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Workforce Assessment of the Inland Waterway Industry: A Survey of Current and Future Training and Personnel Needs

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Workforce Assessment of the Inland Waterways Industry: A Survey of Current and Future Training and Personnel Needs

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16. Abstract

This report describes the findings of a preliminary review of the workforce needs of the inland waterways industry, which currently confronts a human resources crisis and must recruit more people who can work their way up to the skilled positions on towboats. The looming surge in retirements will present a significant hurdle—especially as its large cohort of baby boom river pilots and captains reach retirement age. The industry will need to recruit, train, and retain competent personnel for a very demanding and important set of jobs. While many people can handle the tasks of a deckhand, only a minority will have the requisite combination of spatial relations aptitude, leadership, technical and social skills that it takes to perform effectively as a pilot or captain on the inland river system. Two basic conclusions were drawn from our interviews with industry experts: (1) the rivers present a dangerous and cognitively challenging environment in which to work; and (2) the more demanding jobs on the rivers are best filled by conscientious people who can work well with others and have sufficient cognitive ability to cope with the safety and other challenges that arise with some regularity.

During research on job performance, it was found that cognitive ability is the best predictor of job performance and especially so in the more complex jobs. To be sure, piloting a barge tow is a complex task. Serving as captain is even more so. Clearly the jobs above deckhand require more cognitive ability and more capacity for leadership. Thus, only a subset of those who succeed as deckhands can move on to the more complex and difficult positions of mate, engineer, pilot or captain. We found that the military relies on a test of cognitive ability to ensure that all its recruits have measured intelligence in the normal range or above. The military also wants a high school diploma. Combined, these two screening devices improve the recruit's odds for success in the armed forces. Thus, this study concludes that the average veteran with an honorable discharge is more likely to have the traits conducive to occupational success in the more complex occupations on the rivers. Given this reality, the industry can profit from devising new methods for reaching out to veterans, many of whom have little or no knowledge of the numerous benefits of a career on the rivers.

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Abstract

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Executive Summary

This report describes the findings of a preliminary review of the workforce needs of the inland waterways industry, which faces a number of challenges and is changing in significant ways. The industry is projected to grow over the next 20 years. According to a report by the American Society of Civil Engineers, "[b]y 2020, traffic on inland waterways is expected to increase by 51 million tons of freight from 2012, an overall 11 percent increase. By 2040, this increase is expected to exceed 118 million tons above 2012 levels, an overall increase of 25 percent" (2012: 5). As the volume of freight on barges increases, the demand for trained workers will grow apace. In its estimates of future employment in water transportation occupations, the Bureau of Labor Statistics makes this prediction: "Overall employment of water transportation occupations is projected to grow 20 percent from 2010 to 2020, faster than the average for all occupations….Job growth is likely to be concentrated on inland rivers, the Great Lakes, and along the coasts." If so, it seems likely that the demand for workers on the inland waterways will grow by more than 20 percent and do so during a period in which many in the current workforce will enter retirement.

The looming surge in retirements presents a significant hurdle—especially as its large cohort of baby boom river pilots and captains reach retirement age. The industry will need to recruit, train, and retain competent personnel for a very demanding and important set of jobs. Work on the inland waterways has become more complex in a number of ways. Today's captains and other onboard supervisors need to know a variety of legal rules and regulations that cover work on the rivers and must be able to handle the related documentation and paperwork. They need to effectively use sophisticated navigation and communication equipment. They also need "soft skills", as barge companies increasingly seek people with well-honed social skills for working with young deckhands and other subordinates. Finally, the future may bring new and quite expensive vessels for carrying containers, requiring new skills of inland mariners.

As this report documents, work on inland river vessels differs markedly from that on ocean going vessels. Thus, training must be geared to the unique features of work on the rivers and, in fact, much of the training necessarily occurs on-board the towboats and barges, accumulating with on-the-job experience. Most of the pilots, for example, start as deckhands and work their way up to the position of pilot and then captain. Indeed, a good number will work on the river for 7 to 10 years before reaching the wheelhouse. While many people can handle the tasks of a deckhand, only a minority will have the requisite combination of spatial relations aptitude, leadership, technical and social skills that it takes to perform effectively as a pilot or captain on the inland river system.

During this study, a wide range of individuals in the inland navigation industry were interviewed and mariners at work and in training were observed. Also, instructors and various officials at community colleges and other institutions were interviewed to obtain information on the skills needed to succeed in the various positions on the rivers. Two basic conclusions may be

drawn from the research: (1) the rivers present a dangerous and cognitively challenging environment in which to work; and (2) the jobs on the rivers are best filled by conscientious people who can work well with others and have sufficient cognitive ability to cope with the safety and other challenges that arise with some regularity.

