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TANK VESSEL SAFETY REGULATIONS: THE ROLE OF MARITIME EDUCATION AND TRAINING IN THE UNITED STATES

BY

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Abstract

The severe environmental disasters resulting from certain tanker accidents in the past fifteen years has been the impetus for both a national and international reappraisal of existing safety standards.

In March 1977, the United States began to press for a speedy adoption of stricter tanker safety and pollution requirements while placing renewed emphasis on the formulation of mandatory, global crew training standards and certification criteria, due in part to the worldwide acknowledgement that over eighty percent of vessel accidents were caused by "human error".

With the signing of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, the United States addressed the major impacts of the new Convention requirements during Congressional hearings leading to the passage of the Maritime Education and Training Act of 1980, which revamped existing legislation into one significant act while clarifying and recodifying Federal, state and union relationships in the area of merchant marine training.

This paper examines the major details of the STCW Convention and the Maritime Education Act and their interrelationships to the American Merchant Marine training pipeline. The various programs which provide entry-level, selected advanced, continuing education and refresher training for our tanker personnel are discussed. The educational value and current status of the utilization of shore-based

simulators for "equivalency training" is examined in light of the increased sea training requirements presented in the STCW Convention. The inherent benefit of a well-balanced mix of simulator training and at-sea experience for the safe, professional operation of our Merchant Marine by the "human element" is stressed.

Finally, the total training concept is discussed with emphasis on improved bridge management, sound passage planning and effective vayage training to further upgrade tanker vessel safety.

World Trends

In the past decade, the world's industrialized nation's dependence on imported crude oil and upon increasingly large capacity tankers to carry this cargo, has been aptly demonstrated. To transport the world's petroleum needs, the major shipping companies have shifted their efforts toward more economically efficient carriage. With somewhere between 100 and 200 million tons of oil at sea at any particular time, the world tanker fleet is now represented by approximately one-half of its vessels in the Very Large Crude Carrier (VLCC) category (greater than two hundred thousand deadweight tons (200K DWT)).[1] This represents the most economical method of sea transport per ton of oil carried as chartering, operating and capital costs are a fraction of what they would be for much smaller (15 to 20K DWT) vessels. It would appear at first glance that an overall reduction in the number of tankers through introduction of newer, larger oil carriers would prove to be beneficial regarding safety standards at sea.

Certainly the fact that sea lanes might be less congested, more highly sophisticated equipment for navigation purposes is employed, and the most modern technological innovations are available, has not lessened either the number of ships lost yearly nor the environmental disasters resulting from tanker accidents such as the Argo Merchant and Amoco Cadiz. In the past few years there has been a continuing upward trend in the number of ships lost and the number lost yearly as a percentage of the total world fleet. According to Lloyd's Register of Shipping Information services, in 1979 about .5% of the total world's tonnage was lost due to accidents. Additionally, for the second straight year the number of ship losses exceeded 400, a 15 to 20 percent increase over the years 1974-1977.[2] The following chart depicts the upward trend in tonnage lost yearly and the tonnage lost as a percentage of the total world fleet at risk.

Annual Record of Tonnage Totally Lost: 1974-1979[3]

	World Fleet At Risk		Total Losses		
	No.	GRT	No.	GRT	Ton % World Fleet
1974	61,194	311,322,626	311	869,658	0.28
1975	63,724	342,162,363	336	995,621	0.29
1976	65,887	371,999,926	345	1,156,109	0.31
1977	67,945	393,678,369	336	1,073,127	0.27
1978	69,020	406,001,979	473	1,710,813	0.42
1979	71,129	413,021,426	400	2,304,000	0.49*

* Provisional figures for 1979 losses, final figures higher.

Accident rates for VLCC's are lower than smaller ships

according to data prepared by the United Kingdom Tanker Safety Group. This data was accepted by the Maritime Safety Committee of the Intergovernmental Maritime Consultative Organization (IMCO) for interpretation and computation of their accident statistics.[4] It is important to recognize that greater than 40% of the world's fleet and over 60% of United States flag vessels are represented by tanker tonnage.[5]

Regardless off the statistics, the severe results of tanker accidents have been the impetus both in the United States and internationally to enforce tighter shipping standards. The grounding and subsequent sinking of the Argo Merchant near the coast of New England in the winter of 1976-1977, together with a dozen other major tanker pollution and safety-related incidents, forced a reassessment of the entire tanker safety situation here. Likewise, the Torrey Canyon disaster of 1967 led to the formation of IMCO's Maritime Safety Committee which has the duty of considering shipboard navigation and safety matters and proposing changes or recommending action.

U.S. Trends

The United States began to work in early 1977 on unilateral actions to enhance tanker safety while pressing for the adoption of stronger safety and pollution control and prevention initiatives at the international level through the IMCO forum. During this period in a message to Congress, President Carter proposed tanker vessel improvements in the areas of crew training standards, vessel certification and inspection criteria and vessel equipment and construction standards. Internationally, these concepts have been the

subject of conferences and subsequent conventions or protocols. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, addresses minimum training requirements for all maritime nations. The 1978 Safety of Life at Sea (SOLAS) and 1978 Marine Pollution (MARPOL) Protocols address specifically improved vessel inspection and certification procedures along with construction and equipment improvements. Among these are radar requirements (larger ships must carry two which operate independently), installation of two remote steering systems, two or more individual power units for main steering gear (each capable of rudder control) and more frequent inspections and annual surveys for ships.

National initiatives for tanker safety improvements began immediately under the cognizance of the Coast Guard through promulgation of Tanker Safety Regulations. Although the Coast Guard was given power under the 1972 Ports and Waterways Safety Act to propose its own regulations independently of international treaty, the Coast Guard position was to wait for additional international agreements before acting. Thus the institution of unilateral, more stringent measures did not occur until the post-Argo Merchant time frame. These included institution of a stepped-up Vessel Inspection program which required foreign flag vessels entering our ports to submit to structural checks and examination of firefighting and cargo handling equipment. Regulations for navigation equipment improvements for ships over 1600 tons entering United States' waters were issued in mid-1977, including the authority to ban ships from entry or delay departures if problems

were of sufficient severity. Use of the Marine Safety Information System (MRIS) assists the Coast Guard in identifying ships who have been violators of safety regulations by providing a historical, computerized print out for individual vessels. Many of the aforementioned regulations were the foundation for the Port and Tanker Safety Act of 1978 in which the United States took unilateral action to achieve better safety and environmental protection for our nearshore and inland waters.

