be limited in its ability to detect the potential for collisions, allisions, and groundings in vessel traffic service (VTS) areas when VTS watchstanders do not have accurate information regarding vessel size, tow size, and tow configuration for VTS users engaged in towing operations.

11. The US Coast Guard is not using its Ports and Waterways Safety Assessment process to conduct continuous risk assessments and mitigate adverse safety trends within Coast Guard vessel traffic service areas.

12. The US Coast Guard's collection and quality control of vessel traffic service (VTS) area activity and incident data do not support effective quantitative assessments of risk and safety performance within its VTS areas.

13. The US Coast Guard's vessel traffic service (VTS) monthly activity report incident data do not include geographic position information, which prevents the Coast Guard VTS program from using geographic analyses to identify and mitigate locations of high risk in VTS areas.

14. The US Coast Guard has not widely used regulatory vessel traffic management options, such as routing measures and vessel traffic service (VTS) *special areas*, to prevent vessel accidents in areas of demonstrated high risk across the VTS system.

# 5 Recommendations

As a result of this safety study, the National Transportation Safety Board makes the following safety recommendations:

**To the US Coast Guard:**

> Revise and align Title 33 *Code of Federal Regulations* Part 161, the *Vessel Traffic Service [VTS] National Standard Operating Procedures Manual*, VTS center internal operating procedure manuals, and training curricula, as necessary, to ensure that VTS authority is consistently applied across the US Coast Guard VTS system. (M-16-5)
>
> Incorporate additional training that emphasizes realistic vessel traffic service (VTS) simulation exercises, including detecting and responding to unsafe traffic situations, in your initial training and proficiency requirements for all VTS watchstanders in the US Coast Guard VTS system. (M-16-6)
>
> Require standard on-the-job training (OJT) mentor selection criteria, including appropriate vessel traffic service operator work experience levels and instructor training requirements, for all OJT mentors. (M-16-7)
>
> Require all vessel traffic service (VTS) watch supervisors to achieve a VTS operator qualification and complete a minimum work experience requirement as an operator before serving as a supervisor. (M-16-8)
>
> Modify your *Vessel Traffic Service [VTS] National Standard Operating Procedures Manual*, VTS center internal operating procedure manuals, and training curricula, as necessary, to ensure that VTS watchstanders share a common understanding of how to identify and respond to situations requiring navigational assistance. (M-16-9)
>
> Ensure that vessel traffic service watchstanders are trained in and demonstrate proficiency with the navigation rules and regulations by passing the Coast Guard Deck Watch Officer exam, the Merchant Mariner Credentialing Rules of the Road exam, or another appropriate knowledge test. (M-16-10)
>
> Conduct or sponsor research, with input from appropriate subject matter experts, to develop more effective procedures or methods for monitoring vessel communications on the bridge-to-bridge radio frequency to identify and address developing unsafe situations in vessel traffic service areas. (M-16-11)
>
> Once the research recommended in Safety Recommendation M-16-11 is completed, revise your *Vessel Traffic Service [VTS] National Standard Operating Procedures Manual*, VTS center internal operating procedure manuals, and training curricula, as necessary. (M 16-12)

Work with the American Pilots' Association and the American Waterways Operators to conduct or sponsor research to evaluate and determine the feasibility and benefits of professional mariner representation on the watchfloor at each of the US Coast Guard vessel traffic service (VTS) centers, and establish such representation at VTS centers, as appropriate, based on the findings of that research. (M-16-13)

Revise your *Vessel Traffic Service [VTS] National Standard Operating Procedures Manual*, VTS center internal operating procedure manuals, training curricula, and VTS user manuals, as necessary, to ensure that VTS watchstanders use standard VTS communication phrasing and message markers from the International Maritime Organization Standard Marine Communication Phrases during radio communications with mariners when appropriate. (M-16-14)

Work with the Radio Technical Commission for Maritime Services and the American Waterways Operators to modify regulations, procedures, and equipment standards, as necessary, to ensure that vessels engaged in towing operations broadcast accurate automatic identification system information regarding tow size and tow configuration as well as vessel size. (M-16-15)

Develop a continuous risk assessment program to evaluate and mitigate safety risks for each vessel traffic service (VTS) area in the US Coast Guard VTS system that includes input from port and waterway stakeholders. (M-16-16)

Develop a program for conducting periodic risk assessments of the entire US Coast Guard vessel traffic service system that includes input from port and waterway stakeholders to evaluate and mitigate system-wide safety risks. (M-16-17)

