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Vessel Traffic Systems

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ABSTRACT

This paper will examine the historical impetus for Vessel Traffic System (VTS) development in the United States. Cost benefit techniques utilized to establish the VTS requirements are discussed and the data base upon which the analysis is conducted is critiqued. General Accounting Office criticism of the Coast Guard's VTS development process are analyzed. Finally VTS is examined as a single component in the improvement of port logistics, which must be arrayed against other alternatives to make the most effective use of scarce resources. This final element is discussed with respect to the Federal government's attempt to recover clearly allocatable costs in the form of user fees.

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I. ORIGINS OF VESSEL TRAFFIC SERVICES

A. INTRODUCTION

Of the critical issues in maritime transportation, identified by the Maritime Transportation Research Board, of the National Research Council [Ref. 1], the problems of increased maritime accident statistics and congested, obsolete port facilities are directly associated to the motivation for the establishment of Vessel Traffic Services (VTS).

The purpose of VTS as implemented in the United States is to reduce the probability of shipping accidents. Despite extensive efforts by the United States and other governments and by private industry, maritime accidents of all types are increasing. National and international emphasis has been on physical solutions--design, construction, equipment redundancy, vessel operating requirements, and the regulations to ensure problem alleviation via these solutions. The failure of these solutions to reduce the incidence of accidents has focused recent investigations on the human element involved. The studies [Ref. 2] [Ref. 3] have found that, almost without exception, the proximate or probable causes of collisions, rammings or groundings is some form of human failure. There has been an inverse relationship between the known causes of accidents and the prevention research conducted. Most maritime accidents are due to human inadequacy, while maritime research is directed toward hardware. Reversal of this disparate trend will be protracted. VTS, in this interim, will serve as an additional set of eyes for the pilot, synthesizing the information he requires, to allow him to more rapidly analyze the situation. Additionally, VTS will function as an entity to scrutinize the harbor and forecast and prevent potentially hazardous situations.

In many ports the channels and facilities are obsolete, inadequate and unsafe to service modern ships. Modern ships designed to reduce unit costs, require deeper channels, increased maneuvering space and more sophisticated capital-intensive equipment handling facilities. Larger capital requirements, accelerated costs, parochial interests, and concerns over the environmental effects of dredging have operated counter to the port modernization needs. Large capital requirements and high interest rates have made it difficult for ports to develop funding for the improvements. Large, highly productive ships limit their calls to those ports which can meet their draft requirements and desire minimum turnaround time to reduce pressure on their operating budgets. This port consolidation causes increased congestion. VTS can mitigate the hazards induced by the increased density and through efficient scheduling can limit idle port time.

This commentary will examine the installation of VTS systems in the United States. The methodology utilized to determine the ports which require VTS will be evaluated, as will the data base upon which this methodology is founded. Techniques for increasing the integrity of the data base, and alternatives to conduct the needs analysis will be discussed. Finally, the political realities of the Coast Guard's VTS implementation will be discussed, identifying Congressional, interagency and user interfaces.

B. ORIGINS

Advances in ocean engineering sciences, which resulted from World War II, saw an increased concern for the marine environment domestically and internationally with the International Convention for Prevention of Pollution of the Sea by Oils in 1954. The 1957 International Geophysical Year produced more involvement, but another event in 1957 captured our national interest--the launching of Sputnik I. Space drew our attention away from the more pedestrian pursuits of ocean research. The national commitment to the manned space program produced technological innovations in the decade of the sixties at a pace unprecedented in man's history.

Marine industry, known for relative tranquility, applied spin-offs from space technology beginning a transition which is still in progress. New materials were utilized for vessel construction, new coatings for corrosion control, the expansion of space age technology into maritime trades produced new solutions to old problems. Computer industry growth resulted in improved radar processing, accurate navigation, and automation of engineering functions. Computer aided design of vessels allowed the analysis of structural and loading problems rapidly and precisely. The technological answers were presented to the maritime industry at an accelerated pace, they were adapted and processed to provide the cure expeditiously, far in advance of the industry's ability to analyze the far-reaching ramifications of the solutions. The marine industry had technological wealth but was unsure of the impact of the applications.

The capability existed to design a vessel explicitly correct for any operating environment, yet there existed no environmental model on which to base the design. The vessel master was presented with a cornucopia of navigational instrumentation designed without understanding his reasoning and decision processes. These environmental and human engineering deficiencies existed while the manning of these improved vessels was reduced, despite the doubt that man's critical functions were really duplicated. The doubts were hidden by the euphoria of technological successes in all industries.

The closing of the Suez Canal in 1967 revolutionized the concept of shipping. Advanced design and material capability coupled with the economies of scale to be realized from longer ocean transits witnessed concepts of large expand from 30,000 dead weight tons in the early sixties to 200,000 dead weight tons in the post-Suez crises era. The United States' domestic production of oil could not meet the demand. In 1960, America imported about 1.7 million barrels of oil per day; by 1970 this amount had doubled [Ref. 4]. Although the carriers of oil got larger, our increased demand did not appreciably reduce the flow of traffic in harbors and ports.

The prosperity of the late 1950's and early 1960's precipitated the foundation of individuals and groups concerned with their environment. In particular, the publication of a compilation of "New Yorker" articles titled Silent Spring by Rachel Carson in 1963 produced a unifying effect, "the sort of rallying point of the movement to protect the environment that the anti-slavery book Uncle Tom's Cabin had been for the movement to abolish slavery in the 1850's" [Ref. 5]. As environmental action groups built support and lobbying efforts in the mid-1960's, they achieved small successes in ammendments to the Federal Water Pollution Control Act (1961, 1965, 1966), the Water Quality Act of 1965, and the Clean Water Restoration Act of 1966. Many supporters and organizers of the ecological movement found a more immediate issue which required their efforts, the news media had brought Vietnam into the American living room and in late 1966, anti-war sentiments were beginning. 1967-1968 saw increased anti-war effort. Despite this unrest, the Vietnam War, in full color, continued. Many organizers saw no tangible results for their labors. Guilt and impotence were dominant emotions. Those affected channeled their energies into environmental matters to overcome the malaise.

Many politicians who could not afford to be liberal concerning the war effort found it easy to be broadminded and appease on matters dealing with the environment. The cathartic influence of achieving positive results redoubled the efforts of these action groups and attracted additional followers. The return of disenchanted anti-war demonstrators, coupled with recruitment efforts, resulted in the passage of the National Environmental Policy Act of 1969 and the confirmation of the power of the environmental lobby.

The environmental respite during the social upheaval of the Vietnam protest era of the late 1960's did not permit the incident on 18 March 1967 to go unnoticed. The Torrey Canyon ran aground off the coast of Cornwall. Thirty-five million gallons of heavy black oil were spread over a hundred miles of British and French beaches. Thousands of birds died, while the media covered the inept attempts to limit, burn or neutralize the oil. The governments were totally unprepared to handle the disaster. Daily, ninety thousand gallons of detergent were poured on the oil to aid dispersement; while efforts to bomb the ship and burn floating oil with napalm were ineffective. It was later discovered the toxicity of the detergent was far more harmful to sea life than the oil [Ref. 6].

The Intergovernmental Maritime Consultative Organization (IMCO) convened an immediate session to discuss the ramifications of the Torrey Canyon disaster and laid invaluable foundations for later international agreement, but the process in such an arena is slow.

Domestically, the late 1960's saw the ocean beginning to be recognized as a vast resource, a fountain of food, energy, and minerals to replace increasingly depleted land sources. In light of the grave potential for destruction of the shared resource, maritime industry joined forces to limit the risk of disaster. The Santa Barbara blowout from offshore oil wells in 1969 dramatically pointed out the potential dangers of oil in the marine environment, along with the inadequacy of regulations to reduce the probability of disaster and laws to deal with clean-up and liability.

Although tanker accidents at sea only account for 9.4 percent of ship-generated oil pollution and 3.3 percent of all discharges [Ref. 7], the figures do not accurately reflect the impact. The image of the Torrey Canyon, or more recently the Argo Merchant, breaking up in heavy weather, permeating the ocean with a black scar, is, in the public mind, the major problem. The situation is further exacerbated since accidents resulting from collisions or groundings account for 56 percent of the accidental discharge [Ref. 8] and are more likely to occur near shore (85 percent within 5 miles) [Ref. 9] resulting in damage to coastal areas. This damage is, of course, visible to the public. More importantly, the 10 percent of the total oceanic area represented by the coastal ocean and waters over the continental shelf and slope [Ref. 10] are highly productive and represent the area of greatest biological activity. Organic matter originating in the coastal ocean forms the basis of the chain supporting all marine life. This area is considered the most productive on all the earth [Ref. 11].

In 1970, during this period of increased environmental awareness, the United States Coast Guard, sensing the country's mood, sponsored the passage of two bills to promote port and harbor safety and reduce the probability of collision and marine pollution. These bills were the Vessel Bridge-to-Bridge Radiotelephone Act and the Ports and Waterways Safety Act. The thrust of both acts was to promote navigational safety. The Radiotelephone Act required a VHF transceiver to be onboard vessels of a certain class upon which navigational information would be passed, supplementing the Nautical Rules of the Road whistles signals in the event of confusion. The Ports and Waterways Safety Act provided the Coast Guard the power to prevent the discharge of pollutants in harbors by reducing vessel casualty risks through closer attention to vessel traffic control, establishing rules for handling dangerous cargoes and permitting inspection and enforcement measures ensuring compliance. Neither bill was passed in 1970 by the Ninety-First Congress due to the lobbying efforts and testimony presented by the marine transportation industry. These opinions, while in substantial agreement with the safety goals of both acts, disputed the language of the bills, which they felt lacked specificity, granting the Coast Guard indiscriminate power. The independence of the mariner was threatened by the sweeping proposals, maritime traditions must evolve slowly, or be pressured to be modified. As is often the case, disaster provided the impetus for legislation. On 18 January 1971, a collision in San Francisco Bay resulted in the spilling of 800,000 gallons of heavy fuel oil. The national exposure of the ecological and wildlife damage was presented in brilliant color by National Geographic [Ref. 12].

The Magneson Act (PL679, 9 August 1950) authorizes the President to make rules governing the movement, inspection, and guarding of vessels, harbors, ports and waterfront facilities in the United States upon determining that our national security is endangered. Executive Order (EO) 10173, as amended by EO 11249 delegated this authority to the Coast Guard. The Coast Guard established the San Francisco Harbor Advisory Radar as a test for evaluation purposes in 1970.[1] The radar system advised ships, who were voluntary participants, of traffic in the harbor. The Coast Guard watch standers watched the accident develop and recorded the radar images, yet were powerless to prevent it, since they were unable to communicate with one of the vessels.

Those recorded photographs and the plight of helpless oil-soaked birds battered by waves depicted in National Geographic resulted in public indignation. The images of bearded, long-haired students, construction workers and senior citizens working alongside each other in a volunteer effort to limit the damage, illustrated the unanimity of ecological purpose in a nation deeply divided by an unpopular war.

The National Transportation Safety Board included in its findings that a traffic separation scheme, the use of radiotelephone to exchange passing information and/or a more

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[1]Although the EO is manifestly linked with prevention of sabotage and subversion activity, the Coast Guard carried out a wide range of peacetime port and harbor safety programs under the order.

effective Harbor Advisory Radar system could have prevented the collision. It noted, "This potentially protecting public radar system should no longer be placed in the position of recording the minute stages of public disaster while powerless to prevent it." "The underlying and most significant inadequacy of the Harbor Advisory Radar was the lack of authority of the Coast Guard to regulate this traffic which prevented a publically financed facility from protecting the public against loss" [Ref. 13].

Between the findings of the Coast Guard on 21 April 1971 and the findings of the National Transportation Safety Board on 28 July 1971, the Congress approved the Vessel Bridge-to-Bridge Radiotelephone Act and it became public law on 4 August 1971. The Port and Waterways Safety Act (PWSA) was legislated into law on 10 July 1972. Only token maritime opposition was expressed. Congressional resolve was apparent from the opening remarks in the PWSA hearing:

> "The most recent collision occurred in January, 1971, in the San Francisco Bay and involved the tankers, Arizona Standard and the Oregon Standard, and brought into focus the need for this port and harbor safety legislation....Let no one make the mistake that the mood of Congress is anything but in the direction of this type of legislation" [Ref. 14].

The mood of the 1970's was firmly established, technological accomplishments were viewed with skepticism. Social upheaval shifted priorities from technological advances to environmental improvement and stability. Public opinion overwhelmingly favored responsible development. Safety concerns and environmental impacts are the hallmarks of the decade. Any alteration of the environment was wicked and the courts were flooded with litigation. The 1960's mandate for technological advancement without adequate awareness of the ramifications was being supplanted by concern for ecological stability.

In this constantly changing milieu, the Coast Guard was charged with enacting the guidelines of the PWSA. Arriving at regulations and systems to protect the harbor associated marine environment, while not restricting the commerce of the port, was the intent. This decade-long development will be critiqued and evaluated.

The Coast Guard was positioned between maritime industry battling for the continuance of the economic viability of their livlihood and determined environmentalist. The general public concern may best be characterized by the following:

> "It is a curious situation that the sea, from which life first arose, should now be threatened by the activities of one form of that life. But the sea, though changed in a sinister way, will continue to exist; the threat is rather to life itself" [Ref. 15].

II. VESSEL TRAFFIC SERVICES DEVELOPMENT

A. INTRODUCTION

This chapter will deal with the major issues encompassing the analysis of port improvements through VTS. Four subdivisions have been identified:

1. Legislative directives.
2. VTS definitions.
3. Data required for VTS analysis.
4. Cost benefit discussion.

B. LEGISLATIVE DIRECTIVES

1. Port and Waterways Safety Act

The Congressional mandate in the form of the PWSA provided the Coast Guard with a diverse set of legal mechanisms by which to regulate more structure in port operation. The act, among other things, authorized the Coast Guard to:

- Establish, operate and maintain vessel traffic services and systems in congested waterways.
- Require vessels which operate in a traffic system to carry or install electronics or other devices necessary.
- Control vessel traffic when conditions are hazardous or congested, by specifying times of vessel movement, establishing traffic routing schemes, establishing vessel size and speed limitations and restricting vessel operations to those who have particular operating capabilities.