The industry faces a human resources crisis and must recruit more people who can make the transition to effective execution of the skilled positions. During research on job performance, it was found that cognitive ability is the best predictor of job performance and especially so in the more complex jobs. To be sure, piloting a barge tow is a complex task. Serving as captain is even more so. Clearly the jobs above deckhand require more cognitive ability and more capacity for leadership. Thus, only a subset of those who succeed as deckhands can move on to the more complex and difficult positions of mate, engineer, pilot or captain.

It was noted that there is a tendency for the less cognitively able to drop out of high school. Therefore, requiring applicants for a deckhand position to possess a high school diploma increases the likelihood that they will perform well as deckhands. It also increases the likelihood that they will be able to move into the higher skilled positions in the engine room and wheelhouse. The same is true of those with a GED. However, it was observed that while dropouts with a GED are as cognitively able as those with a high school diploma who do not attend college, they tend to lack the personality traits, such as conscientiousness, emotional stability, and agreeableness, associated with job success. In short, when it comes to hiring a person likely to succeed at the entry level and subsequently at a higher level, a person with a high school diploma is preferable to a dropout with a GED, and the latter is preferable to a dropout without a GED.

However, even a high school graduate may have below average cognitive ability, which is why the military relies on a test of cognitive ability to ensure that all its recruits have measured intelligence in the normal range or above. The military also wants a high school diploma. Combined, these two screening devices improve the recruit's odds for success in the armed forces. Thus, the average veteran with an honorable discharge is more likely to have the traits conducive to occupational success in the more complex occupations on the rivers. Given this reality, the industry can profit from devising new methods for reaching out to veterans, many of whom have little or no knowledge of the numerous benefits of a career on the rivers.

While most training is still provided by employers after employment, the industry is interested in hiring more people with training at the marine academies and the community colleges. At present, the training for the inland waterways is limited and the industry and the educational institutions need to develop a more integrated approach in which employees and aspiring employees learn some skills in the schools and some at work in a structured sequence that improves training and expedites advancement. Employees who succeed in academic settings are more likely to possess the attributes, both cognitive and personality-related, to succeed in the higher level positions.

Some towing companies are devising programs to recruit graduates of the maritime academies and fast track them into the steersman programs to become pilots. It may be possible to place some of this training into the academic programs, so that a new graduate would only need to spend one year after graduation rather than two to earn a pilot's license. The same is probably true for the career path for engineers. For their part, the community colleges could, with some development of their course offerings, play a greater role in training pilots and engineers. At this time, for instance, community college students appear to get few of the benefits from the use of sophisticated simulator programs such as the one at Seaman's Church Institute in Paducah, KY. In Europe simulators are used to accelerate training of river pilots, an approach to training that seems applicable to the development of inland river pilots in the U.S.

Workforce Needs of the Inland Waterways Industry: A Preliminary Survey

Introduction

The U.S. has nearly 12,000 miles of navigable waterways. This network for bulk freight transportation—coal, petroleum, wheat and the like—which is centered on the Mississippi River, is a vital national resource, as nearly 525 million tons or 24% of the nation's waterborne commerce moved on barges along the inland waterways in 2009. According to a study by the U.S. Army Corps of Engineers in their 2004 Civil Works Strategic Plan, waterborne commerce saves $7 billion annually in transportation costs by providing a more energy efficient and environmentally friendly form of conveyance than that provided by transporting freight by rail or truck. The cost saving from moving bulk freight on barges is approximately $13 to $14 per ton.

In addition to lowering transportation costs for bulk commodities, the inland river system also reduces energy costs for commercial and industrial activities by linking energy producers to raw materials. The inland river system also supplies recreational, industrial, and municipal water. Last, it provides a large number of jobs with good wages and benefits.

A good portion of the cargo transported on the inland waterways is hazardous to the environment and must be handled and shipped with the utmost concern for public safety. For instance, 56 percent of all crude petroleum is shipped on the inland waterways (see Table 1). However, spills are rare and the industry has an excellent record in regard to protecting the environment. This is the case even though the rivers present many obstacles to safe navigation and require a well-trained and capable workforce, one that can handle unexpected developments as well as routine events in the course of pushing up to 40 barges through narrow channels in fast moving currents.