Develop or revise, as necessary, your definitions of the activity and incident data collected by vessel traffic service (VTS) centers as necessary to ensure standardized and routine reporting across the entire US Coast Guard VTS system. (M-16-18)

Establish a program to periodically analyze the activity and incident data collected by vessel traffic service (VTS) centers to assess the safety performance of each VTS center and the entire US Coast Guard VTS system. (M-16-19)

Revise the vessel traffic service (VTS) monthly activity report requirements to include geographic coordinates for all incident-related data collected by the US Coast Guard VTS system. (M-16-20)

Establish a program to periodically review each of the 12 vessel traffic service (VTS) areas and seek input from port and waterway stakeholders to identify areas of increased vessel conflicts or accidents that could benefit from the use of routing measures or VTS *special areas*, and establish such measures where appropriate. (M-16-21)

**To the American Pilots' Association:**

> Work with the US Coast Guard to conduct or sponsor research to evaluate and determine the feasibility and benefits of professional mariner representation on the watchfloor at each of the Coast Guard vessel traffic service (VTS) centers, and establish such representation at VTS centers, as appropriate, based on the findings of that research. (M-16-22)

**To the American Waterways Operators:**

> Work with the US Coast Guard to conduct or sponsor research to evaluate and determine the feasibility and benefits of professional mariner representation on the watchfloor at each of the Coast Guard vessel traffic service (VTS) centers, and establish such representation at VTS centers, as appropriate, based on the findings of that research. (M-16-23)

> Work with the US Coast Guard to modify regulations, procedures, and equipment standards, as necessary, to ensure that vessels engaged in towing operations broadcast accurate automatic identification system information regarding tow size and tow configuration as well as vessel size. (M-16-24)

**To the Radio Technical Commission for Maritime Services:**

> Work with the US Coast Guard to modify regulations, procedures, and equipment standards, as necessary, to ensure that vessels engaged in towing operations broadcast accurate automatic identification system information regarding tow size and tow configuration as well as vessel size. (M-16-25)

## BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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**Adopted: September 13, 2016**

# 6 Appendix: Copy of Watchstander Questionnaire

### Introduction

**The National Transportation Safety Board (NTSB) needs your help to assess the effectiveness of Vessel Traffic Service (VTS) systems operated by the US Coast Guard.**

**Completion of this questionnaire is voluntary. You can skip any questions that you wish. We will not identify you or the other respondents, and we will only use statistical summaries in our study.**

**The questionnaire takes 15 to 20 minutes to fill out. Once started, the questionnaire must be completed in one session. Please click "Next" when you are prepared to go through all of the questions from beginning to end.**

**Many thanks for your assistance and your expertise.**

### Employment Status

1. What is your employment status:

- ◯ Coast Guard active duty
- ◯ Coast Guard civilian employee

### General Background Information

2. Which Vessel Traffic Service (VTS) do you work for?

[ ]

3. What is your age group?

- ◯ Under 20
- ◯ 20-24
- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ Over 65

1

4. How many years of work experience do you have as a:

| | None | Less than 1 year | 1-5 years | 6-10 years | More than 10 years |
|---|---|---|---|---|---|
| VTS Operator in Coast Guard VTS facilities | ○ | ○ | ○ | ○ | ○ |
| VTS Operator in non-Coast Guard "VTS-like" facilities | ○ | ○ | ○ | ○ | ○ |
| Licensed Pilot | ○ | ○ | ○ | ○ | ○ |
| Licensed Master aboard Merchant Marine vessels | ○ | ○ | ○ | ○ | ○ |
| Licensed Deck Officer/Mate aboard Merchant Marine vessels | ○ | ○ | ○ | ○ | ○ |
| Commissioned Officer aboard government vessels (Navy, Army, Coast Guard, etc.) | ○ | ○ | ○ | ○ | ○ |
| Warrant Officer aboard government vessels (Navy, Army, Coast Guard, etc.) | ○ | ○ | ○ | ○ | ○ |

Other maritime work experience (please specify the type of experience and number of years):

5. Are you in a supervisory or non-supervisory position?

○ I am a supervisor

○ I am not a supervisor

## VTS Operator Training and Certification

2

6. Have you completed the National VTS Certification course?

- ◯ Yes
- ◯ No

If you answered "no," please explain:

