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Proceedings

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Subchapter M

Towing the line

PROCEEDINGS

Winter 2018 Vol. 75, Number 3

Navigating Subchapter M

Compliance and Assessments

Addressing Safety

A tugboat approaches the Coast Guard Cutter *James* near Mayport, Florida, on March 30, 2017. *James* is the Coast Guard's fifth national security cutter, the Coast Guard's largest and most technically advanced class of cutter, with robust capabilities for maritime homeland security, law enforcement and national defense missions. Coast Guard photo by Petty Officer 1st Class Melissa Leake

On Deck

The *Andrea Doria*. Coast Guard photo

On the Cover: *A milestone nearly 15 years in the making, April 20, 2018, marked the issuance of the first tugboat and towboat certificates of inspection under Subchapter M. Published in the Federal Register on June 20, 2016, 46 CFR Subchapter M established new minimum safety standards for existing towing and tug vessels, like the one on this issue's cover.*

Some have said Subchapter M, as it's frequently called, is the most important rulemaking ever to affect the tugboat and towboat industry.

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Assistant Commandant's Perspective

by Rear Admiral John P. Nadeau
Assistant Commandant for Prevention Policy
U.S. Coast Guard

Marine safety is one of the Coast Guard's 11 statutory missions, and commercial vessel inspections are an integral part of the marine safety program. Coast Guard marine inspectors examine structural integrity, inspect engineering and navigation systems, lifesaving equipment, and fire detection and extinguishing systems. Furthermore, other aspects of commercial vessels are inspected to ensure they meet the required safety and environmental protection standards.

Champion's Point of View

by CAPT Jennifer F. Williams
Director, Inspections and Compliance
U.S. Coast Guard

I am pleased to champion this edition of *Proceedings*, which highlights recent regulatory changes introduced in Subchapter M, the Inspection of Towing Vessels. With such a large number of commercial towing vessels operating throughout the United States, the development of the regulations, associated policies, and training has been a huge undertaking executed over the course of more than 15 years.

The work leading up to the development of regulations is underscored by the Coast Guard personnel and

For decades, the majority of commercial towing vessels were not required to undergo mandatory Coast Guard safety inspections. That changed in June 2016, with the publication of Subchapter M, or the *Inspection of Towing Vessels: Final Rule*. Today, nearly 6,000 commercial towing vessels are subject to inspection requirements and the total number of U.S. flag vessels inspected by the Coast Guard has doubled.

Subchapter M is a groundbreaking regulation in that it allows towing vessel operators to choose between the Coast Guard option or a Towing Safety Management System (TSMS) option. The Coast Guard option is a traditional Coast Guard inspection, where a Coast Guard marine inspector visits the vessel during its dry-dock period and also performs annual inspections. The TSMS option provides vessel operators greater flexibility by allowing them to work directly with an approved third party organization and develop a TSMS that addresses their unique risks. Both options enable the vessel to receive a certificate of inspection from the Coast Guard.

A good safety management system is scalable, dynamic, and customized to match the unique needs and risks of the individual vessel and operator. It reinforces a healthy safety culture and promotes an environment where all employees share the responsibility for safety. In addition, an effective safety management system facilitates continuous improvement and optimizes safety performance. I am a strong advocate for safety management systems, and it is my hope that the majority of towing vessel operators elect to use the TSMS option.

I want to extend my sincere thanks to each of the authors, editors, and Champion for this edition of *Proceedings*. I hope you find the information in the pages that follow useful, and I look forward to working with all stakeholders to improve safety and security.

maritime industry's anticipation of implementing these regulations There is a lot of uncertainty about how the new standards will be applied, or how they will impact operations for nearly 6,000 towing vessels whose operators, crews, and newly established third party organizations (TPO) have had little to no interaction with Coast Guard marine inspectors. The Coast Guard shares the same concerns as it impacts work load, training, and visibility of vessels that choose the Towing Safety Management System option—managed by third party organizations—over the Coast Guard option. Since the publishing of the final rule in 2016, the Coast Guard, Towing Vessel Safety Advisory Committee, American Waterways Operators, towing vessel operators, and third party organizations have discussed many of these concerns. We have developed guides, policies, and frequently asked questions to help address these issues.

Unfortunately, we will not truly know the impact of the new workload, operational impacts, or the dynamics between vessel operators and Coast Guard—or the TPOs—until more vessels complete their initial inspection for certification and a rhythm is developed. But, there is reason for optimism. More than 50 percent of the towing vessel fleet is poised to transition into the inspected fleet with ease because they have either participated in the Responsible Carrier Program, or have adopted International Safety Management Systems. Regardless of option, I hope that this issue of *Proceedings* will shed some light on different aspects of the new inspection requirements, and introduce you to several subject matter experts in the field.

I would like to take this opportunity to extend thanks to my staff for their help in coordinating this edition, and to all the authors who have taken the time to contribute articles. Your efforts are instrumental to highlighting towing vessel safety, and the roles the regulators and the regulated play.

Navigating Subchapter M

The Towing Vessel National Center of Expertise

Your navigator for Subchapter M

by CDR Andrew Bender
Supervisor
U.S. Coast Guard Towing Vessel National Center of Expertise

After navigating a 15-year regulatory process, the towing vessel industry[1] has officially embarked on its voyage as an inspected fleet with the issuance of the first certificate of inspection under Subchapter M (Sub M) on April 18, 2018.

After such a long journey, realizing the safety and environmental compliance objectives of "Sub M" will require a sustained partnership with industry and an unrelenting commitment to compliance at all levels of our service, towing industry, and third-party organization (TPO) personnel.

Background

The Coast Guard and Maritime Transportation Act of 2004 reclassified commercial towing vessels as "subject to inspection," a substantial upgrade from their status as an uninspected or unregulated fleet. With a current portfolio of 12,000 inspected vessels, the addition of a fleet of nearly 6,000 towing vessels increased the Coast Guard inspected fleet by 50 percent—without an increase in Coast Guard resources. As the most impactful maritime-related regulatory change in more than two decades, and one of the most significant, the Coast Guard and towing industry recognized the need for strong partnerships to phase in what is known today as Sub M.

Since January 2017, the Towing Vessel National Center of Expertise has approved nine TPOs, while nearly 150 TSMS Certificates and DOCs, covering over 2,800 towing vessels, have been issued. Coast Guard photo by LCDR Chuck Mellor

To further solidify partnerships and formalize the blueprint to successfully implement the law, the Towing Vessel Bridging Program (TVBP) was launched in June 2009. Simply stated, the TVBP was designed to ease the Sub M transition for Coast Guard personnel and the impacted industry. This bridge to regulatory compliance was key to generating forward momentum for the program.

The program continued to take shape with the opening of the Towing Vessel National Center of Expertise (TVNCOE) in Paducah, Kentucky. Fittingly located at the confluence of the Tennessee and Ohio rivers, and just upriver from the Mississippi, Paducah is a natural inland river hub. It is also home to generations of men and women committed to the safe and secure transport of goods nationwide.

By August 2011, a notice of proposed rulemaking—essentially the first draft of Sub M—was delivered to the public for comment. Five years and thousands of Coast Guard-issued towing vessel decals later, the final rule of Sub M— 46 CFR Subchapter M—was delivered in 2016, with compliance set for July 2018.

Similar to the Cruise Ship, Liquid Gas Carrier, and Outer Continental Shelf NCOEs, the TVNCOE is seven personnel strong. The team of three active duty and four civil service members has a combined total of nearly 200 years of Coast Guard and industry leadership, inspection, and oversight experience. The TVNCOE is a Coast Guard headquarters satellite office for the traveling inspector staff, an assembly of the most seasoned inspection crews in our service.

The TVNCOE is now diligently working to roll out Sub M in the most consistent, efficient, and complete manner possible. The center is responsible for three service areas:

- delivery of expertise
- development and delivery of training
- approval and oversight of third-party organizations (TPOs) responsible for the certification of towing vessel safety management systems

The Towing Vessel National Center of Expertise, located in Paducah, Kentucky, is seven personnel strong. From the left is Steve Douglass, Dave Phillips, LCDR Chuck Mellor, CDR Andrew Bender, CWO4 Mark Belt, Mike Kelly, and Jim Van Wormer. Coast Guard photo by Yeoman 2nd Class Blake Armstrong

Delivery of Expertise

The TVNCOE's ability to develop strong partnerships and ensure transparency among TPOs, industry, and the Coast Guard has been key to the success of this vessel inspection program. It serves as a hub for information collection and dissemination through local meetings with hundreds of members of industry and TPOs, participation in dozens of industry days nationwide, and daily interaction with Coast Guard field personnel and industry representatives. The TVNCOE team, in close consultation with Coast Guard headquarters and other staff members nationwide, has formally cleared more than 320 frequently asked questions and developed national policy letters, work instructions, and job aids to guide thousands of industry and Coast Guard field personnel, while also informally answering hundreds of queries from industry, TPOs, and Coast Guard personnel.

One of the first major projects tackled by the TVNCOE was the development of a website offering "one-stop shopping" for commercial towing vessel regulatory compliance information such as answers to frequently asked questions and links to towing vessel laws, regulations, policy, guidance, and decision aids. As an important component of the TVNCOE's outreach strategy, the website has been continually updated and improved to meet Coast Guard and towing industry needs since its initial launch in 2010. The site has been well-received, reaching nearly 100,000 hits over the last two years.

Complementing the information on the website, the TVNCOE also hosts an automated email service through GovDelivery. Originating in 2012, this service provides the towing vessel community with timely information of interest to Coast Guard-regulated towing vessels including safety information, regulatory updates, and newly issued/updated guidance. The current subscribership of this free service recently surpassed 2,000.

TugSafe

Although July 20, 2018, marked the official beginning of compliance for the towing vessel fleet, the TVNCOE, along with other key Coast Guard stakeholders, had the foresight to provide a decision job aid unlike any other in domestic inspections. The Inspected Towing Vessel Decision Aid—aka TugSafe—was conceptualized to serve as a regulatory checklist generator and compliance guide. It will eventually allow for paperless Sub M towing vessel inspections using a computer, smartphone, or tablet device.

TugSafe streamlines the inspection process by dynamically generating an inspection checklist specific to a given vessel, greatly reducing inspection preparation time and virtually eliminating errors in the application of regulations. Additionally, TugSafe can be used by the towing vessel industry to proactively identify and resolve potential issues prior to a Coast Guard inspection, minimizing repeat inspector visits and reducing vessel downtime. Considering the resources expended by both parties during an average inspection, use of this decision aid is expected to reduce resource demands by thousands of hours annually, exceeding $1 million in efficiencies.

Currently, TugSafe is a working Sub M checklist generator that creates static inspection checklists, links to regulatory websites—no need for paper CFRs—and links to towing vessel policies that are available for use by both the Coast Guard and the towing industry. That said, while the program team celebrated the December 2017 launch, this was not the end-goal for TugSafe. Phase II development—a mobile application based on the Phase I product—is in the works. For use on smartphones and tablets, the new version will refine the individual requirement checklists, the ability to generate inspection reports, and deficiency documentation, or CG-835Vs. TugSafe has a bright future in helping people to work smarter, not harder.

Training

The TVNCOE has trained thousands of Coast Guard and industry members, including advanced journeymen marine inspectors, at the unit in Paducah as well as in Yorktown, Virginia. The TVNCOE also developed and delivered the first Sub M training module as part of the Coast Guard's marine inspector course for apprentice marine inspectors in February 2018. Additionally, it provided a more advanced version for journeymen and advanced journeymen inspectors at district inspected towing vessel colleges, which will continue throughout the Sub M phase-in.

As we progress through the implementation of Sub M, both the development and delivery of formal training will transition from the TVNCOE to the Coast Guard team at Training Center Yorktown.

The TSMS Option, TPOs, and Oversight

Sub M provides an alternative to the traditional Coast Guard domestic inspection regime. It involves a five-year cycle of certificate issuance with four annual inspections. Known as the Towing Safety Management System (TSMS) option, this alternative provides a more flexible option for industry and lessens the resource burden on the Coast Guard.

Based on the premise that companies and vessels operating under safety management systems (SMS) are inherently lower-risk, the TSMS option allows participating companies to be overseen by TPOs, which include those classification societies approved via 46 CFR Part 8 and TPOs approved by the TVNCOE. Third-party organizations act on the Coast Guard's behalf via audits, surveys, and the issuance of TSMS certificates to companies with conforming safety management programs.

Like any significant organizational change or update, company and vessel personnel charged with the implementation of a compliant SMS require executive buy-in, emphasis, and support. Without leadership's call to middle management and vessel operators, an SMS is merely another book on the shelf. The material provides the organizational framework and standards, but it is the people who systematically improve operations and safety through continuous evaluation against those standards.

The commandant of the Coast Guard authorized and enlisted the TVNCOE to approve third-party organizations, and over a 14-month period, the TVNCOE approved—and now oversees—nine TPOs in addition to the eight existing classification societies. The application process consists of prospective TPOs submitting objective evidence that they are independent of management and vessels they intend to service, that they operate under a quality management system, ensure their auditors and surveyors are qualified and maintain continued competence, and demonstrate the ability to carry out expected responsibilities as a TPO.

The approval process involves the review of procedures, forms, experience, and past working history of the TPO and its personnel as well as how TPOs will evaluate TPO personnel, plus a review of the overall impartiality of the organization. To date, Sub M TPOs have issued 139 TSMS certificates and documents of compliance accounting for nearly 2,800 associated vessels.

In the wake of the SS *El Faro* marine casualty investigation and agency recommendations, the TVNCOE has worked tirelessly alongside Coast Guard Headquarters personnel to ensure an aligned, comprehensive approach to TPO oversight. Equally important to the TPO approval process is the Coast Guard's continuous assessment and oversight of all third-party organizations it depends on to ensure proper SMS implementation through each company choosing the TSMS option.

Once approved, the TVNCOE conducts an initial assessment of the TPO to observe processes at work, answer questions that may have arisen since approval, and make recommendations for improvements in audit or survey procedures. The TVNCOE conducts both direct and indirect assessment activities over the course of the five-year validity of the TPO approval. Assessments focus on adherence to the TPO quality management system, performance of vessels it oversees, quality of audit results submission and communication, investigation of complaints received, and personnel competence.

For more information

For questions or more information on Sub M, call us at 270-444-7715, or visit our website at https://www.dco.uscg.mil/tvncoe/

In Conclusion

The towing vessel industry has become the largest fleet of Coast Guard-inspected vessels, and the TVNCOE is honored to continue our work with industry and Coast Guard personnel as we navigate through the phase-in of Sub M. We will continue to forge new and enhance existing towing vessel stakeholder partnerships, provide steady, consistent messaging and guidance to our service, and take a measured, fair approach to recognized organization oversight.

About the author:
For 18 years, CDR Andrew Bender has served the U.S. Coast Guard in many capacities throughout the prevention community. He holds a bachelor of science in operations research from the U.S. Coast Guard Academy and a master of science in industrial and systems engineering from the University of Florida.

Endnote:

1. This point does not include commercial towing vessels already subject to Coast Guard inspection under 46 Subchapter I.

Credentialing Today's Mariner for Tomorrow's Towing Industry

by Michael C. Lewis
Legal Instruments Examiner
U.S. Coast Guard National Maritime Center

LT Katherine Cameron
Customer Service Branch Chief
U.S. Coast Guard National Maritime Center

Mariners in the towing industry, in particular, are facing some new challenges.

In June 2016, the Coast Guard published the *Inspection of Towing Vessels*, 81 Federal Register 40004. Referred to as "Sub M," it necessitates that a fleet of nearly 6,000 uninspected towing vessels become inspected and carry a certificate of inspection (COI). Title 46 Code of Federal Regulations (CFR) 11.465 lists the requirements for national endorsement of a mate (or pilot) of towing. Recent interpretation of this rule has opened the door for an apprentice mate, or steerman, serving as a deckhand to receive credit toward the 360 days required to upgrade to mate (pilot) of towing vessels.

Additionally, the Coast Guard published Navigation and Vessel Inspection Circular (NVIC) 03-16, replacing NVIC 04-01 and providing updated credentialing requirements for towing officers along with instructions for becoming a designated examiner. And, Policy Letter (PL) 01-17 provides guidance for issuing merchant mariner credential (MMC) endorsements of tankerman person-in-charge restricted to fuel transfers on towing vessels.

The Coast Guard's National Maritime Center (NMC) credentials these merchant mariners and river pilots serving in the commercial shipping industry to ensure today's 209,232 professional mariners[1] possess the knowledge, experience, and training to operate safely and competently in the maritime environment.

Subchapter M and Credentialing

It's at the Martinsburg, West Virginia-headquartered NMC that each mariner's professional qualifications are evaluated by one or more of a team of 45 legal instruments examiners to determine if the individual meets the requirements for the credential sought. Occasionally, examiners must research the COI to determine the vessel's inspection status and verify its manning. In accordance with 46 CFR 136.205,[2] the COI describes the vessel, routes it may travel, minimum manning requirements and onboard occupancy limits, safety equipment and appliances required to be onboard, horsepower, and other information pertinent to the vessel's operation. In meeting minimum manning requirements, the COI breaks down the number of mariners required in the deck, engineering, and steward departments in order to safely operate the vessel.

"It's kind of a whole new world we're entering here," Greg Menke, compliance manager for Evansville Marine Services in Evansville, Indiana, said about the advent of Subchapter M. He holds a master of towing vessels on the Great Lakes, inland waters, and Western Rivers, along with a master of unlimited tonnage upon inland waters and first class pilot.

Now that towing vessels are subject to inspections

Coast Guard crews respond to a barge aground in the Hudson River near Catskill, New York, in April 2017. The barge was refloated during the onset of high tide. Coast Guard photo

The towing vessels *Kathy Azlin* and *Amy Frances* are staged next to the damaged *MM-46* barge for lightering operations on the Mississippi River near Natchez, in 2016. Courtesy photo by Adam Davis, NOAA

under Subchapter M, and are being issued a COI, there will be manning requirements for the entire crew. For example, if a COI requires a credentialed, able-bodied seaman (AB), and the person who is serving in that position is not credentialed as an AB, then it could create a situation in which the mariner may be serving outside the scope of their credential. In such a situation, evaluators at the NMC will review the documentation and may request that the applicant provide additional information.

The manning requirements will be identified by the officer in charge, marine inspection (OCMI) and then verified by Coast Guard inspectors and TVNCOE-approved third-party organizations (TPO). Under the preamble, it states, in accordance with 46 CFR 15.501, that the Coast Guard will specify the minimum manning for each towing vessel in all of the vessel's areas of operation listed on its COI, including domestic and international operations. Furthermore, the "OCMI will review operational details of the vessel and work with companies to make decisions on vessel manning which could indicate various levels of manning based on specific routes and service of the towing vessel when determining the number of required crew members for a towing vessel. We do not envision an appreciable increase in the number of qualified individuals needed to man inspected towing vessels."[3]

In addition, the preamble of Subchapter M states that when towing vessels receive their COI, it will trigger the two requirements for inspected vessels outside of Subchapter M:

- 33 CFR 155.710 requires a person-in-charge for certain fuel transfers on towing vessels to be a credentialed officer or hold an MMC with a tankerman person-in-charge endorsement; and
- 46 CFR 15.820(a) requires a chief engineer on certain inland towing vessels.[4]

Credit for mariners serving 12-hour days, or time-and-a-half service, will still be determined on a case-by-case basis in accordance with the vessel's manning requirements and the company's sea service letter.

Navigation and Vessel Inspection Circular 03-16

NVIC 03-16, published in 2016, supersedes NVIC 04-01 as the current circular for outlining the qualifications for towing officers. NVIC 03-16 includes updated towing officer assessment records (TOAR) for near coastal/oceans, Great Lakes and inland, Western Rivers, as well as for limited local areas upon inland waters or Western Rivers. NVIC 03-16 also includes a crossover for mariners who already hold officers in charge of a navigational watch, as well as grandfathering provisions and FAQs.

Mariners may continue to use the old TOARs from NVIC 04-01 until March 24, 2019. After that date, the TOAR from NVIC 03-16 must be submitted. The Coast Guard provided this transition period recognizing that some mariners may have completed TOAR tasks under NVIC 04-01 as part of the endorsement qualification process. Mariners may also submit a combination of old and new TOAR tasks until March 24, 2019. NVIC 03-16 includes an enclosure that provides a table identifying which tasks in NVIC 03-16 correspond to tasks in NVIC 04-01.[5]

NVIC 03-16 also includes instructions for mariners interested in serving as a designated examiner (DE), conducting assessments and signing TOARs for specific tasks on specific routes. Currently, the NMC has more than 4,100 approved DEs. To serve as a DE, mariners must present evidence to establish experience or training in conducting assessments and qualifications on towing vessels in assessment tasks. He or she must also hold the level of credential endorsement on towing vessels that provides proof of qualifications. Evidence must demonstrate an adequate amount of sea service as a master on towing

vessels for the specific route(s) requested.

Deckhand Credit Toward Mate (Pilot) and Local Limited Towing Endorsements

The Mid-America Regional Exam Center working group, a grass-roots organization, deals with licensing issues for employees, including crediting sea service for an apprentice mate (steersman) serving as a deckhand toward a mate (pilot) of towing.

"The intent of the regulations was to hold an apprentice mate steersman for one year. The intent was not to create the position of steersman," said Menke, who serves as Mid-America Regional Exam Center chairman.

Recently, the Coast Guard and towing industry representatives agreed the apprentice mate is essentially a deckhand being trained as a mate (pilot), and the original intent of the regulation did not intend that the entire 12-month period be served in the wheelhouse. As a result, an apprentice mate (steersman) serving as a deckhand can be used to jump to mate (pilot) of towing.

"That came about because of our group. I'm particularly proud of that," Menke said.

He praised NMC Commanding Officer CAPT Kirsten Martin as well as previous NMC commanding officers for attending Mid-America Regional Exam Center meetings and trying to resolve issues while exchanging information and ideas.

"That's key," he said. "We can tell the NMC some of the issues we have. The NMC can tell us some of the issues they have. And we can come up with solutions."

In 2017, the NMC customer service center made 333,274 contacts with industry using LiveHelp, email, and phone.

A Great Responsibility

Based on his time as a river pilot, novelist Samuel L. Clemens wrote *Life on the Mississippi* under the pseudonym Mark Twain, penning much of what a pilot needs to know. In fact, the name Mark Twain originated during Clemens' time on river boats, when a crew member routinely called out the depth of the river using a lead line with a plummet, or weight, at one end. "Mark twain" meant the river was two fathoms deep, which was considered a safe channel.[1]

The excerpts below describe what he experienced as a river pilot:

> *First of all, there is one faculty which a pilot must incessantly cultivate until he has brought it to absolute perfection. Nothing short of perfection will do. That faculty is memory. He cannot stop with merely thinking a thing is so and so; he must know it; for this is eminently one of the 'exact' sciences …*
>
> *… A cut-off plays havoc with boundary lines and jurisdictions: for instance, a man is living in the State of Mississippi today, a cut-off occurs tonight, and tomorrow the man finds himself and his land over on the other side of the river, within the boundaries and subject to the laws of the State of Louisiana.*
>
> Greg Menke, compliance manager for Evansville Marine Services, agrees, "The Mississippi River is a constantly changing, dynamic beast. What a pilot needs to know is tremendous."


In accordance with the Act of Congress, approved Aug. 30, 1852.
No. 576
PILOT'S CERTIFICATE.
The undersigned, Inspectors for the District of St. Louis, certify that Samuel Clemens having been by them this day duly examined, touching his qualifications as a Pilot of a Steam Boat, is a suitable and safe person to be intrusted with the power and duties of Pilot of Steam Boats, and do license him to act as such for one year from this date, on the following rivers, to wit: the Mississippi River from St Louis to and from St Louis and New Orleans
Given under our hands, this 9th day of April 1859
James H. McCord
Inspectors
I, James H. McCord Inspector for the District of St. Louis, certify that the above named Samuel Clemens this day, before me, solemnly swore that he would faithfully, and honestly, according to his best skill and judgment, without concealment or reservation, perform all the duties required of him as a Pilot, by the Act of Congress, approved August 30, 1852, entitled "An act to amend an act entitled 'An act to provide for the better security of the lives of passengers on board of vessels propelled in whole or in part by steam,' and for other purposes."
Given under my hand, this 9th day of April 1859
James H. McCord

Samuel Clemens' River Pilot License issued on April 9, 1859.

Endnote:

[1] Brian Lavery, "Ship: The Epic Story of Maritime Adventure," DK Publishing, Inc., 2004, p. 173.

The crew of the Coast Guard Cutter *Mackinaw* approach the barge *PML 9000* backward to use the cutter's prop wash to help break the ice around the barge after it became stuck in the St. Marys River in December 2013. The *Mackinaw*'s crew freed the barge and both of its escort tugs. Coast Guard photo by Ensign Michael Cooper

Menke recommends the NMC live chat line, in particular, to other mariners, saying, "I have never been disappointed with the service and quickness [with which] they respond to my questions. People like us need to have someone we can call or talk to when we need help."