Congress framed the Coast Guard's efforts to regulate for the "safe and efficient conduct of marine commerce" by requiring minimally, the following considerations:

- The scope and degree of the hazards.
- Vessel traffic characteristics, including traffic volume, sizes and types of vessels, and the nature and level of cargos.
- Geographic, climatic and other conditions of port and waterway configurations.
- Environmental factors.
- Economic impact and effects.
- Local practices and customs.

Finally the Coast Guard was to provide adequate opportunity for consultation and comment to state and local governments, representatives of the maritime industry, port and harbor authorities, environmental groups and other interested parties in the preparation of rules, regulations and standards.

Title Two of the bill is aimed at improving the safety standards of vessels carrying hazardous cargos in bulk and will not be analyzed.

C. VTS DEFINITIONS

The legislative guidelines presented were extremely broad and the development of the conceptual framework for the implementation of the tenants was the responsibility of the Coast Guard. The conceptualization, evaluation and design and implementation of a system as integrated and complex as a vessel traffic control system was a task of major proportions. Vessel traffic services are intended to assist the vessel operator in safe navigation of his vessel where traffic congestion presents an unacceptable risk of casualty. While many features of the problem meet with widespread, theoretical acceptance, each vessel traffic system must be designed and tailored to satisfy the unique local geography, traffic patterns and weather conditions of the harbor.

Despite the involved lobbying effort by the Coast Guard for the PWSA [Ref. 16] [Ref. 17], their experimentation and early analysis to establish the feasibility for VTS and provide the theoretical and practical experience for future implementation was minimal [Ref. 18]. While some specific expertise was gained in the operation of the Harbor Advisory Radar in San Francisco, the pre-PWSA period was one which involved independent analysis targeted to specific limited problems. Early VTS's, shown in Table 1, were developed from informal studies and limited statistical evaluations. These early systems were generally established without eliciting the extensive experience of Western Euoropean ports which have been operating VTS since 1948.

The most important function in establishing an environment in which to investigate a new system is to

Table 1

Basic Vessel Traffic Services in the United States Before 1972 [Ref. 20]

Port/Waterway	Type	Operator
St. Mary's River	Vessel Movement Reporting System (VMRS), TV	USCG
San Francisco	VMRS, Radar, Experimental	USCG
New Orleans	Traffic Lights	Corps of Engineers (COE)
Cape Cod Canal	Traffic Lights, VMRS, Radar, TV	COE
Chesapeake & Delaware Canal	Traffic Lights, VMRS, TV	COE
St. Lawrence Seaway	VMRS	St. Lawrence Seaway Development
Honolulu	Signal Tower	Harbor Master
Los Angeles/Long Beach	Harbor Radar, Teletype Set	LA/LB pilots
Baltimore	VHF-FM Communications	Private
Portland, Oregon	VHF-FM Communications	Private
Boston	VMRS	Private

identify the goals of the design and the purpose for which VTS is intended.

The Coast Guard contracted the Computer Sciences Corporation to assist them in planning VTS under the PWSA. The study, which was completed in March, 1973 [Ref. 19], has formed the foundation upon which the majority of subsequent Coast Guard VTS analysis has been conducted. The study was concerned with three specific tasks:

1. Development of a conceptual framework for VTS.
2. Identification of the roles of the system participants.
3. Development of an algorithm to determine the needs for various levels of VTS.

A follow-on study completed in August, 1973 [Ref. 21] utilized the algorithm to rank twenty-two major ports and waterways to establish relative need for and the sophistication of the VTS.

A vessel traffic service may be defined as "an integrated system encompassing the technologies, equipment and people employed to coordinate vessel movements in or approaching a port or waterway" [Ref. 22]. This official Coast Guard definition is generic but specifically avoids some controversial implementation issues which will be discussed in the following chapter. A more complete definition of VTS would be:

> "A vessel traffic system consists of an integrated plan regulations, people, equipment and facilities for the collection, analysis and dissemination of information to assist and direct as needed, the maneuvering of vessels in waters subject to congested vessel traffic" [Ref. 23].

This definition allows more flexibility to investigate the purpose of the service by: examination of a plan; dissection of the data utilized for development, operation and future modifications; and finally, focusing on the issue of advice versus control.

The objectives of a VTS are:

1. To reduce the probability of collisions and groundings.
2. To expedite the flow of marine traffic.

The methodologies to achieve the above objectives find common threads in studies throughout the world.

The VTS Issue Study Volume 2 described traffic management components or methodologies as elements which could be utilized to build a VTS. These elements consisted of, for example, aids to navigation, port rules and regulations and surveillance techniques utilizing radar or closed circuit television. The combinations of these elements could be constructed to produce either a simplistic or advanced, sophisticated VTS. Three basic levels of traffic coordination were identified ranging from passive, to advisory, to active management. This three-tiered structure could operate concurrently in the most modern system. Passive systems, involved traffic separation schemes, rules and regulations. Advisory coordination involved the exchange of information between vessels and a central station. Active management added the ability of the shore station to direct vessel movements.

Other approaches to vessel traffic management are offered by Dejean [Ref. 24] Fujii and Yamanouchi [Ref. 25] and

Oraizi [Ref. 26]. Dejean proposed a three-level classification of: passive control, which involved instructions or prohibitions before the vessel's entry or departure from the port, based on traffic criteria, local particulars and the vessel itself; active control, as instructions or orders issued during port navigation; and guidance or remote pilotage, as direct land based control without the physical intervention of a pilot on the vessel's bridge. Fujii and Yamanouchi identify six management levels which evolve the usage of only communication, to communication with radar and television surveillance. The six levels are: (1) Information service; (2) Aids of pilot; (3) Signal control; (4) Vessel Management Reporting System (VMRS); (5) VMRS with signal control; and (6) VRMS requiring signal control. Oraizi follows a pattern similar to the Coast Guard's but adds a berthing level as another function of the vessel's direct interface with the shore.

The VTS Issue Study Volume 2 further subdivides its categories as illustrated in Table 2. The levels represent the system chosen, as that level of VTS capable of preventing each mishap. The L_R category is an additional level added by the VTS Analysis of Port Needs study. These seven categories have established the hierarchy by which all Coast Guard systems have evolved.

Table 2

Classification of Vessel Management Systems

Designation	Type	Description
L_0	Passive	Bridge-to-Bridge accidents judged preventable by Radiotelephone were compiled separately to adjust early VTS data for the effects of the Bridge-to-Bridge Radiotelephone Act of 1971.
L_R	Passive	Accidents which could be prevented by regulations including speed, limitations on passing, one-way traffic considerations.
L_1	Passive	Traffic separation schemes to minimize close encounters of vessels. None of the first three levels require shore-based monitoring.
L_2	Advisory	Vessel Movement Reporting System (VMRS). Certain vessels are required to communicate with a Vessel Traffic Center (VTC) their navigational information, VTC plots the vessels and advises vessels of traffic in their vicinity. Minimum reporting requirements are specified.
L_3	Advisory or Active	Basic Surveillance includes radar and/or Closed Circuit Television (CCTV) of selected portions of the port or waterway. The capability improves the VTC's knowledge of vessel presence and movement. Considered necessary where blind corners, bends or intersections exist, especially in restricted waterways.
L_4	Advisory or Active	Advanced Surveillance includes more accurate and complex surveillance equipment and may have limited computer interface.
L_5	Active	Computerized Advanced Surveilance has full computer interface and provide for the highest reliability and accuracy in traffic management. Designed for control in high density, complex traffic areas.

D. DATA REQUIRED FOR VTS ANALYSIS

Determination of the VTS needs of a port or waterway is dependent upon the collection, analysis, and application of data. After the problem definition, the most important feature of correct analysis is accurate data.

The data bases abstracted for utilization in the VTS Issue Study Volume 3 and the VTS Analysis of Port Needs study were the Coast Guard's Marine Vessel Casualty Reports (MCVR) and the Army Corp of Engineer's Waterborne Commerce of the United States. Both of these data bases are readily available and both are required in order to develop and correlate the effectiveness of an algorithm which will establish the VTS requirements.

1. Marine Vessel Casualty Report

Title 46 of the Code of Federal Regulations (CFR) charges the Coast Guard with the responsibility to collect data on marine casualties. Section 4.05-1 of the regulations specifies that the master, owner, agent or person in charge of a vessel involved in a casualty is required to file a report with the Coast Guard if any of the following criteria are met:

1. Accidental or intentional groundings.
2. An occurrence affecting the seaworthiness of a vessel.
3. Loss of life.

4. Injury causing a person to be incapacitated for a period in excess of 72 hours.

5. An occurrence not meeting any of the above criteria but resulting in property damage in excess of $25,000[2].

Reports of marine casualties indicated above are made on a Report of Vessel Casualty or Accident Form (CG-2692) (See Appendix A). Upon the notification of an accident, the Commandant of the Coast Guard or the District Commander will order an investigation, per CFR 46 subpart 4.07-1 by the local office of Marine Safety. The vessel casualty report consists of (1) the endorsements of the District Commander and the Marine Inspection Officer in charge; (2) a letter from the investigating officer detailing his findings; and (3) the CG-2692 casualty report form prepared by each vessel operator involved in the accident. Copies of the above report are forwarded to Coast Guard headquarters where they are recorded on microfiche, and pertinent casualty data is transcribed onto magnetic tape.

2. Waterborne Commerce of the United States

The Army Corp of Engineers (COE) has jurisdiction over the maintenance of clear passage along navigable waterways. In order to effectively weigh the costs and benefits which would accrue to a dredging project, COE

[2]The $25,000 property damage criteria went into effect on 1 January 1981. The previous limit was established at $1500. Future studies will have to acount for the historical anomoly on property damage recorded.

collects data estimating two measures of traffic volume for a diverse set of waterways: vessel trips and cargo tonnage. The COE data is available in annually published summaries and in machine readable form, as a tape.

3. Deficiency of the Data Base

Knowledge of casualty and transit figures are required as input data for an algorithm designed to (1) determine the need for VTS and (2) determine the effect of various levels of VTS. Simply, the probability of an accident occurring is computed from the available data. Next, the cost of those accidents are extracted from the data base and an expected loss computed. Finally the effect that a proposed vessel traffic system would have on the probabilities of accidents is determined and the expected casualty losses recomputed [Ref. 27].

The above description illustrates the need to combine and link the two data bases together. Unfortunately, each file has individual limitations. Additionally, problems with their consolidation coalesce to produce an imperfect product.

a. MCVR Data

The problems associated with the Coast Guard's casualty data base are varied and enduring since the majority of deficiencies which were identified in VTS Issue Study Volume 3 have been found by more recent studies [Ref. 28], [Ref. 29], and [Ref. 30].

The dynamics of the casualty as presently reported are inadequate to conduct in depth analysis (i.e., speed and direction of ship or ships are not included).

The utilization and availability of radar, bridge-to- bridge communication and VTS are not included in the report.

Data contains significant coding errors and there are no logic checks to prevent obvious incorrect input inaccuracies.

Data is not processed in a timely fashion. The delay until the documentation is placed on tape is approximately two years.

The data is entered by the date the file is received at headquarters and not the actual casualty date.

The location data on the MCVR file produces insufficient specificity.

A Coast Guard study in 1971 [Ref. 31] suggested that only about 30% of the reportable vessel casualties are documented on CG-2692 forms. While the report logically reasoned that a higher percentage of the more serious accidents are reported due to the attention received, nevertheless a significant portion of casualty statistics are never recorded into the data base. More recently the Lower Mississippi River Safety Study found vast divergence between the mishaps recorded in the New Orleans VTS logs and the information on the casualty file tape. Approximately 31% of the collisions and allisions[3] monitored by the VTS do not appear on the casualty file. The study did not conduct a case by case analysis to ascertain which casualties were reportable. All groundings are required to be reported but the study noted that 59 percent of the groundings logged were not recorded on the casualty file tape. A total of 335 casualties, consisting of 137 collisions and 198 groundings, were not recorded on the casualty file tape. Assuming all accidents were reportable, a total of 57 percent of the collisions and groundings that occurred went unreported.

A Coast Guard study in 1971 [Ref. 32] revealed an additional inadequacy of the casualty data base, finding the estimated damages recorded on the casualty reports were approximately half of the actual damages. Additionally, the report alluded that property damage, pollution incidents and injuries were also understated but no specific figures were derived. The cause of this inaccuracy lies in early estimates of casualty damage and no required or desired feedback to adjust the deficiency, in addition to a deliberate reduction to minimize the extent of the accident.

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[3]Allision is defined as a vessel collision with a fixed object such as wharves, docks, piers, bridges, submerged objects, aids to navigation or oil rigs. A collision involves two vessels, an allision involves one. VTS Analysis of Port Needs study uses ramming in place of allision.

An Operations/Research Incorporated study [Ref. 33] in 1979 compared Coast Guard estimates of damage to towboats with actual insurance repair costs. It found that repair costs were underestimated by an average of 15 percent during the fiscal years 1972-1976.

All of the Coast Guard data fails to account for the costs associated with loss of revenue, workmen's compensation and diversion from intended destination.

<u>Statistics of Casualties for Fiscal Year 1978</u>, indicates 894 vessels involved in collisions with other vessels while underway reported to the Coast Guard. Potter [Ref. 34] points out that of the 894 vessels in 309 collisions, 586 reported the primary cause as "fault on part of other vessel or person". This illustrates the bias and inaccuracy extant in the present reporting/investigation milieu.

b. COE Data

The COE data, with respect to location, is inconsistent with VTS locations.

COE data is computed by calendar year, while Coast Guard casualty data is compiled by fiscal year.

Recent comparisons have been conducted between COE data and VTS transit logs [Ref. 35] [Ref. 36]. The data files did not match since the COE is primarily concerned with the movement of commerce and does not take into account berth shifts, barge transfers and other types of local movement in the VTS area. The different administrative requirement for data between VTS and COE produce incompatability in information, time periods and geographical area. Analysis of VTS logs for the Houston VTS area found intraport movements, solely within the port complex accounted for 50% of the VTS transits, interport movements within the VTS area accounted for an additional 10%, neither of these transit figures are reflected on COE information. Table 3 provides a VTS and COE data comparison. The Houston study utilizes the COE data for reasons of consistency with the Analysis of Port Needs study and draws no further conclusions. The importance of this information is how it effects the application of the algorithm. If there were less activity in a harbor, reduction in casualties would reflect the reduction in those pressures on the port system that might enhance hazard potential. Therefore, if the activity were understated by utilizing COE data as Table 3 illustrates, so too would be the demonstrated effectiveness of VTS.