STCW Impacts

The international initiative which may very well have the greatest impact in the arena of safety is the STCW Convention. In the early 70's, a subcommittee of IMCO's Maritime Safety Committee was established to study the problem because "in view of the continuing alarming rise in maritime casualties and pollution, it is necessary for urgent action to be taken, aimed at strengthening and improving standards and professional qualifications of seafarers as a means of securing better guaranties of safety at sea and protection of the marine environment".[6] The STCW Convention represents a unique approach to the safety problem in that an acceptable minimum level of training is proposed vice the highest possible standards. It is clearly recognized that many nations will already have or be striving toward higher standards. Approaching improved safety from this vantage point appears very important from what we have learned from vessel accidents. Unfortunately, we have seen that not only substandard vessels go aground or have major accidents. Vessels, particularly

tankers, will only perform in a safe, efficient manner if the master and crew are competent, familiar with their ships' capabilities and well-trained, especially in emergency procedures. It also appears that it is a rare casualty which results from equipment malfunction or failure. The human factor has played a significant role in almost every report of tanker collision, grounding or other major accident. Shortly after the STCW conference the Secretary-General of IMCO emphasized the problem. "It is a major step forward towards ensuring maritime safety, particularly the safety of navigation and protection of the environment, because it has been recognized that over 80% of marine accidents are caused by human errors."[7]

A number of Congressional hearings were convened by the U.S. House of Representatives Merchant Marine Committee prior to the final drafting of these international maritime conventions. During this period a massive reexamination of international and national maritime safety regulations was progressing; initiated in the international sphere by IMCO with the pervasive support of the United States and on the domestic scene through intensified monitoring of vessels by the Coast Guard. Stricter navigational vessel construction and inspection regulations were formulated and eventually codified in the Port and Tanker Safety Act. As these measures were tightened, more emphasis began to emerge in the complex arena of our nation's maritime policies concerning formal schooling and retraining for our seafarers. In related safety hearings before the Subcommittee on the Merchant Marine, John H. Leeper, Senior Project Manager for the National Maritime Transportation

Board of the National Research Council/National Academy of Sciences testified on a study completed by the Board entitled "Human Error in Merchant Marine Safety". This was one of the first instances in which the man-machine relationship, at sea stresses affecting the seaman and the impact of sound training policies at all levels were presented to Congress. Some of the findings of the Board were rather startling. Although the United States was considered among the world's leaders in merchant marine safety, Lloyd's Register of Shipping reported that in 1973 the U.S. lost .21% of active tonnage through merchant marine casualty. This placed behind countries such as Great Britain, Sweden, USSR, Poland France, Germany, the Netherlands, Norway and Japan in safety performance. Additionally, Lloyd's reported that the largest number of vessel losses were by groundings, collisions, fires, and founderings, all of which involve human judgments.[8] Lending further credence to the argument that the human factor is a predominant cause of merchant marine casualties was the report in 1972 by the American Hull Insurance Syndicate that 85% of its claims were for casualties caused by human error; additionally, in fiscal year 1974, Coast Guard statistics showed that only 15% of the vessels involved in casualties reported material or mechanical malfunctions as the principal cause of the incident.[9]

The survey grouped the findings into many areas which tended to adversely affect human performance at sea. Among the most important cited were fatigue, physical fitness, alcohol use, emotional stability, personnel turnover and operational discipline. The survey consisted of a questionaire with detailed responses and follow-on interviews with 359

individuals.[10]

The survey was instrumental in directing Congressional effort into the area of training and certification revisions for our seafarers. A comparison between the levels of safety inherent in air versus sea transportation reveals radical differences as stated in Mr. Leeper's concluding remarks: "The conditions revealed in the survey have not been allowed to exist in air transportation, yet the potential for destruction is as great if not greater in the merchant marine."[11] Some of the recommendations voiced by Mr. Leeper formed a baseline for further study and legislation by the United States to advance existing training standards and certification policies.

> The task of upgrading the safety performance of merchant marine personnel will require a dedicated effort throughout the maritime community. Increased physical and mental standards can be enforced through required physical examinations. Problems in operational discipline and lack of vessel familiarization can be treated through improved training and the use of dynamic testing in the issuance and renewal of licenses.
> No officer should be allowed to stand a deck or engine watch on a ship unless he has had previous experience or special training on that type of ship...
> In the years of the 1980's maritime transportation will have an enormous impact on the energy and environmental concerns of both this country and the world. Not only will ships transport vast quantities of the world's resources but they will carry with them a continuing potential for creating death, destruction, and pollution on a scale unmatched by and other mode of transportation. This condition represents a grave challenge not only for the maritime community but for the Nation as a whole.[12]

The STCW Convention contains seventeen articles dealing with issuance of certificates to seafarers, provisions to cover the transition from state procedures to Convention procedures, educational and training equivalents to seagoing

experience, detainment or delay procedures for ships found posing a significant danger through non-compliance with the Convention, promotion of technical cooperation, amendment procedures and final clauses. The technical provisions of the Convention are included in an Annex containing six chapters. These provisions deal with mandatory minimum requirements for shipboard deck, engineering and radio departments. Basic procedures for maintaining required navigational watches, certification of masters, chief mates and officers-in-charge of ships are delineated. Certification for other watchstanders and continuing proficiency requirements are discussed.

Certification requirements for engineering officers are prescribed in another chapter and are defined in accordance with shipboard power generation capabilities. Watchstanding provisions are outlined for both conventionally-manned and more automated engine room facilities. Training continuum procedures for engineers are established.

The radio department is similarly discussed in terms of watchstanders' competency and required technical expertise to perform maintenance. Minimum essential qualifications for radiotelephone operators are described together with procedures to ensure updating of knowledge.

In an important chapter which was developed by the Subcommittee at the STCW Conference during June-July 1978, minimum standards for tank vessel personnel are discussed. Training and qualifications of masters, officers and ratings requirecompletion of firefighting courses, oil tanker familiarization training, cargo handling equipment and hazards

training, operational sequencing and oil tanker terminology. This chapter prescribes further training for more senior tanker personnel and for those charged with the responsibility for "loading, discharging and care in transit or handling of cargo".[13] According to the Convention these additional prerequisites are:

> (a) relevant experience appropriate to their duties on oil tankers; and
> (b) completed a specialized training programme appropriate to their duties, including oil tanker safety, fire safety measures and systems, pollution prevention and control, operational practice and obligations under applicable laws and regulations.[14]

Other important provisions of this chapter are minimum requirements for training and qualification of personnel manning chemical and liquified natural gas (LNG) tankers. The final chapter to the Annex deals with proficiency for certification in various survival craft.