In addition, towing industry representatives worked with the NMC to resolve some approved local limited language for limited towing endorsements. Mariners holding a MMC endorsed as mate (pilot) of towing vessels may have master of towing vessels (limited) added to their MMC for a local limited area within the scope of their current route once service requirements have been met. The limited towing endorsement typically covers waters from one mile marker to another mile marker. If a mariner holds master of towing endorsements for multiple local limited areas, the total distance cannot exceed 100 miles.

CG-MMC Policy Letter 01-17

Coast Guard Headquarters also published CG-MMC Policy Letter 01-17[6] to provide guidance for issuing a credential endorsement for tankerman PIC restricted to fuel transfers on towing vessels. As mentioned in PL 01-17, persons designated in charge of fueling operations on uninspected towing vessels are not required to hold an MMC with either an officer endorsement or a tankerman PIC endorsement as long as they hold a letter of designation, as described in 33 CFR 155.715.

The towing vessel's transition to inspected status, however, triggers the requirements that PICs must hold an MMC with a tankerman PIC endorsement if they are not serving as a credentialed officer on the vessel, in accordance with 33 CFR 155.710(e)(1).

ATB Determination for Credit Toward Tankerman PIC

The NMC recently updated and posted a listing of articulated tug barges (ATB)[7] that have been evaluated as either acceptable or not acceptable for equivalency as a tank ship for purposes of sea service credit towards a tankerman PIC endorsement. Service on ATBs with an aggregate tonnage of 1,600 gross registered tons (GRT) or more will be creditable on a case-by-case basis and must have prior authorization by the Coast Guard, provided the ATB equipment is comparable to tank vessel equipment. If the

Delta Queen Photo courtesy of Dave Thomson Collection

ATB is not acceptable, mariners cannot use their service toward a tankerman PIC endorsement.[8]

Past Meets Present

Menke deals with credentialing on a daily basis, helping Evansville Marine Service employees obtain original credentials and more experienced mariners with renewals and upgrades. He broke into the ranks of the U.S. Merchant Marine as a deckhand and calliope player aboard the *Delta Queen*, the last surviving steam-powered passenger boat piloted on the Mississippi River watershed.

"Industry has changed so much from when I started until today," he said.

When Menke joined the towing ranks, the Coast Guard had not yet created a towing license, nor the three most common types of towing officer endorsements—apprentice mate steersman, mate (pilot), and master of towing. After a series of tragic accidents in the 1970s, the Coast Guard promulgated the operator of uninspected towing vessels (OUTV) license. Menke received his OUTV license through the "grandfathering" process by proving he could operate a towing vessel and pass the "rules of the road" exam.

"In our business, guys learn from on-the-job training," he said. "They train each other from one generation to the next. It's not a whole lot different than from the days of Mark Twain."

About the authors:

Michael Lewis serves as a legal instruments examiner at the National Maritime Center and spent five years as an evaluator in the Professional Qualification Evaluation Branch. He served four years as a paratrooper in Army Special Forces and Military Intelligence Corps, and graduated from Kent State University in 2006 with a bachelor of science in journalism and mass communication.

LT Cameron joined the U.S. Coast Guard in 2000 and advanced to chief before promoting to chief warrant officer and then lieutenant. She served mainly in the prevention field as a marine inspector and investigator at Sector Corpus Christi, Texas; Sector Baltimore; Marine Safety Detachment Sturgeon Bay, Wisconsin; and Sector Ohio Valley, Kentucky. She currently serves as customer service branch chief at the National Maritime Center.

Endnotes:

1. U.S. Coast Guard National Maritime Center website: www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/National-Maritime-Center-NMC/stats/
2. 46 CFR Subchapter M 136.205, www.ecfr.gov/cgi-bin/text-idx?SID=2f5989226802608bd18eef239b33e70c&mc=true&node=pt46.4.136&rgn=div5#se46.4.136_1205
3. 46 CFR Subchapter M Preamble, IV. Discussion of Comments and Changes, E. Manning (Part 15), p. 40008, www.federalregister.gov/documents/2016/06/20/2016-12857/inspection-of-towing-vessels
4. 46 CFR Subchapter M Preamble, V. Regulatory Analyses, A. Regulatory Planning and Review, p. 40083, www.federalregister.gov/documents/2016/06/20/2016-12857/inspection-of-towing-vessels
5. NVIC 03-16, www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/NVIC/2016/NVIC_03-16(Ch1).pdf, Enclosure 2
6. CG-MMC-Policy Letter 01-17, www.dco.uscg.mil/Portals/9/NMC/pdfs/regulations_policies/cg-mmc_policy_letter_01-17_final_3_9_17-date.pdf?ver=2017-06-26-093731-823
7. ATB Determinations for Credit towards Tankerman PIC, www.dco.uscg.mil/Portals/9/NMC/pdfs/professional_qualifications/atb_list.pdf
8. List of acceptable ATBs can be found at www.dco.uscg.mil/Portals/9/NMC/pdfs/professional_qualifications/atb_list.pdf

In the News: Cooperation Keeps Commerce Moving

Tugs maneuver barges through the Calcasieu Lock along the Gulf Intracoastal Waterway near Lake Charles, Texas, in August 2018. The Coast Guard, U.S. Army Corps of Engineers, and industry partners have been working together to mitigate the impact on commerce as necessary maintenance is performed on the lock systems along the Gulf Intracoastal Waterway. Coast Guard photo by Petty Officer 3rd Class Johanna Strickland

The Role and Importance of the Towing Safety Advisory Committee

by Eric J. Johansson
Professor, Marine Transportation
Maritime College State University of New York

Introduced by New York Representative Mario Biaggi, H.R. 6242 proposed to the 96th Congress, "A bill to establish a Towing Safety Advisory Committee in the Department of Transportation." President Jimmy Carter signed the bill into law on October 6, 1980.

The original composition of the Towing Safety Advisory Committee (TSAC) included 16 members with expertise, knowledge, and experience regarding shallow-draft inland and coastal waterway navigation and towing. Seven members hailed from the barge and towing industry, reflecting a regional geographic balance, and one member represented the offshore mineral and oil supply vessel industry. The balance of eight committee members was drawn equally from port districts, authorities, or terminal operators; maritime labor; shippers; and the general public.[1] Where the shippers were concerned, at least one of the two members were required to be engaged in the shipment of oil or hazardous material by barge.

In May 1981, ADM John B. Hayes, 16th commandant of the Coast Guard, opened the first two-day TSAC meeting with a brief speech in Washington. During the two-day meeting, the committee formed six subcommittees as follows:

- Port facilities and operations
- Tank barges: Subchapters "O" and "D," construction, operation, and retrofit
- Personnel: licensing, certification, and manning
- Personnel: safety standards and working place standards
- Roles and missions for the United States Coast Guard
- Review and restructure of existing regulations

The original committee reviewed issues pertaining to the industry and made brief recommendations. A review of some of the early recommendations reveals several recurrent issues in the discussions over the years. Some of those early and now recurrent recommendations include:

1. **Recommendations specific to integrated tug and barge combinations, a technology that was born in the 1950s**
   a. TSAC Recommendation No. 2: Change 1 NVC 2-81
   b. TSAC TASK 15-02
2. **Recommendations for Improvement of Marine Casualty Reporting**
   a. TSAC Recommendation No. 6
   b. Casualty Reporting/TSAC Recommendation No. 22
   c. Definition of a Marine Casualty—TSAC TASK 13-09
3. **Qualification and credentialing of the Person-in-Charge (PIC) of Fuel Transfers**
   a. TSAC Recommendation No. 12
   b. Tankerman PIC—16-01 Report 3
4. **Recommendations for the Designation of Narrow Channels**
   a. TSAC Recommendation No. 29: Narrow Channel
   b. TSAC TASK 13-05

Over time, the committee has expanded from 16 to 18 members. Two positions for maritime labor were eliminated and three slots for active masters were added—one each from Western Rivers/Gulf intracoastal, offshore, and ship-docking/harbor towing—and one towing vessel engineer with formal training and experience.

The commandant may request individuals representing the U.S. Army Corps of Engineers, Maritime Administration (MARAD), Navigation Safety Advisory Council, and National Boating Safety Advisory Committee participate, as well. In recent years, MARAD has actively participated at TSAC meetings, providing valuable insight.

Experiencing TSAC First-Hand

I learned of TSAC in 2004, but did not attend until a few years later, when I became aware that the public was also

Coast Guard marine inspectors LT Mary Morgan, Petty Officer 1st Class Jeff Deronde, Mike Pearson, and Chief Petty Officer David Labadie, all from Marine Safety Unit Portland, present a Subchapter M Certificate of Inspection to the crew of the towing vessel *Sommer S*, operated by Shaver Transportation, in Portland, Oregon, on July 20, 2018. Subchapter M contains the safety regulations governing the inspection, standards, and safety management systems of towing vessels. Coast Guard photo by LT Anthony Solares

invited, and, in fact, highly encouraged to attend and participate. I've attended every meeting since 2010. Over the years, I have met industry leaders with whom I now have great friendships.

I found the openness of the meetings to be very impressive. The public was provided full access to the committee, as well as its subcommittee, to provide input, and we always took advantage of these opportunities to voice support or concerns during the formal meetings. In particular, I admired impassioned public comments lobbying for mariners' safety. I believe public comments like these had impact, and ultimately may have influenced the addition of active mariners and engineers as sitting members of TSAC. After several years of applying, I was pleased to be appointed to the committee in January 2012.

From Ideas to Taskings

A chairman and vice chairman govern TSAC's biannual—fall and spring—two-day meetings, which are held in various sectors of the United States and open to the public. In 2014, I was named vice chairman. The first day of each meeting is an informal working meeting ahead of the formal meeting the following day. In recent years, this has been readjusted from a working meeting with individual subcommittee meetings to a full meeting with subcommittee progress reports for member input and public comments. The second day remains largely unchanged, and subcommittees are now encouraged to work between meetings and present either a progress, interim, or final report on both days to enhance transparency. Recommendations are now supported by formal written reports.

In 2012, the designated federal officer and assistant designated federal officer displayed eagerness to provide the committee with support to work on not only what TSAC recommended, but also the Coast Guard's requested taskings. TSAC taskings can be proposed by committee members as well as the public before being selected for approval by the committee. TSAC tasking evidenced record growth in 2013, when 10 new tasks were introduced.

As Subchapter M approached implementation, the Coast Guard presented TSAC with vital tasking to support an understanding of new regulations. The importance of Subchapter M will likely increase TSAC's participation in this vital work. To ensure these important tasks are

TSAC Today

My experience with TSAC is that of a true industry/government partnership in action. If you are interested in joining, I recommend beginning with public participation, then applying for membership.

Current Towing Safety Advisory Committee:

- Representing Shippers: Jerry Crooks (Shell Oil) and Mike Fewell (Dow Chemical)
- Representing Offshore Mineral and Oil: Brian Guidry (Edison Chouest Offshore)
- Representing License Engineers: Laura Wilcox (Vitus Marine)
- Representing Active Master of Rivers: Ray Richmond
- Representing Active Master Offshore: Marc Dial (Plimsoll Marine)
- Representing Active Master Harbor Assist: Wes Southworth (Moran Towing)
- Representing Port Districts: Joy Terrell, Lemm Corp, and Eric Johansson (SUNY Maritime)
- Representing Public: Mike Rushing and Joann Salyers
- Representing Tug and Barge:
  - Mike Caliendo (Andrie), Great Lakes region
  - Steve Kress (McAllister Towing), East Coast region
  - Toby Jacobsen (Foss), West Coast region
  - Andrew Gauthier (Crowley), West/Gulf/East Coast regions
  - Chris Myskowski (Marquette Transportation), Western Rivers regions
  - Steve Huttman (G&H Towing), Gulf Coast region
  - Jill Taft (Massachusetts Maritime Academy)

*New members have been nominated

appropriate, TSAC created a vetting committee, under the direction of the vice chair, to review these tasks and make suggestions prior to publication.

When a task is presented by the Coast Guard to the vetting committee, the committee reviews and reverts comments and suggested changes to the full committee for final discussion and approval. Once a task has been accepted by TSAC, the committee makes nominations for a chair and co-chair to lead a subcommittee, followed by an invitation to both TSAC members and the public for participation. Subcommittee membership has fluctuated from 10 to 50 members, with a broad range of interest and knowledge.

In addition to the vetting committee, TSAC developed its own nominating committee, which presents four names for each position when choosing a new chairman and vice chairman. Nominating committee members may not nominate themselves, nor be nominated by others. If a nominating committee member wishes to be nominated, they must withdraw from the committee.

Passion and Professionalism

TSAC is a special committee, with members who are passionate about safety and dedicated to our industry. Our current committee members are hardworking individuals devoting considerable time and effort.

The members and participants are free to agree or disagree while working as a collaborative group. For example, TSAC was recently provided a task that saw more discussion and passion than any other I have ever witnessed. Over the course of three TSAC meetings, both public and member positions, while divergent, were keenly argued and resolved in the spirit of cooperation to better the industry. I give great credit to the public and TSAC members who persevered to bring closure to this task 18 months following the first-draft report, and with dedicated professionalism.

None of TSAC's work would be possible without strong support from the Coast Guard. The committee has been blessed with a great team from Coast Guard Headquarters that has helped in many ways, including selecting new members, collating new tasks, processing completed tasks, and countless administrative tasks.

I would like to commend my TSAC colleagues and friends for their spirit, dedication, and hard work.

About the author:
Captain Eric Johansson, who joined the SUNY Maritime faculty in 1994, is a third-generation Port of NY/NJ Tug Captain and Distinguished Service Professor who holds a master's degree in international transportation management. He founded the annual SUNY Maritime College Towing Forum, now in its 18th year, and has published multiple funded research projects. In addition to his research, he serves on many local maritime committees including the harbor safety committee, energy sub-committee, Harbor School Professional Advisory Committee and as vice chair of the Towing Safety Advisory Committee.

Endnote:

1. H.R. 6242, October 6, 1980

Subchapter M

Taking the long view

by Jennifer Carpenter
Executive Vice President and Chief Operating Officer
The American Waterways Operators

Caitlyn Stewart
Director of Regulatory Affairs
The American Waterways Operators

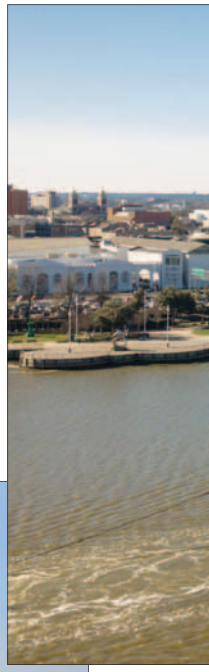
Ever since July 20, 2018, when the requirements of 46 CFR Subchapter M for existing towing vessels took effect, towing vessel inspection has seemed less like a novelty and more like a fact of life. As the Coast Guard and towing vessel operators across the country get accustomed to the new regulatory regime, the journey that brought us to this safety milestone fades further into history. It is worth recalling the goals that launched this journey and the process that got us here, as they provide a touchstone by which to assess the success of Subchapter M implementation and the extent to which it is fulfilling the vision that gave rise to it.

A Proactive Vision

The road to Subchapter M began more than 15 years ago with a bold vision:

- take safety and environmental stewardship throughout the tugboat, towboat, and barge industry to a new and historic level
- ensure that all operators meet minimum standards of safety while recognizing and incentivizing operators who exceed minimum standards
- leverage safety management systems and third-party organizations (TPO) to help the Coast Guard focus its limited resources where they're needed most

The origins of towing vessel inspection date back to 2003 with a working group established by the Coast Guard-American Waterways Operators (AWO) Safety Partnership—a first-of-its-kind public-private partnership that

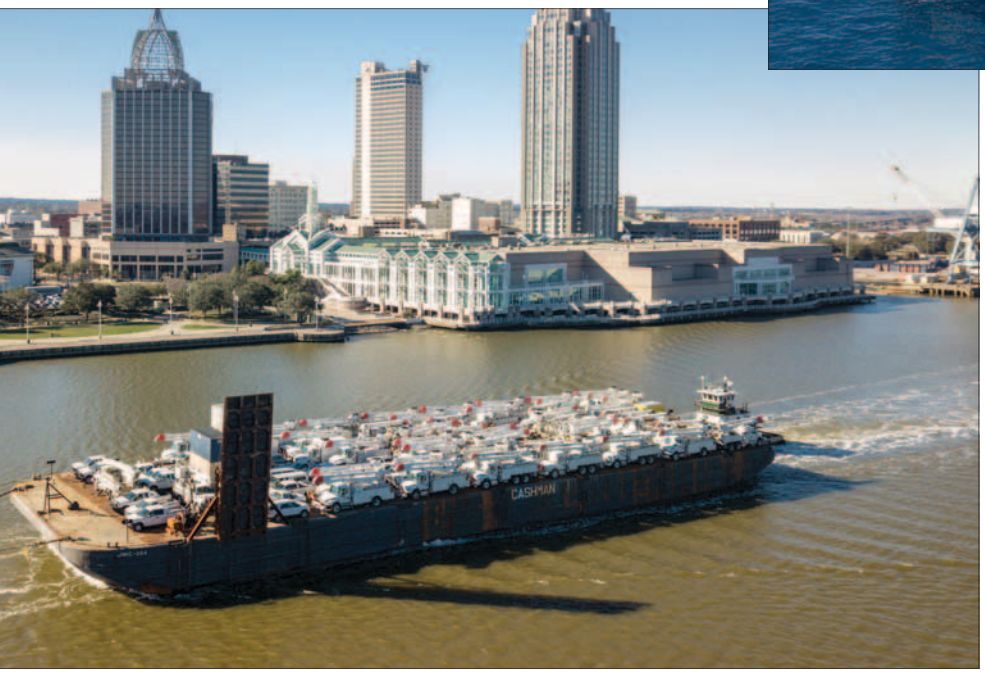


The M/V *Denise Foss*. Photo courtesy of Foss Maritime Company

brought Coast Guard and industry leaders together to improve safety, security, and environmental stewardship. The working group recommended establishing an inspection regime for towing vessels based on the implementation of a safety management system.

While towing industry safety trends had been steadily improving at the time, industry and Coast Guard leaders recognized that a chain could only be as strong as its weakest link. Strengthening the industry's weak links would improve the safety of people, the environment, and property by driving down fatalities, spills, and accidents. Rather than reacting to a casualty or waiting for Congress to act, industry and the Coast Guard shared the goal of working proactively to institute this new kind of safety regime for towing vessels.

The M/V *Karen Andrie* and barge *Endeavour,* an articulated tug-barge unit. Photo courtesy of Andrie Inc.



The M/V *Delta* of Cooper Marine and Timberland pushing a barge loaded with utility vehicles to assist with hurricane recovery efforts in Puerto Rico. Photo courtesy of Cooper/T. Smith Corporation

Importance of Safety Management Systems

In late 2003, leaders of the American Waterways Operators met with the commandant of the Coast Guard to offer their support for establishing a safety and inspection regime for towing vessels, including a requirement for a safety management system (SMS). In 2004, the Department of Homeland Security requested new statutory authority to enable the Coast Guard to do just that. With industry support, Congress responded quickly. The Coast Guard and Maritime Transportation Act of 2004 added towing vessels to the list of vessels subject to inspection, and authorized the Coast Guard to establish, by regulation, an SMS appropriate for towing vessels.

Safety management systems were integral to the towing vessel inspection initiative from the outset for two reasons:

- They provide a framework to identify and mitigate risks at the root of accidents.
- The Coast Guard and industry recognized that adding nearly 6,000 vessels to the inspected vessel fleet would severely strain Coast Guard resources.

Therefore, an approach to inspection leveraging the use of safety management systems and Coast Guard-approved third parties offered the potential to raise safety standards throughout the towing industry while making more efficient use of Coast Guard resources.

Stakeholder Engagement

As the Coast Guard worked to develop regulations to implement its new statutory mandate, the agency started a thoughtful, thorough process of stakeholder engagement, enlisting assistance from the congressionally authorized Towing Safety Advisory Committee (TSAC). In late 2004, TSAC established a working group that first developed an outline and then a comprehensive draft regulatory proposal over a period of three and a half years. They did so with the input of more than 160 individuals from all segments of the industry. This diverse group of stakeholders validated the innovative vision of a new approach to Coast Guard inspection that leverages safety management systems and approved third parties to supplement Coast Guard oversight. At the same time, a subgroup

focused on risk-based decision making analyzed Coast Guard casualty data to ensure that TSAC's recommendations were targeted on the factors most critical to casualty prevention.

In 2007, and again in 2008, the Coast Guard shared the drafted regulations with TSAC for feedback. Through this process of gathering public input, industry experts worked side by side with the Coast Guard to improve the quality and practicability of the regulations eventually proposed. As the proposed rule wound its way through the administration review process, the Coast Guard and industry shared information, increased familiarity, and strengthened lines of communication.

Lightening the Load

In 2009, the Coast Guard launched the Towing Vessel Bridging Program, which introduced voluntary, industry-initiated towing vessel examinations to assess compliance with current regulations. The larger purpose was to ease the transition to inspection by providing Coast Guard and towing industry personnel with opportunities to interact and acclimate to each other's modes of operation.

The Coast Guard also opened the Towing Vessel National Center of Expertise in 2010. Meanwhile, cooperative working groups established under the Coast Guard-AWO Safety Partnership worked to develop and refine tools to orient Coast Guard personnel to the towing industry and resolve issues that emerged during towing vessel examinations.

From Draft to Rule

The notice of proposed rulemaking (NPRM) to establish Subchapter M was published in September 2011. With the NPRM as a discussion draft, the Coast Guard resumed its extensive process of gathering public feedback. Guided by its towing vessel inspection working group, AWO provided comprehensive feedback to the rulemaking docket and also at a series of public meetings across the country. TSAC also carefully reviewed the rule and offered extensive recommendations. When the final rule was published in June 2016, it was a better and more practicable one, reflecting the Coast Guard's thoughtful effort to incorporate stakeholder feedback.

Subchapter M allows towing vessel operators to choose between two compliance options—the Towing Safety Management System (TSMS) option and the Coast Guard option. Under the TSMS option, a towing vessel operator whose safety management system meets the requirements of Subchapter M is issued a TSMS certificate by a Coast Guard-approved third-party organization. The TPO verifies company and vessel compliance with other applicable Subchapter M requirements, and the Coast Guard relies on objective evidence of compliance provided by the vessel owner and TPO to issue a certificate of inspection (COI). Under the Coast Guard option, a towing vessel is subject to annual inspections by the Coast Guard.

True to the vision that gave rise to it, Subchapter M recognizes the role of safety management systems in promoting continuous regulatory compliance and providing early warning of deficiencies that could lead to accidents. Subchapter M promotes the use of safety management systems by providing operators who choose the TSMS option with greater flexibility, not only in the issuance of COIs, but also in meeting other regulatory requirements.

During the two years between publication of the final rule and the July 2018 effective date for the majority of its existing vessel requirements, industry and the Coast Guard worked hard to prepare themselves. The Coast Guard approved TPOs to conduct audits and surveys and extend their oversight capabilities, prepared its workforce to implement and enforce the regulations, and developed implementation guidance to clarify the requirements. Meanwhile, towing vessel operators readied their vessels, trained their crew members, and made decisions about which compliance option to choose.

Incentivizing the TSMS Option and Targeted Enforcement

The Coast Guard's work to incentivize the TSMS option has been, and will continue to be, one of the most important contributors to the success of Subchapter M. Without

The M/V *Patrick J. Studdert.* Photo courtesy of Buffalo Marine Service, Inc.

The M/V *Brandywine* and barge *Double Skin 141*, an articulated tug-barge unit. Photo courtesy of The Vane Brothers Company

industry's embrace of the TSMS option, the Coast Guard would be severely challenged to fulfill its new towing vessel inspection obligations while attending to its other critical missions. In late 2016, the Coast Guard took a significant step to ensure the utility of the TSMS option by recognizing the AWO Responsible Carrier Program, the most widely used SMS in the towing industry, as an existing safety management system under Subchapter M. Beginning in 2017, the Coast Guard Office of Commercial Vessel Compliance promulgated several policy letters to facilitate Subchapter M compliance for companies choosing the TSMS option.

These efforts have been significant encouragements, but maximizing use of the TSMS option is an objective to which industry and the Coast Guard must continue to attend. Even a small number of towing vessel operators jettisoning their safety management systems and shifting to the Coast Guard option could have an outsized impact on industry safety and Coast Guard resources. Establishing inspection user fees that are lower for TSMS option vessels—in recognition of their reduced demand on agency resources—is a crucial next step to ensure that vessel operators are not discouraged from choosing the TSMS option due to redundant costs.

Risk-based enforcement, part of the Coast Guard-industry vision of towing vessel inspection since its inception, is also crucial in realizing Subchapter M's potential to raise the bar of safety throughout the towing industry. During the period between publication of the regulation and its entry into force, industry identified several requirements that posed implementation challenges for towing vessel operators, but offered little positive impact on personnel and vessel safety. AWO has urged the Coast Guard to initiate regulatory changes to eliminate these requirements, and in the meantime promulgate guidance allowing operators to identify and implement acceptable alternatives. Providing a consistent national approach to these low-risk compliance challenges will enable Coast Guard field personnel to focus their attention on the regulatory requirements that will make a difference in protecting people, the environment, and property.