Table 3

VTS and COE Transit Data Comparison [Ref. 37]

YEAR	CODE DATA	VTS DATA	%DIFF
1975	61,545	72,766	18.2%
1976	69,940	74,819	7.0%
1977	64,429	83,132	29.0%
1978	66,884	88,547	32.4%

4. Analysis of Data

The significance of the descrepencies is that there is cast an aura of unreliability concerning the data bases and their use results in grossly underestimated benefits of VTS during the application of the algorithm (discussed in the following section).

A more subtle problem is engendered in the casualty reporting scheme of the Coast Guard. The stated purpose of the casualty investigation is to promote safety, but the mariners involved face possible civil penalties, license revocation and/or criminal prosecution. The policy of combining safety and fault-finding investigations discourages the mariner from submitting a CG 2692 form with candor. The determination of the exact cause of a casualty may therefore be uncertain.

In order that more accuracy in the casualty data base be obtained it will be necessary to separate the fault-finding investigation from the safety inquiry and to protect any information revealed on the Report of Vessel Casualty or Accident Form and subsequent investigation statements obtained from any use, other than marine safety.

Both the Air Force and Navy follow a dual investigative procedure. Air Force Regulations specify that an Aircraft Accident Investigation will be for "the sole purpose of taking corrective action in the interest of accident prevention" [Ref. 38]. A separate Collateral Investigation is held "to preserve available evidence for use in claims, litigation, disciplinary action, and adverse administrative proceedings and for other purpose except for safety and accident prevention purposes" [Ref. 39].

The Navy accomplishes similar separation as outlined in Naval Aviation Safety Program OPNAVINST 3750.6M of 27 October 1980. The Mishap Investigation Report Form (Appendix B) serves to advise the witness to the purpose of the investigation, the immunity granted and the confidentiality of the statement. These promises are made to persuade witnesses to express their opinions and talk freely, even though the information may be unsupported in fact, self-incriminating, embarrassing or cast blame upon a friend or co-worker.

The objective of a safety investigation should be an accurate reconstruction of the events, as would be accomplished by an historian. Fault-finding inquiries, as do trials, find interested witnesses polarizing, supporting adversary positions which operate to distort, since those concerned will only reveal that which supports their case. Disinterested witnesses do not want to get involved due to the inconvenience and the fear of harming someone. In order to break the chain of causation, and reveal the facts so to avoid a similar accident, another channel must be pursued.

The National Safety Council has found that witnesses would be frank and candid with the promise of privilege. Privilege is the doctrine which holds the attorney/client relationship as confidential.

To avoid investigation costs and to present the impartial, highly influential opinion of an investigation board, attorneys have sought to supoena safety investigation records and board members to support their litigation through the Freedom of Information Act (FOIA) 5USC552.

The principal issue is whether witness statements given under a promise of confidentiality to a Safety Investigation Board are exempt from the mandatory disclosue provisions of the FOIA. In Cooper v. Department of the Navy, 558 F2d 274 (5th Cir. 1972) and Brockway v. Department of the Air Force, 518 F2d 1184 (8th Cir. 1975), the Fifth and Eighth Circuits held that an FOIA Exemption 5 permits non-disclosure. The Eighth Circuit found:

> "If the statements are disclosed and the flow of information to the Air Force safety investigation is curtailed, there is the definite possibility that the deliberative process of the Air Force will be hampered...." [Ref. 40].

In Cooper, the Fifth Circuit issued a Summary Judgment[4]. Additional cases have supported the above precedent.

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[4]A Summary Judgment is a court ruling stating there is no genuine issue of material fact and the party is entitled to prevail as a matter of law.

The problem with law by precedent is that it is subject to subsequent challenge. The Air Force and Navy have felt secure in their position and pleased with the positive gains in the accident prevention area due to the concept of privilege. On 21 September 1982, the Ninth Circuit in Weber Aircraft Corp., etc. v. U.S. ruled that the legislative history of exemption 5 only mentioned two privileges--attorney work product and the executive privilege for predecisional deliberations and Accident Investigations cannot be exempted from mandatory disclosure [Ref. 41]. The Air Force, with the Navy's concurrence, is seeking legislation as a rider to the current Military Pay Bill to free investigations from disclosure[5]. Additionally, the Department of Defense has approved a legislative initiative which they hope to have introduced as separate legislation to the 98th Congress.

In order to accurately and completely ascertain causes and to determine corrective measures required to promote safety at sea the powerful deterrent of prosecution for candid responses must be removed. A separate safety investigation should be incorporated which should seek specific exemption, by statute, from release under the Freedom of Information Act.

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[5]Exemption three of the FOIA covers information "specifically exempted from disclosure by statute."

There is an obvious need for the Coast Guard to improve the relevance of the data base through interagency cooperation with the COE, updating cost figures after the insurance claims are settled, increasing the detail of transcribed data and simple reduction of data entry errors. An interesting fact is that the VTS system data mentioned is manually compiled and processed. Despite the fact that three existing systems are computer aided and the microcomputer market is unrestricted, the configurations do not include any data collection capability. This shortcoming does not allow the rapid accurate gathering of statistical information permitting future analysis [Ref. 42].

Finally, regulations indicate one additional deficiency. Subpart 4.07-(C)of CFR 46 calls for the Coast Guard to determine whether there is evidence that any Coast Guard personnel or any representative or employee of any other government agency caused or contributed to the cause of the casualty. The Coast Guard has operational responsibility for traffic control systems, licensing of operators and approval of ship safety standards. Therefore, it is sometimes placed in the position of having to expose deficiencies in its own operations while investigating marine accidents. Currently, an autonomous group, the National Transportation Safety Board (NTSB) exists to perform an independent investigation of major marine casualties as defined in CFR 46 Subpart 4.40. The meeting of criteria for a major casualty status is determined by the Coast Guard, in a preliminary investigation, as per CFR 46 Subpart 4.40-10, the Coast Guard then notifies the NTSB.

An agency such as NTSB could relieve the Coast Guard of its self-policing burdens, to allow findings outside the jurisdiction of the Coast Guard.

E. COST BENEFIT DISCUSSION

Congestion is one of the problems the PWSA empowers the Coast Guard to deal with. When port approach congestion becomes evident, multiple courses of action are available to authorities. Strategies include: the improvement of navigational aids and pilotage services; deeper dredging or widening; the building of new berth facilities, increased port surcharges, introduction or upgrade of vessel guidance; scheduling or regulation schemes or better enforcement; or some combination of these solutions. All of the above modifications must be compared with the "do nothing" alternative which may prove the most attractive.

All the alternatives will ammend the economic port capacity and will have different returns based on capital expenditure and operating costs over the project life.

Although the two VTS goals of safety and facilitation of traffic were pronounced by the VTS Issue Study Volume 3, it recommended an algorithmic analysis which was based on the issue of safety. Expediting traffic was discarded as a specific objective of VTS as a result of a survey of maritime personnel. The survey indicated a wide acceptance of the safety goal but there was skepticism regarding the facilitation of traffic, in fact a sizeable proportion responded that a system may actually delay traffic.

An algorithm was developed to determine the current level of safety in the harbor or waterway and how VTS would effect this standard.

1. Algorithm

Conceptualization of the problem to determine the VTS requirements took on four stages as depicted in the VTS Issue Study Volume 3:

1. Develop a model to define the potential or expected losses for any port.

2. Define a relationship between VTS levels and reduction in potential losses.

3. Develop a procedure to determine the level of VTS required.

4. Develop a procedure for comparing the needs for VTS levels at individual ports, to obtain a relative ranking among ports.

Boundaries of the problem space were delineated by viewing accidents as preventable or not preventable by VTS. Unpreventable accidents were those involving maneuvering difficulty, due to wind or current; mechanical failure, which was sudden and unexpected; and personnel error which was undetectable by the VTC.

Categories of preventable accidents are as follows:

1. Collisions between two or more moving vessels.

2. Collisions involving a moving vessel and a vessel at anchor.

3. Rammings of fixed objects such as bridges.

4. Ramming of non-fixed objects such as floating or submerged objects.

5. Groundings.

Casualty statistics were further delineated by the type of damage, vessel type and the location as shown in the categories of Table 4, which also indicates the MCVR tape codes.

The potential hazard measurements are made with an expected value formulation. This can be expressed as hazard "H" per one-way transit in a through port "p" by a given vessel of class "k", involved in accident type "j" for each damage class "i" (Refer to Table 4).

The product of the probability of each accident (accident type, vessel class, port) and the average loss (type damage, accident type, vessel class, port) results in the expected hazard (loss).

The probability is determined by the quotient of the accident and transit totals, each in their categories. The average damage of each class is determined by the sum of the damage of each category divided by the accidents of each category. National averages were computed for vessel and

Table 4

Definition of Algorithm Categories

Symbol	Definition/Categories	MCVR* Codes: Card Columns	MCVR* Codes: Character Codes
i.	Type of Damage or Loss		
	1. a. Vessel damage	67-70	($ Thousands)
	b. Cargo damage	71-74	($ Thousands)
	2. Property damage	75-78	($ Thousands)
	3. Oil pollution (light/ medium/heavy)	21	1/2/3
	4. Personnel casualties		
	a. Killed or missing	51-58	(No. of persons)
	b. Injured or incapacitated	59-66	(No. of persons)
j.	Nature of Casualty or Accident	32-33	
	1. Collisions: moving vessels		1,2,3,6,7
	2. Collisions: anchored/ moored, docking/undocking		4,5
	3. Rammmings: fixed objects, piers, bridges, etc.		9
	4. Rammings: non-fixed objects		8,10,11,12
	5. Groundings		21,22
k.	Vessel Type		
	1. Cargo ship	13-14	02
	2. Tank ship	13-14	17
	3. Freight barge	13-14	03,28
	4. Tank barge	13-14	18,29
	5. Tugs and towboats	13-14	09
p.	Location or Port		
	1. Various	45-47	Various

* Coast Guard Marine Vessel Casualty Reports Computer Format

cargo loss; number of pollution incidents and deaths/injuries for the years 1969-1971. Property damage was considered port unique and was left to the specific application to determine.

Probability calculations are employed so to be able to utilize the laws of probability when combining accident probabilities derived from historical data with predicted future losses based on traffic projections.

Confidence limits are defined to evaluate the degree of uncertainty in the values of the point estimates calculated. An F distribution for the probability of an accident is used, since it is defined as the ratio of two random variables (accidents and transits) with assumed normal distribution. The student-t distribution was assumed for the damage calculations.

A case-by-case analysis of each vessel casualty which had occurred in a given port was the next procedure to be conducted. The analysis determined which accidents would probably have been prevented if a VTS of a specified level (Table 2) had been in effect. The number of vessel casualties in each category judged to be preventable can then be used to calculate a revised set of accident probabilities. Additionally, the total losses which occurred in the accidents judged preventable indicate the expected savings that would result from VTS, representing half of a cost-benefit assessment.

Application of this analysis is necessarily subjective and requires detailed examination of the causes and circumstances of each casualty. It should be applied by personnel familiar with the port conditions and location, utilizing the accident investigation. The specific criteria established, for which VTS level prevents which type of accident, was established in the VTS Analysis of Port Needs study and is summarized in Appendix C. Appendix D contains the form utilized to assist in the accident prevention determination.

The comparison of ports occurs once the algorithm has been applied, all accidents classified, and the level of VTS calculated. Savings are presented as dollars of property, vessel and cargo loss prevented; pollution incidents avoided; and death/injuries prevented. The savings must be compared with a cost curve for the system to be implemented. High savings may be indicative of the requirement for a complex multi-sectored system to prevent the accidents. The optimal level must be selected based on marginal analysis.

2. Algorithm Application

The results of the research efforts in the algorithm development of the VTS Issue Study Volume 3 was applied in the VTS Analysis of Port Needs study in August, 1973. Twenty-two ports and waterways were selected for analysis based on cargo tonnage, vessel transits and the number of vessels involved in collisions, rammings and groundings.

The algorithm was adjusted, based on the inadequacies of the data base. Annual vessel and cargo loss values calculated were multiplied by two to account for unreported accidents (discussion page 29). An additional factor of two was applied to adjust for underestimated damages (discussion page 30). The product of the study was the ranking of twenty-two ports, which formed the basis for the implementation of VTS in specific areas. The combined summary and recommendations of VTS is presented in Table 5.

Based on the VTS Analysis of Port Needs results, the Coast Guard began producing planning proposals for the areas of New York, New Orleans, and Houston/Galveston. San Francisco and Puget Sound VTS systems had previously been established in 1972.

3. General Accounting Office Critique

As the Coast Guard identified the requirements and designed the VTS systems for the above ports, the General Accounting Office (GAO) was performing an investigation of VTS development. This report entitled, "Vessel Traffic Systems - What is Needed to Prevent and Reduce Vessel Accidents", was issued on 21 January 1975.