The Convention will enter into force one year after acceptance by 25 nations owning among them 50% of the world's gross tonnage. As of December 1980, the Convention had been ratified by seven countries with 37% of the world's gross tonnage. Additionally, the STCW Convention utilizes the "tacit acceptance" principle for amendments. Amendments will be considered accepted two years after introduction unless one-third of the parties to the Convention owning among them 50% of the world's merchant ship gross tonnage object. This procedure has been found to accelerate the amendment process.

What then will be the effect of this Convention on the United States? Have the standards for training and certification been set too low? Is the established procedure for report and control of violations strong enough? Most

importantly, how will the individual nations institute the necessary training and control processes to raise their standards where necessary? These questions and many others concerning the STCW Convention have been debated. As previously noted, the standards are established internationally for the first time and although many of the highly industrialized shipping nations of the world already have in place more restrictive regulations, these minimum standards presently appear to be the best compromise situation. Despite the fact that some feel the standards were not set high enough, the Convention will undoubtedly have a positive effect on less-developed nations' merchant fleets and "flag of convenience" shipping, while standards comparable to those cited in the Convention are implemented as the date of entry into force draws closer. In the past few years, flag of convenience owners have seen this "handwriting on the wall" and in order to protect their lucrative business ventures have begun to channel more of their profits into improving previous low standards. Any qualitative improvement in world shipping should have a positive effect on the daily ingress of tankers at United States' ports.

The Convention has, also for the first time, set generalized international guidelines for the reporting of violations of the Convention. Requirements for detention of the violator are extremely limited, and in any case, where delay of departure is enforced, the ship is due compensation for time lost. The United States has stricter unilateral procedures in place for tankers entering our waters, i.e., the aforementioned Port and Tanker Safety Act. The inter-

national procedures of STCW should also have a positive effect on improved tanker safety. A very important point is that they postulate means for documentation of deficiencies in an international context which, heretofore had not existed.

The implementation of improved training standards by certain nations or the continued upgrading of maritime education and training by nations such as the United States, is a most pressing task. The utilization of refresher courses required at regular intervals, ensuring that those returning to sea duty are thoroughly indoctrinated in the required curricula for their certificates, the use of navigation and engineering simulators during regular, supervised training periods are among the tasks that will lead to comprehensive, positive improvements in the professionalism of our seafarers.

National Legislation

As previously stated, the coming into force of the STCW Convention should have positive benefits for the United States. The U.S. pushed for more sophisticated international standards and it was at our insistence that the STCW conference was convened during the summer of 1978 vice later in the year. The current U.S. standards for certification and training exceed Convention goals in almost every instance. Although some modifications to our existing training programs will be required, the provisions for "equivalent" training and the five year transitional period after the Convention's entry into force will permit the required orderly adjustments. These educational and training standards are a result of policies which have been evolving since the establishment of the

U.S. Merchant Marine and are contained in numerous national legislative acts and in the programs of our maritime academies and schools. Our nation's maritime education and training curricula are more closely related to the human performance factor in tanker safety than all the high technology and automation factors in shipping today. An examination of entry-level training, specialized schooling and refresher and on-the-job training, as well as national legislation dealing with maritime education and training affecting the safe, competent and professional performance of our merchant marine is therefore warranted.

The Merchant Marine Act of 1936 contains in a broad context the policy which fosters Federal participation in the training and education of our nation's seafarers. Under Table I, Section 101 of the Act, it is stated that:

> It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine... composed of the best-equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel...[15]

Section 216 of the Act provides for the Secretary of Commerce to maintain the United States Merchant Marine Academy (USMMA) for the preparation of officers to serve in the merchant marine as a third assistant engineer and/or third mate. Congress felt the need for additional legislation to support the training of maritime personnel and in 1940 passed the Civilian Nautical School Act, providing funding to schools other than state or Federal maritime academies who offered shipboard-based instruction for the purpose of training for merchant marine duty. The 85th Congress passed the Maritime Academy Act of 1958

with the purpose of assisting the states in the maintenance and operation of maritime academies for the education of future merchant marine officers. This act encouraged the idea of partnership between the states and the Federal government in not only providing a wealth of skilled, professional merchant officers but emphasized the training of Naval Science at the state level so that these personnel could serve competently to further enhance the capability of the merchant marine in time of war or national emergency.

Commencing in the mid-1970's, Congress desired to pull together the myriad collection of legislation dealing with maritime education and training into one significant act which would clarify and recodify the Federal-state-maritime union relationship. The task was assigned to a special subcommittee of the House Committee on the Merchant Marine/Fisheries. The Ad Hoc Select Subcommittee on Maritime Education and Training, initially under the chairmanship of Representative Studds and later Representative AuCoin, held hearings during the 95th and 96th Congresses. Their labors resulted in the signing on October 15, 1980 of the Maritime Education and Training Act of 1980, the most comprehensive bill concerning education and training of merchant marine personnel. As stated in the final report of the activities of the House Merchant Marine and Fisheries Committee, 96th Congress, the Act will:

> recodify the existing provisions of law concerning maritime education and training that are currently set forth in the Merchant Marine Act of 1936, the Maritime Academy Act of 1958, the Civilian Nautical School Act, and the numerous other provisions of law scattered throughout Title 46 of the United States Code. Additionally, the above recodified

> statutes have been amended to implement the recommendations of the Studds committee. Most ot the amendments pertain to the operations of the U.S. Merchant Marine Academy at Kings Point, N.Y. and the six State maritime academies or colleges located in Maine, Massachusetts, New York, California, Texas, and Michigan. As so amended, the recodified statutes are set forth as a new title, Title XIII, in the Merchant Marine Act of 1936.[16]

The primary provisions of the Act are:

(1) a five year service obligation for graduates of the USMMA. Active duty Naval service with enlisted status is the alternative to completion of merchant marine service.

(2) prohibition against training foreign nationals except as specifically authorized in other legislation.

(3) authorized Federal support to regional academies.

(4) Federal student incentive payments are authorized in a "fair and equitable manner".

(5) authorizes the Maritime Administration (MARAD) to provide cadet training (comparable to USMMA at sea training) at sea aboard commercial ships.