It's even more important that the Coast Guard take a risk-based approach to Subchapter M enforcement by focusing its limited resources on substandard operators who threaten the safety of our shared waterways. The biggest gains in safety aren't going to be made by expending significant Coast Guard resources on companies and vessels that have implemented a safety management system and are using it to continuously manage and improve their safety and regulatory compliance. What *will* make the industry safer is directing Coast Guard enforcement resources to the small number of substandard operators that raise the risk profile of the entire towing industry.

The Way Forward

Industry and the Coast Guard set ambitious goals for themselves in embarking on the journey to Subchapter M 15 years ago, and July 20, 2018, was not the end of that journey. To realize the promise of Subchapter M and take our industry to its highest level of safety yet for mariners, the environment, and the public, the Coast Guard must have the focus and capacity to direct its resources where they are most needed. This will require maximizing use of the TSMS option and developing effective, efficient means of addressing issues with low-risk requirements and safety-conscious companies.

As Subchapter M implementation progresses, AWO and its members are committed to continuing the same high level of communication and collaboration with the Coast Guard that has served us well throughout this long journey. We are committed to not just regulatory compliance, but to building and continuously improving a culture of safety, security, and environmental stewardship. Although the challenges of the present can be preoccupying, in this new phase of our safety journey, it's important to take the long view.

About the authors:

Jennifer Carpenter serves as executive vice president and chief operating officer of the American Waterways Operators, the national trade association for the tugboat, towboat, and barge industry. She has been with AWO for 28 years and is a former member of the Towing Safety Advisory Committee.

Caitlyn Stewart has been with AWO for 8 years and currently serves as its director of regulatory affairs.

Flexibility and Compliance

Balancing the need for both in the wake of Subchapter M

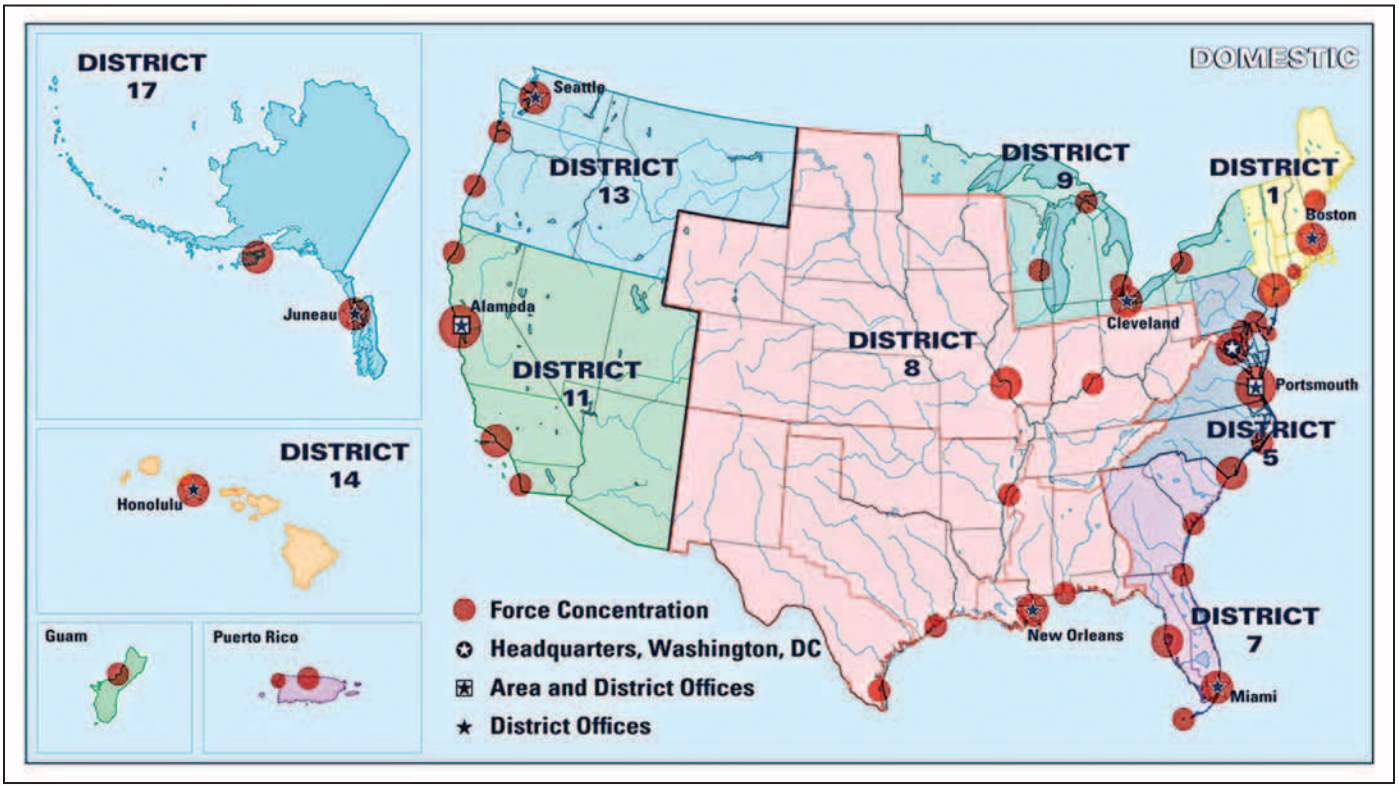
by Jill Bessetti
Towing Vessel Coordinator
Coast Guard District Eight

The transition of our nation's towing fleet to inspected status under Subchapter M represents challenges in both workload and culture for the Coast Guard's entire workforce, particularly those of Coast Guard District Eight. The district is home to more than 10,000 miles of river, 1,200 miles of coastline, and 1,300 miles of intracoastal waterways.[1] With more than 70 percent of towing vessels operating across the 26-state district, the number of vessels requiring inspections has nearly doubled. Throughout the Subchapter M phase-in period,[2] the uncertainty regarding what portion of the fleet will choose either the Towing Safety Management System (TSMS) or the Coast Guard option for Subchapter M compliance has further intensified the implementation challenge.

For nearly a decade during the towing vessel bridging program, towing vessels have been examined under Subchapter C, and thousands of towing vessel decals have been issued across Coast Guard District Eight. The bridging program facilitated the enhancement of important relationships among the maritime industry and with Coast Guard inspectors, which has helped ease tensions associated with the transition of this fleet to inspected status.

Subchapter M regulations allow towing vessel owners and operators to customize the approach they choose to meet the regulatory requirements. They may choose a traditional Coast Guard inspection regime or employ a Towing Safety Management System, which uses third parties to perform the required surveys and audits.

The TSMS option may provide companies greater flexibility in scheduling and performing surveys and audits while also establishing a comprehensive quality control system that will increase the safety and efficiency of all



U.S. Coast Guard graphic

Marine inspectors from Marine Safety Unit Portland conduct a field dry dock examination August 17, 2016, to educate and train the towing vessel community on new regulatory standards—Subchapter M—that began being enforced in July 2018. U.S. Coast Guard photo

Coast Guard Petty Officer 1st Class Jeff Deronde presents Scott Shaver, president of Shaver Transportation, with a Subchapter M Certificate of Inspection using the Coast Guard option, in Portland, Oregon, on July 20, 2018. Deronde is a marine inspector at Coast Guard Marine Safety Unit Portland. Coast Guard photo by LT Anthony Solares

towing vessel operations. As a result, Coast Guard inspectors are expected to spend less time aboard vessels choosing compliance under the TSMS option as compared to vessels opting for a traditional Coast Guard inspection.

A Balanced Approach to Compliance

To allow Coast Guard Headquarters staff time to consider industry-proposed alternatives to a number of Subchapter M requirements, District Eight released field guidance to operational commanders at the onset of Subchapter M implementation. This encouraged officers in charge, marine inspection (OCMIs) to use discretion on certain items required under Subchapter M. The deferment of these items allowed for immediate issuance of certificates of inspection (COIs), providing industry more time to meet certain requirements and continue the flow of commerce.

Operators were encouraged to work with their local OCMIs and/or TPOs to have any items in the deferred status documented prior to issuance of the COI. In late October, District Eight rescinded this guidance as Coast Guard Headquarters promulgated the "Special Consideration" work instruction, CVC-WI-010(1), which addressed many of previous deferments and serves as guidance to assist OCMI's in the application of certain requirements under Subchapter M.

"District Eight operational commanders will implement Subchapter M within their areas of responsibility at a pace unit resources can support based on sector-specific evaluation of risks to the marine transportation system. More specifically, my intent is for D8 units to strive to minimize negative impacts to our workforce, commerce, and the unit's overall risk profile and operational readiness," Admiral Paul F. Thomas, Coast Guard District Eight's commander, wrote in his Commander's Intent.

The Paradigm Shift

In late April 2018, Coast Guard District Eight hosted a training session for marine inspectors conducting Subchapter M inspections. This training provided a venue to discuss a consistent, technical approach to implementation and a forum to hear from industry partners on a variety of items associated with TSMS. The training also laid the foundation for a "train the trainer" program throughout the district to increase the number

CAPT Blake Welborn, commanding officer of Coast Guard Marine Safety Unit Houma, presents two certificates of inspection to LeBeouf Bros. Towing, LLC, in Houma, Louisiana, on May 10, 2018. These certificates mark two of the first COIs to be issued in U.S. Coast Guard District Eight in accordance with the Subchapter M towing regulations. Coast Guard photo by Petty Officer 3rd Class Travis Magee

of qualified inspectors for the inspected towing vessel program. In addition, the role of the marine inspector in observing vessel and company audits as part of a third-party organization was further defined, which represents a paradigm shift in comparison to traditional Coast Guard inspections.

With the oversight of TSMS-option vessels, this paradigm shift changes the role of Coast Guard marine inspectors. While the time aboard a TSMS-option vessel may be reduced as compared to vessels choosing the traditional Coast Guard option for compliance, the oversight scheme of TSMS vessels will be greatly enhanced, particularly when it comes to marine causalities. Saying what you do and doing what you say is a large part of the oversight within this shift. Coast Guard traditional "boots on deck" inspections for TSMS-option vessels will now be more focused on the verification that safety management systems are working processes throughout a company as opposed to colorful, but static binders, on a shelf.

The First Certificates of Inspection in District Eight

All District Eight units have been working hard to communicate expectations to the industry through outreach days, marine safety information bulletins, and company visits. This has no doubt increased the confidence in industry as well as in the Coast Guard to implement the unique program established in Subchapter M. Issuance of certificates of inspection for TSMS-option vessels began in early May, with Sector Houston-Galveston and Louisiana's Marine Safety Unit Houma issuing the first certificates of inspection in District Eight.

As the district prepares to handle the bulk of the

workload for this new regulation, it is without question ready to work side by side with industry to maintain the highest levels of safety and continue to promote commerce on some of the nation's busiest waterways.

About the author:

Jill Bessetti is currently District Eight's towing vessel coordinator in New Orleans. She has 15 years of dedicated service to the Coast Guard in active duty and the Reserves.

Endnotes:

1. www.atlanticarea.uscg.mil/Our-Organization/District-8/
2. 46 CFR 136.202

Left: LT Ross Phillips, a marine inspector at Sector Houston-Galveston, presents the initial certificate of inspection (COI) to the captain of the towing vessel *Sacred Heart* on May 7, 2018, near Channelview, Texas. This marks one of the first COIs to be issued in accordance with the Subchapter M towing regulations in U.S. Coast Guard District Eight. Coast Guard photos by Petty Officer 3rd Class Travis Magee and Petty Officer 3rd Class Johanna Strickland

CDR Daniel Cost, commanding officer of Marine Safety Unit Lake Charles, issues the area's first certificate of inspection for the new Subchapter M towing vessel regulations to the Devall family of Devall Towing and Boat Services on August 15, 2018, at Devall Fleeting Area in Sulphur, Louisiana. The new regulations encompass more stringent towing inspection, operational, and safety standards. Coast Guard photo by Marine Safety Unit Lake Charles

Towing Vessel Inspections Training

Past, present, and future

by CWO4 Rob Birdwell
Instructor
Coast Guard Marine Inspection and Investigation School
U.S. Coast Guard Training Center Yorktown

LCDR Christian Barger
Former School Chief
Marine Inspection and Investigation School
U.S. Coast Guard Training Center Yorktown

It has finally arrived—July 20, 2018. It's been 15 years since Congress classified towing vessels as subject to inspection in 46 USC 3301, mandating that they obtain a certificate of inspection (COI) from the U.S. Coast Guard to operate. The transition of this entire fleet of vessels into the Coast Guard inspection regime has been—and will continue to be—a major undertaking. Just under 6,000 towing vessels will be progressively brought into the system, ensuring the safe operation of those assisting in the navigation of deep draft vessels within our nation's harbors and delivery of 27,000 barges of various cargoes throughout our waterways.[1]

Ready for the Call

During the course of this two-year transition, many questions were asked that only led to uncertain answers. For instance, of the nearly 6,000 towing vessels now subject to inspection under 46 CFR Subchapter M, how many will choose to go the route of incorporating a third-party organization (TPO) into their vessel inspection process versus solely relying on the Coast Guard? This question is incredibly important, because in its answer lies a related answer to the next question: Will the Coast Guard be prepared with enough trained and qualified marine inspectors to meet the industry demand?[2]

Prior to July 20, the Coast Guard had been responsible for inspecting and issuing COIs to about 12,000 vessels. The addition of nearly 6,000 towing vessels to this existing workload means that now 18,000 vessels will need to be inspected using the same 700-member workforce. Training will be needed on the most up-to-date requirements, techniques, and procedures for conducting vessel compliance inspections and examinations.

Training Center Yorktown's (TCY) Marine Inspection and Investigation School delivers entry- and advanced-level training for officers, enlisted, civilian, and auxiliary personnel performing vessel inspections and examinations. Since 2010, in anticipation of towing vessels becoming subject to inspection, TCY collaborated with the Towing Vessel National Center of Expertise (TVNCOE), Office of Commercial Vessel Compliance (CG-CVC), and Force Readiness Command (FORCECOM) to develop multiple training solutions and performance qualification standards (PQS) related to towing vessels.

These products target audiences of various experience levels, from those junior enlisted with no experience in inspections to the most seasoned of marine inspectors. The training courses have included an uninspected towing vessel examiner (UTVE) course, a surge orientation for inspected towing vessel verifying officers, and an inspected towing vessel (ITV) unit in the marine inspector course (MIC). These courses, coupled with UTVE and inspected towing vessel inspector (ITVI) PQS products managed by the schoolhouse, help ensure the workforce is ready to tackle the implementation of 46 CFR Subchapter M.

Uninspected Towing Vessel Course

The Coast Guard and towing vessel industry recognized a mutual need to acclimate to a new inspection regimen. As a result, the Towing Vessel Bridging Program (TVBP) was implemented June 12, 2009. The program called for extensive industry outreach, proper training of the workforce, and examining every tow vessel that would become inspected under the then-impending 46 CFR Subchapter M final rule. For the Coast Guard, the program gave marine inspectors an opportunity to learn more about the industry and become educated on the regulations, rules, and policies that govern it. For the tow industry, the program established meaningful Coast Guard/industry interactions through scheduled exams in which the Coast Guard applied the existing regulations of 46 CFR Subchapter C.

The TVBP consisted of three phases, each with an element of training for the Coast Guard workforce. In July 2010, as part of phase one and two, the TVNCOE created a just-in-time training for uninspected towing vessel examiners at their location in Paducah, Kentucky, to bridge

Students from the uninspected towing vessel examiner course convening 03-13 attend training aboard a working towing vessel. Coast Guard photo courtesy TRACEN Yorktown

the training gap until a formal course could be brought online. In 2012, Training Center Yorktown finished the development of the UTVE course and convened the first course. The just-in-time and UTVE courses were delivered quarterly over a six-year period, reaching more than 600 students. The course was instructed as a collaborative effort among TCY and TVNCOE members. The vast majority of the attendees were petty officers (E-4 thru E-6) and apprentice marine inspectors (W-2/O-1 thru O-3).

The scope of the lessons focused on examination preparations, vessel documentation, navigation, lifesaving, firefighting, pollution prevention, towing vessel gear and equipment, security, and data entry into the Marine Information for Safety and Law Enforcement database.[3] These lessons used the few, but already applicable, regulations for uninspected vessels in 46 CFR Subchapter C. The course provided students the opportunity to learn new information in the classroom and aboard working towing vessels for a hands-on, performance-based style of learning. This format was successful through partnership with the towing industry, which provided vessels to serve as training aids.

Phase three of the TVBP began in July 2018, and signaled the transition of focus from 46 CFR Subchapter C to Subchapter M. The UTVE course was discontinued and all efforts were shifted to the development of a new ITVI curriculum, job aids, and PQS.[4]

Towing Vessel Performance Qualification Standards

While classroom training is extremely effective in delivering consistent baseline knowledge and skills, it is recognized that trainees best hone their skills and truly demonstrate proficiency while on the job. Performance qualification standards are the Coast Guard's guides for on-the-job training, designed to identify the minimum level of competency required for a member to perform a specific job on his or her own.[5]

In 2009, the first national UTVE PQS was promulgated by the Office of Commercial Vessel Compliance (CG-CVC) as part of the TVBP. It consisted of 78 tasks and

a requirement for the member to take part in a local towing vessel industry orientation and indoctrination. This significant step to formalize towing vessel examinations and ensure the consistency of those members performing them nationwide was expanded upon in 2014 with an updated UTVE PQS product.

In 2011, TCY took over responsibility for the development and maintenance of all marine inspection PQS. This shift better aligned resident and on-the-job training through a single performance standard and ensured validity of the PQS through a regular maintenance regimen. The new PQS products, including a 2014 UTVE update, include a PQS workbook, training aid, and job aid. These three components ensure consistent guidance and qualification experience for trainees and their verifying officers and also ensure that the tasks trained are reflective of the job performed.

Like all training products, the 2014 PQS was developed through the collaboration of subject matter experts from the training center, program, NCOEs, and field units. The 2014 UTVE PQS reduced the list to 64 tasks, but expanded the individual steps required to be verified for each task while specifying the conditions under which the task/steps were to be performed, the standard to which the trainee should be held, and authoritative references specific to each step. It retained the requirement for local industry orientation and indoctrination in order to get trainees familiar with the uniqueness of the towing industry. While the necessity for UTVE qualifications has decreased with the implementation of 46 CFR Subchapter M, the UTVE PQS remains valid for those performing examinations on towing vessels not applicable to the inspection requirements.

As part of the shift to ITVs, an ITVI PQS, training aid, and job aid were developed in 2016 through collaboration among TCY, CG-CVC, TVNCOE, traveling inspector training support staff, and district towing vessel coordinators. This workgroup went line by line through the final rule[6] to identify a comprehensive task list associated with the new job. The resulting product consists of 111 tasks covering every facet of inspecting a towing vessel, whether the vessel elected the Coast Guard option or third-party organization, including the unique review and oversight of towing safety management systems (TSMS).

The ITVI PQS retained the requirement for a towing industry familiarization and added the prerequisite for attendance of the marine inspector course to align with the other inspected vessel PQS. This brand-new PQS necessitated the creation of verifying officers (VO) to qualify the workforce. As such, attendees of the aforementioned ITV surge orientation were the first to work with the ITVI PQS. Their use of it in the surge orientation served as a pilot to validate that the proper tasks and steps were identified in performing the job. The attendees were given a letter identifying them as capable of performing ITVI VO functions nationally.

As with all of the 32 marine inspector PQS products managed by TCY, the ITVI PQS is on a regular maintenance schedule. While school staff performs reviews of the PQS, the best input for continual improvement comes from the field. The ITVI, along with all other marine inspector PQS, has a change recommendation form at the end through which those in the field can submit recommendations directly to the schoolhouse for consideration in the next revision. Detailed feedback is a necessity to keep the training product valid in an ever-evolving field.

Inspected Towing Vessel Inspector: Verifying Officer Surge Orientation

As with anything new, someone has to be first. The implementation of new regulations and development of a new PQS created a void of qualified inspectors and verifying officers in the workforce. VOs are members already qualified who can also be entrusted to guarantee standards are upheld during the PQS process. They are therefore responsible for qualifying new inspectors.

But who could best fill these shoes, since no one in the Coast Guard possessed the ITVI qualification? The solution quickly came to life through 125 of the most senior marine inspectors in the Coast Guard. Marine inspection training officers (MITO) and advanced journeyman marine inspectors (AJMI) from 27 sectors and all districts around the nation were hand-selected to become the first verifying officers charged with the development of new ITV inspectors. This target audience of MITOs and AJMIs were expected to go back to their commands and conduct training, attend inspections with trainees, sign PQS, and administer qualification boards. This approach was designed to quickly grow the number of qualified members needed to meet the demand of ITV inspections.

TCY, the TVNCOE, CG-CVC, and a select few subject matter experts developed the ITV VO surge orientation curriculum. A gap analysis was conducted comparing the ITVI PQS against some of the most common marine inspector qualifications in order to identify unique tasks that needed to be trained. In consideration of resource availability and the seniority of the target audience, the team was careful to instruct only information that would be new and unique to these types of vessels. The instructional blocks included policies, rules, and the applicability of 46 CFR Subchapter M. They also included new construction requirements, documents, credentialing, manning, lifesaving, navigation, firefighting, machinery, terminal gear, and TSMS.

In the spirit of performance-based training, it was the team's goal to deliver hands-on training and exercises onboard working towing vessels, specifically involving students in auditing an active TSMS. The towing industry

An instructor discusses towing vessel inspection. Coast Guard photo courtesy TRACEN Yorktown

quickly responded to solicitations to provide platforms. The performance-based exercises were developed to provide familiarization with the applicability of 46 CFR Subchapter M and give practice toward performing verification of a company's TSMS. The students were able to identify compliance or non-conformities through objective evidence in the company's TSMS. They were then able to spend time on the vessel working with its crew while conducting an inspection and comparing their findings against the TSMS.

Half a day was also specifically dedicated to a "train-the-trainers" learning session that focused on the soft skills and best practices for being a successful VO. Keith Core of CG-CVC instructed this lesson. He took the opportunity to talk about the learning styles of adults and the most productive ways to foster the learning process.[7] Throughout the training, there were performance components focusing on effective communication of feedback and the importance of maintaining consistency through a structured training program. This innovative approach provided new VOs with the tools to most effectively train the up-and-coming workforce.

Inspected Towing Vessel Inspector: Marine Inspector Course

With the discontinuation of the UTVE course in 2016 and the purposeful limitation of the ITV VO surge orientation to four sessions in 2017, questions arose about the need for continued efforts to maintain a workforce large enough to meet the anticipated demand. In 2018, CG-CVC requested TCY add an ITV unit to the MIC curriculum as a short-term solution until decisions could be made on the development of other forms of training. The addition of an approximately eight-hour ITV segment within the existing MIC footprint placed adjacent to the barge inspection unit presented the best option. It allowed the content to reach more than 120 apprentice marine inspectors.

Once again TCY, CG-CVC, and the TVNCOE worked together to develop the training. This time, the team modified content to focus on entry-level ITVI knowledge and skills appropriate for apprentice marine inspectors (AMI). A TVNCOE content gap analysis identified principles unique to towing vessel regulations that do not otherwise relate to content already taught in the existing small passenger vessel and barge inspection units of the course. The content was then further refined to ensure it aligned with the expectations for performance from an AMI, which was determined to focus on inspection of Coast Guard option towing vessels and only the ability to identify potential nonconformities with TSMS vessels to trigger further audit. While the job is still new, it is anticipated that a full TSMS verification and corresponding third-party oversight will be a function of journeyman marine inspectors (JMIs). Therefore, this target audience of AMIs does not require an in-depth look at these concepts.

This short-term solution piloted the newly added section in the second session of fiscal year 2018. Staff from the

TVNCOE primarily delivered the content, as they were able to provide the most current expertise on the evolving field. With this addition, upon graduation from MIC, AMIs will be well equipped to begin working on their ITVI PQS under the tutelage of VOs previously trained during the inspected towing vessel verifying officer surge orientation.

The Future of Inspected Towing Vessel Training

What will the future of towing vessel inspection training look like? The future content and format of any training solution is truly unknown, as training principles, field performance, and subject matter continue to evolve. However, it is known that some form of ITV inspection performance support will be needed in the long term to ensure a capable workforce—appropriately sized and competent—to meet the demands associated with inspection requirements in 46 CFR Subchapter M.

It is critical to develop any performance support product based on a detailed analysis of the job to ensure the proper solution is implemented to resolve the performance gap and provide the best return on investment. This concept is the basis on which the FORCECOM training system standard operating procedures and human performance principles are built. With towing vessel inspection in its infancy, the challenge of performing a valid analysis resides in the uncertainty of what the world of work for a towing vessel inspector truly looks like. One must also consider whether there are actually any skills, knowledge, or environmental gaps impacting the workforce's ability to perform the job. As field performance actually takes shape following the July 2018 implementation, opportunities to perform an accurate analysis will become available to initiate long-term options.