Table 1: Percent of All Freight by Type Transported on the Inland Waterways in 2010

Commodity	Percent on Inland Waterways
Crude Petroleum	56%
Coal	15%
Other Fuel Oils	24%
Basic Chemicals	22%
Agricultural Products	18%
Nonmetallic minerals	19%

This report describes the findings of a preliminary review of the workforce needs of the inland waterways industry, which faces a number of challenges and is changing in significant ways. That the industry confronts significant issues in regard to its workforce is clear, as it is projected to grow over the next 20 years. According to a report by the American Society of Civil Engineers, "[b]y 2020, traffic on inland waterways is expected to increase by 51 million tons of freight from 2012, an overall 11 percent increase. By 2040, this increase is expected to exceed 118 million tons above 2012 levels, an overall increase of 25 percent" (2012: 5). As the volume of freight on barges increases, the demand for trained workers will grow apace. In its estimates of future employment in water transportation occupations, the Bureau of Labor Statistics makes this prediction: "Overall employment of water transportation occupations is projected to grow 20 percent from 2010 to 2020, faster than the average for all occupations….Job growth is likely to be concentrated on inland rivers, the Great Lakes, and along the coasts." If so, it seems likely that the demand for workers on the inland waterways will grow by more than 20 percent and do so during a period in which many the current workforce will enter retirement.

The looming surge in retirements presents a significant challenge—especially as its large cohort of baby boom river pilots and captains reach retirement age. The industry will need to recruit, train, and retain competent personnel for a very demanding and important set of jobs. And work on the inland waterways has become more complex in a number of ways. Today's captains and other onboard supervisors need to know a variety of legal rules and regulations that cover work on the rivers and must be able to handle the related documentation and paperwork. They need to effectively use sophisticated navigation and communication equipment. They also need "soft skills", as barge companies increasingly seek people with well-honed social skills for working with young deckhands and other subordinates.

As this report documents, work on inland river vessels differs markedly from that on ocean going vessels. Thus, training must be geared to the unique features of work on the rivers and, in fact, much of the training necessarily occurs on-board the towboats and barges,

accumulating with on-the-job experience. Most of the pilots, for example, start as deckhands and work their way up to the position of pilot and then captain. Indeed, a good number will work on the river for 7 to 10 years before reaching the wheelhouse. While many peoplecan handle the tasks of a deckhand, only a minority will have the requisite combination of spatial relations aptitude, leadership, technical and social skills that it takes to perform effectively as a pilot or captain on the inland river system.

Methodology for Information Gathering

During the first stage of this study, information was gathered from a large number and types of sources. The variety of sources used and people contacted reflects the complex nature of the inland waterways industry. In addition to analysis of quantitative data collected by the Coast Guard, the Army Corps of Engineers and the American Waterways Operators, the research team consulted with industry leaders and observed inland mariners at work to identify the practical demands of working on the rivers. Some of these meetings involved semi-structured interviews during which the participants discussed the obstacles the barge companies face in developing and retaining an effective workforce.

The research team engaged in a qualitative assessment of workforce training and education. Members of the research team observed the deckhand training course of a leading barge company, participated in a national workforce development workshop at the annual Transportation Research Board conference and participated in a maritime academy work session in Paducah, Kentucky.

In order to obtain information about formal opportunities for education related to the waterways, the researchers visited West Kentucky Community and Technical College, Mountwest Community and Technical College and Seaman's Church Institute—all of which offer various education and training programs for one or more waterways occupations. Discussions were also held at a meeting with representatives of the maritime academies in an effort to recruit more academy grads into the inland industry.

In order to better understand the regulatory side of the inland waterways industry, the team visited the Sector Ohio Valley office of the US Coast Guard in Louisville, KY and US Army Corps of Engineers (USACE) District offices in Louisville, KY and Huntington, WV. Members of the team also visited the site of the Olmsted lock and dam project, which is currently under construction on the Ohio River downstream from Paducah, KY.

Last, the team conducted an exhaustive online search on waterways education institutions and sent inquiries to many of these programs. An online survey was distributed to institutions that utilize the maritime simulators in their education and training programs.

Section 1: The Nature of Work on the Inland Rivers

Some work environments are inherently dangerous—with construction and mining being obvious examples. The extent to which redesign of the physical environment (e.g., high railings,

protective shields, methane detectors, etc.) can reduce serious accidents, injuries, and spills is limited, as human error is always possible (Perrow 1984). Thus, in dangerous settings, it is also necessary to effectively train the workers in the safest procedures to reduce the incidence of human error. This is not easy to do, as many workers resist complying with safe practices and accidents can arise from a failure to consider safety when making a decision. So, it is necessary to not only design the work practices but to select employees likely to follow safe work routines and make the right decisions when confronting hazardous conditions.