The GAO Report was a scathing criticism of the Coast Guard's VTS development effort. The report begins by

Table 5

Combined Summary: Composite Ranking of Ports and Waterways and Initial VTS Level Selections

	Relative Ranking of Estimated Annual Damages Caused by C/R/G				Relative Ranking of Estimated Annual Reduction due to VTS			Composite Ranking Total
Port or Waterway	Dollars	Pollution	Deaths/ Injuries	VTS Level Selections*	Dollars	Pollution	Deaths/ Injuries	
New York	1	1	2	$L_0 2L_2 2L_3$	1	1	1	7
New Orleans	2	2	1	$2L_2 L_3$	2	3	2	12
Houston/Galveston	3	3	3	$L_2 L_3$	4	4	3	20
Sabine-Neches (ICW 265-290)	4	4	6	$L_0 2L_2$	6	5	6	31
Chesapeake Bay	5	8	4	$L_0 L_2 L_3$	9	9	4	39
ICW 80-99 (Morgan City)	9	5	10	$L_R L_2$	3	8	7	42
ICW 107-129 (Cote Blanche)	13	6	12	L_4	5	2	5	43
Baton Rouge	11	9	14	L_2	7	7	9	57
San Francisco	8	17	5	$L_2 L_5$	11	10	8	59
ICW 50-69 (Houma)	18	12	15	L_2	8	6	10	69
Chicago	10	18	13	L_R	10	11	11	73
Delaware River & Bay	7	7	9	L_0	17.5	17.5	17.5	75.5
Tampa	6	10	11	L_0	17.5	17.5	17.5	79.5
Puget Sound	16	20	8	L_2	12	12	12	80
Mobile	12	13	17	L_0	17.5	17.5	17.5	94.5
Detroit River	14	22	7	L_0	17.5	17.5	17.5	95.5
ICW 155-179 (Vermillion River)	19	11	18	L_0	17.5	17.5	17.5	100.5
St. Louis	15	16	21	L_0	17.5	17.5	17.5	104.5
Long Island Sound	20	14	19	L_0	17.5	17.5	17.5	105.5
LA/LB	17	21	16	L_0	17.5	17.5	17.5	106.5
Corpus Christi	21	15	20	L_0	17.5	17.5	17.5	108.5
Boston	22	19	22	L_0	17.5	17.5	17.5	115.5

*Multiple selection indicates the area is sectorized, for example, New York has one L_0, two L_2 and two L_3 sectors.

illustrating the collision and dollar loss figures which demonstrate the severity of the problem. The report quotes Coast Guard officials and documents, then reveals how the Coast Guard's behavior was not in agreement with these references. GAO felt the Coast Guard effort had been misdirected toward more sophisticated VTS systems in few ports rather than a simpler VTS in more ports [Ref. 43]. They accused the Coast Guard of inaccurate cost/benefit analysis [Ref. 44]. Additionally, they viewed that the Coast Guard had been slow in implementing vessel movement regulations and those that were enacted lacked overall direction and were inconsistent [Ref. 45]. The published report indicated the Coast Guard's political defenses were unguarded, after delaying their response twice, in early October, 1974 and late November, 1974 [Ref. 46] the Commandant's comments were issued in late February, 1975.

The Coast Guard successfully refuted the analysis of the GAO, demonstrating the inaccurate utilization of the data base, by the GAO, for both accident and cost benefit analysis. The Coast Guard's analysis of the GAO figures for accidents revealed they included MCVR data of American flag vessels experiencing accidents in foreign waters over which VTS could exercise no control [Ref. 47]. They proved the GAO's cost analysis and discipleship for increased VMRS level VTS did not accurately reflect life-cycle costs, since it did not include extensive manpower costs. The Coast Guard stated that the division between sophisticated and basic systems was not with the inclusion of surveillence devices, as GAO argued, but with the implementation of a manned VTC which dramatically increased life-cycle costs [Ref. 48]. The Coast Guard concurred in GAO's analysis with regard to regulation, countering with the fact that the complexity of the task requires that regulations receive careful scrutiny. They pointed to several examples of established regulations, stating the "promulgation of regulations under the Act [PWSA] has not been rapid, but the progress has been steady" [Ref. 49]. The Coast Guard failed to illustrate that an algorithmic analysis is based on the prediction of increased congestion followed by increased probability of accident, which can be a powerful influence on increasing the VTS level in a port or waterway.

The GAO report illustrates the nature of the organization, one which makes simplistic arguments, lacking depth or factual analysis, but has intuitive Congressional appeal (in this instance spread the VTS wealth to many ports). GAO is a master of impact, presenting easy to read graphs, startling pictures, in double-spaced, carefully orchestrated, subtitled construction. A GAO report generally is on target in that the program is not being optimized, but they often overstate their case. The organization's purpose is satisfied if they coerce the agency into a re-evaluation of their behavior and criterion for the initial analysis. While the Coast Guard was successful in defending the VTS program, the headlines were generated by the original GAO report and the Coast Guard's Congressional support was injured. The Coast Guard's internal confidence was bruised and a careful and complete defense did not avoid long-term deleterious effects to the VTS project. They repeatedly testified to Congress on the inacuracies of the GAO report, twice at length [Ref. 50] [Ref. 51], in an attempt to restore their damaged reputation. This diminished presence is confirmed in that Congress authorized funds for the installation of surveillance radar at New Orlean's VTS, but stipulated the funds not be used until the Coast Guard completed a comprehensive study of the communications and electronic surveillance needs of the entire New Orleans area [Ref. 52]. This development had a profound effect on VTS New Orleans and will be discussed in Chapter III.

The self-assured, bold statements such as:

> "The Coast Guard believes it alone possesses sufficient expertise in this new discipline [VTS] to determine the minimum level required in each port or area" [Ref. 53].

> "The Coast Guard intends to implement the vessel traffic system program on the basis of cost/benefit considerations and national needs" [Ref. 54].

are not based on confidence, but indicate the defensive posture of the Coast Guard. The GAO challenge was the prologue for a general decline in VTS effort. While the programs continued, and were administered competently, they were without the earlier intense sponsorship.

4. Algorithm Examination

The GAO chose not to censure the weakness and application of the algorithm as presented in the two studies; those flaws will be elaborated upon.

The algorithm was developed to exploit the existing data bases. The advantage of having pre-existing data bases is offset if the content is inaccurate (Section D3). The most striking weakness of the application in the VTS Analysis of Port Needs study is the reliance on correction factors to attenuate the inadequacy of the data. While the analysis, though subjective, was proper and subsequently has been documented by VTS log data, the rigorousness is subjective and not statistically stable. The selection of a multiple of four exposed the Coast Guard to accusations that such a procedure would allow an analyst to come to any conclusion by simply deciding what the outcome should be and choosing the data adjustment factor accordingly. In fact, the Ad Hoc Committee for Ports and Waterways in New Orleans made a similar indictment [Ref. 55].

The inaccuracy of the data discussed in the previous section, coupled with the adjustment factor superimposed over a small sample size gathered over three years, makes the outcome suspect. The study failed to follow an adage of Mark Twain's: "Get your facts first, then you can distort them as much as you please."

Although subsequent studies have performed sensitivity analysis on the variables [Ref. 56] to illustrate the effects of the coefficients, no such investigation was performed in the 1973 study.

The algorithm does not attempt to handle the results of a catastrophic accident since the data is aggregated. The danger of this approach is that the average accident will not be debilitating; the marine disaster, however, will have far-reaching effects. The problem is two-sided, aggregated data producing an average will serve to hide a significant accident in a large data base or a large accident will overstate the evaluation in a small sample. Either case will tend to distort the result. The disaster is not an outlier causing perturbations in the analysis but a genuine part of the population which must be handled. Although the base would be small it would be preferrable to handle the catastrophic accidents in a separate analysis, determine the VTS needs to avoid, and decide if the cost benefit ratio exists to justify the more complex system. Alternatively, the reduced probability of the disaster may allow the build up of reserves in savings with the lesser system, so a large loss can be managed. Overlayed on this analysis and not taken into account, is the fact that each accident has the potential to assume cataclysmic proportions A reduction in this potential is not accounted for in the model [Ref. 57].

The costs of a vessel, with respect to lost operating revenue due to an accident, is not accounted for in the model. With vessel costs between twenty-five and forty thousand dollars per day [Ref. 58] [Ref. 59], this sum could easily be greater than estimated repair costs.

The algorithm does not allow for the benefits of the facilitation of commerce. VTS could permit a harbor to remain active despite retarded visibility, thereby avoiding vessel demurrage and enabling full harbor employment.

The benefits of the algorithm are expressed in the losses avoided by:

1. Damage to the vessel and its cargo.
2. Property damage.
3. Pollution damage.
4. Death/injury avoidance.

Comparisons among ports can be accomplished by contrasting the factors; this can become subjective (how does one equate property damage to pollution incidents). The conversion of the factors to dollars via an application of weighting factors is also subject to potential controversy. For example, there has always been a dispute about how to establish a dollar value for a death or serious injury.

Arraying the factors separately and ranking each casualty type separately appears the best way to arrive at the result with the least dispute (Table 5).

A major difficulty with this algorithm or any model which is developed based on past data is that there is no surety that the future will reflect the past. Any changes in conditions which might effect marine casualties will lessen the effectiveness of the model unless they are taken into consideration. Increases in commerce, changes in the variety of vessels and more reliable operators are all factors of the port analysis.[6] The fear of Very Large Crude Carrier (VLCC) transits through American ports, might produce a factor which would operate to increase the VTS level; more proficient operators, more modern navigation equipment and decreased traffic density due to fewer transits, might aid the suppression of accidents therefore assisting VTS effectiveness. Environmental pressures which caused dredging delays resulted in these fears never materializing in American ports. The reopening of the Suez Canal, the oil glut, depressed shipping rates, inflated ship-building costs, high ship operating costs, served to limit VLCC expansion.

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[6]The hysteria which followed Noel Mostert's "New Yorker" articles and subsequent, well written but highly subjective book <u>Supership</u>, had unique widespread effects on port development.

Therefore, a prediction which reckoned on a safety margin for VLCC's would be incorrect.

The advantage of using past data, particularly if adjusted for known or predicted modifications, is that it allows the port hazard and weather conditions to be automatically included in the model, since these factors clearly impacted on the casualty statistics. The approach avoids the need to develop possibly highly variable judgments about the relative risks various vessels encounter in different ports under current conditions [Ref. 60].

Ideally, if the data base is large enough, a casualty predictor should be able to be developed for each port based on the data. The Houston/Galveston VTS Casualty Analysis study produced just such a predictor, simply the product of the number of transits and the commerce in tons. A correlation factor of .98 resulted and least squares line produced a formula for casualties [Ref. 61]. Although the limited data has not been evaluated in different ports, it verifies what is naturally assumed: casualties are related to amount of commerce and transits. This type of tool, available from the algorithm can be utilized to increase or decrease the level of VTS, or the port facilities, based on their effect on the predicted casualties.

The probabilistic and statistical data which is generated, all must be overlaid onto the political structure which may yield entirely unexpected answers. This structure will be examined in Chapter III.

5. Simulation

The VTS Analysis of Needs study produced a list of ports and the recommended level of VTS to avoid preventable accidents. The next phase requires current, port unique data. This data is gathered via a specially equipped Coast Guard trailer, with the capability to record radio channel communications and radar images [Ref. 62]. This raw data is then analyzed to produce: 1) vessel density at various locations; 2) identification of port routes; 3) compilation of vessel close encounters; 4) vessel speed; and 5) radio channel loading and efficiency [Ref. 63]. The data, gathered over a period of several days, is then manually manipulated to produce the optimum location for surveillance and radio equipment, and confirm the VTS level and sector assignments arrived at in the VTS Analysis of Needs study. The problem with this approach to system design is that the analysis is based on limited observed data which is subject to distortion in the extraction of the above variables. Additionally, the manual manipulation of the data is exposed to subjectivity based on the degree of experience and familiarity with the port, embodied in the analyst.

To provide an improved caliber of precision concerning equipment, sight selection and a strictly quantifiable accident reduction percentage attributable to VTS, simulation modeling should be utilized as a tool.

Proper simulation involves the abstraction of essential components of a problem to provide accurate portrayal, while eliminating unnecessary complexities which obscure the facets to be observed. This synthesis is highly complex, involving initially the extraction of the correct problem to be analyzed, and the selection of the details to be targeted for elimination or inclusion in the model. In a simulation effort the purpose and methodology must be firmly established; if this is not the case, our input techniques will create a trend in a truly random pattern. Additionally, the level of model accuracy is important and its sensitivity to varying coefficients must be understood. The accuracy and completeness required is determined by the decision to be made, generally the slicker the simulation, the more incapable it will be in handling exceptions. A VTS simulation model must be designed to evaluate traffic flow, VTS capacity, safety and capacity of a specific port, without overemphasis on less important factors. Obviously the simulation model must be designed with sufficient capacity and be easily modifiable to conform to a variety of port unique characteristics while not effecting the model's basic operation.

The analysis of these concepts in the design produce a clearer concept of the interrelating effects of a VTS, harbor, vessels, and the environment. There are definite advantages to following a simulation approach. First, the synthesis and abstraction produce the important variables to be considered, without sacrificing accuracy. A VTS model should abstract the major variables of: vessel characteristics, harbor characteristics, vessel routes, and rules of engagement scenarios (following the rules of the road). Variables such as vessel wind loading, bank suction, or squat are not necessary since traffic behavior, and not detailed, individual vessel response, is the intent of the model.

The ability to repeat the analysis is a second advantage. Data can be generated under controlled conditions; small modifications can be applied and the effects examined. The comparison of nearly identical situations can result in an optimal (within model limits) solution.

The third advantage is flexibility. Real world situations can be simulated, upon which can be layered a variety of traffic management techniques.

Simulation models in general have two limitations which must be understood. If the model is too large and /or the computer is too small, the simulation will not replicate the actual operation but respond slower. If the model gets too complicated, representing each detail of vessel operation it is likely not to produce an accurate depiction.

The most important limitation is in the input data and design of the model, an improper or unvalidated model may produce irrelevant or inappropriate data.

The Coast Guard experience with VTS simulation was initiated with an attempt to modify aircraft simulations to reflect vessel characteristics [Ref. 64]. The analysis produced error since the scope of the study was too narrow. The study was to identify aircraft simulation models the Coast Guard could use with minimal change and get good results. The conclusions of this study found that any conversion would only result in a temporary solution. Coast Guard efforts, therefore, were applied to manual analysis.

There was a failure to conceptualize appropriate aircraft models and abstract useful portions because of the view that there was a large difference between the two applications, the aircraft model being complicated and the VTS model more simplistic. Failure to see parallels in the model resulted in a delay in VTS simulation. The model differences that aircraft operate in three dimensions, at a higher rate of speed, therefore need information more rapidly, can be abstracted as an exact match to vessel control. The abstraction is possible due to the vast difference in controlability between aircraft and ships. A Boeing 747 weighs 300 tons, has 200,000 horsepower and a variety of control surfaces to effect a maneuver. A VLCC of 300,000 tons has approximately 40,000 shaft horsepower and minimum control capability. The aircraft is 1000 times lighter and has six times the horsepower. The ship needs information in a timely fashion, just as the aircraft does, since it must anticipate and begin its maneuvering early. The ship needs to have the capability to detect small perturbations in its position since its reaction is so slow, early analysis is required to permit timely response.