7. What year did you complete the National VTS Certification course?

8. How adequate was the National VTS Certification course in preparing you to perform the duties of a VTS Operator?

| Very inadequate | Somewhat inadequate | Somewhat adequate | Very adequate | N/A (never completed the course) |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

9. How adequate was the qualification process (conducted in-house at your VTS facility) in preparing you to perform the duties of a VTS Operator?

| Very inadequate | Somewhat inadequate | Somewhat adequate | Very adequate | N/A (never completed an in-house qualification process) |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

10. How long did you work at your VTS facility before you were allowed to stand watch as a fully qualified VTS Operator?

- ◯ N/A. I immediately began standing watch on my own as a fully qualified VTS Operator
- ◯ Less than 4 weeks
- ◯ 4-8 weeks
- ◯ 9-16 weeks
- ◯ 17-24 weeks
- ◯ More than 24 weeks

3

11. What requirements did you have to complete at your VTS facility to be fully qualified as a VTS Operator? Check all that apply.

- ☐ I don't know; operator qualification was not a clearly-defined process at my facility
- ☐ I passed a written (knowledge-based) exam at my facility
- ☐ I passed a practical (skills-based) exam at my facility
- ☐ I passed an oral exam/qualification board at my facility
- ☐ I stood watch under the direct supervision of a qualified operator
- ☐ I completed a ship ride
- ☐ I completed a port facility visit

Other (please explain):

12. Are you ever required to re-qualify as a VTS Operator?

- ◯ Yes
- ◯ No

13. If you answered "yes" to Question 12, how often are you required to re-qualify?

- ◯ Every 3 months
- ◯ Every 6 months
- ◯ Every 9 months
- ◯ Every 12 months
- ◯ Every 18 months
- ◯ Every 24 months
- ◯ Other (please explain):

4

14. Are there additional training requirements that you would recommend to enhance VTS Operator proficiency?

- ○ Yes
- ○ No

If you answered "yes," please explain:

## VTS Operations (Operator Questionnaire)

15. How effectively does your VTS achieve the following:

| | Very ineffective | Somewhat ineffective | Neutral | Somewhat effective | Very effective |
|---|---|---|---|---|---|
| Reducing the risk of collisions | ○ | ○ | ○ | ○ | ○ |
| Reducing the risk of allisions | ○ | ○ | ○ | ○ | ○ |
| Reducing the risk of groundings | ○ | ○ | ○ | ○ | ○ |
| Reducing the severity of accidents | ○ | ○ | ○ | ○ | ○ |
| Improving emergency response to accidents | ○ | ○ | ○ | ○ | ○ |
| Reducing vessel traffic congestion | ○ | ○ | ○ | ○ | ○ |
| Improving the efficient movement of traffic in poor weather | ○ | ○ | ○ | ○ | ○ |

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16. Select four tools that you use the most as a VTS Operator:

- [ ] Closed-circuit television (CCTV)
- [ ] Automatic Identification System (AIS)
- [ ] Telephone
- [ ] Cellular phone
- [ ] Very high frequency (VHF) radio
- [ ] Global Positioning System (GPS) data
- [ ] Radar
- [ ] Operator display
- [ ] Hydro-meteorological information
- [ ] E-mail

Other (please specify):

17. What additional equipment or technology would you like to have?

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18. Select four attributes that affect safety the most in your VTS area:

- [ ] Traffic conditions (vessel traffic volume, density)
- [ ] Large proportion of vessels not required to participate in VTS
- [ ] Prevailing environmental conditions (wind severity, poor visibility, strong currents, ice, other hazards)
- [ ] Large proportion of vessels operated by organizations with a poor safety record
- [ ] Waterway complexity (blind turns, busy intersections, difficult overtaking, confined areas)
- [ ] Large proportion of vessels moving passengers (cruise ships, ferries)
- [ ] Proximity of urban areas to waterway (potential for severe impact on surrounding human population)
- [ ] Large proportion of vessels moving petroleum and other hazardous materials
- [ ] Proximity of environmentally sensitive areas to waterway (protected ecosystems, wildlife)

Other (please specify):

19. Select four types of error that have the greatest potential to lead to an accident in your VTS area:

- [ ] Communication errors between vessels
- [ ] VTS failure to recognize a developing unsafe situation
- [ ] Communication errors between VTS and vessels
- [ ] Master/pilot failure to recognize a developing unsafe situation
- [ ] VTS failure to give accurate, useful, or timely information to vessels
- [ ] Master/pilot failure to give accurate, useful, or timely responses to VTS
- [ ] VTS incorrect handling or use of sensors, equipment, or other navigation decision-support technology
- [ ] Master/pilot incorrect handling of vessel or vessel navigation equipment