(6) Secretary of the Navy may appoint state maritime school students as midshipmen in the U.S. Naval Reserve.

(7) state academy graduates who receive Federal support will incur a three year service obligation.

(8) incorporation of the Civilian Nautical School Act with basically no changes.

(9) continuation of supplementary training currently provided by MARAD.

(10) authority to provide surplus marine equipment to approved maritime training schools.

In a report issued during Ad Hoc Subcommittee hearings,

another rationale for passage of the Maritime Education and Training Act can be found:

> (the Act) provides even-handed Federal support of Federal and State maritime academies so that current and projected shortages of merchant marine officers for U.S. flag vessels can be accomodated as efficiently as possible...will ensure that graduates go to sea.[17]

There exists various means for an individual to complete the required training and qualify as a merchant marine officer. The four primary suppliers of officers are the USMMA, the six state operated maritime academies or colleges, the Marine Engineers Beneficial Association Calhoon school and the "Hawsepipe", in which unlicensed seamen obtain the prerequisite training through experience and on-the-job training, take the examination for third assistant engineer or third mate and receive their initial license as a merchant marine officer. Before taking the written exam, candidates must meet citizenship, age and sea experience requirements. The Coast Guard administers the licensing and certification program, including management of the written exam. Although the Coast Guard is intimately involved in vessel safety and crew certification standards, they do not conduct merchant marine training per se. The Coast Guard-MARAD relationship in this area has been succinctly stated by Rear Admiral W.M. Benkert, USCG:

> Our program does not perform training of merchant crews. That is a statutory responsibility of the Maritime Administration. We do, however, work closely with MARAD, through a joint memorandum of understanding to insure the correct meshing of crew qualification standards and crew training.[18]

The Department of Commerce's Maritime Administration-sponsored education programs:

> help provide well-trained personnel for the American merchant marine, help coordinate maritime labor policies with national and international organizations; provide "hands-on" training to qualified seafarers,...and set manning levels for subsidized vessels.[19]

U.S. Training Facilities

The principal, entry-level facility for maritime officers is the USMMA, Kings Point, N.Y. Cadets receive training in all facets of maritime affairs, engineering and deck seamanship during four years of school leading to a B.S. degree. One-half of each cadet's sophomore and junior years are spent at sea aboard U.S. commercial ships. The final few weeks of each at sea assignment is spent working ashore in a maritime-related occupation such as a commercial port facility. To complete graduation eligibility, students must pass all courses and pass the Coast Guard certification exam for third mate, third assistant engineer, or in certain cases, dual license qualification which enables the prospective officer to gain initial employment in either deck or engineering billets.[20] Additionally, graduates must accept commissions as Ensigns in the U.S. Naval Reserve if offered. Enrollment at the Academy was 1109 for fiscal year 1979, with 253 graduates. Of these, 95% found employment aboard commercial vessels or were assigned to duty in the Navy or Coast Guard.[21]

MARAD operates five regional radar training centers, located in New York City, Toledo, New Orleans, Seattle and San Francisco. Comprehensive, basic and advanced, theoretical and practical, radar training in collision avoidance is offered at each facility for the purpose of reducing accidents by collision at sea, resulting damage to cargo, loss of life

and, possibly, massive environmental disaster. Marine radar display units such as those found on U.S. flag vessels are used. Simulated radar video provides realistic training for:

> qualified merchant mariners, operators of inland waterway and offshore drilling and mining vessels, maritime academy students, and personnel of the National Oceanic and Atmospheric Administration, Coast Guard, Army Corps of Engineers and U.S. Naval Reserve.[22]

Courses to prepare for radar recertification exams are also taught. Courses are offered in the use of the gyrocompass, automatic direction finding (ADF) equipment, fathometer and LORAN at these regional centers. MARAD sponsors firefighting indoctrination and refresher training at four regional locations, utilizing Naval facilities at the Military Sealift Command, Earle, N.J., and the Naval Technical Training Center, Treasure Island, CA, and their own centers at Toledo and New Orleans. Expanded use of these facilities is planned to accomodate the tighter regulations dictated by recent Coast Guard regulations and those international Conventions pending ratification which require specific fire fighting training by tanker personnel.[23] Both classroom and "hands-on" methods are utilized. Recently-introduced training includes a special ten week deck elective course on the Great Lakes, offered at the USMMA.[24] In the area of continuing education, MARAD offers short marine diesel engineering training programs of five weeks for active marine engineers and a one week curriculum for masters, chief mates and port engineers at Kings Point.[25]

There are six State maritime academies training future officers for our merchant marine. They are:

(1) State of New York Maritime College, Fort Schulyer, NY

(2) Maine Maritime Academy, Castine, ME

(3) Texas Maritime College, Galveston, TX

(4) Massachusetts Maritime Academy, Buzzards Bay, MA

(5) California Maritime Academy, Vallejo, CA

(6) Great Lakes Maritime Academy, Traverse City, MI

These state-sponsored maritime colleges provide approximately six hundred qualified merchant marine officers yearly. Five of the six academies award bachelor's degrees to graduates, while the Great Lakes academy is a three year associate degree program. Graduates of the four year programs may enter the merchant marine as third mate or third assistant engineer upon successfully passing the certification exam, while graduates of the three year program may receive a first class Great Lakes pilot's license or become a third assistant engineer. Graduates of state academies are commissioned as U.S. Naval Reserve officers if qualified. According to MARAD, in 1979, 86.5% of the state graduates were employed afloat or serving on active duty with the Navy or Coast Guard.[26] Numerous additional maritime education and safety-related training is conducted by the state colleges such as adult continuing education, special radar and oil pollution courses (Texas Maritime), short courses for experienced personnel (Maine Maritime), and a graduate program for advanced training of marine professionals in such fields as marine transportation (SUNY Maritime).[27] One of the major differences between the state academies and the USMMA is the use of training vessels for at sea experience. While the USMMA trains cadets on commercial vessels, the salt water state academies use dedicated Federally-owned and academy-operated training ships for cruises. The States bear the brunt of the operation costs for these vessels, including fuel, [illegible]

of the operating costs for these vessels, including fuel. The Great Lakes Maritime Academy differs in that their students train on Great Lakes' commercial vessels. These schools provide and added, proven flexibility to our input of merchant marine officers, evidenced by instances of accelerated graduations during the Vietnam era when the nation's maritime capability was taxed.