A simulation model was contracted for in 1978, and finalized in July 1981 [Ref. 65]. The model appears excellent and validated well in the design tests, an analysis is beyond the scope of this study. The lack of VTS development, briefly mentioned in the GAO section, and the current moritorium on VTS [Ref. 66] (discussed in Chapter III) has not allowed the model to be fully tested.

6. Conclusions

The primary fuel for a cost benefit study, or needs investigation, which might produce an obvious, easy to implement, overlooked solution is accurate, timely, precise data.

With a small amount of data, a great deal of imaginative thinking is required. The vital ingredient to this process is viewing the problem remotely, to avoid a myopic view, most often the resulting design will be significantly simpler. This also avoids the danger of becoming too involved in technique while disregarding the purpose of the analysis.

The GAO in directing their analysis on the degree of hardware involved, vice the data analyzed, portrayed a common American malady. Hardware studies and applications attract more attention than traffic data gathering or analysis. Research concerning equipment is easier, in that the results are more concrete, therefore the investigation is more exciting and accumulates more recognition. The nation is enamored with technological solutions and has a fascination with gadgets which results in research conducted with little thought to incorporating it into the operating systems. Therefore the technological intent, however excellent, doesn't blend into the application with harmony but rather appears included as if an afterthought. The lack of effort in data gathering and analysis to obtain a better understanding of underlying traffic theory is an enigma, since that should be the basis upon which hardware development decisions are made. With complete data, pragmatic solutions to problems can be pursued, limiting the problems of disjointed research, which often provides more areas for investigation than clarifications. The multiple factors effecting the outcome of reliable modeling make it imperative to get accurate, complete data.

The Coast Guard's defense of utilizing closed circuit television as a VTS surveillance technique, illustrates the above conjecture. The justification for the ill-fitting, useful, but minimally cost effective fascination was shallow and unsubstantiated [Ref. 67].

The Coast Guard failed to step back and demonstrate the validity of the algorithmic model; instead they attacked the GAO analysis. This failure was probably prompted by the fear that the data base and statistical adjustments would be challenged. They chose instead to go on the offense vice defend the algorithm.

Cost-benefit analysis with the algorithm is excellent. The approach is simplistic, readily understandable, without complex mathematics, so Congressional investors can be easily convinced of the validity.

The algorithm is a crude approximation which demonstrated an order of magnitude improvement in safety as the result of VTS investment. It is expandable, in that simple simulation techniques can easily be embroidered on the model to magnify the results. The algorithm fulfils the Coast Guard's objectives as stated in a 1971 position paper, "Vessel Traffic Services and Systems" and echoed in Congressional testimony:

> "...to select the minimum level of services and systems required in each port or area to minimize the hazards to vessels, fixed objects and the environment with the least public cost, disruptions of marine traffic and economic impact."

An interesting contrast exists in foreign VTS development. The concept of foreign VTS's is to maximize the efficiency of the docks, coordinate pilotage, and promote optimum vessel throughput by the careful management of vessel movements. This approach emphasizes economics and varies from the more narrowly defined objective of increased vessel safety fostered in the United States. European port authorities install and operate VTS to make the port more attractive to maritime trade by the facilitation of traffic movement. Safety is considered a subset of the orderly movement of traffic. This view is motivated by the keen competition for trade, between ports, to allow products and raw materials to reach the European interior. With vessel costs astronomical, a swifter turnaround in a port will be an inviting prospect. Therefore government and private investment has been aimed at improved facilities to ensure an increased profit and success against neighboring countries so as to improve balance of payment margins.

To increase throughput you generally need a higher level of VTS than would be required to maximize safety. This higher level would increase the efficacy of the port with respect to its neighbors and the question that is evoked is whether VTS should serve the entrepreneural ambitions of the port. This question intimately weds economic issues with politics. The political implications will be examined in Chapter III.

III. POLITICAL/IMPLEMENTATION ISSUES

The appeal and exigency for VTS is persuasive; the combination of equipment and people, both shoreside and at sea, and regulations designed to make maritime transportation in an area safer. Marine traffic management, space management with which we have engendered extensive experience on the highways, airways and railways, is a familiar concept. Intuitively, shore based authorities can have a more complete view of the overall traffic problem than any individual ship. Their surveillance equipment can be better. They can gather more sources of information and more quickly integrate the results. They have enforcement power for traffic rules and regulations and can orchestrate one way movement and queuing systems.

While there might be some dispute as to the degree of safety enhancement achieved by VTS schemes, Congressional testimony received throughout the country from a complete representation of marine interests, indicates general support for the above statement.

The striking nature of the analysis that determined where to install VTS was that the benefits were not compared to the advantages returned from alternatives, which would increase the safety (reduce the congestion) of the port or waterway. Rather, the analysis simply decided the VTS level, if any, that would produce a favorable benefit to cost ratio in a marginal optimization. Since 1977, on the basis of findings of cost-effectiveness analyses, the Coast Guard has not proposed to add new VTS installations or to make major system upgrades to existing systems [Ref. 68]. During this same time period the ports of Europe and Asia have vastly expanded traffic management systems in scope and sophistication. Additionally, more ports have initiated VTS based on the philosophy that traffic would be facilitated.

Evidently the safety justification for VTS development has reached its limit, however, the increments to be accrued from such investment have not been fully realized. The rejection of traffic facilitation as a goal has a more fundamental reason than the uncertainty of mariners, expressed in the <u>VTS Issue Study, Volume 3</u>,; it is derived from the Constitution.

Federal policy with respect to port development, has been one of nondiscrimination, the origins are found in Article 1, Section 9 of the Constitution which provides, in part, that:

> "No preference shall be given by any regulation, of commerce or revenue to the ports of one State over those of another..."

The policy of nondiscrimination has promoted a tension which has characterized American society from its beginning, egalitarianism versus elitism. There is a pressure for "no preference" to assure that funds appropriated are distributed geographically as widely as possible, versus support for the best or most economically correct solution from a regional or national viewpoint. Current economic constrictures have indicated that the capital intensive nature of port and harbor development will not permit the support of ineffective or second best ports in the misguided interest of political egalitarianism.

Background for formulation of the constitutional policy noted above was centered on a need to develop a long, relatively undeveloped coastline into that of a maritime power. Inefficient land transportation avenues fostered the necessity to develop all of the natural ports along the seaboard in order to most efficiently receive and distribute products from and to the hinterland. Basic mistrust of centralized government left port and harbor planning and development at the state and local level. Aid, provided by the Army Corps of Engineers (COE) in the form of dredging and port and harbor technical assistance, represents the largest federal support. While a VTS developed to promote public safety and preserve environmental quality was recognized as required, one aimed at increased traffic flow would represent preferential treatment. The emphasis is to maintain geographic uniformity, so as not to provide one state or region with an economic advantage.

This fragmented structure, based upon limiting discrimination, historically presented no problem in port development. Although some excess capacity resulted, the costs were not very large and growing trade generally matched the port expansion. Recent advances in shipping technology and environmental concerns impacted on this constitutional precedent, producing the imperatives which require the establishment of a regional or national policy focusing on port development.

Traditional break-bulk cargo vessels, of relatively small size, allowed the development of a large number of port facilities, each serving its own economic area, each harbor having the depth to service most commercial carriers. The absence of the environmental concerns of dredge spoil disposal and coastal zone management, permitted channel dredging and greater port land usage to expand in proportion with the slow growth in vessel size. This combination of simple shipping technology and the absence of environmental regulations kept port development cost low [Ref. 69].

Rapid technological advances, with the introduction of containerization and intermodal services, have dramatically increased the capital intensity of port facilities required to accommodate the movement of cargo. The larger size of these vessels, along with the increased size of dry and liquid bulk carriers, to reduce the unit cost of shipment, has required deeper harbors and channels. The cost of development increased further due to heightened environmental awareness concerning the disposal of dredge spoils (from 6.5% to 1519%) [Ref. 70]. Additionally the length of the approval process has grown enormously during which capital investment is stagnant, unable to adequately serve the intended ship population. The Coastal Zone Management Act of 1972 encouraged state and local governments to limit shoreside development with a concomitant dramatic increase in land acquisition costs for port expansion.

Decisions on where to install VTS cannot be made independently, but must be examined in the context of total port development. An installed, overloaded VTS may be adequate if additional berths are available, an option which may be more cost-effective than enlarging the VTS. The elements of port operations must be examined together to permit optimization and further, they must be examined regionally to distinguish how best to allocate scarce resources.

Where to invest in increased VTS parallels the controversy concerning which harbors and waterways to dredge. Historically, navigation channels in American ports have been the responsibility of the Federal Government. Dredging and subsequent maintenance has been conducted by COE using funds appropriated by Congress. As a consequence, the entire port structure has been developed on the assumption of continued federal responsibility. Ports have been built, rates set, expansion plans drawn based on the above involvement, channel construction and maintenance have not been included in the cost structure.

COE cost benefit analysis only investigates if the local benefits outweigh the dredging costs, never noting if a competing port or channel facility would be a more appropriate investment.

A national port development policy to decide how best to allocate resources for dredging, VTS development and increased capital investment for shore infrastructures is required, but clearly outside the limits of the Constitution. The current Administration's solution to this dilemma is to cut government expenditure in the area of dredging, forcing the ports to assume the costs. The policy is consistent with the recovery of clearly allocatable costs from users. User fees is a seventies concept [Ref. 71] given increased intensity under the banner of "New Federalism." In testimony before the Senate Sub-Committee on Water Resources, OMB Director David Stockman voiced the administration's position:

> "I believe that not requiring users to bear the full cost of their activities encourages overdevelopment of high cost ports.... Instituting a market test of the value of port maintenance and development will eliminate dredging that users are unwilling to pay for and establish quickly, where dredging is economically viable" [Ref. 72].

Since this port expense is unplanned the effects on port authorities and state and local governments is profound.

The framing of port policy via a market mechanism saw twelve separate pieces of legislation debated in the Ninety-Seventh Congress with no compromise emerging [Ref. 73] COE is currently developing a new legislative iniative involving regional coordination and partnership with less than full federal cost recovery [Ref. 74].

The policy of cost recovery is also the subject of review with respect to VTS. The recommendations in the Coast Guard Roles and Missions Report were as follows:

> 1. For those ports where a Vessel Traffic Service could be operated by a State or local organization and that organization is willing to assume the responsibility, the operations should be turned over to the local authorities under general supervision by the Coast Guard. Any existing VTS which a qualified State or local authority is not willing to take over should be closed, unless the Secretary determines that compelling national needs require its continuation.
>
> 2. For VTS's operated by the Federal Government, the costs of operating such systems should be recovered from the primary beneficiaries of the service through an appropriate user charge policy.

An internal Coast Guard review, as required by the Roles and Mission Study, is currently being conducted to determine the need for VTS.

Authentic cost benefit can only be achieved by weighing all port development alternatives against each other. Under the current fragmented control structure this is not possible. The establishment of a lead agency to coordinate a licensing procedure for all options including VTS, through which port or local authorities could weigh the alternatives is required. The Coast Guard, or bureau directly concerned, could act as a regulatory agency to ensure uniformity, so to facilitate foreign and interstate commerce.

In the long run, traffic regulation and the operation of priority rules should attempt to reduce the cost of ship time in port and maximize the difference between the costs of regulation and the benefits of reduced delay with the system. Similarly, it will be worth investing in wider or deeper approach channels, if the benefits of the reduction of delay exceed the extra capital costs. Benefits for either of the above schemes would not be realized if a docking queue existed, so the total structure of the port must be viewed in allocating investment dollars.

The problem with facilitation analysis of VTS is that the assessment of the expected _future_ yield is made from _available_ data. The lack of experience with similar investments make reasonable assessments difficult. Unique investment considerations always produce results which are considerably less reliable.

The lack of firm data makes the analysis difficult. Yet broad appraisals can be made from the limited data to indicate and quantify the definite positive gains from VTS installation. Such an evaluation was determined for the

Houston/Galveston VTS [Ref. 75]. A conservative estimate of 50,000 transits was assumed (conservative based on COE or VTS estimates). An average transit time of two hours was assumed yielding 100,000 transit hours per year. VTS statistics indicate a three percent reduction in transit time, which results in 3,000 transit hours per year savings. If an average vessel cost is $10,000 per day, the yearly savings due to VTS presence is $1,250,000. The reduction in transit times must be formally quantified via a program which automatically analyzes origin, and destination points and transit time and arrays this data into a statistical base. The cost-benefit justification, while difficult, when summed with the hazard reduction figures, can produce a clear gain. The ability to move in reduced visibility also offers areas for additional revenue capture.

The willingness of local and state authorities to assume VTS operations will be a direct outgrowth of the confidence local mariners display in the service, demonstrated by their participation. Despite difficulties in arriving at a cost-benefit ratio vocal support from local industry will override strict cost-benefit considerations.

The PWSA was very specific in its provisions to ensure the Coast Guard consulted all facets of the marine industry when establishing the rules and regulations for a VTS. To ensure success of the early systems, deliberations with maritime industry were extensive.

There was a distinct measure of political risk aversion in the adoption of the original VTS location. San Francisco was chosen due to the relative simplicity of the harbor, therefore adequate radar coverage could be achieved with the minimum amount of equipment. Additionally, a pilot operated Marine Exchange provided a service similar to VTS, so the port was familiar with the concept. The Coast Guard District Commander interfaced with all aspects of marine industry to solicit their views and implemented their ideas in the design [Ref. 76]. The Coast Guard's careful site selection and involvement of users guaranteed successful implementation.

Puget Sound was chosen for the second VTS installation ostensibly due to predicted increases in tanker traffic caused by the Alaskan pipeline and to be able to interface with the British Columbia VTS. Extensive upgrades to the system in 1976, despite being fourteenth out of twenty-two in the _VTS Analysis of Port Needs_, indicate the decision may have been politically motivated. The deep water port is not very difficult to navigate and the state of Washington has exhibited a strong commitment to marine safety and environmental sanctity[7]. Therefore, Coast Guard VTS investment selection was planned to achieve success. Re-investment in the upgrades is suspect due to the relative safety accounted for in the VTS Analysis of Port Needs. This may be attributed partly to a political need to demonstrate high performance ability of an installed VTS in the wake of the GAO critique and partly to the fact that the Chairman of the Senate Committee on Commerce, Science and Transportation, a staunch supporter of the PWSA and the Coast Guard, was Warren G. Magneson of Washington.