To be sure, barge companies operating on the inland waterways confront a demanding, sometimes treacherous environment in which to work, as the river levels and currents change frequently, the barge tows are large and difficult to maneuver, the tows move 24 hours per day, seven days a week, the temperatures on deck can vary from over 100 degrees in summer to below zero in the winter, and the deckhands must perform heavy tasks in all weather conditions (Henrickson and Wilson 2007). Moreover, the crew members must function as a close knit team, as they live on board for approximately30 days in a row, working two six hour shifts each day. Successful crew members must possess the right combination of physical, mental, and personality attributes to cope with the demands of their assigned roles. That raises the question--how can their employer select the right employees, those who can handle the rigorous physical demands of working on the river and perform the work in the specified, safe manner while also being able to make the safest decisions when problematic situations arise?

Piloting a barge tow is an especially daunting task, as pilots and captains confront many challenging situations—lock approaches, bends in the river, swift currents, bad weather, changes in navigable channel widths, and closely spaced bridge piers, to mention a few. Pilots need extensive training to meet these and other difficult situations and emergencies, as the environment in which they operate is complex and calls for continual learning. “The same mile of river,” Erik Larson observes, “can change with the season, with the rising and falling of the river height, with various effects of wind or current and with the time of day or night (Larson p22). The task of steering a tow is rendered more difficult by the size of some tows. A tow with 15 barges in a configuration three barges wide and five barges long is approximately 1150 feet long and 105 wide (including the towboat) and weighs fully loaded 25,000 tons.

Depending on the number of barges, a towboat has a crew that varies from eight to ten: the captain, the pilot, the engineer, a cook, a lead deckhand, a mate deckhand and one to three additional deckhands. Each tow has a pilot and a captain, because the pilot controls the tow while the captain is off duty. Deckhand is an entry level position that offers a great deal of opportunity for advancement through a series of supervisory positions, culminating in positions in the wheelhouse as pilot or captain. Each position in the series of promotions carries more responsibility and calls for increasing cognitive ability and knowledge.

Deckhands

The main task of a deckhand is the assembly of the individual barges into a secure tow that will not break apart when pushed by the towboat. This is done with the use of steel rigging to hold the barges tightly together. A loose or improperly rigged tow is difficult to steer and therefore unsafe. The lifting and positioning of the rigging requires physical strength. One informant said that during training the deckhands must pass a test that calls for carrying 85 pounds of rigging over a specific distance and up and down stairs. The pilots and mates worked as deckhands prior to their current positions and fully understand all aspects of properly rigging a tow. Most deckhands are male; but some are female; and the industry is seeking more female applicants.

New deckhands go to work after approximately two weeks of initial training, during which they practice the safest techniques for rigging the tow and performing their other tasks. Their work is closely supervised during their first tour on the river to ensure compliance with the approved methods for rigging a tow.

Deckhands must be able to perform heavy labor outdoors in extreme heat and cold—especially heat, as the summer weather on the lower Mississippi is very hot and humid with temperatures on the deck near or in excess of 100 degrees. An informant said that ideally, a candidate for a deckhand position will have worked outdoors for 18 or more months, often in construction. The same informant said that people who served in the infantry with the Army or Marine Corps are similarly capable of handling the combination of heavy work under difficult weather conditions.

Deckhands and other employees need to be able to accept orders and abide conscientiously by the numerous safety rules that govern the work. They must also work cooperatively with others. Even otherwise accomplished people, such as the self-employed who have held positions of authority in the past, may have difficulty with faithful compliance with the routine requirements.

There are no certifications for deckhands or educational qualifications. However, some companies are asking for a high school diploma or GED. We will discuss below the justifications for these educational requirements.

Engineers

The engineer is a skilled mechanic who works in the engine room. Engineers have to know how to operate and repair a diesel engine. They also need knowledge of liquid and air hydraulic systems as well as those for electrical, HVAC, and plumbing.

Some of the engineers were trained in the Navy or high school; and many attend community colleges or other technical programs, such as Prosser School of Technology, which offers courses in diesel mechanics. But, much of the training occurs after employment. In fact, many start as deckhands and begin training informally by working with the vessel engineer

during their off-duty times. They can then work in the shipyard repairing and overhauling engines under the guidance of skilled engineers during their month-long days off the river.