Other (please specify):

7

20. Which two sources of information do you rely on the most to identify an unsafe or hazardous traffic situation?

- [ ] VTS National Standard Operating Procedures (NSOP)
- [ ] VTS Internal Operating Procedures (IOP)
- [ ] Personal experience as a VTS Operator
- [ ] Sensors, equipment, or other navigation decision-support technology
- [ ] The watch supervisor

Other (please specify):

21. To what extent do each of these potential pressures affect the way you perform your job?

| | Never | Rarely | Sometimes | Frequently |
|---|---|---|---|---|
| Sensor or equipment failure | ○ | ○ | ○ | ○ |
| Port economics | ○ | ○ | ○ | ○ |
| Legal liability in the event of an accident | ○ | ○ | ○ | ○ |
| Interactions with non-VTS participants | ○ | ○ | ○ | ○ |
| Poor weather conditions | ○ | ○ | ○ | ○ |
| Interactions with pilots | ○ | ○ | ○ | ○ |
| Interactions with masters | ○ | ○ | ○ | ○ |
| Language barriers | ○ | ○ | ○ | ○ |
| Watch turnover procedures | ○ | ○ | ○ | ○ |
| Unexpected changes in workload | ○ | ○ | ○ | ○ |

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22. How often would you say that your VTS is engaged in the following activities:

| | Never | Rarely | Sometimes | Frequently |
|---|---|---|---|---|
| Collecting vessel traffic information | ○ | ○ | ○ | ○ |
| Analyzing vessel traffic information | ○ | ○ | ○ | ○ |
| Providing information to facilitate safe and efficient vessel movement | ○ | ○ | ○ | ○ |
| Calling attention to vessel conflicts, unsafe circumstances, or other hazards | ○ | ○ | ○ | ○ |
| Recommending actions to resolve vessel conflicts and unsafe circumstances | ○ | ○ | ○ | ○ |
| Directing vessels to take a specific course of action to prevent an accident | ○ | ○ | ○ | ○ |
| Ensuring vessel compliance with navigation regulations | ○ | ○ | ○ | ○ |

## VTS Operator Experience

23. Please read each of the following statements and mark the selection that best fits your opinion (based on your experience as a VTS Operator):

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| I have the equipment and technology to identify vessel conflicts | ○ | ○ | ○ | ○ | ○ |
| I have the training to recognize vessel conflicts | ○ | ○ | ○ | ○ | ○ |
| I have the authority to intervene and resolve vessel conflicts | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| I often recognize vessel conflicts, but it is too late to intervene and resolve them | ◯ | ◯ | ◯ | ◯ | ◯ |
| I feel pressure to compromise safety in order to keep vessel traffic moving | ◯ | ◯ | ◯ | ◯ | ◯ |
| I have the authority to control the movement of a vessel without seeking a supervisor's approval | ◯ | ◯ | ◯ | ◯ | ◯ |
| I am able to anticipate changes in workload when standing watch | ◯ | ◯ | ◯ | ◯ | ◯ |
| I am able to compensate for changes in workload when standing watch | ◯ | ◯ | ◯ | ◯ | ◯ |
| I have deviated from standard operating procedure in response to workload changes | ◯ | ◯ | ◯ | ◯ | ◯ |
| I frequently have to use workarounds to do my job | ◯ | ◯ | ◯ | ◯ | ◯ |
| Watches often have inadequate operator coverage to effectively handle vessel traffic volume | ◯ | ◯ | ◯ | ◯ | ◯ |
| Watch turnover procedures are efficient and effective | ◯ | ◯ | ◯ | ◯ | ◯ |
| I have enough time to complete administrative tasks without interfering with my traffic management duties | ◯ | ◯ | ◯ | ◯ | ◯ |
| My work conditions (space, lighting, temperature, furniture, etc.) are adequate | ◯ | ◯ | ◯ | ◯ | ◯ |
| I routinely communicate using IMO's Standard Marine Communication Phrases (SMCP) | ◯ | ◯ | ◯ | ◯ | ◯ |