It can be said with confidence that the future of all marine inspection-related training continues to shift toward a performance-based approach delivered through blended learning products. The yesteryears of training consisting of students attending weeks of classroom lectures at the training center are giving way to a learning environment where students work hands-on observing, practicing, and being assessed on the performance of tasks that would be expected on the job. This results in far less time spent in lecture and a significant increase in resident training focused on working in labs or on vessel platforms.

It is also realized that training can and may be more appropriate and effectively delivered through means other than in residency at the training center. As such, future training products are using a blended approach where some content is delivered online and some through structured on-the-job training, to be facilitated by VOs in the field using student and coach's guides developed and managed by the training center. Additionally, more and more support is being provided through job aids and electronic performance support solutions—essentially electronic job aids—which provide an economical means to support the workforce when and where they are actually doing the job.

As previously mentioned, time will determine the long-term format of a towing vessel training option. Will it become a part of a larger marine inspector performance support architecture? Will it remain a part of MIC or stand-alone, like the previous UTVE course? Perhaps ITV will combine with barge training in a completely new course. The options are endless.

Conclusion

The evolution of towing vessel training will continue to coincide with the formalization and implementation of the job itself. Understanding that training must be reflective of field performance and delivered to the right audience at the right time to ensure the greatest return on investment, we must be willing to be patient to get a long-term sustainable training solution implemented.

In the meantime, Training Center Yorktown will continue to work with CG-CVC and the TVNCOE to meet the immediate needs of the field at a level commensurate to the requirements of the Towing Vessel Bridging Program. The end result of immediate and long-term solutions will be the continued highly competent Coast Guard inspection workforce that our organization, commercial industry, and public have come to expect.

About the authors:

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LCDR Christian Barger has served in the U.S. Coast Guard and marine safety field for 14 years. He currently serves as the Waterways Management Division Chief at Sector Upper Mississippi River. From 2014 to 2018, he was assigned to Training Center Yorktown, where he served as an instructor and school chief of the Marine Inspection and Investigation School. He earned his Coast Guard Master Training Specialist designation in 2016.

Endnotes:

1. Data captured from the "Industry Background" section of the Towing Vessel Industry Familiarization Workbook developed by CG-CVC-1, July 1, 2016
2. Chris Parsonage, Flexibility and Complexity, Operators need to select their Subchapter M strategy for compliance, www.sname.org/sname/mt
3. Curriculum outline for the Uninspected Towing Vessel course, course code 502234
4. Decision Memo: Inspected Towing Vessel (ITV) Training and Qualification, CG-CVC-1, March 10, 2016
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Assessing Today's Bridge Officers

NSAP: A powerful tool for dynamic evaluation

by Keith Fawcett
Marine Casualty Investigator
U.S. Coast Guard Investigations National Center of Expertise

Towing companies conduct periodic assessments of their wheelhouse personnel to evaluate the competency of those personnel who perform critical functions in dynamic situations they confront in the maritime environment. Routinely these checks can be accomplished through simulator training, assessments by more experienced company captains, and a host of other means.

In the case of the ferry operation and blue water assessments I audited in regards to this article, I have found that the Navigation Skill Assessment Program (NSAP) provides a similar level of identification of performance gaps as well as strengths in competency for a host of towing vessel navigation operations.

But do these typical evaluations fully identify the competency and skill gaps for each individual officer? Do they speak to their strengths and offer constructive recommendations for training to close these gaps and improve the safety of marine operations?

My answer is yes. The NSAP, a relatively new tool, achieves these greater goals and does so in an objective and repeatable manner, ultimately providing a roadmap for improving mariner skills and reducing maritime risks.

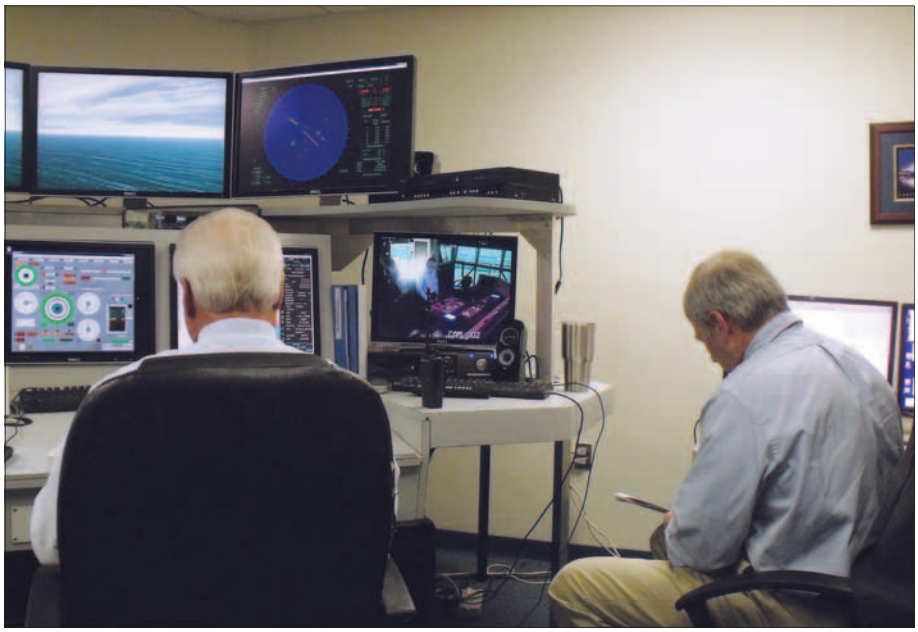
Realistic Simulations, Comprehensive Feedback

Barry Torrey, Staten Island Ferry's senior port captain, watched one of his vessel captains direct a simulator vessel along a computer-generated waterway. He monitored a collection of displays showing an image of the simulator vessel's bridge along with displays repeating the simulator's radars, controls, and the electronic chart display showing the vessel's position on a complex waterway.

At that moment, only the NSAP assessment team and the port captain in the simulator control room knew that a planned assessment "event" was about to take place. The simulator vessel approached a color-coded line on the control room chart display visible only to the simulator operators. The assessment team called out the trigger event on a VHF radio and triggered the movement of a vessel stored in the simulator computer program, creating an event.

Triggered events come in many forms—a vessel emergency, a change in the weather, another vessel meeting or approaching the assessed vessel, a significant change in visibility, or similar commonplace events. Each event is carefully tailored to provide a realistic and believable challenge for the deck officer being assessed.

As the simulated voyage continued, the assessment team and port captain worked together to measure how close to accepted standards the deck officer performed the duties of officer in charge of the navigation watch. They did this by observing how the assessed officer directed the vessel in relation to the simulated events and comparing those actions to various standards of performance. In the assessment I observed, a senior port captain and an additional port captain were in attendance to provide



The NSAP assessment team, comprised of experienced master mariners, monitor the progress of an assessment scenario via closed-circuit TV and the simulator's computer monitor system. Other NSAP facilitators are on the simulator's bridge along with the bridge officer being assessed. Photo courtesy of author

Facilitators and the mariners being assessed meet at the NSAP at the Pacific Maritime Institute in Seattle to review the outcomes of the assessment process. NSAP photo

comprehensive feedback, each offering comments and observations about each event on the assessment sheet as the simulation unfolded.

The Staten Island Ferry port captain, a regular participant in the assessment process, explained at critical points how the specific operating procedures required for his company would apply to a specific event. This allowed for some of their specific protocols to be measured during the course of the assessment. In this case, the deck officer operating the simulated vessel directed a member of the bridge team to make a public address announcement at a predetermined time before approaching the landing dock, as the company's operating procedures require.

By allowing the inclusion of these unique procedures—but enforcing a broader portfolio of accepted performance standards for all required skills—the assessment of deck officers, captains, and mates becomes a true reflection of their overall competency as an organization. It is also an indicator of both the strengths and potential weaknesses of their mariners.

> 1,600 assessments on merchant marine professionals using the NSAP model … noted a number of characteristics of poor seamanship and navigation skills in the merchant marine community.
>
> —U.S. Navy Comprehensive Review of Recent Surface Force Incidents, October 26, 2017, p. 49

NSAP to Test Risk Mitigation

Staten Island Ferry, owned and operated by the New York City Department of Transportation, is the busiest ferry route in the United States, transporting 23.9 million passengers in fiscal year 2017. It is also the world's busiest passenger-only ferry. These facts make clear the benefits of using such a program for risk mitigation.

Meanwhile, back in the bridge simulator, the deck officer is confronted with another occurrence in a series of planned events. The NSAP assessor noted the specifics of how the deck officer handles each one. At the end of the assessment, a computer printer produced a detailed chartlet showing how the participant managed this event—a critical turn in the waterway. Showing colored segments indicating the acceptable maneuvering area layered over the navigational chart, the color chartlet indicated how effectively the deck officer maneuvered the vessel through the turn, allowing the assessor a means of communicating how well the vessel was handled during a post-assessment debrief.

The assessment voyage continued. The bridge officer continued to confront highly realistic events throughout the remainder of the passage. To facilitate the realism of a vessel voyage, the bridge is manned with a helmsman and a mate to assist the officer directing the operation of the vessel and aid the officer in the use of otherwise unfamiliar equipment.

For deep draft ocean assessments, there are management level assessments designed to challenge captains and chief mates, while other versions of the assessment are targeted at junior officers, third mates, and second

The bridge officer is assessed in a realistic maritime environment. To facilitate the realism of a vessel voyage, the bridge is manned with both a helmsman and a mate to 1) assist the officer directing the operation of the vessel, and 2) aid the officer in the use of otherwise unfamiliar equipment. NSAP photo

mates—operations level. Regardless of which version is being conducted, each assessment voyage lasts less than an hour and is designed to have an equivalence between all versions of the assessments.

Team Evaluation

At the conclusion of a run, a computer-generated voice says, "Your exercise has been suspended." However, even though the simulation exercise may be complete, the real work of the assessment is just about to begin. In the simulator control room, the NSAP assessment team and the port captain met to compare notes and arrive at a combined appraisal for the bridge officer being assessed. The port captains shared their unique perspectives on their respective vessel operations to ensure the assessment met the needs of each operation.

Once the discussions and observations are assembled, the assessment team met with the deck officer. Armed with the report, assessment worksheets, and notes, the team began constructively walking the officer through the entire voyage. They pointed out the individual events to illustrate how the bridge officer handled them in comparison to the desired standards of performance with respect to the areas of communications, bridge resource management, ship handling, navigation regulations, and the use of bridge navigation equipment.

The experience is designed to be positive, constructive, and supportive of the training needs of the bridge officer, aiming to close any applicable performance gaps. In most cases, the bridge officer being evaluated has already self-assessed his or her performance, so the discussion centers around the desire and means to improve performance in these critical vessel operating areas.

Procedures and Protocols

To ensure these complex assessment exercises are manageable and effective for the bridge officers, the program follows a comprehensive set of procedures and protocols. For example, each person attending the assessment program signs a non-disclosure agreement to protect the integrity of the assessment program.

On arriving at the Maritime Institute of Training and Graduate Studies (MITAGS) in Linthicum Heights, Maryland,[1] the Staten Island Ferry's bridge officer group gathered with the Staten Island Ferry port captain and met the assessment team—generally master mariners and

Several repeat clients of the program use the NSAP as part of their interview and hiring process, as it has become the most efficient means to determine mariner competency. It is obviously more cost effective than learning that the mariner lacks the critical competencies required in the challenging and unforgiving maritime environment after hiring. An opportunity to close performance gaps and reduce the risks before a catastrophic marine casualty is an opportunity well spent.

adjunct simulator team experts. The group learned about the NSAP concept through a video presentation and was then familiarized with the bridge navigation simulation system and the team members supporting the system.

The bridge simulator is state-of-the-art, complete with external visual displays that are hyper-realistic, displaying the dynamic image of the waterway as well as shore features, other vessels, and the ever-changing weather conditions the bridge officer will encounter during the assessment scenario. The participants' vessel models the precise handling characteristics of a vessel similar to that used by the specific industry's sector. The computer program driving the simulation takes into effect the forces imparted by the marine environment in terms of current or wind, allowing for the presentation of a variety of believable weather conditions.

After the initial briefing and familiarization is complete, each bridge officer is given time to complete their

NSAP: A Program of Critical Importance

Recent Navy accidents occurring in the Far East, along with a host of other historical accidents, indicate a need to continually assess the competency of bridge officers in light of their great safety responsibilities. The Navy has released its *Comprehensive Review of Recent Surface Force Incidents,*[1] which represents a summary of significant actions needed to fix the larger problems and their causes leading up to these incidents. In this report's section on individual training, the authors made this recommendation:

> *Create an objective, standardized assessment program to periodically assess individual seamanship and navigation skills over the course of a Surface Warfare Officer's career. This process should be informed by the MITAGS Navigation Skills Assessment Program (NSAP) principles to assess Surface Warfare Officer seamanship and navigation skills at every career milestone, including an objective assessment by SWOS prior to initial qualification as Officer of the Deck. [NETC, 31Mar2018]*

The report explains the significance and value of the NSAP as follows:

> *One example of this training can be found at the MITAGS, which developed a program to objectively assess civilian seamanship and navigation skills and provide recommendations for focused training and improvement. This program, the Navigation Skills Assessment Program (NSAP), assesses the performance of individuals in a one- or two-day scenario to measure performance in five areas:*
>
> - *ship handling*
> - *communications*
> - *bridge equipment use*
> - *Bridge Resource Management (BRM)*
> - *application of the Nautical Rules*
>
> *BRM is the process by which bridge watch officers make use of all available human, equipment, and information resources to safely and effectively navigate a ship …*
>
> *The failure of qualified, trained, and certified personnel and watch teams to execute their duties safely and professionally, while unacceptable, is not uncommon.*
>
> *For example, the review team observed instruction at MITAGS, which has performed over 1,600 merchant mariner assessments using the NSAP model described above, and noted a number of characteristics of poor seamanship and navigation skills in the merchant marine community. For example, 36 percent of individuals turned to port in extremis; 35 percent were unable to properly tune their navigation radar; 30 percent did not make proper use of electronic chart system safety features; and there was an overall overreliance on electronic chart systems as a single source of navigation information, as well as a broader neglect of visual and radar equipment.*

Endnote:

1. http://s3.amazonaws.com/CHINFO/Comprehensive+Review_Final.pdf, October 26, 2017

independent voyage plans. To ensure assessment objectivity and eliminate any unfair advantages, the bridge officers navigate a fictional but fully realistic waterway on a vessel similar to one of their own vessels. Because of this, the assessment is also designed to account for any lack of familiarity with equipment. The goal is to analyze the operation and navigation skills of each of the bridge officers, allowing the company to make an informed decision about any potential training and further skill improvements needed for their mariners.

At the conclusion of the assessment voyage, each bridge officer is individually debriefed in a private setting and given an opportunity to reflect on his or her own professional performance—a rare occasion for any professional mariner. During the debrief, a senior member of the company—like the Staten Island Ferry senior port captain—will normally be present, which is extraordinarily valuable to both the mariner and the company. These senior personnel ensure the assessment and debriefing incorporate specific company culture or priorities and give the company direct feedback about the character and nature of their deck officers in a safe and unbiased manner.

One of the unique benefits of the program is the opportunity to capitalize on additional training offered to maximize the attendees' time. During the Staten Island Ferry assessment program, for example, the company elected to provide its attendees with additional training in fatigue reduction, the role and responsibilities of a vessel master, and reporting procedures for marine casualties, among other subject areas.

This particular group of deck officers was the sixth group to be assessed by the Navigation Skills Assessment Program. As an early adopter of NSAP, Staten Island Ferry

NSAP facilitator Captain Olav Nysetter explains the unique control functions of the starboard bridge radar unit to a Staten Island Ferry captain prior to the captain's individual familiarization exercise. Photo courtesy of the author

To date, the NSAP program has assessment scenarios developed for:

- NSAP Oceans—Management Level (masters and chief mates, deep draft vessels on oceans routes)
- NSAP Oceans—Operations Level (junior officers, deep draft vessels on oceans routes)
- NSAP Workboat—deck officers operating vessels of a tonnage less than 3,000 International Tonnage Convention (ITC)
- NSAP Ferry—bridge officers operating ferry vessels
- NSAP River—deck officers operating vessels less than 3,000 ITC on routes generally not subject to the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW)
- NSAP New Hire—primarily used to assist companies in the hiring process
- NSAP new pilot assessment programs

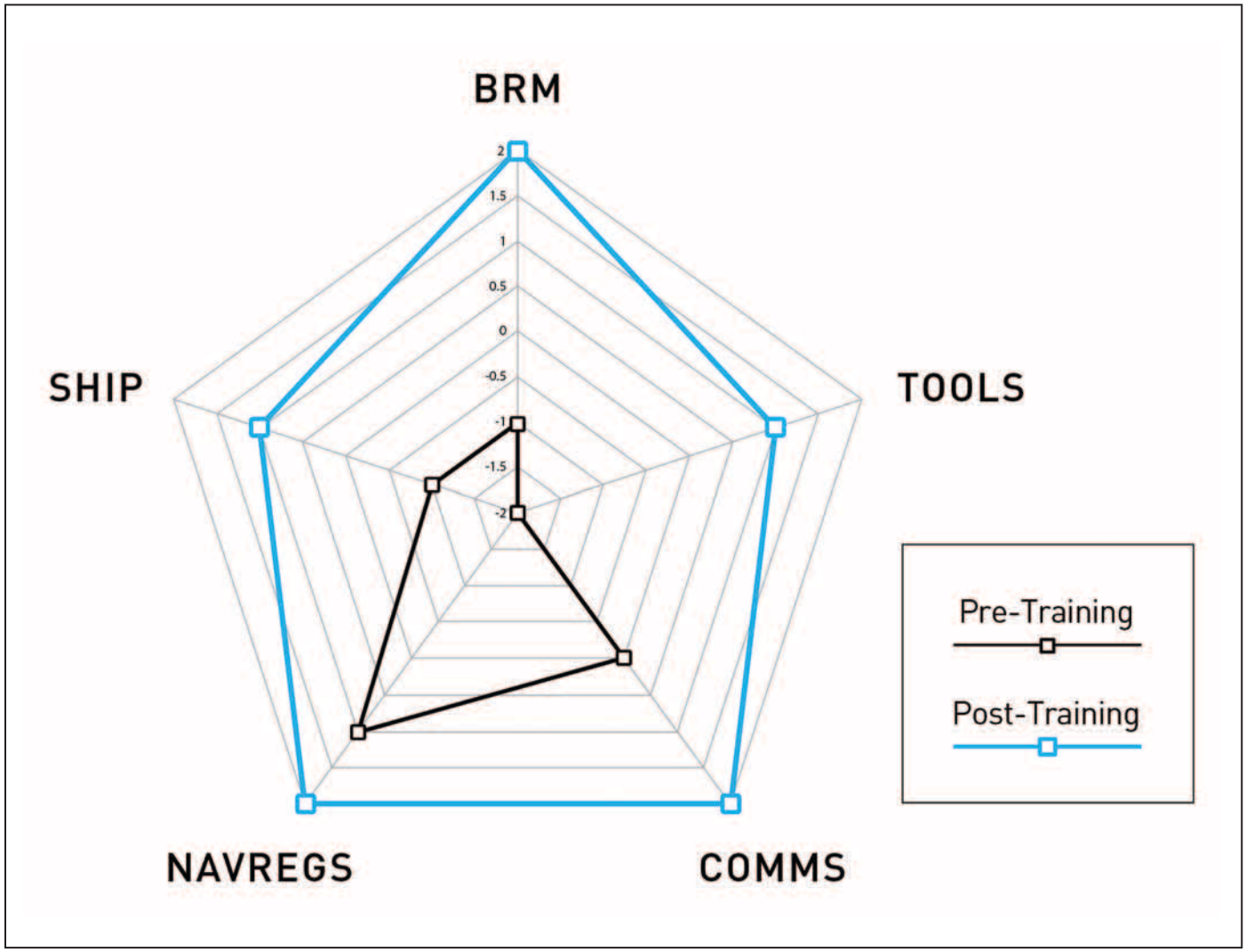


Diagram indicating areas of examination in the NSAP assessment. A detailed report identifies performance gaps so marine companies can create an appropriate training plan to close those gaps and improve the safety of marine operations. Figure courtesy of NSAP

also participated in three beta testing sessions of the program for their ferry operation before shifting into the live production version of the assessment program.

Focused Training and Improvement

At the conclusion of each specific company's assessment program, the NSAP offers comprehensive data on individual performance and, more importantly, a composite picture of company-specific trends and risks associated with the operation of that company's fleet. As noted in the NSAP brochure, "The vision of the NSAP is to reduce catastrophic maritime incidents by addressing mariner competency and knowledge and use of technology."

The NSAP assessment criteria used to evaluate the competence and skill of these officers was developed to the highest standards using the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 standards as a minimum measure of performance. Working with experts from diverse segments of the maritime industry, as well as experts in the field of the objective measurement of human performance, the program provides a challenging experience and a useful measurement tool for maritime companies.

About the author

Keith Fawcett is a licensed merchant mariner and a staff member at the Coast Guard Investigations National Center of Expertise. He worked in the marine industry for more than 20 years, generally in Gulf of Mexico operations. As a Coast Guard marine casualty investigator, he has conducted high-profile marine casualty investigations for the Coast Guard, including that of the sinking of the SS El Faro, *which was lost in October 2015. He also received the Coast Guard's 2015 Sener Award for excellence in marine casualty investigations.*

Endnote:

1. The training is also offered at the Pacific Maritime Institute in Seattle, Washington, as well as at five other global locations.

Addressing Safety

Towing Vessel Stability

An often overlooked but critical safety consideration

by Captain William J. Sullivan
Manager, Vessel Repair and Regulatory Compliance
Donjon Marine Co., Inc.

There is no doubt that towing vessels have become more complex, and regulatory compliance is placing increasing clerical demands on the mariner. As such, once in service, consideration for maintaining towing vessel stability can seem inconsequential, at best. It is important to note, however, that understanding basic stability and knowing how to comply with the stability instructions for one's vessel is tantamount to the safety of people, property, and the environment.

In general, the term "stability" refers to the ability of a vessel to float upright. It also refers to its resistance to inclination by an external force.[1] When it comes to towing vessels, loss of stability often leads to a series of events which can quickly result in a fatal outcome.

Just as you wouldn't drive your car without adjusting the side and rearview mirrors for maximum visibility, reviewing your stability letter should be a regular occurrence prior to sailing any vessel. Doing so will help to ensure the safety of the vessel and all those on board.

Subchapter M—Towing Vessel Regulations

46 CFR§140.605 states:

a) Prior to getting underway, and at all other times necessary to ensure the safety of the vessel, the master or officer in charge of a navigational watch must determine whether the vessel complies with all stability requirements in the vessel's trim and stability book, stability letter, COI, and Load Line Certificate, as applicable.

b) A towing vessel must be maintained and operated so the watertight integrity and stability of the vessel are not compromised.

Clarifying Expectations and Application

As with most other responsibilities for operating a towing vessel, the responsibility for complying with the stability letter lies with the vessel master. As a matter of fact, the stability letter is addressed specifically to the master, with an opening statement that reads, "You are responsible for

Coast Guard Cutter *Cleat* is shown alongside the tug boat *Texan* in the Delaware River, near Philadephia, in December 2011, while Coast Guard crew members conduct a boarding. Coast Guard photo by Senior Chief Petty Officer David Allen

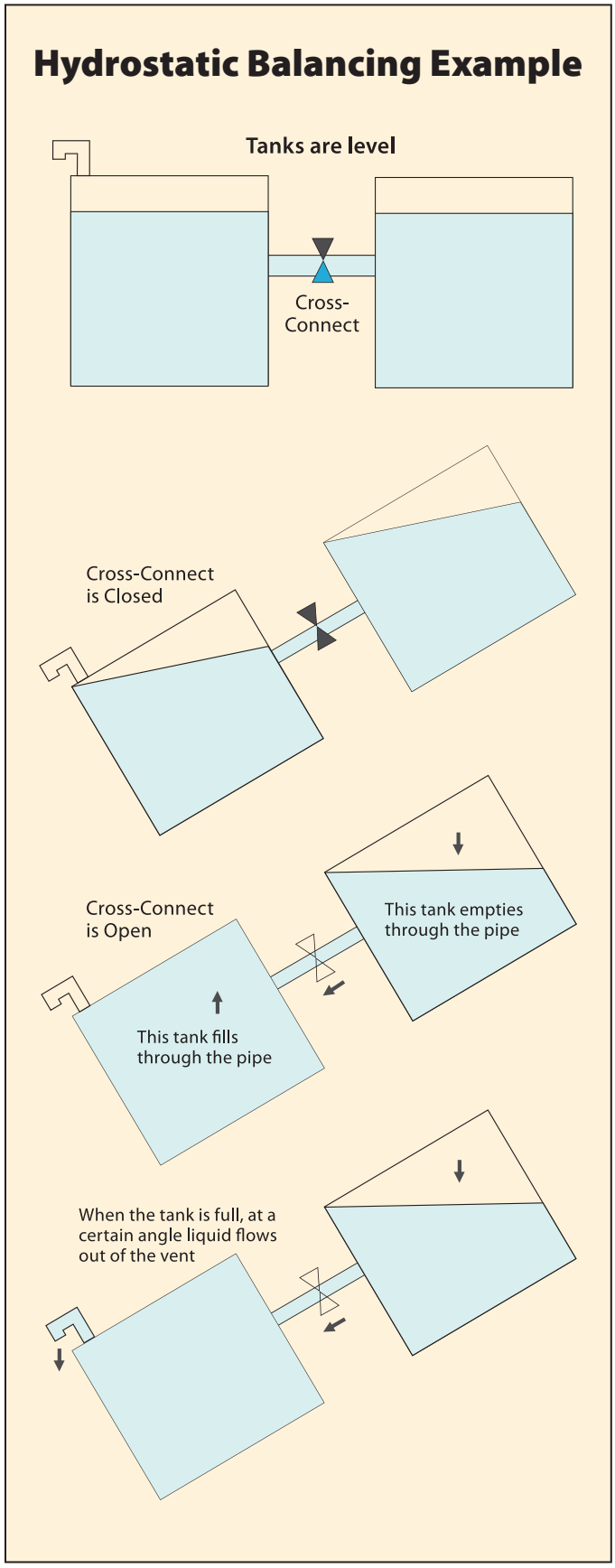


Illustration from the U.S. Coast Guard January 18, 2006, report *Investigation into the Circumstances Surrounding the Sinking of the Tug* Valour

maintaining this vessel in a satisfactory stability condition at all times and for following the instructions and precautions listed below." Failure to properly enforce the requirements of the stability letter is not only considered an act of misconduct, but is simply poor seamanship.