Analysis of extensive Congressional hearings [Ref. 78] [Ref. 79] on the topic of VTS uncovers substantial differences in support for the concept directly attributable to the degree of consultation the Coast Guard conducted with local constituents.

An ideal system design technique was utilized in the formation of VTS New York, where a formal VTS Advisory Committee was formed consisting of a Coast Guard and local marine industry, per the tenants of the Federal Advisory

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[7]A Washington state law enacted in 1975 (Substitute House Bill No. 527, Ch. 125, 44th Sess., 1975) called for, in part, that tankers in excess of 125,000 DWT be prevented from proceeding up the channel beyond a certain point and that tankers between 40,000 DWT and 125,000 DWT must have (a) shaft horsepower in ratio of one for each two and one-half DWT; (b) twin screws; (c) double bottoms; and (d) two radars. The law eventually declared void by the Supreme Court [Ref. 77] illustrates Washington's desire to protect her estuary.

Committee Act of January 1, 1972. While some minor dissent was expressed there appeared to be, overall, complete communication and common agreement between the regulators and the users. Involving the users in the design process produced a design which was supported by all parties[8].

The above design was in marked contrast with that pursued in establishing the New Orleans VTS. The Congressional testimony featured dissatisfaction, indictments of cover-ups of unnecessary expenditures [Ref. 81] and heated debate. All previous VTS design initiatives had utilized advisory committees, however, administration attempts to limit this proliferation throughout the Federal structure in 1974 resulted in regulations which made committees more difficult to establish [Ref. 82]. The Coast Guard determined the PWSA did not require a committee, only consultation, and a District request for an advisory group was denied [Ref. 83].

The results of this denial can be observed in a comparison of the participation rates between

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[8]The New York VTS was never fully established. The design, owing to the harbor configuration and traffic density, was complex. Statement of work and design inadequacies made the extensively computer aided system incapable of handling vessel loading in a real time fashion. System bugs and inconsistent performance debilitated the design and the contract was terminated for the convenience of the government [Ref. 80]. New York VTS operations were suspended in March, 1982, demonstrating that agreement, while vital, does not necessarily achieve a capable final product.

Houston/Galveston VTS and New Orleans VTS. Houston/Galveston VTS has shown a voluntary participation rate in excess of ninety-five percent for the entire system [Ref. 84], whereas, New Orleans VTS participation statistics indicate a participation rate as low as fifty-five percent [Ref. 85].

This figure demonstrates the significant implementation problems of the New Orleans VTS. These problems can best be described in an excerpt from a "Fair Play" editorial entitled "You do it MY way":

> "Interested persons are invited to particpate in this proposed rulemaking by submitting written views, data or arguments. Each person submitting a comment should include his or her name and address and give reasons for each comment. All comments received before the expiration of the comment period will be considered before final action is taken on this proposal. It is important that all interests be encouraged to submit their comments. Besides giving those affected by proposed rulemaking the impression that they are in some way participating, the large quantities of paper thus generated enable the department, after suitable shredding, to considerably econmize on its winter fuel bills" [Ref. 86].

Incidents such as described in Appendix E presented before a national symposium on piloting and VTS [Ref. 87] do little to engender faith in the VTS concept. The Rules of the Road [Ref. 88] clearly provide that a smaller more maneuverable vessel will not hamper a vessel in a channel constrained by her draft, yet the Coast Guard proved impotent and unable to enforce the regulations in a space they controlled. The inability of the Coast Guard to manage the harbor space, can only eventually result in tragedy, followed by strict regulations.

Following Congressional hearings in 1975-1976 [Ref. 89] [Ref. 90], which painted the Coast Guard in an unfavorable light the agency originated a series of articles in trade journals to elicit support for VTS. The campaign pursued two tactics: one, an appeal to the business community and two, a solicitation for maritime industry support. A "Business Week" article [Ref. 91] appealed to national pride, stating we had gotten a late start but "have developed the most modern equipment". In "Marine Engineering/Log" [Ref. 92] the reliability and accuracy of the system was described and the potential benefits to users were detailed.

Continued intense interface with the maritime community is required of the Coast Guard to persuade users of the benefits, difficult to ascertain from the soft database.

Specifically, the following areas which result in friction must be mutually understood by both the Coast Guard and the maritime community and measures enacted to mitigate the effects.

The mariners fear of VTS as a controller must be allayed. The word control has ominous overtones to the tradition of the independent mariner. The word suggests to the mariner the usurption of his responsibility and freedom to act independently to manuever his vessel according to his own training and judgment, with no reduction in accountability. This anxiety translates to VTS being viewed as a "spying network for the Captain of the Port" [Ref.93]. There is a feeling that a statement such as:

> "It must be clearly understood that the responsibility for the safety of any vessel and its crew remains with the Captain or Master and cannot and will not be assumed by the VTS" [Ref. 94]

is meant to be a disclaimer of liability [Ref. 95] vice assurance that the Coast Guard has no designs on the traditional authority structure. Pilot job security and the questioning of his qualifications are subsets of his loss of control. There is still no clear understanding of VTS as a service and adjuct to a pilot permitting him to perform his job in a more capable manner.

A second issue is the unreliable nature of the data received from a VTC. This criticism is directed toward systems without surveillance techniques, strictly VMRS. Industry has demonstrated that the value of information based on reporting and dead reckoning by computer is, at best inaccurate and worst, extremely dangerous. There is no check for non-participating ships, vessels with radio-failure or non-towing vessels below 65 feet, all will be unknown to the computer but capable of inflicting serious collision damage. Inaccurate reports of speed and varying currents can produce wide tolerances in where ships will meet, unapprehended by the VTC. In a harbor or waterway with any volume VMRS will not work, and produces great risks for those who rely on the information. It is interesting to note VRMS is the system recommended by GAO. The added communications burden to ensure the dead reckoned trace is updated, further reduce the pilots ability to perform his job. The output given ships does not justify the input, there is little assistance for piloting. The Congressional removal of funds for surveillance equipment for New Orleans VTS makes it the only major system operating in strictly a VMRS mode.

Finally, the issue of training of VTS operators has caused consternation to maritime trades. The VTS is manned by Coast Guard officers and men who receive on-the-job training and are subject to frequent transfers. While there should be no requirement for the watchstander to be a pilot, air controllers are not, industry feels the training is inadequate.

The solutions to the above confidence and operator problems can be solved by more closely involving pilots in the operations of VTC. The expense of making VTC operators civil servants may be overriding, but having a VTC operator as a military career specialities is possible[9]. Employing a pilot as a coordinator of training would increase the

[9]Recent overtures by the Coast Guard to designate the billets as career specialties resulted in adverse reactions from the VTC operators [Ref. 96].

awareness of the Coast Guard operator and the confidence of the mariner. Requiring a manning rotation which would have a pilot supervise a VTS watch, would offer a transfer of expertise and achieve basic, but vital communication between ship and shore. Apprentice pilots should be required to stand a significant number of watches in the local VTC, prior to gaining journeyman status. Further, pilots should be required to file a passage report and negotiate their movement plan with the VTC, and follow the plan as far as reasonable, once it is approved [Ref. 97]. Pilots thus becoming field agents of VTS, could aid in the enforcement of regulations, reporting ships who violate mandatory traffic separation schemes or refuse to move ships they found improperly manned or equipped [Ref. 98].

Training of the VTS staff and complete involvement of the user organizations is a requisite to safe, efficient operations.

The PWSA was ammended on 17 October 1978 as the Port and Tanker Satety Act in the wake of tanker disasters[10]. The new

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[10]The Argo Merchant ran aground and sank off Cape Cod on 15 December 1977. Although small (27,000 tons), the threat to Georges Bank fishing grounds produced sensation [Ref. 99]. Two days later, the Sansinena (Torrey Canyon sister ship) exploded in Los Angeles Harbor killing nine persons. Other significant December accidents included: Oswego Peace, December 24; Olympic Games, December 27; and Grand Zenith, December 29. In total fifteen casualties occurred between 15 December 1977 to 27 March 1978. The Amoco Cadiz disaster on 10 March 1978 is, to date, the worst tanker accident.

act renewed Congressional intent to utilize VTS as a method to reduce the hazards in ports and waterways and that section is substantially unchanged. For reasons of efficiency, it is important that the Coast Guard and marine industry collaborate to optimize VTS and not let a disaster cause Congress to legislate improved user/regulator interface.

Among the improvements required to increase marine industry's willingness to invest in VTS is an improved data base to quantify proofs, and to entice the involvement of the insurance industry. If actuary rationale can be found for VTS and marine industry offered reduced premiums, their participation would be assured. To ensure complete success, participation is insufficient, what is required is full involvement and committment to the goals, demonstrated, by continued dialogue and suggestions for improvement.

There has been recent evidence of the maritime community's recognition of the value of VTS. Department of Transportation budget cuts for 1982 prompted the announcement by the Coast Guard to close San Francisco and New Orleans VTS in March of this year.

The Coalition To Save VTS was formed in San Francisco, comprised of both United States and foreign flag operators trading regularly in the Bay area. The Coalition began levying a $125 fee on all vessels arriving in San Francisco Bay, receiving a high compliance ratio [Ref. 100]. The

Coalition petitioned the Secretary of Transportation and Congress to continue the service, demonstrating a willingness to pay their fair share and suggested ways to make the operation more effective. The funds were restored by Congress. The Coast Guard and the Coalition are currently in negotiations to determine apportionment.

New Orleans VTS was closed on 15 March 1982. After a brief shutdown, the industry, in the area which voiced the most opposition to VTS, began petitioning Congress to appropriate funds for the VTS's operation. The Coast Guard received funds but had already transferred a large percentge of personnel. New Orleans VTS resumed operation on 1 September 1982.

IV. CONCLUSIONS

The most pressing requirement in organizing a productive VTS, from the vantage of both hazard reduction and expediting traffic, is the expansion and enrichment of the accident and transportation data bases. A uniform, automated data collection system should be established which would extract relevant data from the individual VTS files. The Coast Guard should interface with the Corp of Engineers to determine if transit data can be refined and expanded to better identify traffic density. The collection of accident statistics needs to be improved so underlying causes can be discovered, in order to revise bridge structure and equipment and how VTS will interface with the pilot or master. The necessity for an automated data base which require casualty and transit statistics will probably necessitate a complete overhaul of MCVR and transit files.

With the foundation of an accurate data base concerning traffic and casualties, the use of simulation models should be expanded and validated. The beauty of relevant simulation is that benefits can be quantified more precisely. The percent reduction in accidents of a certain type can be determined by applying the model before and after a management scheme is imposed. The product of that reduction and the dollars the accidents will cost, as determined from the algorithm, will give dollars saved. Additionally, the effects of increased port loading on the management system can be easily determined. From this data you can calculate the marginal investment return to be realized from system upgrade or re-design. The large amount of data that can be generated to specific dimensions can answer the difficult question: If routing measures, designed to reduce collision, by drawing vessels closer to one another, in fact increase the risk of accident? The inherent problem is that the results obtained would be no better than the validity of the assumptions made regarding the accident and traffic projections.

Research efforts on VTS, in addition to data base improvements, should focus on establishing international requirements for shipboard transponders. The technological and cost tradeoff must be examined to arrive at the optimum mix. The equipment must possess the ability to utilize data link communication to avoid voice communication problems, accomplish specific identification and permit accurate location. This must be an international effort through IMCO to avoid the navigation equipment problems that have occurred in the past: where the governing body for the Malacca Straits required a Decca Navigation; Japan demanded Satelite Navigation equipment; while a joint Arabian Gulf navigation board demanded compulsory Omega; and Western European countries and America desire still another navigation suite. Similar examples can be sited where ships which travel world wide require seven different sewage disposal systems [Ref. 101]. Unilateralism in establishing the requirements of this inexpensive, yet highly effective surveillance aid, must be avoided to promote international cooperation and prevent the proliferation described above.

If our ports are to effectively compete with those of Canada and Mexico, regional port councils must be formed to focus investment dollars on those ports and projects which promise the highest return. Only by overcoming the parochial attitudes which dominate the port associations today, will ports emerge with the necessary capital and concentrated lobbying power to permit intelligent, accelerated development.

The efforts of the Reagan administration to recoup clearly allocatable user fees from dredging and VTS operations, has served to coalesce the port lobby, so they can be adequately represented during the negotiations which will determine their continued existence [Ref. 102]. While some of the larger natural harbors have rejected the symbiotic regional partnership, pressure from the maritime trades have caused their concession [Ref. 103]. The ability of that lobby to secure fast-track legislation for dredging and marshall funds for port infrastructure and VTS upgrading will determine their effectiveness. The current proposals concerning user fees for dredging will establish the pattern, the Coast Guard will follow to decentralize their operation of VTS. The Coast Guard, however, must at the same time, intensify research efforts.

The time period following the GAO criticism of the Coast Guard has generally found the agency following the mandates of the Port and Tanker Safety Act but in a methodical fashion, with no real enthusiasm. The evolution of VTS has been plodding. Initially the Coast Guard sought its new mission with zeal, evaluating the new authorization as an extension of their traditions, to make the waterfront safer. The Coast Guard generally regarded favorably, for no one could argue with or denigrate their lifesaving mission, have been embroiled in a much more complex issue which involved tradeoffs not previously experienced. The age of environmental awareness has placed the Coast Guard between warring factions polarized in their beliefs. While the determinations made can be argued, the necessity of a referee to judicate and arrive at the correct decisions for waterways which are both environmentally and economically sound is indisputable.

The Coast Guard's role as a regulator of waterway and shipping standards can only be maximized through exacting well-defined research, and intelligent compromise, based on the analysis. The analysis accurate and complete, the Coast Guard must be willing to persevere, responding to disapproval with incisive, sensible observations. The political acumen of the Coast Guard has been whet over the past ten years in the transition from predominately a service agency to one heavily involved in regulatory tasks.

The Coast Guard requires political support of powerful regional, environmental and maritime lobbies to compete for scarce Federal funds. With these funds they can continue and enhance the research to reduce costly shipping accidents.