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| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| Pilots routinely communicate using the IMO SMCP | ○ | ○ | ○ | ○ | ○ |
| Masters/bridge crews routinely communicate using the IMO SMCP | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are collected and recorded in VTS Monthly Activity Reports | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are being used effectively to enhance my abilities as an operator | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are being used effectively to enhance navigation and waterway safety | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have the best overall traffic picture | ○ | ○ | ○ | ○ | ○ |
| Pilots (aboard a vessel) have the best overall traffic picture | ○ | ○ | ○ | ○ | ○ |
| VTS Operators and pilots cooperate well to improve the safety and efficiency of vessel traffic | ○ | ○ | ○ | ○ | ○ |

24. Do you have any additional comments related to VTS effectiveness?

○ Yes

○ No

If you answered "yes," please explain:

VTS Operations (Supervisor Questionnaire)

11

25. Have you ever worked as a VTS Operator?

- ◯ Yes
- ◯ No

If you answered "yes," please provide the facility name and the dates that you worked there:

26. Did you complete the National VTS Certification course?

- ◯ Yes
- ◯ No

27. What year did you complete the National VTS Certification course?

28. Are there additional training requirements that you would recommend to enhance VTS Operator proficiency?

- ◯ Yes
- ◯ No

If you answered "yes," please explain:

12

29. How effectively does your VTS achieve the following:

| | Very ineffective | Somewhat ineffective | Neutral | Somewhat effective | Very effective |
|---|---|---|---|---|---|
| Reducing the risk of collisions | ○ | ○ | ○ | ○ | ○ |
| Reducing the risk of allisions | ○ | ○ | ○ | ○ | ○ |
| Reducing the risk of groundings | ○ | ○ | ○ | ○ | ○ |
| Reducing the severity of accidents | ○ | ○ | ○ | ○ | ○ |
| Improving emergency response to accidents | ○ | ○ | ○ | ○ | ○ |
| Reducing vessel traffic congestion | ○ | ○ | ○ | ○ | ○ |
| Improving the efficient movement of traffic in poor weather | ○ | ○ | ○ | ○ | ○ |

30. Select four tools that your VTS Operators use the most in their daily work:

- [ ] Closed-circuit television (CCTV)
- [ ] Automatic Identification System (AIS)
- [ ] Telephone
- [ ] Cellular phone
- [ ] Very high frequency (VHF) radio
- [ ] Global Positioning System (GPS) data
- [ ] Radar
- [ ] Operator display
- [ ] Hydro-meteorological information
- [ ] E-mail

Other (please specify):

13

31. What additional equipment or technology would you like to have?

32. Select four attributes that affect safety the most in your VTS area:

- ☐ Traffic conditions (vessel traffic volume, density)
- ☐ Proportion of vessels not required to participate in VTS
- ☐ Prevailing environmental conditions (wind severity, poor visibility, strong currents, ice, hazards)
- ☐ Proportion of vessels operated by organizations with a poor safety record
- ☐ Waterway complexity (blind turns, busy intersections, difficult overtaking, confined areas)
- ☐ Proportion of vessels moving passengers (cruise ships, ferries)
- ☐ Proximity of urban areas to waterway (potential for severe impact on surrounding human population)
- ☐ Proportion of vessels moving petroleum and other hazardous materials
- ☐ Proximity of environmentally sensitive areas to waterway (protected ecosystems, wildlife)

Other (please specify):

14

33. Select four types of error that have the greatest potential to lead to an accident in your VTS area:

- [ ] Communication errors between vessels
- [ ] VTS failure to recognize a developing unsafe situation
- [ ] Communication errors between VTS and vessels
- [ ] Master/pilot failure to recognize a developing unsafe situation
- [ ] VTS failure to give accurate, useful, or timely information to vessels
- [ ] Master/pilot failure to give accurate, useful, or timely responses to VTS
- [ ] VTS incorrect handling or use of sensors, equipment, or other navigation decision-support technology
- [ ] Master/pilot incorrect handling of vessel or vessel navigation equipment

Other (please specify):

34. Which two sources of information do you think VTS Operators should rely on the most to identify an unsafe or hazardous vessel traffic situation?