The master is not the only crew member responsible for compliance, however.

As stated in Marine Investigations Lessons Learned 01-10, *Towing Vessel Stability Requirements,* "Although vessel stability letters are addressed to the master, all of the deck officers are responsible for stability issues. Vessel engineers are also responsible to ensure that the master and other deck officers are aware of noncompliance issues that take place within the engine room."

I would go so far as to suggest the entire crew be familiarized with the contents of the stability letter so that all on board have a good understanding of its requirements and can contribute to the safety of the vessel. Furthermore, while it is required that the stability letter be posted and visible in the wheelhouse, it's a good idea to also post a copy in the engine room as a reminder to the engineering department.

There may also be some confusion as to the applicability of stability letters as they are referenced on coastal and ocean-going towing vessel load line certificates. This may lead some to believe that they only apply when in load line areas. In fact, stability letters apply to a vessel at all times, continuously in effect.[2] Bad things can happen at any time. For instance, I am aware of, and have witnessed, numerous marine casualties that occurred in fine weather on inland waters as a result of open weather doors on the main deck.

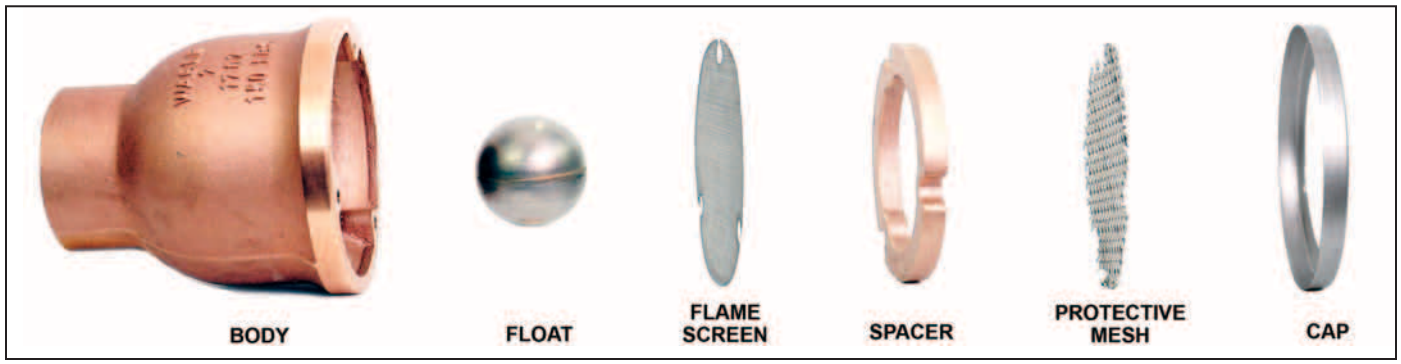
Best Marine Practice

If not mentioned on a vessel's stability instructions, the following are considered good marine practices:

- Bilges and voids pumped to a minimum content at all times, consistent with pollution prevention requirements. This prevents free surface effect.
- Maintain freeing ports operable and completely unobstructed, which prevents decks from being awash.
- Keep main deck hatches and weather doors closed at all times while underway to prevent flooding.
- Minimize slack tanks. This also prevents free surface effect.
- Keep cross-connections between tanks closed at all times while underway. This prevents hydrostatic balancing.
- Make every effort to determine the cause of any list prior to correcting it.

Hydrostatic Balancing

One of the more important instructions found on the



An inverted vent check valve protects tanks and bulkheads from pressure build-up during loading and unloading of liquid or dry cargo and assures maximum efficiency during operations. The ball float prevents contamination of the tank cargo from sea water during heavy seas. Illustration courtesy of Wager Company USA

stability letter is the requirement to keep cross-connections between port and starboard tanks closed while underway. As noted above, this prevents hydrostatic balancing.

Hydrostatic balancing is a condition that occurs when a vessel heels as liquid from higher tanks flows to lower tanks in search of an equal level, which moves the center of weight off of centerline, thereby increasing the heel angle, creating a "list." Keeping the cross-connections closed not only prevents hydrostatic balancing. As tanks are isolated, any potential problems within those tanks will limit reductions in stability. Once hydrostatic balancing starts, it can be difficult to diagnose, and even more difficult to correct while underway.

The tug *Atlantic Enterprise* prepares to take on a pilot in the Strait of Canso, Nova Scotia, Canada, with the crane barge *Farrell 256* in tow. Photo courtesy of Jack Ronalds

Why the List?

Arguably the most critical instruction found on all stability letters is the requirement to determine the cause of any list prior to taking corrective action. The reason for this is simple. Transferring ballast or fuel to correct a perceived list while underway may exacerbate the situation, especially if the cause of the list is from hydrostatic balancing.

Although it may take some time to determine the cause of the list, doing so prior to taking corrective action will almost certainly prevent worsening the situation. I suggest a pre-sail checklist that includes ensuring correct valve positioning prior to every voyage. Such a checklist can not only prevent complacency and confirm compliance with stability instructions, but may also save time when investigating a sudden list and provide an additional peace of mind for the vessel master.

Preventive Maintenance

Preventive maintenance can have a profound effect on the reliability of equipment that contributes to the continued stability of a vessel. For instance, I always made it a habit to disassemble, service, and reassemble all of my vessel's inverted vent check valves every year prior to hurricane season. Specifically, make sure the float balls are intact and the flame screens are not clogged. Lubricate the fasteners upon reassembly and maintain critical spares just in case.

Conclusion

Although towing vessels are becoming technologically advanced in many ways, some things will never change. Vessel stability will always be a critical factor for the master and crew. As we progress through the 21st century and embrace technological innovation, professional mariners cannot afford to overlook the tenets of basic seamanship.

About the author:

A graduate of SUNY Maritime College, Captain William J. Sullivan sailed on towing vessels for 15 years prior to serving ashore in various management positions. Currently overseeing vessel repair and regulatory compliance at Donjon Marine, he has received numerous meritorious citations including the J. Howard Pew Award for Heroism and the Maritime 9-11 Transportation Medal for his efforts to evacuate victims from lower Manhattan in the immediate aftermath of the September 11, 2001 terrorist attacks.

Endnotes:

1. Felix M. Cornell and Allan C. Hoffman, "American Merchant Seamans' Manual," Sixth Edition, Cornell Maritime Press, 1981, p. 15–7.
2. Marine Investigations Lessons Learned 01-10, "Towing Vessel Stability Requirements," February 18, 2010.

Coast Guard Academy Graduate Tackles Real-World Issues

by Ensign Erin Morgan
Coast Guard Academy, Naval Architecture and Marine Engineering
Class of 2018

During the summer before cadets' first class year at the Coast Guard Academy, they have the opportunity to apply to different internships around the nation—and some worldwide. One of the opportunities available to naval architecture majors like me is with the Marine Safety Center (MSC) in Washington, D.C.

Designing a Research Project

As an independent research project is a requirement of the internship, MSC staff engineers presented me with the topic of towing vessel stability. Before this six-week internship, I'd had very little introduction to regulations or towing vessels, if any, so I immediately began researching 46 CFR Subchapter M and the increased regulation of towing vessels across the nation.

This internship was in the summer of 2017, the lead-up to the compliance deadline. My first week at the MSC was spent catching up on the Subchapter M implementation process. As a naval architecture undergraduate, stability, in general, was of interest to me—looking at hull forms and righting arms curves is what got me interested in majoring in naval architecture to begin with. Because of the lack of regulation in previous years, there wasn't much data on the current fleet.

The question I decided to pose was whether the current fleet of inland river towing vessels could pass the stability requirements of 46 CFR Subchapter S parts 170 and 173, now required for vessels subject to Subchapter M. The plan for study was to gather geometry files of a few different inland river towing vessels and test them against Subchapter S. The goal was to estimate a general state of stability of the towing vessels currently operating on the inland river system. All research presented in this article is the result of the study completed over the six-week internship.

Ensign Erin Morgan at Sector Mobile. Coast Guard photo by LT Daniel Burke

The study was narrowed to just inland river towing vessels in order to bound the results. Inland river towing vessels, compared to harbor tugs, for example, have different hull shapes and therefore would not produce the same results in terms of their stability.

The Hypothesis

Before analyzing the individual towing vessel models, I predicted that the downflooding angle would be the likely limiting factor of a towing vessel's ability to meet the stability criteria. A downflooding angle, as defined in Subchapter S, is the angle from the waterline to the first opening that cannot be closed watertight. When a vessel heels over past the downflooding angle, it means that flooding can occur through that non-watertight opening. Subchapter S, Subpart 170.173, states that a vessel's angle to downflood must be greater than 15 degrees. Additionally, the majority of the stability criteria in parts 170 and 173 use the downflooding angle as part of the limiting criteria for righting arm and righting energy.

My prediction was based on studying previous towing vessel casualties and from the operational profile of inland river towing vessels. Since profits for towing companies are directly related to how fast they can move products, these vessels carry a lot of fuel in order to make fewer stops along their transits, thus reducing their time for barge delivery. While these towing vessels load up with as much fuel as they can reasonably carry, their

Tow Boat on Chain of Rocks canal, just north of St. Louis. By LSqrd42 | Shutterstock.com

freeboard is sometimes decreased to as little as 1.5 ft. The increased draft directly relates to the decrease of a vessel's downflooding angle by raising the waterline from which the angle was initially measured.

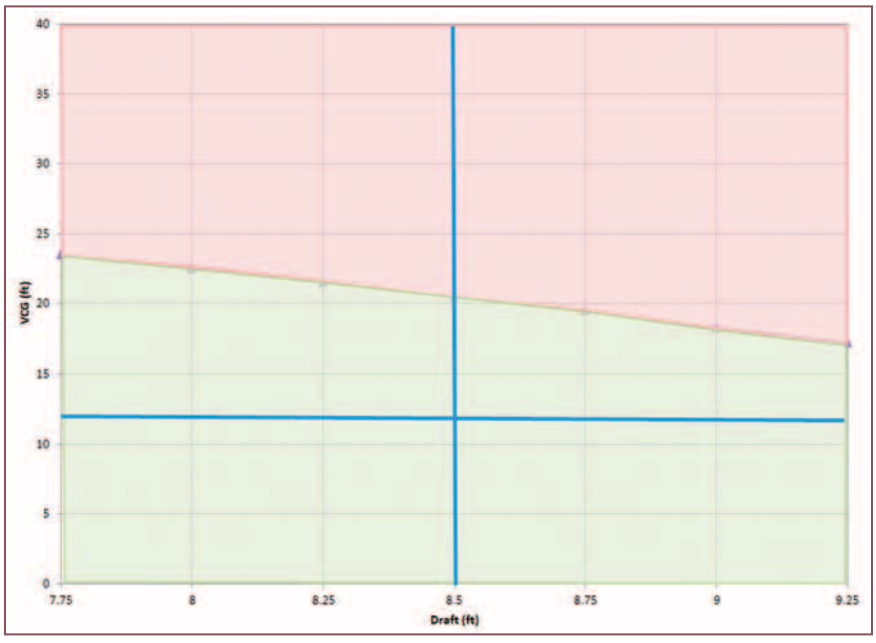
Testing the Models

Once the models were gathered, the first step was to define where these downflooding points were. In order to accurately test the stability of the vessels, I declared the outboardmost doors on the vessels as the downflooding points. These doors were, on average, located 4- to 6-feet inboard with the coamings raised less than 1 foot above the deck.

In some of the vessels assessed, these outboard doors were, in fact, watertight doors. However, for the purpose of this study, they were included as non-watertight doors based on the normal operations of the towing vessels. Even if they were classed as watertight doors, operators of these vessels tend to keep the doors open during transit in order to get fresh air in the engine room and other compartments of the vessel. In the study I developed, I wanted to recreate the most realistic condition to assess a towing vessel's stability.

Using a hydrostatics software, I created limiting vertical center of gravity curves in order to identify the current state of stability. These graphs show the maximum vertical center of gravity (VCG) a vessel can have in order to pass a given criteria. In my graphs, I plotted the maximum VCG against the draft of the vessel. Once the maximum VCG was calculated for a range of drafts across the plot, I compared the VCG of the vessel at its defined operation draft to the graph. The vessel passes the criteria if its operational draft and corresponding VCG falls below the curve and fails if they fall above.

I had a total of seven vessels provided to me for this study. In the end, I bounded a range of likely drafts and corresponding displacements for each vessel. The VCG was estimated to be 1 foot above the main deck based on similar vessels and input from industry professionals.



Limiting vertical center of gravity curve example for Hull 1. Coast Guard graphic by Ensign Erin Morgan

Barges on the Ohio River. Photo courtesy of author

Design drafts and displacements for each model were provided to me with the models. The drafts used in the analysis were extended half a foot above and below to create a typical range the vessel might span as it loads and unloads fuel, cargo, or equipment. Out of all seven vessels, the largest freeboard, given the full load information on the vessels, was three feet. The lowest was 1.5 feet.

Three criteria derived from the intact stability regulations for protected routes, 46 CFR Subchapter S Section 170.173 paragraph (e) (2), were analyzed. The first limit I tested is that the vessel must have a positive righting arm to at least 25 degrees of heel. This limiting VCG curve shown in Figure 1 (previous page) is from Hull 1. The design draft for Hull 1 is eight and a half feet, and the VCG is 12 feet above the keel. Hull 1 passes the first criteria. This is illustrated by being below the line and in the green area. An analysis like this was done for each of the vessels for each of the criteria.

The second criteria, where the downflooding angle has to be at least 15 degrees, is where the majority of the vessels failed. Only two of the seven vessels passed this criteria: the two vessels—hulls 5 and Hull 7—with the most freeboard; both had 3 feet of freeboard.

To confirm that the freeboard was the direct factor to this, I did an analysis of a vessel, Hull 6, with a length between Hull 5 and Hull 7. Hull 6 also had a beam identical to Hull 7, but its freeboard was half that of hulls 5 and 7. Hull 6 failed to meet any of the criteria tested at its design draft.

The conclusion derived from this information was that neither the length of the hull nor the beam was a driving factor in how the vessel responded. It proved that the freeboard is what will determine whether the vessel passes or fails the criteria.

Recommendations for Safety and Stability

The purpose of this study was not to come up with a comprehensive solution to improve the stability on all inland river towing vessels that do not pass the current regulations. However, based on this brief study, I can offer a proposal that can be integrated on an operational level in order for a vessel to achieve better overall stability and safety.

First and foremost, the downflooding angle has to be improved. This was identified early in the study as the vessels' most likely mode of failure. The analysis done over the course of this study proved that theory to be true, as only two of the seven vessels used were able to pass the downflooding criteria.

As mentioned earlier, the downflooding points used in this study were, in fact, watertight doors. To reiterate, the purpose of this was based on the common trend that towing vessels operate with these doors open. With these doors shut over the course of a vessel's transit, then the downflooding point can be raised to more than a few inches above the deck. This translated into an increase of the angle to downflooding by up to 5 degrees for some of the vessels. Overall, this increases the general safety of the vessel and allows for some vessels that had previously failed to pass.

Real-World Experience and Application

Not every cadet gets the opportunity to work with as many different aspects of the fleet or industry as I did last summer, and for that, I am grateful. I greatly enjoyed the time I spent on this project, which was just the beginning of my research. During my senior year at the academy, I was able to turn this project into an independent research project. While the focus shifted slightly, it still involved stability requirements for towing vessels and how these vessels would be affected by Subchapter M. Though my time at the academy has run out, that study is being continued by cadets who will graduate in 2019.

Acknowledgements:
The author would like to thank the industry partners that provided the hull forms she based her Marine Safety Center research on. She would also like to acknowledge the Marine Safety Center, specifically LT Daniel Burke and all the staff engineers, for their support of her project.

About the author:
Ensign Erin Morgan reported to the Coast Guard Academy in the summer of 2014. She majored in naval architecture and marine engineering. During her first class summer, she had the opportunity to intern with the Marine Safety Center in Washington where the majority of this research took place. She graduated in May 2018 and reported to the Coast Guard Cutter Mellon *in Seattle as a student engineer.*

Keeping Towing Vessels on Course

Coast Guard inland cutters help keep commerce flowing

by Walter T. Ham IV
Public Affairs Officer
Office of Navigation Systems
U.S. Coast Guard

A typical day for the crew of the U.S. Coast Guard Cutter *Wyaconda* starts before sunrise, hundreds of miles from the nearest seacoast. Based in Dubuque, Iowa, the northernmost river buoy tender maintains the aids to navigation (ATON)—more than 1,300 buoys and 315 beacons—that save lives, protect property, and enable commerce on the Upper Mississippi River. This buoy tender covers 300 miles of the Mississippi River from Clinton, Iowa, to St. Paul, Minnesota, and an additional 30 miles of other rivers.

Known as the Western Rivers, the Mississippi and its numerous tributaries connect domestic U.S. inland shipping ports between the Appalachian and Rocky mountains to the Gulf of Mexico and international markets around the world. The Western Rivers are part of more than 7,000 miles of inland waterways with nearly 14,000 buoys and beacons serviced by Coast Guard buoy tenders. These tenders, like the *Wyaconda,* are named for Native American tribes.

Often the only federal presence on these vital economic arteries, the Coast Guard's 18 river buoy tenders average 47 years of service and are often 20 years older—or more—than the crew members serving on them. Like other cutters in the Coast Guard's inland fleet, *Wyaconda* is old. Commissioned in 1965, the cutter spends nearly half of every month underway between March and late December.

Senior Chief Petty Officer Travis W. Cook, the officer-in-charge of *Wyaconda,* said his 16 crew members work hard to keep their cutter operational so they can maintain buoys and beacons in constantly changing conditions, often battling ice and high water.

"Ice can cause substantial buoy and fixed ATON damage, which means running harder to keep up with necessary work," said Cook. "This year, we had to break significant ice to get out of port in the spring and to work our upper river reaches."

The *Wyaconda* crew enables commercial shipping traffic at the northern end of this vital river system. Petroleum products, rock, gravel, sand, and steel travel on this stretch of the Mississippi River. Coal travels up the river to power plants, while corn, fertilizer, and soybeans are shipped down from St. Paul, Minnesota, to St. Louis.

More than 300 miles south of Dubuque, the St. Louis-based Coast Guard Cutter *Cheyenne* faced harsh weather and river conditions this year.

"High water and ice often come with little to no warning and can wipe out the majority of our floating aids and destroy many of our shore aids," Master Chief Petty Officer Michael A. Love, the *Cheyenne*'s officer-in-charge, said. "In January 2018, we experienced near-historic low water and above-average ice conditions at the same time, and 90 percent of our buoys were dragged off station or their moorings broke free."

Spending nearly 100 days underway every year, *Cheyenne* maintains more than 350 buoys on the Mississippi, Missouri, and Kaskaskia rivers. The 16-member *Cheyenne* crew also maintains more than 200 shore-based aids, including 153 on the Missouri River. Love said that keeping the shore-based ATON visible is a particularly challenging task, especially on the steep banks of the Missouri River.

"This typically involves three to ten crew members moving up and down a sixty-degree river bank, clearing brush up to twenty feet high over an area the size of a hockey rink with chainsaws and other power equipment in hundred-degree heat," said Love, a 24-year Coast Guard veteran.

Hundreds of miles to the northeast, the Sewickley, Pennsylvania-based Coast Guard Cutter *Osage* maintains more than 780 fixed and floating ATON across 638 miles of the Ohio, Monongahela, Allegheny, and Kanawha rivers. Among those ATON, the 18-member *Osage* crew services beacons and buoys on the Ohio River between the inland ports in Pittsburgh, Pennsylvania, and Huntington, West Virginia.

According to Senior Chief Petty Officer Shane A. Yonushonis, the *Osage* officer-in-charge, the cutter also

has to steer clear of ice that can damage its rudders, shafts, and propellers.

"Ice makes it impossible for our cutter to get underway due to a lack of icebreaking capabilities, and this year's ice caused a lot of damage that we are still repairing," said Yonushonis.

Additionally, the 56-year-old *Osage*'s onboard heating and cooling systems don't keep the crew warm in the winter or cool in the summer. Yonushonis said they've installed window unit heaters and air conditioners to bridge the gap on the hottest and coldest days.

Improvising, adapting, and persevering, the crews of the *Wyaconda, Cheyenne,* and *Osage* operate 1960s-era vessels on unpredictable waterways to maintain the aids to navigation that help keep the U.S. economy on course.

Commercial Workhorses

Tugboats, towboats, and barges are the workhorses of the U.S. maritime economy. Approximately 3,800 towboats and 27,000 barges transport 342 million short tons of cargo worth approximately $82 billion on the Western Rivers every year.[1] Towing vessels convey more than 50 percent of U.S. grain exports, 22 percent of domestic petroleum products, and 20 percent of domestic coal shipments. They also reduce traffic congestion on America's railways and roads. Two 60,000-barrel capacity river barges can transport as much cargo as 80 train cars or 300 trucks.

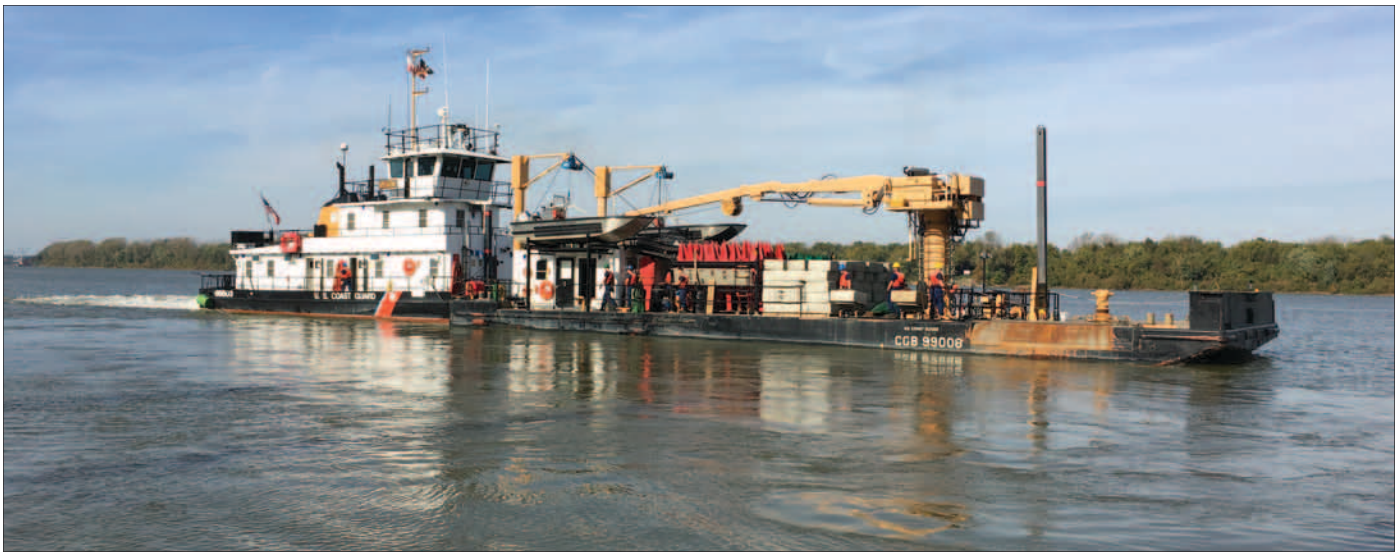
These slow-moving, heavy-hauling, cost-efficient vessels are widely used across the U.S. marine transportation system (MTS). This complex, interwoven, and intermodal series of coastal, intracoastal, and inland waterways travels across state and national borders, linking American highways, railroads, and pipelines to markets around the world. With more than 25,000 miles of navigable waterways, the MTS enables passenger and cargo movement for more than 68,000 vessel calls, and facilitates maritime cargo that contributes $4.6 trillion to the U.S. economy annually.