Too many narrow seas and saturated harbors exist to avoid the concept of VTS. Though some local, isolated resistance remains, the world trend toward intelligent traffic management and successful implementation in this country have demonstrated the profits of improved waterway safety. The Coast Guard must zealously promote VTS, while allaying fears that they might exercise total control. While VTS is not a panacea, it must perform an integral role in accident reduction.

Report of Vessel Casualty or Accident (CG-2692)

DEPARTMENT OF TRANSPORTATION U. S. COAST GUARD CG-2692 (Rev. 3-67)	REPORT OF VESSEL CASUALTY OR ACCIDENT	Form Approved Budget Bureau No. 48-R114.5 REPORTS CONTROL SYMBOL MVI-4017

INSTRUCTIONS

1. An original and two copies of this form shall be submitted, without delay, to the Officer in Charge, Marine Inspection, in whose district the casualty occurred, or in whose district the vessel first arrived after such casualty.
2. If the person making the report is a licensed officer on a vessel required to be manned by such officer, he must make the report in writing and in person to the proper Marine Inspector. If because of distance it may be inconvenient for such an officer to submit the report in person, he may submit the required number of copies by mail. However, to avoid delay in investigations, it is desired that reports be submitted in person.
3. This form should be completed in full; blocks which do not apply to a particular case should be indicated as "NA". Where answers are unknown or none, they should be indicated as such. All copies should be signed.

NOTE. (1) Report all deaths and injuries, which incapacitate in excess of 72 hours, on CG 924E whether or not there was a vessel casualty.
(2) Attach separate Form CG-924E to this report for each person killed or injured and incapacitated in excess of 72 hours as a result of the vessel casualty reported herein.

TO: Officer in Charge, Marine Inspection, Port of	DATE SUBMITTED

I PARTICULARS OF VESSEL

1. NAME OF VESSEL	2. OFFICIAL NUMBER	3. HOME PORT	4. NATIONALITY
5. TYPE OF VESSEL (Frt., pass., tkr., etc)	6. PROPULSION (Steam, diesel, etc)	7. GROSS TONNAGE	8. REGISTERED LENGTH OR L O A
9. HULL MATERIALS	10. YEAR BUILT	11. RADIO EQUIPMENT ☐ TRANSMIT ☐ RECEIVE	☐ VOICE ☐ CW (Key)
12. (a) RADAR EQUIPPED ☐ YES ☐ NO		(b) IF YES, RADAR OPERATING AT TIME OF CASUALTY ☐ YES ☐ NO	
13. (a) CERTIFICATE OF INSPECTION ISSUED AT PORT OF		(b) DATE CERTIFICATE OF INSPECTION ISSUED	
14. (a) NAME OF MASTER OR PERSON IN CHARGE (Indicate which)		(b) DATE OF BIRTH	(c) LICENSED BY COAST GUARD ☐ YES ☐ NO
15. (a) NAME OF PILOT (If on board at time of accident)		(b) PILOT SERVING UNDER AUTHORITY OF LICENSE ISSUED BY ☐ USCG ☐ STATE ☐ FOREIGN	
16. (a) NAME OF OWNER(S), OPERATOR(S) OR AGENT (Indicate which)		(b) ADDRESS OF OWNER(S), OPERATOR(S), OR AGENT	

II PARTICULARS OF CASUALTY

17. (a) DATE OF CASUALTY	(b) TIME OF CASUALTY (Local or zone)	(c) ZONE DESCRIPTION	(d) TIME OF DAY ☐ DAY ☐ NIGHT ☐ TWILIGHT
18. LOCATION OF CASUALTY (Latitude and longitude; distance and TRUE bearing from charted object; dock; anchorage; etc.)			
19. BODY OF WATER (Geographical name)	20. RULES OF THE ROAD APPLICABLE ☐ INLAND ☐ GREAT LAKES ☐ WESTERN RIVERS ☐ INTERNATIONAL ☐ OTHER (Specify)		
21. (a) DID CASUALTY OCCUR WHILE UNDERWAY: ☐ YES ☐ NO			
(b) IF YES, LAST PORT OF DEPARTURE		(c) IF YES, WHERE BOUND WHEN CASUALTY OCCURRED	

22. (a) WEATHER CONDITIONS WHEN CASUALTY OCCURRED: ☐ CLEAR ☐ PARTLY CLOUDY ☐ OVERCAST ☐ FOG ☐ RAIN ☐ SNOW ☐ OTHER (Specify)						
(b) VISIBILITY (Miles, yds., ft., etc.)		(c) WIND DIRECTION	(d) FORCE IN KNOTS	(e) GUSTY ☐ YES ☐ NO	(f) AIR TEMPERATURE	
23. (a) SEA CONDITIONS WHEN CASUALTY OCCURRED	(b) SEA WATER TEMP (If available)	(c) HEIGHT OF SEA	(d) DIRECTION OF SEA	(e) HEIGHT OF SWELL	(f) DIRECTION OF SWELL	
24. (a) NATURE OF CARGO (Specify)	(b) AMOUNT OF DRY CARGO (Long tons)		(c) AMOUNT OF BULK LIQUID (Long tons)	(d) AMOUNT OF DECK LOAD (Long tons)		
25. (a) DRAFT FORWARD			(b) DRAFT AFT			
26. (a) TYPES OF LIFESAVING EQUIPMENT USED, IF ANY			(b) NO. LIVES SAVED WITH LIFESAVING EQUIPMENT	(c) LIFESAVING EQUIPMENT SATISFACTORY ☐ YES ☐ NO (If no, explain in item 34)		

PREVIOUS EDITION MAY BE USED (Over)

27	CREW	PASSENGERS	OTHER (Specify)	28 ESTIMATED LOSS/DAMAGE TO YOUR VESSEL	$
NUMBER ON BOARD				ESTIMATED LOSS/DAMAGE TO YOUR CARGO	$
DEAD MISSING				ESTIMATED LOSS/DAMAGE TO OTHER PROPERTY	$
INCAPACITATED (over 3 days)				(Specify whether vessel, dock, bridge, etc.)	

29 NATURE OF THE CASUALTY (*Check one or more of the following. Give pertinent details in item 30.*)

	COLLISION WITH OTHER VESSEL(S) (*Specify*)		EXPLOSION/FIRE (*Other*)
			GROUNDING
			FOUNDER (*Sinking*)
	COLLISION WITH FLOATING OR SUBMERGED OBJECTS		CAPSIZING WITHOUT SINKING
	COLLISION WITH FIXED OBJECTS (*Piers, bridges, etc.*)		FLOODING SWAMPING ETC. WITHOUT SINKING
	COLLISION WITH ICE		HEAVY WEATHER DAMAGE
	COLLISION WITH AIDS TO NAVIGATION		CARGO DAMAGE (*No vessel damage*)
	COLLISION (*Other*)		MATERIAL FAILURE (*Vessel structure*)
	EXPLOSION/FIRE (*Involving cargo*)		MATERIAL FAILURE (*Engineering machinery, including main propulsion, auxiliaries, boilers, evaporators, deck machinery, electrical, etc.*)
	EXPLOSION/FIRE (*Involving vessel's fuel*)		
	FIRE (*Vessel's structure or equipment*)		EQUIPMENT FAILURE
	EXPLOSION (*Boiler and associated parts*)		CASUALTY NOT NAMED ABOVE
	EXPLOSION (*Pressure vessels and compressed gas cylinders*)		

30 DESCRIPTION OF CASUALTY (*Events and circumstances leading to casualty and present when it occurred. Attach diagram and additional sheets, if necessary*)

31 DAMAGE (*Give brief general description and state if vessel is a total loss.*)

III ASSISTANCE AND RECOMMENDATIONS

32. AUTO ALARM TRANSMITTED BY YOUR VESSEL: ☐ YES ☐ NO

33(a) ASSISTANCE RENDERED BY STATIONS AND VESSELS (*Include Coast Guard and other stations and vessels*)	(b) OTHER ASSISTANCE RENDERED

34. RECOMMENDATIONS FOR CORRECTIVE SAFETY MEASURES PERTINENT TO THIS CASUALTY (*Include explanation of unsatisfactory lifesaving equipment*)

TITLE	SIGNATURE

GPO 949-632

Mishap Investigation Report (OPNAV 3752/1)

**MISHAP INVESTIGATION REPORT
ENCLOSURE PRIVACY ACT STMT.
AND ADVICE TO WITNESSES**
OPNAV 3752/1 (5-80) S/N0107-LF-037-5205

REPORT SYMBOL OPNAV 3752-1

THIS IS PART OF A LIMITED USE NAVAL AIRCRAFT MISHAP INVESTIGATION REPORT. LIMITED DISTRIBUTION AND SPECIAL HANDLING REQUIRED IN ACCORDANCE WITH OPNAVINST 3750.6

PRIVACY ACT STATEMENT AND ADVICE TO WITNESSES

This is a Privacy Act Disclosure Statement and a Statement of Advice to Witnesses provided under the authority of SECNAVINST 5211.5 and OPNAVINST 3750.6.

PLEASE READ THIS STATEMENT CAREFULLY. CERTIFY THAT YOU UNDERSTAND IT BY YOUR SIGNATURE AT THE BOTTOM

I understand that:

a. I have been requested to voluntarily provide information to a board conducting an investigation of a Naval aircraft mishap.

b. I *am not* being requested to provide a statement under oath or affirmation.

c. Disclosure of personal information by me is voluntary, and that failure to provide any such information would have no direct effect on me.

d. The purpose of the information provided by me is to determine the cause of a naval aircraft mishap and/or the damage and/or injury occurring in connection with that mishap.

e. All information provided by me to the Aircraft Mishap Board will be used ONLY for safety purposes

f. The information provided by me shall *NOT* be used:

(1) In any determination affecting my interests.

(2) As evidence or to obtain evidence in determining misconduct or line of duty status of killed or injured personnel.

(3) As evidence to determine the responsibility of myself or other personnel from the standpoint of discipline.

(4) As evidence to assert affirmative claims on behalf of the government.

(5) As evidence to determine the liability of the government for property damage caused by a mishap.

(6) As evidence before administrative bodies, such as Naval Aviator/Naval Flight Officer Evaluation Boards (USN) or Field Flight Performance Boards (USMC)

(7) In any other punitive or administrative action taken by the Department of the Navy.

(8) In any other investigation or report of the mishap about which I have been asked to provide information.

SIGNATURE			PRINT NAME *(First, Middle, Last)*
DATE	RANK/RATE	SERVICE	TELEPHONE NO.

WHERE YOU MAY BE LOCATED

STATEMENT *(Continue on reverse and attach separate sheet(s) if necessary.)*

APPENDIX C

Criteria for VTS Prevention Level Selection

1. Vessel Bridge-to-Bridge Radiotelephone (L_0)
   - Vessel collisions in waters where maneuvering room was available, and in which at least one of the vessels had prior knowledge of the other's presence.
2. Regulations (L_R)
   - Bridge rammings caused by excessive tow lengths or under powered tugs.
   - Bridge ramming due to a lack of coordination.
3. Traffic Separation Schemes (TSS) (L_1)
   - Vessel collisions that occurred in waters which had sufficient width and depth ammenable to a TSS and low to medium traffic density.
4. Vessel Movement Reporting System (VMRS) (L_2)
   - Accidents occurring as a result of two vessels meeting in especially critical and crowded restricted waters without advance knowledge of each other.
   - Accident caused by an apparent lack of traffic coordination where advance knowledge of movements will allow for queuing.

- Accidents caused by the lack of coordination between vessels in vicinity of barge fleeting areas and vessels in other critical areas.
- Accidents involving dangerous or hazardous material where priority movement might be considered.

5. Basic Surveillance (L_3)
   - It is difficult to determine whether surveillance would be necessary to prevent a particular accident. Applied in areas where the accident potential was so great that only a minimum error can be tolerated.
     - Critical intersections and bends particularly in restricted waters.
     - Collisions between a vessel underway and one anchored.
6. Advanced Surveillance and Automated Advanced Surveillance (L_4L_5).
   - In extremely hazardous and congested ports. Where the level of traffic density is high and the traffic patterns are diverse and complicated. Where it is thought a computerized queuing system would ease congestion and reduce delays.

APPENDIX D

Accident Prevention Determination Sheet

Accident Prevention Determinations

Case #____________________ ☐ Preventable ☐ Unpreventable

If traffic patterns or congestion in the area are such that L(O)(B to B) would not prevent the accident, what assistance is required from a source external to the ship to prevent the accident.

1. Reduce amount or complexity of information processing required.
   - ☐ a. reduce the number of ships in the area—L(2)
   - ☐ b. reduce the uncertainty about other ships' positions—L(2)
2. Give the vessel more time for information processing.
   - ☐ a. warn of other shipping—L(2)
   - ☐ b. reduce speeds, increase clearances—L(2)
   - ☐ c. environmental advisories—L(2)
   - ☐ d. advance warning of critical or hazardous areas—L(2)
3. Give vessel more or better information.
   - ☐ a. other ships' position—L(2)
   - ☐ b. knowledge of other ships' intentions—L(2)
   - ☐ c. position fixing—L(3)
   - ☐ d. central collection and broadcast of traffic data—L(2)
   - ☐ e warning of ship standing into danger—L(3)

(only the lowest level which will produce the desired result is shown; levels are refined after considering data elements 4-6)

4. Traffic congestion ☐ Hi ☐ Lo (judgement from a look at transits and use of local knowledge)
5. Traffic patterns ☐ Complicated ☐ Simple (judgement from a look at physical characteristics of area)
6. Accident congestion ☐ Hi ☐ Low (from a plot of all accidents)
7. Final level selected ____________

Diagram of Accident

Brief Narrative of Accident

APPENDIX E

VTS Incident

The following incident happened on August 17, 1979, just a couple of weeks ago.

It was a beautiful day and the blue fish were running in New York. Naturally, everybody that had a boat was out there fishing for blues. Of course, the blue fish, being smart, were staying between the red and the black buoys in the channel.

There were at least 150 boats in the area. There also was a ship called the EXXON NEWARK heading into New York, and I was on the 50,000 ton HESS VOYAGER about half a mile behind. Now, as the EXXON NEWARK's pilot came into Ambrose Channel, he could see that there wasn't a spot wide enough for even a small boat to pass through the fleet of fishing boats. He called me on the radio and said, "Jim, you better hold back because I have all these idiots up ahead of me." I said that I could see the problem and I slowed down.