The barge companies, themselves, have training programs for engineers. Some companies have the aspiring engineer take a general aptitude test to qualify for entry into an apprenticeship program. Often, however, this aptitude and interest has already been demonstrated during employment, so a test is not needed for entry into a training program.

It can take three to five years to advance through a series of positions from apprentice to junior engineer to chief engineer, during which time a person works on all types of engines and vessels. Training occurs throughout employment. Given the technical requirements, the companies are increasingly interested in hiring engineers who have passed tests to obtain certification. However, the Coast Guard does not require engineers on the inland waterways to be licensed.

Pilots and Captains

The pilots and captains tend to start as deckhands and work their way up. Training to be a pilot is regulated by the Coast Guard and requires 18 months of training in a steersman program under the direction of a captain prior to certification as a pilot. Most people in training to become a pilot have worked at least two years on the river as deckhands and mates.

Some companies require a general cognitive ability test (such as the PRO 3000) and/or an educational credential (a high school diploma) to become a pilot; but some do not. Apparently, the task of piloting a towboat requires an unusual degree of two-dimensional spatial ability. Erik Larson conducted research on river pilots and found that the average river pilot has two-dimensional spatial abilities that are 2 standard deviations above average. This means that the average pilot he tested scored in the top 2 percent of the population on this skill.

Towboat pilots and captains are difficult to train and retain, as the training is lengthy and they can switch companies at will, earning as much as $900 per day or $162,000 per year. The looming shortage of pilots and captains is a function of the time and cost that it takes to train a pilot.

Training for Pilots and Captains

An aspiring pilot enters the Merchant Marine Credential (MMC) program, which is also referred to as the steersman program. Most companies have some requirements such as serving as a second mate or above, possession of a high school diploma or a G.E.D, and possession of a valid First Aid/CPR/AED Certification. Background checks are administered to ensure that candidates have no narcotics, DWI/DUI or criminal convictions as defined by the Coast Guard within the past five years. Applicants also need letters of recommendation from boat captains or other high-level supervisors. Before or during steersman training, the applicant will acquire credentials for operating radar and VHF radios.

Safety is emphasized throughout the lengthy steersman training period with the trainee being supervised closely by the ship's captain. The steersman must complete 240, 12-hour days of wheelhouse training on the river. This takes close to a year and a half to complete. A director of training for steersmen said that his company currently trains about 30 people in its steersman program. Not all will successfully complete the program and obtain a pilot's license, however.

The steersman program entails a great amount of documentation to ensure mastery of basic piloting skills. At the end of each trip, the captain who is training the steersman evaluates his performance in regard to 13 piloting skills and other related attributes: boat handling, steering, flanking, locking, river current and drafts, wind, knowledge of route, judgment, confidence, use of electronics, application and use of rules and regulations, and environmental sensitivity. A grade from 1 to 10 is entered for each of these skills.

The steersman in training keeps a daily log, which indicates the total hours and miles steered, tow size, weather conditions, river stage and conditions, number of loaded and empty barges, and distance travelled. The steersman must record remarks for each watch served and the lessons learned on that watch. All these documents are reviewed by a company official, who serves as the director of pilot development.

Other barge company personnel

A barge company has office employees for logistics, finance, IT, and other business positions. Many of these workers have never worked on the river. But many have, as barge companies have operations personnel who have maritime experience as engineers and boat captains. These people know the river and the types of challenges that can develop. They keep track of each tow while it moves toward its destinations and frequently serve as a resource to solve problems as they arise. Some barge companies are now hiring college graduates with no maritime experience to assist with interpretations of the various rules for transporting cargo.

Section 2: The Attributes of Those Most Suited for Work on the Inland Waterways

In the previous section, we observed that the deckhands must be reliable, trainable, and safety conscious if they are to consistently perform their tasks in a safe and conscientious manner and exercise good judgment in a dangerous environment. Human resources people in the industry seek even-tempered people, who cooperate with others. Thus the attributes they seek in applicants are in line with the research on job performance, which demonstrates that cognitive ability and certain personality traits predict higher levels of job performance. This is so even when the job is relatively simple, such as are many laboring positions. Clearly, due to the hazardous nature of the river environment, the barge industry needs to recruit deckhands with the cognitive ability and conscientiousness needed to perform well. They also need people who work well in a team and are willing to cooperate with others.