The Western Rivers are some of the most traveled waterways in the MTS, and the prosperity of the American heartland pumps through these vital economic arteries. The Mississippi River and its tributaries serve as a conduit for billions of dollars in trade.

While tugboats, towboats, and barges transport bulk commodities in and around the United States, as well as between domestic ports and U.S. territories, they are the most prominent commercial vessels on the Mississippi River and its tributaries. Towing vessels make up more than 90 percent of the Western Rivers' commercial fleet and provide a cost-effective way to transport coal from the Ohio River basin, grain from the Upper Mississippi River, and petroleum products from the Lower Mississippi River.

As America's multimission, maritime service responsible for the safety, security, and stewardship of U.S. waterways, the Coast Guard works with international, interagency, and industry partners to maintain safe, efficient, resilient waterways. Maintaining beacons and buoys is one of the Coast Guard's oldest mission, tracing its roots to the ninth law passed by Congress that created the U.S. Lighthouse Establishment in 1789.

Today, the Coast Guard operates a fleet of 76 ATON, or "black hull" cutters, including the fleet's 35 cutters that maintain the buoys and beacons on inland waterways. In addition to the 18 river buoy tenders, the inland fleet includes two other types of tenders. Inland buoy tenders (WLI) service ATON in U.S. coastal and inland waters from the Great Lakes to Alaska. Inland construction



U.S. Coast Guard Cutter *Obion,* a 65-foot river buoy tender, travels up the Ohio River north of its Owensboro, Kentucky, homeport. Coast Guard photo by Petty Officer 2nd Class Thomas Troia

A tow pushes 35 barges under a Vicksburg, Mississippi, bridge. Coast Guard photo by Petty Officer 3rd Class Jonathan Lally

tenders build and maintain beacons in U.S. waterways from New Jersey to Texas. Combined, the three types of inland fleet cutters have an average of 53 years of service.

The inland fleet also includes the Coast Guard's oldest cutter in service today. Known as the "Queen of the Fleet," the inland construction tender USCGC *Smilax* was commissioned in 1944. From its Atlantic Beach, North Carolina, homeport, *Smilax* builds beacons and performs structural maintenance on beacons in North Carolina's coastal and inland waterways. It also maintains critical buoys marking the inlets along the Atlantic Coast.

The Coast Guard is examining options for replacing its inland cutter fleet's capability. This includes analyzing the possibility of renewing and standardizing its inland maritime mission capability with state-of-the-market cutters.

The Western Rivers buoy tenders are part of the New Orleans-based Coast Guard District Eight, which covers more than 10,000 miles of inland waterways, including the Western Rivers system, and more than 900 miles of the Gulf Coast. Rear Admiral Paul F. Thomas, district commander, said the Western Rivers buoy tender crews have demonstrated great tenacity, dedication, and expertise in an extremely demanding operational environment.

"The crews of the Coast Guard inland river fleet have used their training and experience to achieve a high level of proficiency," he said. "The crews go through a rigorous standardized qualification process and use operational risk management to assist in maintaining the river and its unique challenges."

The admiral added that the fleet they operate is well beyond its scheduled service life and needs to be modernized.

"The current inland fleet is in a state of obsolescence, endangering our ability to be 'Always Ready' to prepare for, respond to, and quickly recover from major incidents, increasing the risk to the maritime economic infrastructure and vital marine transportation system," Thomas said. "In addition, these cutters were constructed in an era when lead paint and asbestos insulation were the accepted industry standards, which are now forbidden in shipboard construction. The presence of lead and asbestos can pose a serious health risk to Coast Guard personnel. It requires extensive maintenance and oversight to manage

U.S. Coast Guard Cutter *Cimarron* prepares to work a buoy on the Tennessee River. Coast Guard photo by Senior Chief Petty Officer Robert M. Sevon

those risks, increasing the need to replace these aging vessels."

He added that the Coast Guard must also prepare for significantly increased vessel traffic on these waterways in the coming decades. "Worldwide demand for waterborne commerce is expected to more than double by the year 2025, while the total value of marine freight is estimated to increase by 43 percent domestically and 67 percent internationally between 2010 and 2020," he said. "The Coast Guard must keep pace with port and industry efforts for increased efficiency and infrastructure investment to meet the demand of future maritime trade growth."

Crucial Waterways

Based in Owensboro, Kentucky, the Coast Guard Cutter *Obion* confronts numerous engineering challenges that can impact its ability to get underway.

"Strained availability of parts for aged and obsolete engineering systems and the increasing unpredictability of engineering casualties on those systems have significantly elevated scheduled and unscheduled maintenance hours," said Senior Chief Petty Officer Cameron L. Morgan, the *Obion* officer-in-charge. "The impact is fewer hours underway conducting the mission and a need to further compact those possible underway periods."

The *Obion* maintains 504 buoys and 202 beacons on 677 miles of the Ohio and Green rivers. Morgan said his 16-member crew also responds to increased navigational hazards and shoals during low water and increased debris during high water.

"Debris in the river, lifted off the river bank by the rising water, can be anything from small sticks to full-size trees," he said. "The operational environment is highly dynamic, impacted by weather, locks, vessel traffic, river current, and fixed and floating aid servicing requirements further burdened by the unpredictable state of those aids upon visiting them."

More than 140 miles south in Buchanan, Tennessee, the Coast Guard Cutter *Cimarron* covers 588 river miles on the Tennessee and Cumberland rivers. *Cimarron*'s officer-in-charge, Senior Chief Petty Officer Robert M. Sevon, said his 13 crew members put in long days to maintain 192 lights and day beacons and more than 1,000 buoys.

"We will typically go anywhere from 50 to 100 miles a day, performing maintenance on our fixed aids with the small boat while maintaining the buoyed channel with the cutter," said Sevon, who has five years of experience on three different river buoy tenders. He said his cutter runs along the edge of the channel, confirming that buoys are marking the appropriate depth and checking for new shoaling.

"The buoy deck is a busy place, with cranes moving fifteen hundred-pound sinkers and hardworking young Coasties pushing nearly six hundred-pound buoys and ninety-foot shots of chain from place to place," Sevon said. "This is hard, constant work that leaves most tired and humbled by the end of the day."

To keep their shore-based ATONs visible to mariners, the *Cimarron*'s crew also has the tough task of clearing vegetation, climbing structures, and changing out old equipment.

"They will battle snakes, wasps, and poison ivy to clear the area of brush and trees with chainsaws and other heavy equipment, ensuring the mariners can see

U.S. Coast Guard Cutter *Greenbrier* operating during high water. Coast Guard photo by Master Chief Petty Officer Michael J. Ellis

the beacons on the overgrown river banks," said Sevon.

Added to this heavy workload are periods of unscheduled maintenance, where parts needed to fix their equipment often are no longer available and have to be custom built.

Young by river buoy tender standards—it was commissioned in 1990—the Natchez, Mississippi-based Coast Guard Cutter *Greenbrier* serves as the southernmost river buoy tender in the Western Rivers system, maintaining buoys and beacons where the Mississippi River ends its 2,320-mile journey. Its 17-member crew covers approximately 180 miles of the Mississippi River and more than 300 additional miles of smaller rivers, according to *Greenbrier*'s officer-in-charge, Master Chief Petty Officer Michael J. Ellis.

"Southbound cargo from the north travels all the way from the upper Midwest to reach major shipping ports like Baton Rouge, Louisiana, and New Orleans. It is our job to see them through the final stretch," he said. "Northbound vessels pushing empty barges will start their long journey in our section of the river. We want to ensure they have a good and safe start."

In addition to servicing 169 shore-based beacons, including 16 deemed "critical" by the towing industry, *Greenbrier* typically establishes 300 to 350 buoys during low water. Ellis said he has to predict the changing water levels and adjust to the seasonal fluctuations along the Lower Mississippi River to set buoys correctly. When the water levels are high enough for "bank to bank" navigation, the crew removes all buoys, replacing them when the water levels drop again.

"River operations are sometimes more akin to art than science, as we use our buoys to paint a clear picture of the available channel for our primary customer—the towing industry," said Ellis. "They're often pushing a fleet of barges that rivals the size of an aircraft carrier, so we can't afford to get it wrong.

"We take our responsibility to them very seriously."

About the author:

Walter T. Ham IV serves as the public affairs officer for the U.S. Coast Guard Office of Navigation Systems. A retired U.S. Navy chief journalist with a master's degree in nonfiction writing from Johns Hopkins University, he previously served as a Pacific Stars & Stripes reporter and a civilian public affairs officer for the U.S. Army, U.S. Air Force, and U.S. Navy.

Endnote:

1. Vessels—U.S. Army Corps of Engineers (October 2017), Waterborne Transportation Lines of the United States: Calendar Year 2016

   Cargo—U.S. Army Corps of Engineers (2016), Waterborne Commerce of the United States Part 2: Calendar Year 2016

   Value—Oak Ridge National Laboratory (2017), Freight Analysis Framework, Version 4

A Voyage Fraught with Challenges

Learning from the grounding of the MODU *Kulluk*

by Keith Fawcett
Marine Casualty Investigator
U.S. Coast Guard Investigations National Center of Expertise

Captain Marc Dial
Plimsoll Marine

A series of failures and gallant rescue attempts had already taken place by the time the mobile offshore drilling unit (MODU) *Kulluk* grounded on the rocky, remote shores of Ocean Bay, Alaska, in late December 2012. From the time the critical towing component failed, four vessels rendered assistance, but the *Kulluk* grounded despite these rescue attempts. The Coast Guard helicopter crews did successfully evacuate the *Kulluk*'s crew under hazardous conditions.

During the voyage, multiple tow lines parted, the main engines and generator engines on the principal towing vessel failed, and a series of hurricane-like low-pressure weather systems thwarted the towing and rescue operations. Finally, the unified command would order the last tug to cast the towline off in close proximity to a dangerous, rocky Alaskan shore.

A year after the grounding, the Coast Guard completed its investigation. One of the safety recommendations stemming from the incident directed the towing industry to examine the *Kulluk*'s official Coast Guard Report of Investigation and recommend to the Coast Guard their suggested best practices for similar towing operations.

In spring 2016, the Towing Safety Advisory Committee (TSAC) submitted the TSAC Kulluk 14-01 Report and Recommendations to the Coast Guard. One of the recommended "best practices" involves looking at the critical

Three life rafts—two pictured—lie on the beach adjacent to the mobile offshore drilling unit *Kulluk* southwest of Kodiak City, Alaska, on January 3, 2013. The *Kulluk* grounded after many efforts by commercial towing vessels and a Coast Guard cutter to move the vessel to safe harbor during a winter storm on a tow from Dutch Harbor, Alaska, to Everett, Washington. Coast Guard photo by Petty Officer 2nd Class Zachary Painter

shackles, which are considered "terminal gear" in 33 CFR 164.74:

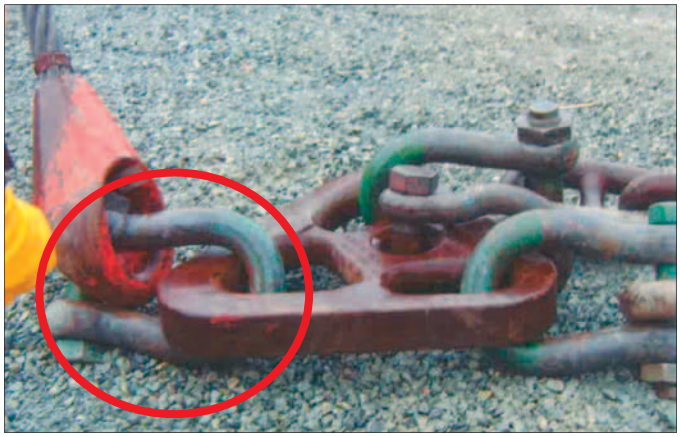
> *Towline and terminal gear when towing astern (b) Terminal Gear (1) The material and size of the terminal gear are appropriate for the strength and anticipated loading of the towline and for the environment; (2) Each connection is secured by at least one nut with at least one cotter pin or other means of preventing its failure.*

In the case of the *Kulluk*'s towing gear, a critical component had failed, but there was no way to determine exactly what had happened. Did the nut and cotter pin securing the shackle work off? Did the component shatter due to excessive overloading and cyclic loading, or was there a manufacturing defect?

We do know the following about the shackle that connected the tow pennant to the triangular towing plate: The tow plan specified an 85-ton shackle, but 120-ton shackles were substituted and the tow plan had not been updated to reflect that change. The pedigree of that 120-ton shackle is unknown, but it was believed to have been from a reliable manufacturer. When it was new there were certificates attesting to its safe working load as well as its breaking load, but that was in a "new," unused condition.

Using this same shackle, the *Kulluk* was towed from Washington state across the Gulf of Alaska to Dutch Harbor, Alaska. From there the uniquely shaped *Kulluk* made a round trip to the drilling site in the Beaufort Sea, north of the northern reaches of the Alaskan Arctic coast. The same shackle was then reconnected in Dutch Harbor roughly six months after the *Kulluk* had initially arrived, connecting the pennant wire and the towing hardware for the massive MODU. This final connection occurred on the day of departure before the nearly 1,300-mile winter-ocean return tow.

With that final, critical connection, the winter voyage across the Gulf of Alaska began. No one had determined the towing history of each component of the vital terminal gear. No one had measured the main towing shackle and the other critical gear for deformity. No one noticed a discrepancy in the capacity of the towing shackles contained in the tow plan and the one in use, and no one could explain with absolute certainty the type and method of cotter pin and lock nut used to secure the vital shackle. Additionally, no one had used non-destructive testing to determine if the shackle was near failure or had been distorted by the previous thousands of ocean towage miles.



Arrangement of critical towing components in the yard in Dutch Harbor, Alaska, just prior to the departure on the accident voyage. The red circle indicates the critical component that failed, leading to the loss of the tow on the morning of December 27, 2012. Coast Guard photo

And so, on the morning of December 27, 2012, several days into the voyage, the towing winch monitor alarmed 38 times with strains of at least 300 metric tons. With the loss of the critical shackle, the *Kulluk* suddenly was adrift

A Coast Guard MH-60 Jayhawk helicopter crew from Air Station Kodiak conducts the 13th of 18 hoists to rescue crew men from the mobile drilling unit *Kulluk* southwest of Kodiak City, Alaska, on December 29, 2012. The single tug *Aiviq* suffered mechanical problems towing the *Kulluk* during a return tow from Alaska to Seattle, prompting the Coast Guard to deploy cutters and aircraft, while the operating company dispatched additional response vessels. Coast Guard photo by Petty Officer 1st Class Sara Francis

Kulluk—The Towmaster's Perspective

In spring 2012, I was contracted as towmaster on behalf of a major oil company for the tow of the *Kulluk* from Seattle to Dutch Harbor Alaska scheduled for July, pending acceptable weather forecasts. At the first meeting, it was noted that several entities would be involved in the planning—the oil major, the drilling contractor, the Coast Guard, Seattle Pilots, and the owner of the multipurpose towing vessel and assist tugs, among others.

As a whole, the tow was freely discussed and debated among all the principals, including factors like assist vessels, distance offshore for the route, rescue/response resources, weather routing, crew size, variable deck load amount, and stowage. I spent a significant amount of time on the tow route and weather routing with regards to ports of refuge and aiding the oil company with producing the towing procedures for the voyage.

The decision to "man" the tow—which was decided by the oil company and the class societies—was made during these discussions, as well. I recall both the drilling contractor and the planning team questioned the necessity of manning the tow, considering the risks involved. In the end, the oil company preferred to have a manned tow. At that point, the drilling contractor and I became heavily involved with route and emergency planning in an attempt to mitigate risks to the riding crew and minimize exposure from frontal weather systems common to this area.

During the final planning stages for the tow, there was a sudden change to part of the tow equipment arrangement that was attributed to the lack of certification for the shackles on the main towing bridle. The result was the substitution of 120-ton shackles that were reported to have certificates—though, to my knowledge, those certificates did not arrive onboard before the *Kulluk* sailed from Seattle.

Once the tow was underway, we experienced very good weather for crossing the Gulf of Alaska. Early in the tow, I requested that the towing vessel *Aiviq* give me periodic loads on the tow wire, but the *Aiviq* informed me that the state-of-the-art tow winch tension gauge was not functioning. As a result, I further reduced the working weather window that I would allow before considering taking the tow into a safe refuge area, or safe havens,

The MODU *Kulluk* prepares to be taken in tow departing Seattle en route to Alaska. Photo courtesy of Vigor Industrial LLC

Photo of the Kulluk aground in Oceans Bay, Alaska, sometime after December 31, 2012. *Coast Guard photo*

in the event of unexpected weather events.

The *Kulluk* tended to pitch heavily and slam into oncoming swells, but was very resilient. This included taking some seas over and onto on the foredeck, at times. The rig tended to be uncomfortable, as the bottom of the *Kulluk* was a saucer with no keel, meaning there was no central axis. At times this resulted in an oscillating motion that caused the *Kulluk* to yaw behind the tug. Rig handling in close quarters was challenging, as the rig rotated quite easily, and to stop the rotation could be difficult. Overall, the tow to Dutch Harbor was uneventful, and the rig behaved as any rig would under a steady tow, more or less.

Later that year, Offshore Rig Movers International informed me that the oil company had requested that I attend the tow of the *Kulluk* from Dutch Harbor back to Seattle. When I asked about the conditions and timing of the tow, I learned the plan was to use a single towing vessel with no escort vessel, and that the sailing would occur in late December. I recommended that the tow be moved to a later date and that they should consider multiple towing vessels.

The oil company said that neither of those suggestions were options for them. After conversations with other experienced towmasters, ice masters, and pilots with experience in the Gulf of Alaska, I declined the assignment, only willing to change my mind in the event the oil company was willing to change the parameters of the tow to meet minimum safe standards under these winter conditions.

Sometime after the *Kulluk* grounding, Coast Guard investigators interviewed me as part of the Coast Guard formal investigation into the *Kulluk* incident. The focus of the interview was related to my experiences on the summer 2012 tow from Seattle to Alaska and rig towing in general.

When the report of investigation was released, the Towing Safety Advisory Committee (TSAC) was asked to examine and adopt a tasking statement regarding the towage of rigs like the *Kulluk* in high latitudes and when these operations would be considered "critical tows." This led to my invitation to attend TSAC meetings held to address Task 14-01. During a series of meetings over the next year or two, I attempted to illustrate what I saw that led to the incident. I also worked to aid the committee in formulating recommended towing practices, as used in the industry, including tow procedures, as opposed to a voyage or tow plan, as noted in CFRs. It was gratifying to see my input included in TSAC's final report on the *Kulluk* and recommendations to the Coast Guard.

In 2015, the TSAC co-chairman invited me to submit my *curriculum vitae* in consideration of being named an at-large member of TSAC. In March 2018, I learned from the Deputy Secretary of Homeland Security that I had been appointed to the TSAC committee as a full representative. I continue working to leverage my experience to improve the safety and effectiveness of towing operations.

—Captain Marc Dial

in the Gulf of Alaska with 18 souls aboard.

One of the investigation's critical safety recommendations was to have TSAC examine what went wrong. TSAC accepted this important tasking and formed a *Kulluk* subcommittee. The various working groups were established from a broad segment of the drilling rig towing industry. The subcommittee began exploring the relevant gaps and failures identified in the *Kulluk* Report of Investigation. Four subgroups were formed, each tackling the issues identified in the investigation report.

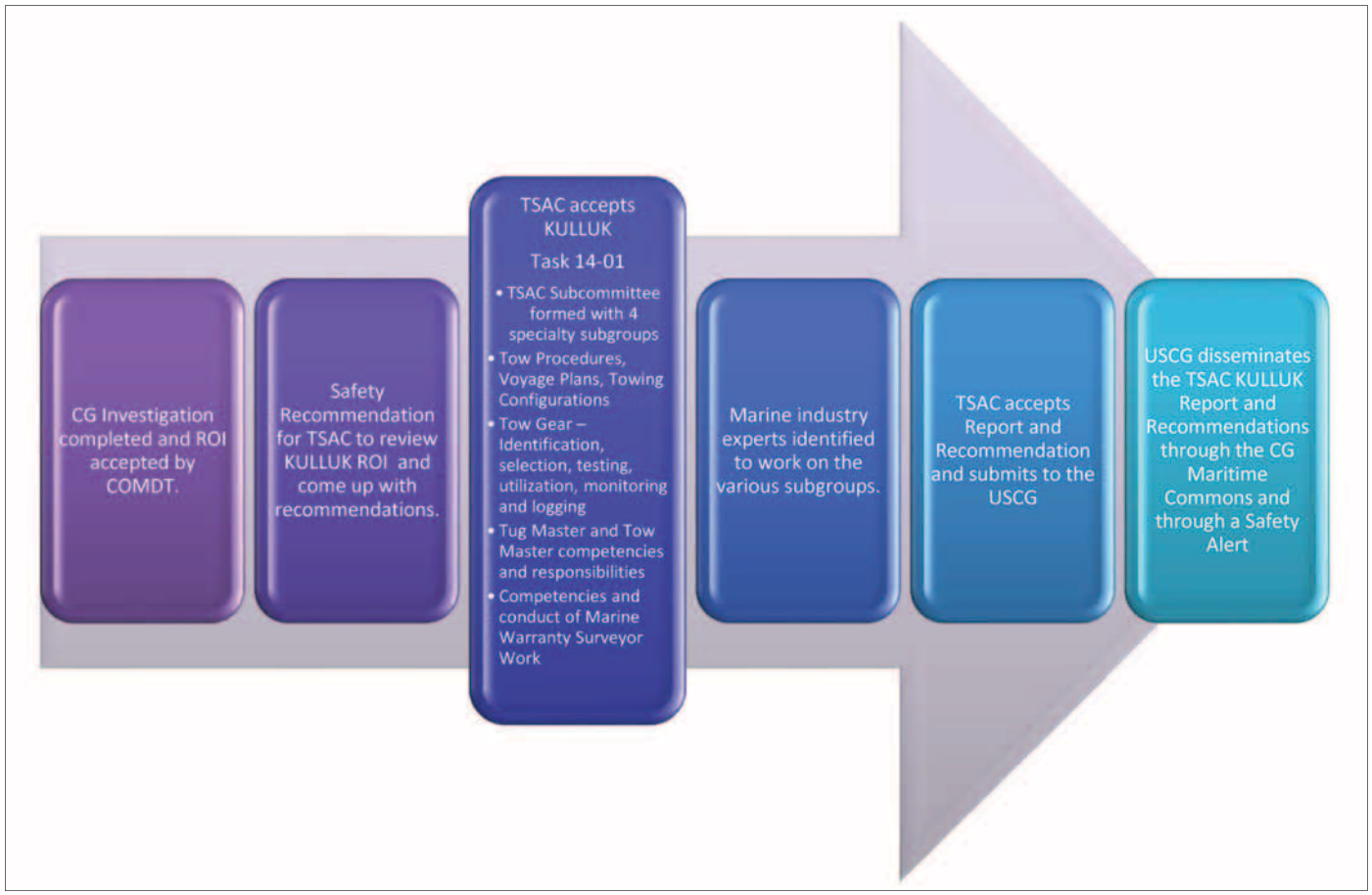
Returning to the initiating event for the incident, after the initial shackle failed there was a long series of towing and equipment failures that occurred on that return voyage. The subcommittee worked to create best practices to reduce a critical loss of tow in the future towing operations. One component of towing operations, the issues related to the shackle, cut across the work of each TSAC subcommittee subgroup, so each group examined that terminal gear as well as every related issue with the towing operation, including:

- the identification and description of the shackle in the tow plan
- the suitability of a shackle in future towing operations
- how the towing vessel would tow with that shackle
- how a marine warranty surveyor would look at that shackle before approving a tow

The highly experienced marine industry professionals in these workgroups were dedicated to reducing the likelihood of a similar incident. To this end, they created a risk identification matrix and process flow charts—tools to help key decision makers for these towing operations design well-thought-out towing plans.

In a case like the *Kulluk,* if an operating company was creating a tow plan for the accident voyage and was using the TSAC-recommended best practices, they would look at the risk assessment matrix and determine that this was a "critical" tow. The risk and the consequences associated with a single towing vessel on a winter tow across the Gulf of Alaska would make it a high-risk voyage. Once that classification kicked in, the following best practices would be recommended:

- Develop standardized terminology for towing equipment. For example, the triangular plate to which the lost shackle was connected had



A Coast Guard inspector surveys damaged parts and equipment aboard the storm-damaged mobile offshore drilling unit *Kulluk* in Kiliuda Bay, Alaska, on January 10, 2013, after it went aground on Sitkalidak Island during a Gulf of Alaska winter storm on December 31, 2012. Coast Guard photo

confusingly been referred to by various names, including "fish plate" and "delta plate."