He did what should be done. He called the Coast Guard and asked them if they could give him some assistance. He pointed out that there were at least a 100 boats in the Channel and that all of them were stationary. He blew the danger signal. At that time, we were to make vessel traffic reports on channel 12. But, the young man on 12 said that they had no control of the boats in our way to go back to channel 13. In the meantime, both of our ships were moving up the channel.

The pilot of the EXXON NEWARK called on channel 13, and, after a lot of discussion, finally spoke to a Lieutenant Commander who said, "Are those boats in your way?" When told that the boats were in the way, he asked if they were commercial or party boats and if the names of the boats in the way could be transmitted.

The pilot responded that he could not get the names of the boats, it was all he could do to handle his vessel. The Lieutenant Commander said that he would be back on the air shortly. After a long time, he did come back to say, "I am very sorry to tell you that there is nothing we can do for you at this time. But, if you get the names of the fishermen, we can go after them."

At this point, the Captain of the EXXON NEWARK got on the radio, "I am the master of the EXXON NEWARK and I am going to make this a formal protest." I cut in and said, "I will join in the protest," as did the captain of the HESS VOYAGER. He also suggested that they start a tape rolling. Of course, we don't know whether or not the transmissions were taped.

In the meantime, we both are changing course, changing course again and slowing down.

Two big tankers are both backing and filling so that Mr.

Jones can get his fish. So, we went back to Big Brother. We both called the Coast Guard again and asked that they please do something about the situation. They said that if we could get the names of any of the fishing boats they would go after them. They also said that they couldn't do anything about boats we couldn't identify.

I went on the air to say that I was a member of the Advisory Committee of the New York Traffic Service. I asked to be informed about who I could talk to about this type of situation. I had a sense of responsibility because I had been trying to sell the vessel traffic service system to everyone. I felt that it was a great thing; just what we needed.

Yet, all of a sudden, we were finding out that, even if we get a vessel traffic service system, we cannot control party boats. In the New york area, I estimated that there are about 733 million boats operated by people who know nothing about the rules of the road but know a great deal about the price of boats.

I wonder if the Coast Guard's vessel traffic service systems will only be able to control the party boats and the tankers, but not the little motor boats? I think that is a question that is very important to all of the pilots in the United States.

LIST OF REFERENCES

1. National Research Council, Maritime Transportation Research Board, Critical Issues in Maritime Transportation, July, 1980, pp. 11-12.

2. National Research Council, Research Needs to Reduce Maritime Collisions, Ramings and Groundings, Washington, D.C., National Academy of Sciences, 1981.

3. National Research Council, Human Error in Merchant Marine Safety, Washington, D.C., National Academy of Sciences, 1976.

4. U.S., Department of Commerce, U.S. Ocean Policy In the 1970's: Status and Issues, Washington, D.C.: U.S. Government Printing Office, 1978, p. VI-1.

5. Ersendrath, Charles R., "Environmental Protection: A State of Mind", Horizons USA, xx 1977, 26.

6. M'Gonigle, R. Michael and Zacker, Mark W., Polution, Politics and International Law, Berkeley and Los Angeles, California: University of California Pressi, 1979, p. 144.

7. Petroleum in the Marine Environment, Washington, D.C.: National Academy of Sciences, 1975, p. 6.

8. Porricelli, J. D. and Kieth, V. F., "Tankers and the U.S. Energy Situation: An Economic and Environmental Analysis", Marine Technology, October, 1974, pp. 353-355.

9. Grimes, C., "A Survey of Marine Accidents with Particular Reference to Tankers:", Journal of Navigation, XXV March, 1972, 501.

10. U.S. Department of Commerce, Ocean Policy In the 1970's, p. vi-4.

11. Gross, M. Grant, Oceanography: A View of the Earth, 2nd ed., New Jersey: Prentice-Hall, Inc., 1977, p. 334.

12. National Geographic, Vol. 139, No. 6, June 1971.

13. National Transportation Safety Board, Marine Casualty Report, *Collision Involving the SS Arizona Standard and SS Oregon Standard at the Entrance ot San Francisco Bay on January 18, 1971*, Washington, D.C.: Department of Transportation, 1971, pp. 18-19.

14. U.S., Congress, House, Committee on Merchant Marine and Fisheries, *Port and Harbor Safety Hearings*, before a subcommittee on Coast Guard Coast and Geodetic Survey and Navigation, House of Representatives, on H.R. 867, H.R. 3635, H.R. 8140 and H.R. 6232, 92d Cong., 1st. sess., 1971, p. 2.

15. Carson, Rachel L. , *The Sea Around Us*, New York: Oxford Univesity Press, 1951, p. IV.

16. U.S., Congress, *Port and Harbor Safety Hearings*, on H.R. 867, H.R. 3635, H.R. 8140 and H.R. 6232.

17. U.S., Congress, House, Committee on Merchant Marine and Fisheries, *Port and Harbor Safety, Hearings*, before a subcommittee on Coast Guard, Coast and Geodetic Survey and Navigation, House of Representatives, on H.R. 17830, H.R. 18047, 91st Cong., 2d sess., 1970, pp. 4-51.

18. Computer Sciences Corporation Report, *Vessel Traffic Systems Issue Study*, Vol. III, Los Angeles, Computer Sciences Corporation, 1973.

19. *Ibid*., pp. 4-51.

20. Hill, R. C., *Increased Safety Through Vessel Traffic Systems*, Proceedings of the Marine Safety Council, Vol. 30, Liverpool, Liverpool Polytechnic Press, 1973, pp. 252.

21. U.S. Coast Guard, *Vessel Traffic Systems, Analysis of Port Needs*, Washington, D.C., Department of Transportation, 1973.

22. U.S. Coast Guard, *Vessel Traffic Issue Study* , Report on the Issues, Vol. II, Washington, D.C., Department of Transportation, 1973, pp. 1-6.

23. Computer Sciences Corporation Report, *Vessel Traffic Systems Issue Study*, p. 4-2.

24. Dejean, G., *Marine Traffic Systems, The Pilot's View*, International Symposium on Marine Traffic Service, Liverpool, Liverpool Polytechnic Press, 1978, p. 265.

25. Fujii, Y., "A Semiquantitative Analysis on Marine Traffic Management Systems," Electronic Navigation Research Papers, No. 20, 1978.

26. Oraizi, Homayoon, Selection of a Marine Traffic Control System, International Symposium on Marine Traffic Service, Liverpool, Liverpool Polytechnic Press, 1978, pp. 170-187.

27. Computer Sciences Corporation Report, Vessel Traffic Systems Issue Study, p. 6-5.

28. Commander William J. Ecker, USCG, Casualty Analysis of Selected Waterways, International Symposium on Marine Traffic Service, Liverpool Liverpool Polytechnic Press, 1978, pp. 13-93.

29. Center for Wetland Resources, Lower Mississippi River Safety Study: Baton Rouge to the Gulf of Mexico, Baton Rouge, LA, Sea Grant Publishing, 1981.

30. U.S. Coast Guard, Vessel Traffic Systems, Houston/Galveston Casualty Analysis, Washington, D.C., Department of Transportation, 1981.

31. U.S. Coast Guard, Casualties Occuring vs. Casualties Reported, MIS Report, Washington, D.C., Department of Transportation, 1971.

32. U.S. Coast Guard, Analysis of Ports Needs, pp. 5-6.

33. Operations Research, Inc., Human and Physical Factors Affecting Collisions, Ramming, and Groundings on Western Rivers and Gulf Intracoastal Waterways, Report No. CG-D-80-78, Washington, D.C., Operations Research, Inc. 1979.

34. Potter, P. T., CG Vessel Traffic Service Program, Newport, R.I., Center for Advanced Research, Naval War College, 1980, pp. 55-56.

35. Center for Wetland Resources, Lower Mississippi River Safety Study.

36. U.S. Coast Guard, Houston/Galveston Casualty Analysis.

37. Ibid.

38. Air Force Regulations, 127-4 Section 19(a)(1), Jan. 1, 1973.

39. Air Force Regulations, 110-14 Section 1(a), July 18, 1977.

40. Brockway v. Department of the Air Force, 518 F. 2d 1184, 8th Cir., at 1190-91, 1975.

41. Weber Aircraft Corp., ETC. v. United States, 688 F.2d 638, 9th Cir., at 643, 1982.

42. U.S., Congress, Committee on Merchant Marine and Fisheries, Vessel Traffic Control, Hearings, before the Subcommittee on Coast Guard and Navigation House of Representatives on Vessel Traffic Control, 94th Cong., 1976, p. 275.

43. U.S. General Accounting Office, Vessel Traffic Systems - What is Needed to Prevent Vessel Accidents, Report to the Congress, Washington, D.C., Government Printing Office, 1974, pp. 7-10.

44. Ibid., p. 11.

45. Ibid., p. 14.

46. Ibid., p. 23.

47. U.S., Congress, Committee on Commerce, Ports and Waterways, Hearings, before the Committee on Congress, Senate, on Ports and Waterways Safety Act of 1972, 9rth Cong., 2d sess., 1976, p. 245.

48. Ibid., p. 244.

49. Ibid., p. 244.

50. Ibid., pp. 243-248.

51. U.S., Congress, Vessel Traffic Control, Hearings, pp. 2-20.

52. Center For Wetland Resources, Lower Mississippi River Safety Study, p. 2.

53. U.S., Congress, Ports and Waterways, Hearings, p. 244.

54. U.S. Congress, Vessel Traffic Control, Hearings, p. 10.

55. U.S., Congress, Vessel Traffic Control, Hearings, p. 285.

56. U.S. Coast Guard, Houston/Galveston Casualty Analysis, pp. 87-92.

57. Ibid., p. 20.

58. Ibid., p. 19.

59. U.S. Coast Guard, Analysis of Ports Needs, p. 17.

60. Computer Sciences Corporation Report, Vessel Traffic Systems Issue Study, p. 6-4.

61. U.S. Coast Guard, Houston/Galveston Casualty Analysis, p. 65.

62. McIntosh, J. A. and Brown, L. B., The Outfitting of a Vessel Traffic System Data Collection Trailer, Coast Guard Research and Development Center, Groton, Connecticut, Washington, D.C., Government Printing Office, 1974.

63. Buhler, L. and Geiger, J., Vessel Traffic Data Extraction Methodology, Silver Spring, Maryland, Operations Research, Inc., 1976.

64. Telsch, R. W., Applicability of Air Traffic Control Simulation Models to Vessel Traffic Systems, Mitre Corp., Bedford, Mass., Washington, D.C., U.S. Coast Guard, 1974.

65. Grassler, E. and Meader, N., Vessel Traffic Services Traffic Management Summary Report, Analytical Sytstems Engineering Corp., Burlington, MA, Washington, D.C., Coast Guard Office of Research and Development, 1981.

66. U.S. Coast Guard, Vessel Traffic System, Roles and Missions Report, Washington, D.C., Department of Transportation, 1982, p. 128-129.

67. U.S., Congress, Vessel Traffic Control, Hearings, pp. 227-228.

68. U.S., Coast Guard, Roles and Missions Report, p. 126.

69. U.S. Department of Commerce, Ocean Policy in the 1970's, p. v-4.

70. Comptroller General of the United States, Report to the Congress, _Dredging America's Waterways and Harbors_, Report to the Congress, Washington, D.C., Government Printing Office, 1977, p. 19.

71. U.S. Department of Commerce, _Ocean Policy in the 1970's_, p. v-9.

72. _Fairplay International Shipping Weekly_, 279, 3 September 1981, p. 12.

73. _Ibid_.

74. Srachn, Mike, United States Army, Office of Legislative Affairs, Converstion, December, 1982.

75. U.S. Coast Guard, _Houston/Galveston Casualty Analysis_, p. 92.

76. National Research Council, _Proceedings: Symposium on Piloting and VTS Systems_, Washington, D.C., National Academy of Sciences, 1980).

77. Dixy Lee Ray, Governor of Washington, et. al., v. Atlantic Richfield Company and Seatrain Lines, Incorporated, 98 S.CT. 988, 1978.

78. U.S., Congress, _Vessel Traffic Control, Hearings_.

79. U.S., Congress, _Ports and Waterways, Hearings_.

80. Lieutenant Scott Burnette, U.S. Coast Guard, Vessel Traffic Services, Conversation, 10 December 1982.

81. U.S. Congress, _Vessel Traffic Control, Hearings_, p. 167.

82. _Ibid_., p. 157.

83. _Ibid_., p. 136.

84. U.S. Coast Guard, _Houston/Galveston Casualty Analysis_, p. 34.

85. Center for Wetland Resources, _Lower Mississippi River Safety Study_, p. 224.

86. _Fairplay International Shipping Weekly_, 264, 24 November 1977.

87. National Research Council, Piloting and VTS Systems, pp. 168-170.

88. U.S. Coast Guard, Navigation Rules, Washington, D.C., Department of Transportation, 1977, Rule 9(c)-(d), p. 12, Art. 25, p. 199.

89. U.S. Congress, Vessel Traffic Control, Hearings.

90. U.S. Congress, Ports and Waterways, Hearings.

91. Business Weekly, Industrial Editorial, 2436, 14 June 1976.

92. Marine Engineering/Log International, LXXXIII, November, 1978.

93. Center for Wetland Resources, Lower Mississippi River Safety Study, p. 224.

94. U.S. Coast Guard, "Questions and Answers Relating to VTS New Orleans", June, 1976.

95. National Research Council, Piloting and VTS System, p. 141.

96. DeVoe, D. B., Abernathy, C. N., Royal, J. W., Vessel Traffic Service Watchstander Performance in Routine Operations, Cambridfge, MA, Transportation Systems Center, 1979, p. 43.

97. Koburger, C. W., Jr., Capt., "Pilots in the Marine Traffic System", Navigation: Journal of the Institute of Navigation, Winter, 1979-1980, p. 265.

98. Ibid., p. 266.

99. M'Gonigle, R. Michael and Zacher, Mark W., Pollution, Politics, and International Law, Berkeley, University of California Press, 1979, p. 127.

100. Fairplay International Shipping Weekly, 9 September 1982, p. 25.

101. Fairplay, 24 November 1977, p. 4.

102. Fiarplay, 3 September 1981, p. 12.

103. Ibid., p. 13.