Other extremely active participants in the continuing education of merchant marine officers and seamen are the maritime unions. The leading maritime labor-operated school is the Marine Engineers Beneficial Association (MEBA), Jesse E. Calhoon Engineering school, one of the major suppliers of U.S. Merchant Marine officers. Begun in 1966, MEBA's Calhoon school offers a three year program leading to accredidation as a third assistant engineer. Classroom studies and shipboard regimen are combined in a three year program. Students are required to study electricity, electronics, general maritime studies including firefighting and first aid, industrial arts such as welding, marine engineering, mathematics, sciences and physical education. Training is managed in three phases: (1) basic classroom studies ashore for six months; (2) demanding training at sea aboard commercial vessels for twelve months; (3) classroom and simulator training ashore for the final eighteen months. The MEBA curriculum graduates 590 students annually. Refresher and advanced training is also provided to union members by this school.[28]

Probably the most advanced curriculum for marchant marine deck officers is offered by the Maritime Institute of Technology

and Graduate Studies (MITAGS), Linthicum Heights, MD, a school founded by the International Organization of Masters, Mates and Pilots (IOMM&P). This post-graduate program is designed "to enable licensed deck officers to enhance professional skills."[29] Courses are based on real world problems and needs of the deck officer. Extensive utilization of simulators to effect rapid, accurate navigational, cargo handling and hazardous material movement decision-making is stressed. Course offerings include Marine Cargo Operations, Admiralty Law, Ship's Business, All Weather Navigation, Ship's Control Systems, Gas Carrier Operations and Emergency Medical Training (EMT). The school uses a full mission simulator with all-around vision, day and night simulation and realistic motion and audio techniques. Near-future additions include the current construction of a liquified natural gas (LNG) ship simulator to train deck officers in handling and transfer aspects of this specialized cargo carrier. Concentrated, advanced training in realistic scenarios for seasoned deck officers is the inherent philosophy at the MITAGS.[30] Today's complex systems demand extensive training for continued safe, reliable sea transportation and cargo delivery.

Entry-level training for unlicensed personnel is provided at various union-operated and financed schools. The Harry Lundeberg School of Seamanship at Piney Point, MD, teaches the basics of marine education with increased emphasis on the safety-related aspects of shipboard life. Firefighting courses are a requirement for attendees. Instruction is given in deck, engineering and steward duties. Additional reorientation work and upgrading is available for former

seamen returning to duty.[31] Approximately 2300 men and women graduate from the Lundeberg school each year.[32] The National Maritime Union Upgrading and Retraining School is another facility providing entry-level training for the unlicensed seaman or engineer. This school trains 345 seafarers annually.[33] MEBA District #2 Associated Maritime Officers Union High Seas School and Great Lakes School train 165 and 140 unlicensed personnel in steam and diesel engineering fields.[34] Maritime training in the area of shipboard telecommunications through both residence training and correspondence courses is offered by the American Radio Association Technological Institute for Maritime Electronics (ARA-TIME) based in New York City. High technology radio equipment maintenance, repair and operation is studied by approximately 300 personnel annually.[35] At Easton, MD, the Radio Officers Union (ROU) performs similar training for prospective shipboard radio officers.[36] Various other vocational institutes offer additional selective, entry-level maritime courses around the country.

According to MARAD, many new, safety-related courses of instruction are being considered for future implementation. These are Automatic Radar Plotting Aids, Satellite Navigation systems, OMEGA, and an advanced firefighting course with emphasis on fire party leadership and management. Additionally, a Marine Chemist program is proposed as an additional safety requirement for certain types of ships, i.e., chemical and oil tankers.[37]

As the arm of the executive branch tasked with safety inspections and certification of tankers and their personnel,

the Coast Guard must effectively train their officer and enlisted personnel assigned to these duties. Much of this schooling is performed at the Marine Safety School (MSS), Yorktown, VA. Coast Guard junior officers receive a twelve week basic indoctrination course in marine safety matters. A similar, more technical curriculum for enlisted personnel is the five week Marine Environmental Systems course for petty officers (MESPOC). Other entry-level, basic and advanced courses in maritime safety relating to the U.S. Merchant Marine are presented. MSS Yorktown's goal provides the cornerstone for Coast Guard regulation and certification actions: "(to) train marine officers and petty officers in the Coast Guard's commercial vessel safety, marine environmental protection, and ports safety and security programs."[38]

Effects of STCW on U.S. Training

As the United States' maritime authorities look to systems which will further enhance tanker safety, the increased utilization of navigation and engineering simulators to balance underway training appears to be one of the most cost effective methods. The new IMCO requirements promulgated by the STCW Convention will force a reappraisal of our current training methods and cause an increased use of simulators to achieve required experience. Under the new rules, one year at sea experience will be necessary for an individual to qualify for licensing as a third mate. Current Coast Guard requirements call for six months underway training as the prerequisite. The Convention allows individual nations to make use of equivalent training to supplement at sea training in order to

achieve the one year goal. As stated in Article IX of the STCW Convention:

> (1) The Convention shall not prevent an Administration from retaining or adopting other educational and training arrangements, including those involving sea-going service and shipboard organization especially adapted to technical developments and to special types of ships and trades, provided that the level of sea-going service, knowledge and efficiency as regards navigational and technical handling of ship and cargo ensures a degree of safety at sea and has a preventive effect as regards pollution at least equivalent to the requirements of the Convention.[39]

The lengthened requirement for one year seagoing experience prior to licensing as a third mate will most adversely impact the State maritime academies. While the USMMA cadets spend a minimum of 300 days involved in underway training, the State schools' norm is now about six months. The use of navigation simulators to provide the balance will no doubt be exercised by the Merchant Marine Academy, however the states will have to find a blend of additional practical underway experience and shore-based training periods to satisfy the additional six month period. The types of simulators available, how much simulation time will be accepted for equivalency purposes, training aboard small vessels as partial fulfillment of the underway prerequisite and the possible utilization of pierside training ships to provide some equivalent time is being investigated. Currently, the Coast Guard is considering a maximum of three months equivalency time to be fulfilled by simulators.[40] Final regulations will be determined by the Coast Guard in conjunction with MARAD and the affected educational institutions. Underway training qualifications for personnel seeking certification as third assistant engineer or Great Lakes duty will not be affected by the terms of the Convention; only those

attempting to secure positions as third mate need the additional sea training or equivalency certification. As previously mentioned, this problem is currently the most pressing onefor the United States.