- Give special attention to the main shackle, as it is a specific point of vulnerability.
- Shackles should be double-nutted and peened.
- Shackles can be considered a potential weak link in the tow configuration due to constant movement of the tow, shock load, side loading, and the number of moving parts that make up each shackle. Every reasonable precaution should be taken to ensure the longevity and performance of shackles used in critical ocean tow configurations.

The subcommittee examined a large number of issues during the course of its work. In considering just the best practices developed and associated with this single critical component alone, we can see the value of industry experts working together to identify risks and develop proactive strategies.

Starting with the parting of the tow until the moment the *Kulluk* grounded, personnel struggled in dangerous conditions to ensure the safety of the rig's personnel, prevent its grounding, and protect the fragile Alaskan environment. We will never know what happened to that single shackle, but these best practices taken holistically—including competent towing operators, proper equipment, well-constructed towing plans, and attention to critical details like anticipating weather severity—will reduce the likelihood of another grounding like the *Kulluk*.

Shackle Recommendations

We recommend the following additional requirements for all shackles used in critical ocean tows:

a. All shackles must be Alloy/Grade B steel
b. All shackles must be bolt type
c. All bolt type shackles must be double-nut (2-jam nuts) secured with locking bolts
d. Cotter key peened at end of bolt (optional)
e. At no time are materials other than locking bolts and cotter keys to be used in securing bolt-type shackles

- Shackles shall never be welded on
- Shackles shall be selected so as to minimize any tendency to rotate or to cause joining members to jam. They should also minimize bending loads to which the shackle could be subjected

It is recommended to:

- Multiply Extreme Towline Tension by 1 to obtain the safe working load (SWL)[1] of the main shackle
- Multiply SWL by 3 to obtain the minimum required proof load of the main shackle[2]
- Finally, under the section entitled "Terminal Gear," it is recommended that only new terminal gear be used for critical tows. Furthermore, it is recommended that all terminal gear be provided with certifications and traceability back to the original mill and certifications that appropriate destructive type tests and non-destructive examinations, including but not limited to x-ray, have been carried out

Endnotes:

1. SWL = Safe Working Load, defined as "The load for which a rope, fitting, or working gear is designed." U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002, page 450.
2. U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002, pages 3–8.

About the authors:

Mr. Keith Fawcett is a licensed merchant mariner and a staff member at the Coast Guard Investigations National Center of Expertise. He worked in the marine industry for more than 20 years, generally in Gulf of Mexico operations. As a Coast Guard marine casualty investigator, he has conducted high-profile marine casualty investigations for the Coast Guard, including that of the sinking of the SS El Faro, *which was lost in October 2015. He also received the Coast Guard's 2015 Sener Award for excellence in marine casualty investigations.*

Captain Marc Dial is a licensed master mariner and TSAC representative. He sailed deep sea from 1979 to 1993 worldwide on tankers, break bulk, and bulk carriers. After receiving MODU master endorsement in 1993, he participated in and was appointed as rig mover or towmaster in the majority of approximately 200 towing operations involving jackups and semi-submersibles worldwide. Additionally, he has attended a wide variety of load-outs and sailaways, accident investigations, and arbitrations on behalf of owners and interested underwriters.

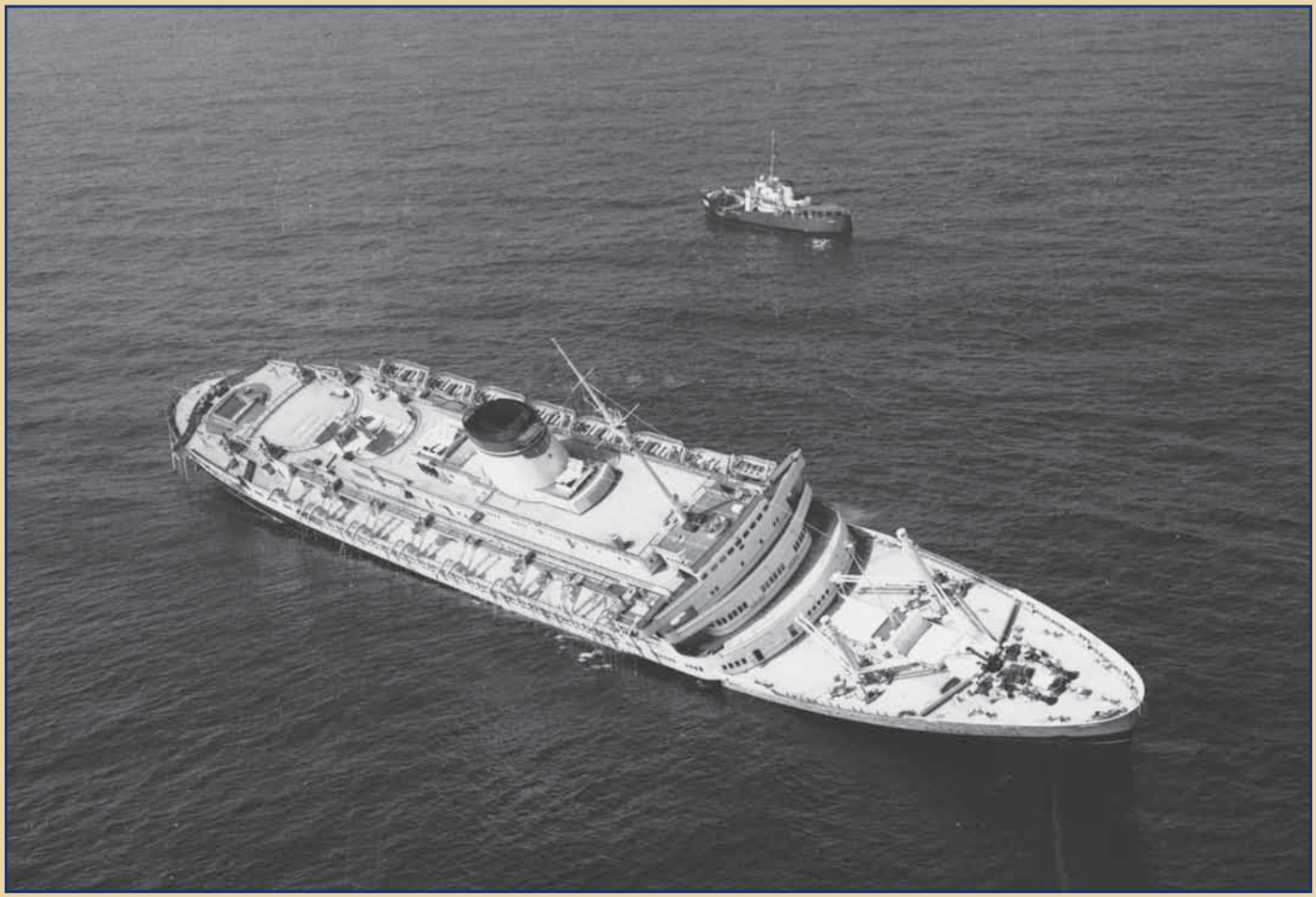
Historical Snapshot

Remembering the *Andrea Doria*

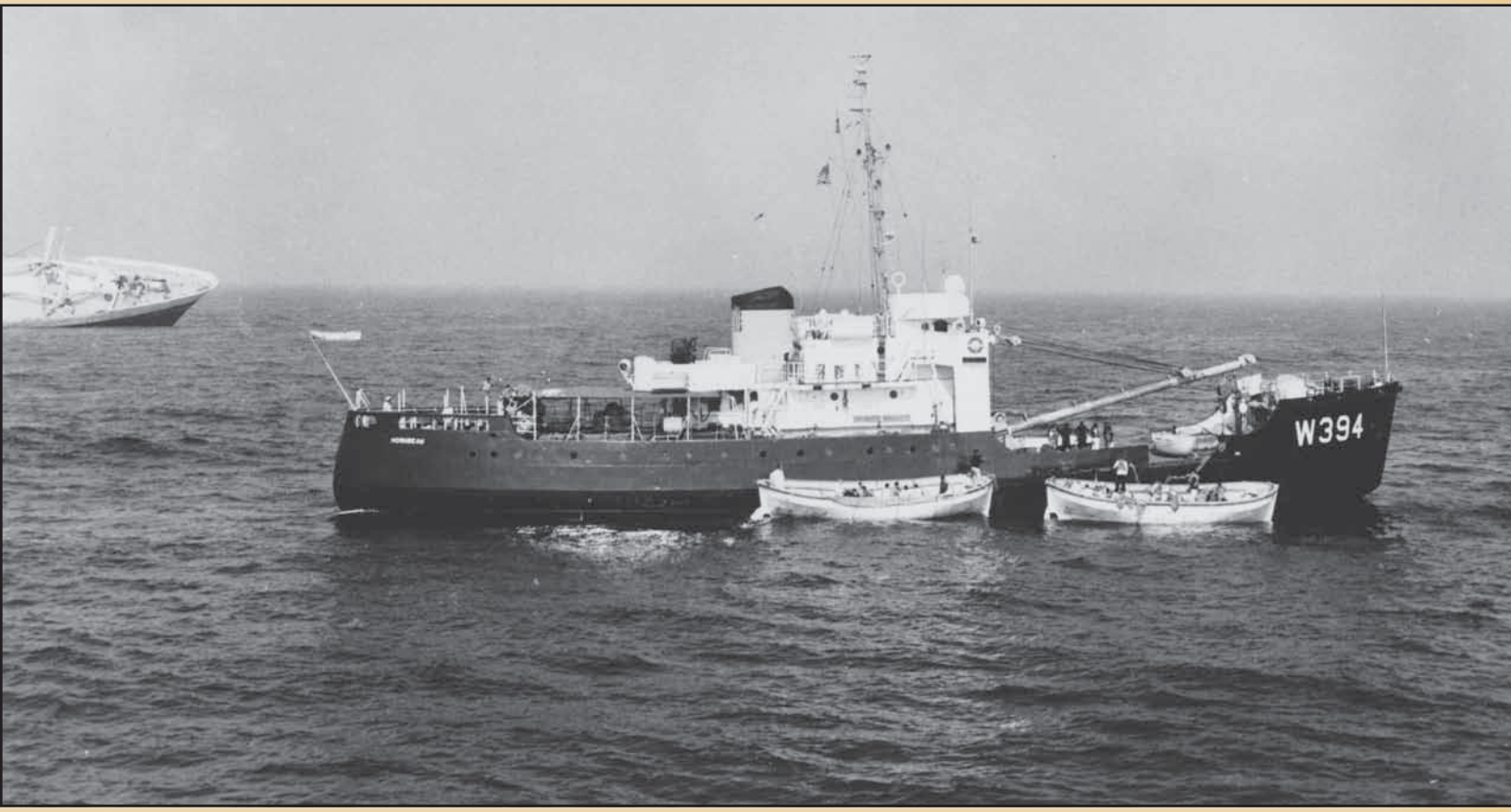
Confusion leads to catastrophe

BY LCDR KENT G. SIEG
External Affairs Branch
U.S. Coast Guard Atlantic Area

The SS *Andrea Doria* was to be the finest passenger ship built in postwar Italy. Its builders marshalled universal political and public support, dedicated an immense sum of money, and engaged the finest shipbuilder as well as one of the world's best architects. The *Andrea Doria* was expected to represent the return of long-faded Italian maritime glory and leadership. When it began sinking as a result of a collision at sea on a 1956 summer's night, its unexpected foundering and the attendant expected loss of life aboard would send trembling reminders around the world of the SS *Titanic*'s sinking 45 years earlier.[1]



The SS *Andrea Doria* lists sharply to starboard as it begins the downward trip into the sea. In the background is the Coast Guard buoy tender *Hornbeam* with some of the survivors from the sinking ship on board. This tragic ending of the SS *Andrea Doria* resulted from her collision with the MS *Stockholm* liner. Coast Guard photo



Last survivors of the stricken *Andrea Doria* are taken aboard the Coast Guard Cutter *Hornbeam.* Many of the people had to spend the night in lifeboats before rescue craft could locate them in the dense fog. Coast Guard photo

Auspicious Beginnings

By consensus, among the most gorgeous ships ever christened, the roughly 29,000-ton *Andrea Doria* was named after a famous Genoese explorer. The ship was opulent, with grand dining rooms and massive social halls. The onboard artwork alone cost more than $1 million. Beyond that, it was the first liner to have three swimming pools. She also was a safe ship, having been equipped with a double hull, enough lifeboats for all souls aboard, a modern radar system, and 11 watertight compartments.[2]

After her maiden voyage in January 1953, passage on the *Andrea Doria* became one of the most sought-after tickets for the trans-Atlantic crossing. She had made a full 100 crossings by the time of her sinking, mostly from Genoa and Naples to New York and back. Celebrities competed to sail to Europe in style aboard the *Andrea Doria.* It was a favorite of luminaries like director Orson Welles, comedians Laurel and Hardy, and actors like Tyrone Power. Assorted politicians and religious authorities of the Catholic church heading to or from Rome traveled aboard her, as well. Even former U.S. Secretary of State George Marshall sailed aboard the *Andrea Doria* on his way to collect his Nobel Peace Prize. The passenger list for her last, ill-fated voyage was just as impressive, boasting Cary Grant's wife, Philadelphia's mayor, actors, songwriters, and members of the media. In addition, a large number of Italians emigrating to the United States were berthed on the C Deck.[3]

A Tragedy of Human Errors

At 11:10 p.m. on July 25, 1956, the *Andrea Doria*'s fate was sealed as she collided with the Swedish liner MS *Stockholm.* The site of the collision was a location triangulated some 180 nautical miles off of the Coast Guard Lightship *Ambrose,* situated at the mouth of New York Harbor, and 45 miles southeast of Nantucket Island. It occurred in a busy area that mariners had dubbed "the Times Square of the Atlantic." Known as an area where crossing traffic could be expected, this incident could have been avoided, its cause attributed to chance and a series of basic errors that resulted in tragedy.

Both ships had been heading directly for each other at relatively high speeds in foggy conditions. Each had the other on radar at different times, but contact was not maintained. If either ship had altered course or speed in reaction to an apparent, yet unrecognized, sighting of each other, then no collision would have occurred.[4] Theories on ways to have avoided the collision place the blame in the hands of one ship or the other. One theory is that Peder Larsen, the *Stockholm*'s helmsman, allowed his ship to

yaw considerably along its heading. Another suggests the *Stockholm*'s radar had been set at the wrong scale, allowing for the misjudgment of relative distance. Another theory, and a possible result, is that the *Stockholm*'s third officer, Johan-Ernst Carstens-Johannsen, misjudged the *Andrea Doria*'s heading. Still, some blame could be placed on Harry Gunnar Nordenson, the *Stockholm*'s captain, who purposefully plotted his vessel's voyage into a shipping lane encumbered with heavy oncoming traffic.

Conversely, the crew of the *Andrea Doria* did not perform radar plotting that evening, the results of which would have compelled them to turn earlier, thus avoiding the episode entirely. Additionally, moments before impact the second officer on the *Andrea Doria* had left his post at the radar station to help Piero Calamai, the ship's captain, determine the nature of faint lights seen off the bow—it was the *Stockholm*. The reaction that followed made the collision unavoidable.

Assuming that the oncoming vessel would turn starboard well in advance, the *Andrea Doria*'s captain ordered a 4-degree leftward turn without starboard drift about six minutes before the collision. Yet, in spite of his specific orders, some significant drift to the right did occur. Minutes later, the *Stockholm*'s third officer ordered a further turn, this time to starboard, which was completed just one minute prior to the accident. These actions narrowed the gulf between the vessels.

Just at that moment, the *Stockholm* made a fatal mistake. Upon gaining sight of the *Andrea Doria,* and hearing but not responding to its foghorn, Carstens-Johannsen ordered a hard turn to starboard with the engines to run full astern. Captain Calamai saw the oncoming vessel turning directly into his ship as a result of the *Stockholm*'s maneuver. He ordered "Hard-a-port!," but the *Stockholm* struck the *Andrea Doria* aft and below the starboard bridge wing.[5]

A Range of Damages

Both ships then rotated in opposite directions. The force of the collision was so massive that the bow of the smaller *Stockholm* appeared to be completely severed, as its anchors and 30 feet of its bow were apparently missing. Fortunately, quick thinking to empty the freshwater tanks raised the *Stockholm* just enough to get it above the water by a mere 4 inches. Unlike the *Andrea Doria,* it would not sink that day.

On the *Andrea Doria,* conditions were far more dire. Only one of its watertight compartments had been breached, but the ship began listing at 25 degrees because five empty fuel tanks had also been ruptured. As these tanks filled with water, this weight, heavier than the empty tanks on the opposite side, caused the ship to roll to the starboard. Such a condition was not unforeseen, as ballasting problems had been observed during sea trials. The water weight and pressure would cause the retaining walls of three other watertight compartments to collapse—one more than the vessel could endure. Eventually all of the compartments would flood, as their watertight integrity had been designed for a maximum list of 20 degrees.

A Coast Guard helicopter helps evacuate patients from the stern of the damaged Swedish liner MS *Stockholm* after her collision with the Italian passenger liner SS *Andrea Doria.* The bow of the *Stockholm* is a broken twisted mass of steel as a result of the collision. Coast Guard photo

It was apparent to all that the *Andrea Doria* was going to sink, and that the approximate 1,700 passengers and crew would require immediate rescue, but a bleak scenario rivaling that of the *Titanic* sinking seemed to be developing. Flooding had knocked out the ship's electricity and, even more ominously, more than half of the vessel's lifeboats were destroyed in the collision. The boats on the port side couldn't be launched

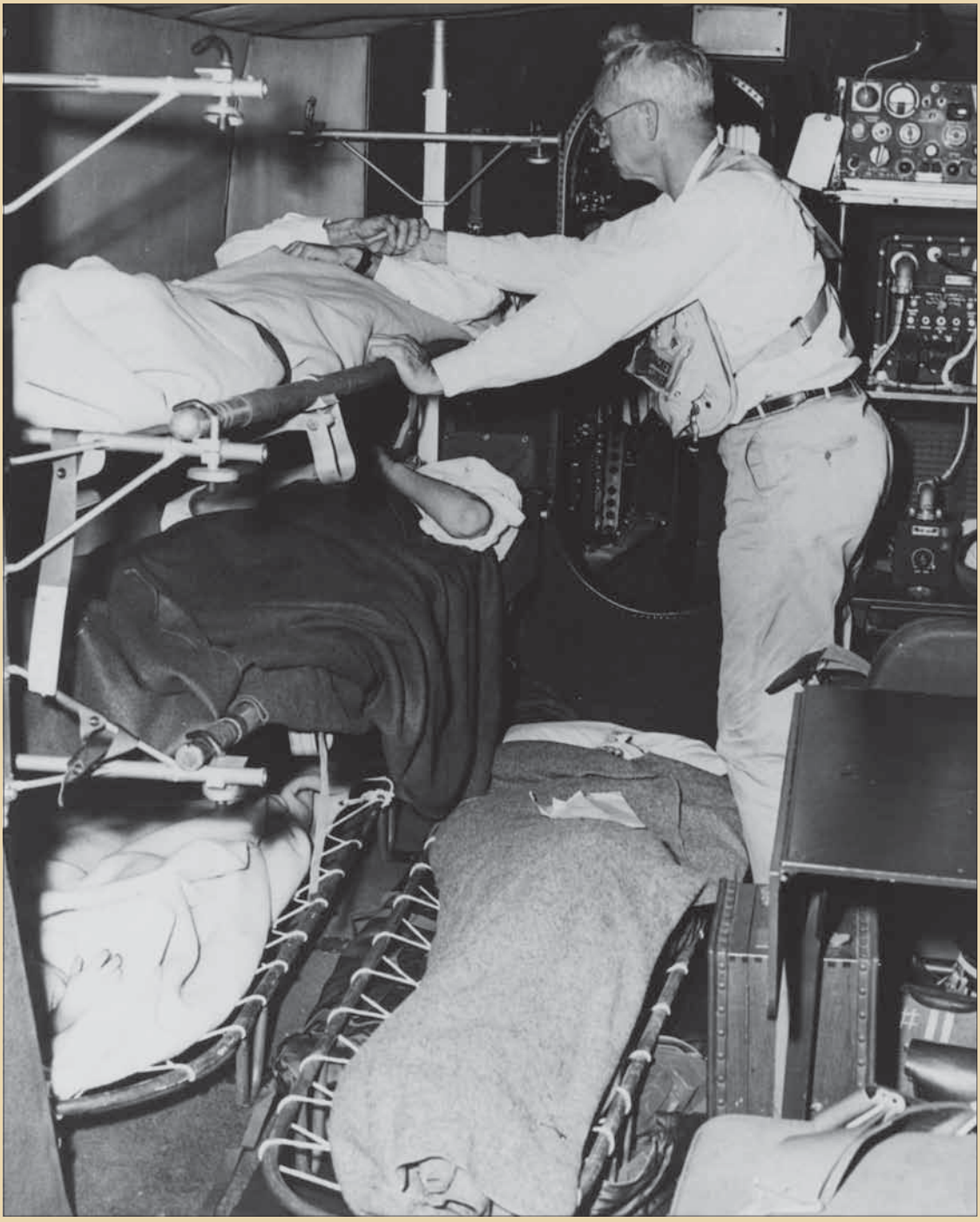
Critically injured survivors of the sinking SS *Andrea Doria*, after first being treated at Nantucket Island Hospital, are transferred to a waiting Coast Guard UF-10 amphibious plane which will transport them to Boston for further treatment at the U.S. Public Health Service Hospital in Brighton, Massachusetts. Coast Guard photo

because the ship's list was too great, and those on the starboard side could only accommodate a portion of the passengers aboard. The only way to get people into most of the few remaining lifeboats was to lower the empty boats into the water and then have folks make their own way through the waves to them. This represented such an unpromising course of action that it compelled Captain Calamai to belay his order to abandon ship. By 11:20 p.m., its radiomen had begun frantically tapping out Morse Code distress signals.

Rescue Response

As one would expect, the Coast Guard was the first organization to respond, doing so quickly. The *Andrea Doria*'s SOS was heard first at civilian radio stations in Nantucket and Long Island, and apparently by a few other ships within range. Due to atmospheric conditions, Coast Guard stations in Argentina, Newfoundland, and Bermuda also picked up the low-range frequency (500 kilohertz) signals, and triangulated the exact location. But it was the Coast Guard radio station at Long Island's East Moriches that recognized the scope of the disaster and kicked off the response mission. Within five minutes, Petty Officer First Class Robroy A. Todd had sent a brief teletype report on the situation to the Sea and Air Rescue Coordination Center and Eastern Area Command Headquarters in downtown New York City.

Receiving the highest-priority message, as indicated by four bells, pause, four bells, LT Harold W. Parker, Jr., the officer on duty at the rescue center, alerted every available cutter in the Third District area of operations. Coast Guard cutters able to do so were directed to respond promptly. Within three minutes, the cutter *Tamaroa* was underway from its berth at the Sandy Hook Lifeboat Station. The *Owasco* began preparations to embark from its standby duty in New London, Connecticut. The cutters



Injured survivors of the *Andrea Doria*–SS *Stockholm* collision are treated aboard a Coast Guard amphibious plane en route to Boston from Nantucket Island. The doctor is CDR Thomas Dixon, surgeon, of the U.S. Public Health Service. Coast Guard photo

Yakutat and *Campbell* were in Cape Cod Bay engaged in cadet training exercises when they were ordered into action.

The *Evergreen* was diverted from oceanographic duties and an ice patrol during which it had placed a wreath over the spot where the *Titanic* went down. Two other cutters in port in Massachusetts—the *Hornbeam* and the *Legare*—received the order to respond. Ensign Robert Boggs, the *Hornbeam*'s executive officer, had to send out patrols to canvass taverns in town to recover the crew. The *Legare* set off at 1:50 a.m. The tug *Mahoning* also came to the rescue. Back in Manhattan, LT Parker eventually had to order two petty officers to guard the operations center against a horde of aggressive newsmen who were grabbing dispatches.[6]

While the Coast Guard certainly responded, other merchant vessels were far closer to the site of the wreck. The chartered freighter M/V *Cape Ann* heard the signals, was the first to make direct radio contact with both distressed ships, and the first to arrive on the scene in about half an

At Logan Airport in Boston, patients are loaded into waiting ambulances for the trip to the U.S. Public Health Service Hospital, in Brighton, Massachusetts. Coast Guard photo

hour. Sadly, it was not much help, with only two lifeboats aboard. Two U.S. Navy ships—the *Pvt. William H. Thomas* and the *Edward H. Allen*—responded, offering eight lifeboats. The USS *Heyliger* arrived a bit later. The M/V *Robert E. Hopkins,* a tanker just having left Boston, also reported that it would come to the assistance of the stricken boats.

Fast Action, Low Casualty Rate

Perhaps the most important of this lot would be the SS *Ile de France,* a large liner 44 miles away, whose captain made a costly financial decision to turn around and assist in the rescue. Under the international rescue rules established in 1948, it could have continued on its journey, as other vessels were already engaged. Its arrival within three hours was a welcome site to survivors and rescuers alike. The Coast Guard would later award the *Ile de France* a Gallant Ship Award plaque.[7]

The Coast Guard cutters did arrive on-scene shortly after other vessels. *Tamaroa* was the first, and all provided rescue coordination and operational support.