- [ ] VTS National Standard Operating Procedures (NSOP)
- [ ] VTS Internal Operating Procedures (IOP)
- [ ] Personal experience as a VTS Operator
- [ ] Sensors, equipment, or other navigation decision-support technology
- [ ] The watch supervisor

Other (please specify):

15

35. To what extent do each of these potential pressures affect the way you perform your job?

| | Never | Rarely | Sometimes | Frequently |
|---|---|---|---|---|
| Sensor or equipment failure | ○ | ○ | ○ | ○ |
| Port economics | ○ | ○ | ○ | ○ |
| Legal liability in the event of an accident | ○ | ○ | ○ | ○ |
| Interactions with non-VTS participants | ○ | ○ | ○ | ○ |
| Poor weather conditions | ○ | ○ | ○ | ○ |
| Interactions with pilots | ○ | ○ | ○ | ○ |
| Interactions with masters | ○ | ○ | ○ | ○ |
| Language barriers | ○ | ○ | ○ | ○ |
| Watch turnover procedures | ○ | ○ | ○ | ○ |
| Unexpected changes in workload | ○ | ○ | ○ | ○ |

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36. How often would you say that your VTS is engaged in the following activities:

| | Never | Rarely | Sometimes | Frequently |
|---|---|---|---|---|
| Collecting vessel traffic information | ○ | ○ | ○ | ○ |
| Analyzing vessel traffic information | ○ | ○ | ○ | ○ |
| Providing information to facilitate safe and efficient vessel movement | ○ | ○ | ○ | ○ |
| Calling attention to vessel conflicts, unsafe circumstances, or other hazards | ○ | ○ | ○ | ○ |
| Recommending actions to resolve vessel conflicts and unsafe circumstances | ○ | ○ | ○ | ○ |
| Directing vessels to take a specific course of action to prevent an accident | ○ | ○ | ○ | ○ |
| Ensuring vessel compliance with navigation regulations | ○ | ○ | ○ | ○ |

## VTS Supervisor Experience

37. Please read each of the following statements and mark the selection that best fits your opinion (based on your experience as a VTS Supervisor):

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| I feel pressure to compromise safety in order to keep vessel traffic moving | ○ | ○ | ○ | ○ | ○ |
| VTS Operators feel pressure to compromise safety in order to keep vessel traffic moving | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have the equipment and technology to identify vessel conflicts | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| VTS Operators have the training to recognize vessel conflicts | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have the authority to intervene and resolve vessel conflicts | ○ | ○ | ○ | ○ | ○ |
| VTS Operators often recognize vessel conflicts, but too late to intervene and resolve them | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have the authority to control vessel movements without a supervisor's approval | ○ | ○ | ○ | ○ | ○ |
| Watches often have inadequate VTS Operator coverage to effectively handle vessel traffic volume | ○ | ○ | ○ | ○ | ○ |
| VTS Operators are able to anticipate changes in workload when standing watch | ○ | ○ | ○ | ○ | ○ |
| VTS Operators are able to compensate for changes in workload when standing watch | ○ | ○ | ○ | ○ | ○ |
| VTS Operators may have to deviate from standard operating procedure in response to workload changes | ○ | ○ | ○ | ○ | ○ |
| VTS Operators frequently have to use workarounds to do their job | ○ | ○ | ○ | ○ | ○ |
| Watch turnover procedures are efficient and effective | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have enough time to complete administrative tasks without interfering with their traffic management duties | ○ | ○ | ○ | ○ | ○ |

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| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| VTS Operator work conditions (space, lighting, temperature, furniture, etc.) are adequate | ○ | ○ | ○ | ○ | ○ |
| VTS Operators routinely communicate using IMO's Standard Marine Communication Phrases (SMCP) | ○ | ○ | ○ | ○ | ○ |
| Pilots routinely communicate using the IMO SMCP | ○ | ○ | ○ | ○ | ○ |
| Masters/bridge crews routinely communicate using the IMO SMCP | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are collected and recorded in VTS Monthly Activity Reports | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are being used effectively to enhance VTS Operator abilities | ○ | ○ | ○ | ○ | ○ |
| "Near miss" incident data are being used effectively to enhance navigation and waterway safety | ○ | ○ | ○ | ○ | ○ |
| VTS Operators have the best overall traffic picture | ○ | ○ | ○ | ○ | ○ |
| Pilots (aboard a vessel) have the best overall traffic picture | ○ | ○ | ○ | ○ | ○ |
| VTS Operators and pilots cooperate well to improve the safety and efficiency of vessel traffic | ○ | ○ | ○ | ○ | ○ |

38. Do you have any additional comments related to VTS effectiveness?

◯ Yes

◯ No

If you answered "yes," please explain:

## End of Questionnaire

**You have completed the questionnaire. Thank you for your assistance. If you have additional questions or concerns, please contact the study managers (Dr. Loren Groff or Dr. Eric Emery) by e-mail at VTSStudy@ntsb.gov or by phone at 202-314-6175.**

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