The entire philosophy of at sea training has beem examined by the Ad Hoc Select Subcommittee. Proposals have included the use of commercial vessels for the five state academies (Maine, Massachusetts, Texas, Californis and New York) which currently operate Federally-owned training ships. Since the ships average age is 25-30 years old, the cost effectiveness of maintaining these vessels has been queationed. Procurement of newer training ships has to be a consideration since the state-operated ships are fast approaching the end of their productive years. The superintendents of these five colleges are vehemently opposed to the use of commercial vessels for cadet instruction. Their feeling is that training aboard today's commercial merchant vessels cannot approach that which is achieved on a school ship supervised by a maritime academy. On the school ship:

> ...training is intensive in all phases...can't do that on a commercial ship; the cadet is an observer... the school ship program is attached to the academic program; faculty is part of the ship's crew.[41]

This assessment of the situation is certainly valid; the academy-operated and manned vessel has many more intrinsic training possibilities that the commercial vessel which has to maintain a time critical schedule. these vessels are operated on a slim profit therefore cannot take the necessary time to train cadets in such critical areas as engineering casualty control drills in which engines must be stopped, electrical casualties which

could possibly entail loss of ship's power, emergency ship-handling drills, etc. Moreover, the superintendents claim that their academies' underway training for six months is the equivalent of one year of cadet training aboard a commercial vessel. Additionally, they queation the theory that increased time at sea will result in a lessening of safety- related accidents. They maintain there is no proof of direct relationship between the two; that periodic refresher training underway is more beneficial.[42] From this vantage point, it appears that the state academies will have to increase their at sea training time to about nine months and utilize the remaining three months in various types of equivalency training such as simulators, small vessels and dockside training aboard their ships. Since the academies are very concerned about the monetary impacts of greatly increased underway time, such as fuel, crew costs, maintenance, tug services, and so forth, the more equivalent instruction they can substitute for actual sea time will curtail additional funding required from the State or Federal government. These fiscal problems associated with the new requirements were referred to by the Maritime Administration:

> A MARAD study, published in September 1979, predicted that increased annual vessel operating costs for the State academies to meet the 12-month sea time requirements in 1981 dollars total 4.8 million if that time is spent entirely at sea; but amount to between 2.1 and 2.9 million if simulators are used.[43]

Simulators for Safety-Related Training

It appears that the increased use of simulators will supplement the USMMA and the State academies underway training and should then be reported to IMCO by the Coast Guard as our

interpretation of the equivalence article, together with the number of days in which simulation will be used. The advantages of simulators besides the all important fuel and cost savings include the reduced chances of accidents and concomitant environmental damage ocurring and the unique opportunities for cadet training. Realistic simulators present the student with the opportunity to perform on his own, to take certain risks or attempt maneuvers without fear of the consequences if he should make a mistake. The repetitive nature of simulation allow students more opportunities to perform than would be possible if only underway training were available.

Possibly the major reason why simulators have not been adapted for use at all our training facilities is the price tag. A full mission, highly sophisticated, shipboard bridge simulator costs upward of five million dollars.[44] However, the answer may be available; current technology can provide less sophisticated bridge simulators for about four hundred thousand dollars.[45] This type of simulator may be sufficient to fulfill the needs of the state academies for cadet training while more expensive, higher technology and more capable systems either are currently in use or could be procured for more advanced training needs. Interestingly enough, if the use of these simulators prevent just one major environmental disaster, the price would be insignificant compared to the real cost of a major tanker collisiion and subsequent pollution clean-up.

State-of-the-Art Simulation

Two of the world's most sophisticated navigational simulators in use today are the MARAD Computer Aided Operations Research Facility (CAORF) at Kings Point, NY, and the full mission, day/night ship simulator at Marine Safety International (MSI) located in New York City. These are not the only simulators available for research and training but they do represent state-of-the-art. Other simulation training facilities such as MEBA (engineering) and MITAGS (navigation and cargo handling) have been mentioned. CAORF and MSI simulation operations differ in that the MARAD facility is mainly directed at human factors research relating to vessel safety while MSI, the only commercial facility of its kind in the United States, provides a wide assortment of classroom and simulation training for numerous shipping clients such as Exxon Corporation and Texaco Incorporated.

CAORF was constructed in 1976 and has been utilized by MARAD to research training and safety problems associated with the navigation and shiphandling of merchant vessels. CAORF can simulate any class of ship and any port. Both day and night simulation capability is available through the use of computer generated imagery. Corresponding radar video is presented to the bridge team on actual shipboard equipment. Closed-circuit television (CCTV) is utilized as a human factors monitor to observe the bridge team under any of a variety of navigational and piloting situations. Safety-related problems such as ship control and maneuverability, grounding and collision avoidance strategies, analysis of piloting operations in specific harbors, bridge system design addressing the most viable procedures for team management and operating procedures

and training methods for all potential watchstanders have been studied at CAORF.[46] Most recently, an enormously important research program aimed at the cost effectiveness of simulator training for both entry-level and master/chief mate personnel has been initiated at CAORF by the Coast Guard and MARAD. In a report of the project's findings to date entitled Empirical Investigation of Simulator/Training System Characteristics, the authors discuss a goal of the project:

> A major product of this research program will be the development of training system acceptance criteria for use by the U.S. Coast Guard in the approval of simulator-based training programs for meeting some licensing requirements. These will constitute a major product of the current phase of the investigation...as well as... the likely role of the ship bridge simulator in the deck officer training and licensing process in the near future.[47]

CAORF has assumed the leading role for future development of simulator-based training programs for both initial qualification of merchant marine officers and continuing refresher education available to experienced seafarers for recertification and general safety-related instruction. Hammell and Puglisi emphasize that simulator-based training has been recognized in the U.S. in certain instances as a means of certification and licensing for pilots in the Port of Valdez, Alaska, and that the Port and Tanker Safety Act of 1978 calls for setting standards for certification through utilization of shore-based simulators.[48] The STCW Convention requirements for lengthened at sea training have reinforced the need for expansion of this training methodology. An effective balance is certainly what is required as emphasized in the project evaluation:

> The mix of elements and their characteristics

> should be determined to achieve the necessary level of training effectiveness at the minimum cost. It is important to note that the simulator is but one element of the training system. Effective training could not be conducted on the basis of the simulator alone; rather, all the elements of the training system are necessary to achieve effective training. Some of the training objectives are likely to be best achieved via simulator-based training while others may be best achieved via classroom training, and still others may be best achieved via at-sea training and/or experience.[49]

Marine Safety International (MSI), a private, commercial shipboard simulation facility utilizes total ship control training, cargo handling simulation mechanics and engine room training together with classroom instruction geared to various industry and government clients. The visual simulator can present the characteristics of many different classes of tankers and gas carrying vessels, combined with the ability to simulate the actual handling characteristics of these vessels in any sea state, current or wind condition. Maneuvering in pilot waters provides the training and watchkeeping skills required for effective and safe shiphandling. Classroom training curricula is designed in compliance with requisite company needs, i.e., length of training courses, initial level of expertise and instructional objectives. Besides employing a number of qualified master mariners and engineers, MSI also utilizes the services of "nautical assistants", equally well-trained and highly skilled professionals who are still employed in seagoing merchant ship officer billets and are currently between voyages. The presence of these personnel as classroom and shiphandling instructors certainly adds credibility to the MSI program. The economic livlihood of a facility such as MSI is based again on the inherent

assimilation between safety and effective training.