The fact that the efforts lasted 11 hours significantly contributed to the low casualty rate. The rescue vessels saved 1,663 persons, with 51 determined to have been lost. The rescue had succeeded, but not without some black marks. While the actual working crew men had stayed aboard the *Andrea Doria,* many stewards and other service personnel abandoned ship even before passengers did, and their acts gave the crew of the *Andrea Doria* an undeserved bad name.

Salvage Efforts

The final act of the *Andrea Doria*'s sinking began at 9:45 a.m. on July 26. It soon capsized and sank at 10:09 a.m. The sinking of the 697-foot ship represented the loss of a

With 1,600 of its passengers and crew members removed to rescue ships, the stricken *Andrea Doria,* listing badly to her starboard side, is now a ghost ship. Coast Guard photo

$30 million investment—an immense sum of money at the time. It was also the death knell of classic luxury liners, according to Coast Guardsman Bob Wallace, who photographed the incident from the *Evergreen.*[8]

In addition to cutters, the Coast Guard also sent in aircraft from Floyd Bennett Field in Brooklyn. LCDR R.P. Cunningham led two planes that had been patrol bombers during World War II. They arrived on scene and began dropping more than a hundred flares attached to parachutes that ignited 500 feet above the water's surface. Looking for survivors in the water was a dismal task, and Paul Grimes, an enlisted flight engineer on Cunningham's plane, dourly noted that one "had a helpless feeling, wishing you could do more."[9]

Come morning, heavy fog delayed the deployment of aircraft, but soon Coast Guard helicopters were dispatched to lift and transport those critically hurt from the *Stockholm* to land. Additionally, another Coast Guard plane took reporters for a flight over the *Andrea Doria* on July 26. The many ships involved in the rescue disembarked a large number of survivors at the Lightship *Ambrose.* From there they were taken to the pier by Coast Guard boats where they reunited with anxious relatives.

On the final morning of the rescue, the *Hornbeam* arrived, and its skipper made plans to take the *Andrea Doria* into tow. The intention was to tow the stricken ship to a nearby shoal before it sank, thus making salvage of the ship more likely and feasible. Unfortunately,

the permission required by international law per towing of a foreign-registered vessel was not authorized until 9:30 a.m., and by that time, the sinking was far too progressed to allow for any action. Soon thereafter, the *Hornbeam* rescued Captain Calamai and the remaining 60 crew men aboard from a lifeboat.[10]

Coast Guard cutters *Tamaroa* and *Mahoning* were able to guide the *Stockholm* back to Pier 97 in the Port of New York. The last casualty of the tragic event died of a heart attack aboard the *Stockholm* during this time. A happier story was the surprising discovery aboard the *Stockholm* of an *Andrea Doria* passenger thought to be among those who perished. The violent nature of the collision threw Linda Morgan, from her cabin onto the deck of the *Stockholm,* bedding and all.

The Surviving Ships

The *Stockholm* itself is a notable survivor, and was ultimately repaired at the cost of $1 million. Astonishingly, the ship, under the moniker M/V *Astoria,* still sails as the world's oldest cruise ship, operated by the UK-based Cruise & Maritime Voyages. However, for its part in this tragic affair and because it possessed a prior and subsequent track record of ocean mishaps, for some time this vessel was derided by old salts as "the ship of death."[11]

Several of the Coast Guard cutters involved in the *Andrea Doria* rescue went on to glorious service careers, with a number deploying to war, and some remaining a part of the Coast Guard fleet for upwards of a half-century. Of note, one of the cutters would be engaged in the search following the 1999 ocean crash of John F. Kennedy Jr.'s plane. The *Hornbeam* would participate in the Cuban quarantine in October 1962, and remained in active service until 1999. The *Tamaroa* would be involved in the search for the missing ship F/V *Andrea Gail* of "Perfect Storm" fame. That cutter would be among the last physical remainders of the naval vessels engaged in the rescue of *Andrea Doria* passengers. After efforts to save the cutter, which was far past its serviceable life, the *Tamaroa* was finally sunk to become a reef at the end of 2016. A Texas Tower replaced the Lightship *Ambrose* at its New York station in 1967, yet the former lightship was renamed and relocated, and remained in service until its decommissioning in 1983.[12]

Lessons Learned

The Coast Guard did not investigate the accident because it involved foreign-flagged liners and the collision occurred in international waters. A Congressional committee did look solely into safety considerations, which was the extent to which law allowed, but it did seem that cause would be determined as part of legal cases, including more than 1,000 lawsuits. However, a full hearing did not occur. The shipping lines involved wanted to tamper the resultant notoriety, and within weeks quietly agreed to settlements with each other, the insurers, and passengers.[13]

The Coast Guard connection to the *Andrea Doria* has not yet ended. Arising from the collision, rule changes compelling radar contact and starboard turns when approaching still exist.

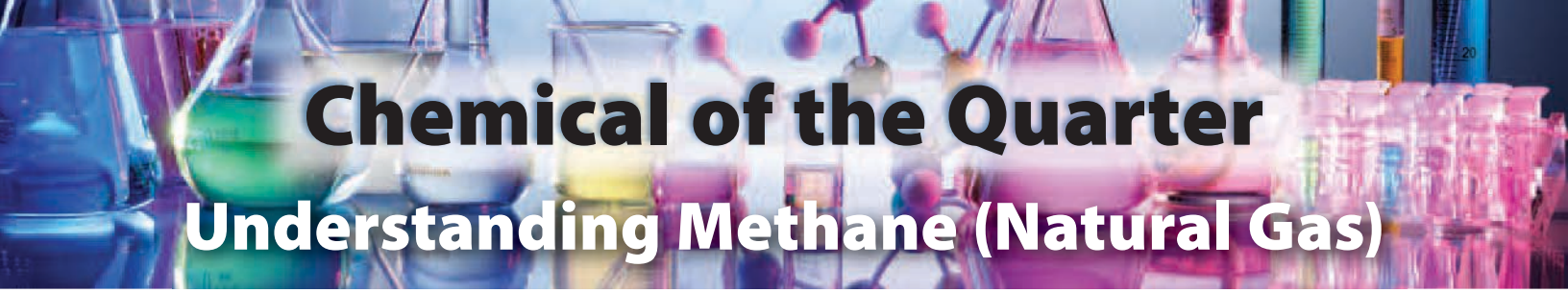
Over-reliance on radar was a major culprit in this accident. This led to mandatory training for the use of radar becoming more systematized and widespread. Furthermore, approaching ships are required to hail each other by radio communications, but most significantly, such vessels are always required to make a starboard turn. It is notable that the employment of these very measures would have eliminated any possibility of the collision that sank the *Andrea Doria.*

About the author:

LCDR Kent Sieg was a reservist assigned to the Atlantic Area Historian at the time of this article's submission. He previously served on active duty as an intelligence analyst and collector, in administrative oversight positions, and as a special project officer at various sites in the United States, Europe, and the Middle East, including service in Operations Noble Eagle, Liberty Shield, Enduring Freedom, and Deepwater Horizon. He holds a doctorate in history from the University of Colorado and continues to serve as a government historian.

Endnotes:

1. For background on the sinking of the *Andrea Doria,* see Robert Ballard, *Lost Liners: From the Titanic to the Andrea Doria the Ocean Floor Reveals Its Greatest Ships* (Hyperion: 1997); Gary Gentile, *Andrea Doria: Dive to an Era* (Gentile Productions: 1989); Richard Goldstein, *Desperate Hours: The Epic Rescue of the Andrea Doria* (Wiley: 2003); and William Hoffer, *Saved: the Story of the Andrea Doria, The Greatest Sea Rescue in History* (Simon & Schuster: 1982).
2. William H. Miller, Jr., *Doomed Ships: Great Ocean Liner Disasters* (Dover Publications: 2006), pp. 58–61.
3. Goldstein, pp. 16–24.
4. In addition to the previously listed sources, an especially useful source for much of the speculation and conclusions in this and subsequent paragraphs comes from Samuel Halpern, "An Objective Forensic Analysis of the Collision Between *Stockholm* and *Andrea Doria*" (Maine Maritime Academy: 2008).
5. Joe Haberstroh, *Fatal Depth: Deep Sea Diving, China Fever, and the Wreck of the Andrea Doria* (Lyons: 2003), pp. 36–42.
6. Goldstein, pp. 87–93.
7. See the S.S. *Ile de France* Gallant Ship Award online at: www.marad.dot.gov/about-us/maritime-administration-history-program/usdot-maritime-gallant-ship-award/ss-ile-de-france/.
8. Nick McCrea, "Mainers Bond over *Andrea Doria* Shipwreck Connection," Bangor Daily News, 28 July 2011.
9. Goldstein, pp. 151–52.
10. National Park Service, "U.S. Coast Guard Cutter HORNBEAM," Historic American Engineering Record No. NLJ-139, n.d.
11. Alan Feuer, "From 'Death Ship' to Cruise Ship," New York Times, 23 September 2006. The value of direct loss of the *Andrea Doria* alone was estimated at $30 million.
12. The history of these various cutters appears in the Coast Guard Historian's U.S. Coast Guard Cutters & Craft Index, located online at: www.uscg.mil/history/cutterindex.asp. Some of the personnel involved had careers just as venerable as the cutters that responded. LT Parker, who played a leading role in the coordination of this rescue, later served to the rank of Rear Admiral, ultimately commanding both the Eleventh and Thirteenth Coast Guard Districts and heading the Office of Boating, Public, and Consumer Affairs. He passed away in January 2017.
13. Goldstein, pp. 224–39. Loss of life continues to haunt the *Andrea Doria*'s ongoing saga. At least 16 divers have died while exploring the dangerous, collapsing wreck.



Chemical of the Quarter

Understanding Methane (Natural Gas)

by LT Jake Lobb
Hazardous Materials Division
U.S. Coast Guard Office of Design and Engineering Standards

What is it?

Methane, or CH4, is the smallest hydrocarbon compound, belonging to the series of organic compounds called alkanes, or paraffins. It is the primary component of natural gas, constituting 55–95 percent of its volume. Natural gas can be further refined to remove impurities like hydrogen sulfide and carbon dioxide, and heavier hydrocarbons, such as ethane or propane. After being refined, natural gas is commonly 97 percent or more methane, with the remaining balance being predominantly ethane, or C_2H_6. Therefore, methane and natural gas are often used interchangeably.

Why should I care?

➤ ***Natural Gas as Fuel***

Natural gas is an attractive alternative fuel, as its combustion yields up to 50 percent less carbon dioxide per unit energy than coal and 26 percent less than gasoline. Natural gas also contains far fewer sulfur containing compounds than other hydrocarbon fuels, thereby reducing SO_x and H_2S emissions. Therefore, natural gas is becoming more commonly used to power electrical generation plants, public transportation, and commercial maritime vessels. In fact, the consumption of natural gas has increased 5.2 percent globally since 2015, a trend that is expected to continue upward.

In response to the increased global demand of natural gas, world markets are rapidly building infrastructure to handle the unique challenges presented by natural gas and liquefied natural gas (LNG). Domestically, the U.S. Departments of Transportation, Interior, Energy, and Homeland Security oversee the design and construction of pipelines, rail systems, ground transportation, and marine shipping terminals. The United States is now a net exporter of natural gas. The Federal Energy Regulatory Commission oversees the design and construction of these export terminals. There are currently four in operation, five undergoing construction, and 19 in the planning or proposal phases.

➤ ***Shipping Concerns:***

At atmospheric pressure and temperature, natural gas exists in gaseous form. In order to reduce volume and provide more economical transport, natural gas is often liquefied, reducing the volume 600 to 1. In order to liquefy natural gas at near atmospheric pressures, the temperature must be reduced to -161°C (-258°F). All materials that hold or handle LNG must be specifically designed and rated for cryogenic service. Furthermore, the maritime LNG carriers must have a highly complex cargo containment and transfer system that ensures its safe transport.

➤ ***Health and Environmental Concerns***

Natural gas is non-toxic, colorless, and odorless, however, it is flammable in a range of 5–15 percent by volume in air. It also displaces oxygen, and therefore can cause asphyxiation. The extremely low temperatures of LNG will cause frostbite in direct contact with skin. Specialized gloves and other personal protective equipment must be worn for safe handling. LNG is not considered a marine pollutant, as contact with the water will cause instantaneous evaporation. However, natural gas is itself a greenhouse gas and voluntary emission is to be avoided.

What is the Coast Guard doing about it?

The Coast Guard Office of Design and Engineering Standards maintains the U.S. Code of Federal Regulations Title 46, Part 154, which provides design, construction, and operational requirements for maritime vessels that transport liquefied gas. These regulations dictate that the Marine Safety Center verify that each vessel is designed in accordance with international and domestic regulation. Furthermore, the Coast Guard Liquefied Natural Gas Carrier National Center of Expertise is a dedicated team of highly experienced individuals who oversee the inspector training and qualification process, and act to advocate Coast Guard regulations and policy to the industry.

About the author:

LT Jake Lobb is currently working in the Hazardous Materials Division of the Office of Design and Engineering Standards at U.S. Coast Guard Headquarters. He was previously stationed on CGC Waesche *out of Alameda, California, and as a Marine Inspector out of Coast Guard Sector Mobile, Alabama. A 2010 graduate of the Coast Guard Academy, he earned a B.S. degree in Naval Architecture and Marine Engineering. He also earned his master's degree in Chemical and Biomolecular Engineering from Rice University in 2017.*

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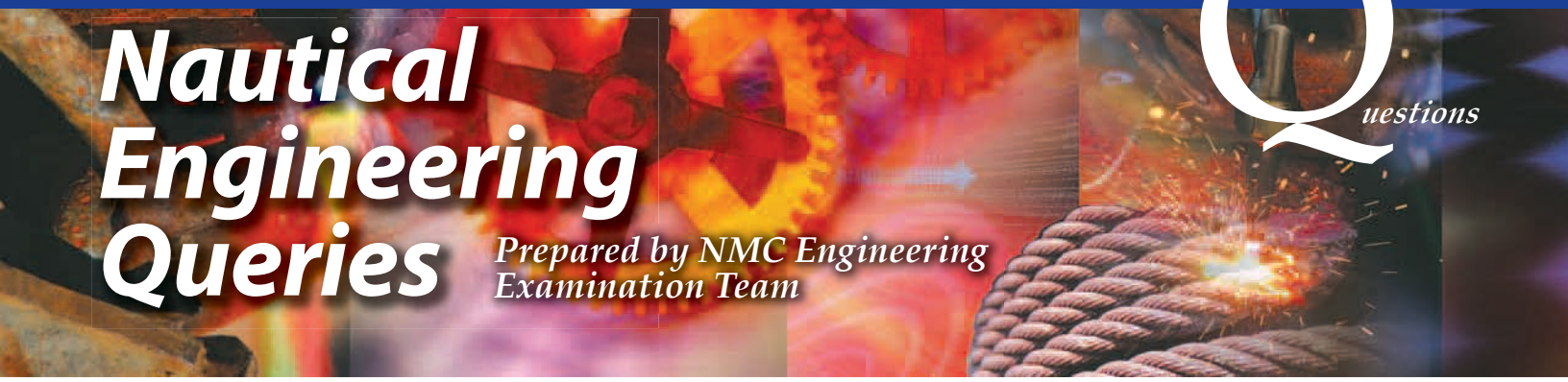

Nautical Engineering Queries

Questions

Prepared by NMC Engineering Examination Team

1. A common-emitter circuit has an input voltage of 0.1 volt, an output voltage of 2.0 volts, an input current of 0.5 milliamps, and an output current of 10 milliamps. What is the power gain?

A. 20
B. 40
C. 400
D. 4000

---

2. A casing drain is provided for axial piston and bent axis variable stroke pumps to _____ .

A. vent off any accumulated air from the system
B. drain off any accumulated water from the pump casing prior to its being started
C. assist in the complete removal of hydraulic oil from the system prior to opening for major or minor repairs
D. prevent damage due to agitation and overheating of oil accumulated in the casing associated with normal internal leakage

---

3. Which component will receive the greatest load in a two-stroke/cycle diesel engine?

A. lower half of the connecting rod bearing at the crankshaft end of the rod
B. upper half of the main bearing
C. lower half of the piston pin bearing in the connecting rod
D. lower half and upper half of each bearing share the load equally

---

4. An obstruction in the top connection of a boiler gage glass will cause the _____ .

A. water level to remain constant in the glass
B. water level to rise slowly in the glass
C. gage glass to overheat and break
D. gage glass to be blown empty

Engineering Answers

1. *Note: The common-emitter (CE) circuit is the amplifier configuration generally used for transistors because of its excellent combination of voltage gain and current gain.*

A. 20 Incorrect.

B. 40 Incorrect.

C. 400 **Correct answer.**

Reference: Grob, *Basic Electronics*

The power gain (A_P) of the amplifier is the product of the voltage gain (A_V) and the current gain (A_I).
The mathematical solution is as follows:

$A_P = A_V \times A_I$
$A_V = V_{out} \div V_{in} = 2.0 \div 0.1 = 20$
$A_I = i_{out} \div i_{in} = 10.0 \div 0.5 = 20$
$A_P = 20 \times 20 = 400$

D. 4000 Incorrect.

---

2. *Note: In addition to the pump suction and discharge lines and any servo control lines, these pump types are also fitted with a continuously open casing drain line, which drains the pump casing to the hydraulic system reservoir.*

A. vent off any accumulated air from the system — Incorrect .

B. drain off any accumulated water from the pump casing prior to its being started — Incorrect.

C. assist in the complete removal of hydraulic oil from the system prior to opening for major or minor repairs — Incorrect.

D. prevent damage due to agitation and overheating of oil accumulated in the casing associated with normal internal leakage — **Correct**

Reference: Stutman, *Applied Marine Hydraulics*

Lubrication of the pump pistons and cylinder walls is facilitated by a small seepage of hydraulic oil from the pressure (working side) of the pistons to the casing side of the pistons through the clearance space. This seepage (internal leakage) must be continuously drained away to prevent agitation, overheating, and hydraulic lock, all of which can cause damage to the pump.

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3. *Note: With compression pressure acting on the piston crown with each up stroke and firing pressure acting on the piston with each down stroke, the net forces acting on the piston of a two-stroke/cycle diesel engine are always in the downward direction even though there are changes in the inertial forces created by the moving parts. This impacts the bearing loading and associated wear patterns of the running gear.*

A. lower half of the connecting rod bearing at the crankshaft end of the rod — Incorrect.

B. upper half of the main bearing — Incorrect.

C. lower half of the piston pin bearing in the connecting rod — **Correct.**

Reference: Norman & Corinchock, *Diesel Technology*

With the net force always acting downward on the piston crown, the lower portion of the piston pin bearing in the connecting rod receives the greatest load.

D. lower half and upper half of each bearing share the load equally — Incorrect.

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4. *Note: When the top and bottom connections of a boiler gage glass are unobstructed, continual circulation results. Steam leaves the steam space of the boiler, enters the top of the gage glass, condenses, and the resulting condensation continually drains back into the water space of the boiler. The water in the glass being slightly cooler than the water in the boiler will result in a level just slightly lower than the actual water level in the boiler. If either the upper steam connection or the lower water connection is obstructed, the water level in the glass will tend to rise above the actual boiler water level and eventually fill the glass.*

A. water level to remain constant in the glass — Incorrect.

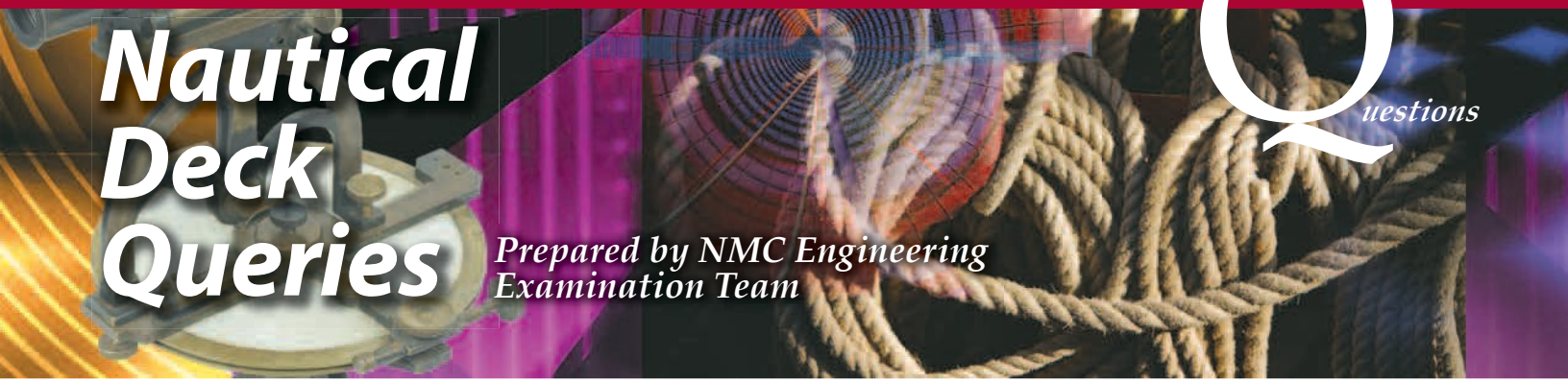
B. water level to rise slowly in the glass — **Correct.**

Reference: Hesselton, *Boiler Operator's Handbook*

If the upper steam connection is obstructed, the water level in the glass will rise slowly in the glass, indicating a level increasingly higher than the actual boiler water level.

C. gage glass to overheat and break — Incorrect.

D. gage glass to be blown empty — Incorrect.



Nautical Deck Queries

Prepared by NMC Engineering Examination Team

1. **BOTH INTERNATIONAL AND INLAND: Which vessel must show an after masthead light if over 50 meters in length?**

   A. a vessel trawling
   B. a vessel engaged in fishing
   C. a vessel at anchor
   D. a vessel not under command

---

2. **Which term describes the angle measured from the observer's meridian, clockwise or counterclockwise up to 180° to the vertical circle of the body?**

   A. observer's longitude
   B. local hour angle
   C. meridian angle
   D. azimuth angle

---

3. **What size sheave diameter should be used with a 3-inch manila line?**

   A. 3 inches
   B. 6 inches
   C. 9 inches
   D. 12 inches

---

4. **Which could cause a virtual rise in the center of gravity?**

   A. using an on-board crane to lift a freely swinging heavy object
   B. transferring ballast from the forepeake to the after deep tank
   C. filling a partially filled tank
   D. emptying a partially filled tank

1. A. a vessel trawling — **Correct.**

Reference: 33 CFR 83.26—Fishing vessels, Rule 26(b)(ii), which states:

A vessel, when engaged in trawling, by which is meant the dragging through the water of a dredge net or other apparatus used as a fishing appliance, shall exhibit: a masthead light abaft of, and higher than the all-round green light; a vessel of less than 50 meters in length shall not be obliged to exhibit such a light but may do so.

B. a vessel engaged in fishing — Incorrect answer.

C. a vessel at anchor — Incorrect answer.

D. a vessel not under command — Incorrect answer.

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2. A. observer's longitude — Incorrect answer.

B. local hour angle — Incorrect answer.

C. meridian angle — Incorrect answer.

D. azimuth angle — **Correct.**

Reference: *The American Practical Navigator,* 2002 Edition.

Azimuth angle is an arc of the horizon, or an angle at the zenith, between the principal vertical circle and a vertical circle measured either clockwise or counterclockwise through 180° starting at the north point of the horizon in north latitude and the south point in south latitude.

---

3. A. 3 inches — Incorrect.

B. 6 inches — **Correct.**

Reference: *Formula for the Mariner,* Richard Plant, 2nd Ed.

Solution is as follows:

Sheave diameter for rope = 2 × circumference of the rope
Sheave diameter = 2 × 3"
Sheave diameter = 6"

C. 9 inches — Incorrect.

D. 12 inches — Incorrect.

---

4. A. using an on-board crane to lift a freely swinging heavy object — **Correct.**

Reference: *Stability and Trim for the Ship's Officer,* William E. George, 4th Ed.

When the object is lifted, the center of gravity of the object shifts to the head of the boom, causing a rise in the center of gravity and loss of stability.

B. transferring ballast from the forepeake to the after deep tank — Incorrect.

C. filling a partially filled tank — Incorrect.

D. emptying a partially filled tank — Incorrect.

In the News: Coast Guard Transfers Smugglers, Cocaine to DEA

Coast Guard Cutter *Joseph Tezano* intercepted a go-fast vessel off Loiza, Puerto Rico, on September 16, 2018. Four days later, the crew transferred three smugglers and approximately $3.3 million dollars of cocaine to Drug Enforcement Administration agents at Sector San Juan on September 20, 2018. The interdiction was the result of ongoing multi-agency law enforcement efforts in support of Operation Unified Resolve, Operation Caribbean Guard, and the Caribbean Corridor Strike Force. Coast Guard photo by Ricardo Castrodad

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