> For all the automation and electronic wizardry of today's ship, the ultimate responsibility for their safe operation lies with the officers and crews who man them. The human element is still key. The MSI training approach, therefore, emphasizes making critical decisions while under severe stress and in confusing situations...intensive practice for what might happen in the real world.[50]

Realistic simulator training is the keynote at MSI. All types of visibility and real world audio can be achieved and docking can be performed using bow thrusters and/or tugs. An important addition for industry today is the LNG cargo handling simulator which provides the cargo officer with "hands on" realistic decision-making. Cargo, ballast control, gas detection and custody transfer systems and a loading and stress calculation computer are available. As is the case with all simulation, many casualities can be practiced and observed by instructors and trainees through one-way glass in the LNG, engineering and ship control simulators which would be precluded aboard ship due to safety problems and economic constraints. Restricted visibility training is accomplished utilizing all current high technology radar, collision avoidance, navigation aids, VHF communications and Vessel Traffic Services (VTS). Train-engineers at all certification levels is accomplished utilizing an engine room simulation of a steam powered propulsion system. Realism is afforded through use of actual engine room sounds and heat.[51]

The benefits of alternative training methods such as simulation to provide "equivalency" experience appears to be a methodology whose time has come. Another company which has been a recent leader in efforts to develop more high technol-

ogy and less expensive simulation equipment is Ship Analytics of Stonington, CT. After extensive research into training programs utilizing simulation equipment, the company feels the integration of seagoing experience with shore-based simulation training is the most viable method. The development of shiphandling expertise, according to a Ship Analytics' spokesman is thus achieved:

> Training, if it is to be effective, must be aimed at isolation and development of those (shiphandling) skills. The skills, once acquired, must in turn, be exercised periodically if they are to be retained.[52]

It is clear that all these necessary skills, including emergency shiphandling training cannot be gained from at sea experience alone. The President of Ship Analytics has succinctly stated why this is so:

> ...there are two basic reasons....First, it is impractical, if not dangerous, in normal ship operations to expose a trainee to situations that are conducive to development of many shiphandling skills. Second, even if the trainee were permitted to manoeuver the vessel under these conditions, there is no way for him to evaluate his performance and no way to duplicate the situation so that he can correct his mistakes thereby improving his performance.[53]

With the recent promulgation of the STCW Convention and the desire to improve our nation's maritime training, the use of shore-based simulators appears to be one of the best methods to both quantitatively and qualitatively measure the standards we establish for our merchant marine. Combined with underway training, simulators will give us both cost effective instruction and the necessary general operating and emergency response training to further upgrade entry-level and continuing maritime education.

The Total Training Concept

In stressing a total safety-related program consisting of shore-based and at sea periods, two further methods can be adopted to increase tanker safety. The first is the well-established concept of passage planning incorporating all aspects of sound bridge management. The second concept is a viable, workable shipboard training package which can be implemented aboard ship during each voyage. Both of these training efforts will invariably lead to an improvement in knowledge and professionalism for all hands, increased safety awareness and ability to react in emergency situations, thereby enhancing the safety record of U.S. flag vessels. These concepts are particularly important for a nation with a highly regulated merchant marine such as the United States. With much emphasis on the increased use of technological improvements, redundancy of navigational systems and emergency equipment, and the overall excellent training facilities available, both government and industry efforts should focus on the human aspect. In a paper presented at the International Tanker Safety Conference (INTASAFCON 4), a member of the Operational Services Division of Shell Marine International, stressed this necessity:

> Looking more closely at the records for Shell ships leads to one clear conclusion. That is that accidents in a well managed fleet are rarely due to equipment failure, but most often are due to faulty operations, or what is frequently termed human error. Within that category, we find that it is rare that the erring individual had inadequate knowledge; indeed most were well-trained had good records and were strongly motivated. More often, the inability of an individual to recognize his own fallibility, or the inherent hazards of a situation, led to a cumulative series of minor faults or errors, culminating in a accident.[54]

Although individual and bridge team training is enhanced through the maximum use of simulators and at sea experience, it is of tantamount importance that individual U.S. flag ship owners place emphasis on the necessity for extensive voyage planning. The rationale for formulation of a voyage plan which documents all required shipboard manning procedures, navigational duties and system double checks is aptly presented in a paper on the subject of Bridge Management Training presented at the International Symposium on Ship Operations in September, 1980. In analyzing the problems and interrelationships of ship accidents and human error, the authors point out that:

> 6. Each accident is the culmination of a series of events often small in themselves and often a matter of coincidence rather than cause-and-effect.
> 7. In this chain of events human error plays a large part; people make mistakes, and they overlook warning signs.
> 8. People are reluctant to recognise their own fallibility.
> 9. Whilst bridge organisation and procedures are quite adequate when all is in order, there is usually inadequate guidance on the use of procedures to minimize risk of "one man errors", particularly with respect to monitoring the ship's track and reacting to emergency situations.
>
> These analyses lead to the conclusion that there are two types of human error:
> a. incompetent failure, when a man is performing a task for which he did not have sufficient personal skill, and
> b. competent failure, when a man fails to perform to his usual standard.
>
> Of the two, evidence suggests the latter is the more insidious, for it can seemingly occur without warning on any ship in any situation, particularly in times of stress. It follows that training in personal skills, though essential, cannot in itself resolve the unavoidable problem of the fallibility of the individual.[35]

The necessity to combat this sort of failure lies in the

establishment of sound passage planning from the port of departure to ship's arrival. The planning method based on the concept taught in British maritime academies, consisting of a four phase approach to ship operation's management appears sound. The system consists of appraisal of navigational factors which will affect a specific voyage, complete contingency plans for the entire track with alternative choices if the meteorological situation dictates rerouting, execution of the voyage with individual watchstanding responsibilities specified and understood by means of a set of promulgated regulations/duties in a shipboard document, and most importantly, a system of continued monitoring and checking navigational data and ship's course, especially in pilot waters. The relationship of the master to the pilot and the need for positive observation of the pilot by competent personnel at all times must be stressed. Essential in this entire philosophy of sound bridge management is the need for checks and double checks of individual bridge duties by team members qualified in navigation and bridge watchstanding.[56] Monitoring of radars, collision avoidance equipment, all electronic navigation apparatus and course plotting will assure the reduction of possible human misjudgments.

One aspect of tanker training which must not be overlooked is that which can be accomplished during the duration of each voyage. With turnover of personnel, there is increasing liklihood that a number of individuals may not be totally (or even remotely) familiar with pertinent emergency equipment and shipboard design of the vessel class on which they are employed. Additionally, the possible environmental disasters

which could result from a lack of systems knowledge of tanker vessels demands that a continuing training symposium, however relaxed, be conducted. It is the responsibility of the individual ship owner or corporation to make this a matter of policy by appointing a training officer or committee which can plan activities for the duration of the voyage. A shipboard training officer, preferably the chief mate, should supervise this activity underway. The shore establishment can assist not only in the planning stages but by providing ship class films, videotapes or cassettes for enroute viewing. Subject matter should involve vessel emergency and damage control drills, pollution control devices and emergency medical training. This training can be further supplemented at sea with regularly scheduled drills to ensure all hands are aware of assignments in case of an emergency and to reduce reaction time in the event an incident occurs. Such rehearsals often lead to an actual reduction in intensity of a disastrous situation either through increased reaction time when emergencies occur or by providing the requisite training to altogether prevent an accident.

Total safety awareness and crew emergency training can best be formulated underway via use of actual equipment during simulated emergency exercises in appropriate shipboard spaces. This method is favored in lieu of the strict lecture or classroom training scenario as it adds the required realism to the situation and is much less boring.

In an article covering Tank Vessel Training, some current examples of the overall lack of tanker training are cited:

> You may certainly rest assured that there are Second Engineers at sea today who have had no previous tanker experience and who haven't even received the most fundamental training in tanker operations. You can believe it, that in tankers at sea, right now, there are officers who have never done a firefighting course, never worn a breathing set and who have only the vaguest idea of how to conduct a search and rescue procedure.[57]

In critiquing certain types of officer and crew training sessions aboard tankers, O'Sullivan lists specific attributes that make for interesting, practical voyage training:

> a) The logic of limited time was excellent.
> b) Visual aids-the equipment itself.
> c) Audience participation-the equipment was handled and used during the presentation.
> d) All levels of experience were given several days to prepare their presentation. Keeping them busy doing things for themselves is a tremendous source of learning.
> e)Everyone was given the opportunity to gain experience and practice in presentation techniques.[58]

Thus the importance of underway training for our tanker personnel is well-founded. Besides providing for orthodox casualty control and emergency procedural drills; on-the-job training and all exercises which further knowledge regarding the tanker vessel can only aid in reducing the possibility of incompetent failure by seafaring personnel.

Summary and Conclusions

The technological innovation associated with current tanker transportation must be complemented by an associated upgrading of our training programs and philosophies. Rapid growth in size of vessels and increased regularity of cargo movements, such as oil, chemicals and liquified natural gas aboard specialized tanker vessels demand a critical appraisal of the state of our crew training if major environmental disasters are to be prevented. Stricter safety and ship

design regulations associated with the MARPOL '78 and SOLAS '78 Protocols and the Port and Tanker Safety Act will undoubtedly foster more reliable transport of crude oil and hazardous chemicals. It is likely that the STCW Convention will receive the necessary ratification late this year and be implemented sometime during the latter part of 1982. The Coast Guard and MARAD must continue research into the use of simulator-based training to count as "equivalency" time for at sea experience in accordance with new Convention procedures. It is recommended that three months of bridge simulation training be utilized as "equivalency" time for purposes of United States' certification of deck officers. An additional month should be credited for small boat training and pierside training conducted aboard academies' training vessels. This recommendation will allow maximum flexibility for the state maritime academies, which currently train prospective deck officers at sea for six months. It will cause an increase of only eight weeks underway time per student spaced over the four year curriculum. The USMMA, which currently trains at sea for nearly ten months of its four program will be unaffected by further underway requirements and could devote the remaining two months to a combination of simulator training at CAORF, Kings Point, and small boat training. The Coast Guard and MARAD should strongly consider submitting these "equivalency" arrangements to the Secretary-General of IMCO pursuant to Article IX of the Convention when the STCW instrument is ratified by the Senate. This should allow the academies sufficient time to ensure a smooth transition from current practice to formation of new curricula while devising monetary strategies in consonance

with MARAD and State governments (where necessary) to pursue increased training requirements.

Finally, the shipping industry will need to revitalize its training programs in view of the increased size of its tankers, high technology systems manning and operational requirements together with the concomitant need to survive economically. With worldwide pressure to reduce the size of crews while at the same time satisfying the maritime unions in the United States, the need for more specialized, safety-related training of our personnel must not be understated. In a Safety at Sea editorial, today's training dichotomy is aptly set forth:

> crew quality and ship sophistication have a complex relativity which is obvious; the cheapest crews are frequently at a loss to comprehend and thus effectively utilize advanced designs and sophistication to its best advantage, and it follows that for modern tonnage a very small, but nevertheless a high quality crew with a strong common language facility throughout, is the way that things will go...to compete today, costs have to be minimized and the temptation is to follow the pattern set by others by reducing the crew...with advances in technology comes the requirement for a higher quality for the reduced crew-and evolution to all purpose officers and ratings....Crew levels must be taken out of the commercial argument and placed in the context of safety where they really belong.[59]

Ultimately, after basic training has been received and personnel are serving at sea, it will be industry initiatives that provide necessary refresher training utilizing simulators and a continuity of safety instruction aboard ship during the voyage. International Conventions and Coast Guard regulations willserve as guidelines; but for actual training of the human element, there will be no international board issuing plans and directives. If the human safety factor is to be thoroughly

emphasized, it must be via germination of independent industry training methodology geared to satisfy, and ultimately surpass, international and national directives.

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