In order to obtain applicants likely to have higher levels of cognitive ability, some companies now require a high school diploma or a GED. Another way to ensure the desired levels of cognitive ability is to hire veterans who have demonstrated cognitive ability by passing the military's Armed Forces Qualifying Test—the AFQT. Another advantage of hiring veterans is that they have demonstrated the ability to work with others and perform tasks conscientiously—by successfully completing their time in the military and leaving with an honorable discharge. Those who served in infantry positions have also demonstrated an ability to work in adverse weather conditions.

A substantial level of cognitive ability is needed for the job of deckhand; but even higher levels are needed for the supervisory position of mate and higher levels still for work as a pilot. In that most people in the higher positions start as deckhands, it is imperative that some of the deckhands have the cognitive ability it takes to perform well in the more cognitively demanding positions.

The Military and Selection for Cognitive Ability

The military administers an aptitude test to all applicants and rejects approximately 30 percent of its applicants for scoring too low on its cognitive ability test, which is essentially an intelligence or IQ test. It also requires a high school diploma, although occasionally it makes exceptions and takes people with a GED. But GED holders must score substantially higher than high school graduates (see Table 2).

Each branch of the military has a different cutoff point on the AFQT. Prior to 2012, the Army and Marine Corps required a score at the 31st percentile or higher, while the Navy enlisted only those who score at the 35th percentile and the Air Force requires a score at the 36th percentile.

The Armed Services Vocational Aptitude Battery (ASVAB) has ten tests in all, four of which are used to construct the Armed Forces Qualifying Test (AFQT), which is a test of cognitive ability or intelligence. The four in the AFQT are: Word Knowledge, Paragraph Completion, Arithmetic Reasoning, and Mathematical Knowledge. The six others that complete the AVSAB are: General Science, Electronics Information, Coding Speed, Automobile/Shop Information, Numerical Operations, and Mechanical Comprehension (M&H 994:582). The AFQT is one of the most highly g-loaded tests, which means it measures general intelligence very well.

The AFQT has been administered to a random sample of Americans and has been converted into a distribution of IQ scores for the general population. Herrnstein and Murray created a table that relates cognitive classes to high school completion. There are five classes in all: the very bright or top 5 percent of the population with scores of 125 and up; the bright (20 percent) with standard scores ranging from 111 to 124; the average or normal with scores ranging from 90 to 110 (50 percent); the dull with scores from 76 to 89 (20 percent); and the very dull with scores of 75 or below (the bottom 5 percent of the population).

Table 2: Cognitive Classes and High School Drop Out Percentages

Cognitive Class	Verbal Description	AFQT IQ Range	Percentile Range	Percent of Population	% High School Dropout
I	Very Bright	125 and up	95th percentile	5%	0
II	Bright	111-124	75th to 94	20%	0
III	Normal	90-110	25 to 74th	50%	6
IV	Dull	76-89	6th to 24th	20%	35
V	Very Dull	75 and below	5th and below	5%	55

The results in Table 2 indicate that virtually all Americans in the top two classes (IQ > 110) graduate high school and all but six percent of those in the normal range (IQ 90 to 110) graduate high school. The dropout rates in the bottom two cognitive classes are quite significant—34 percent of the dull and 55 percent of the very dull are dropouts. However, many of the dull and very dull manage to complete high school, which suggests that the military's use of a cutoff score on the AFQT in addition to a diploma is wise. It ensures that all members of the armed services have measured cognitive ability in the normal range. But the requirement of a high school diploma provides additional information about the likely job performance of a recruit as will be explained below.

Table 3: Estimated Average IQ by Category of Educational Achievement

	I.Q. Estimate (mean)
Dropouts—No GED	87.8
GED	98.5
High School Diploma—All	106
High School Diploma—No college attendance	98.5
College Graduates	115
MDs, PhDs, Professional Degrees	126

There is a clear relationship between the average level of cognitive ability and the level of high school achievement (see Table 3). The average high school graduate (IQ estimate of 106) has substantially greater cognitive ability than the average dropout (IQ estimate of 87.8). Thus, the average dropout has below normal intelligence. However, dropouts who pass the GED exam have the same cognitive ability as the high school graduates who do not attend college (IQ estimate of 98.5). These estimates of cognitive ability strongly support the utility of requiring a high school diploma or GED, especially when seeking candidates who can move up from the position of deckhand.

GED Recipients versus High School Graduates Who Do Not Attend College

Heckman and Lafontaine (2006, 2007, 2008) have found that the average person with a GED is not as successful as the average high school graduate who does not attend college, despite scoring as well on the Armed Forces Qualifying Test (AFQT). They (2007:7) write: "Although GED recipients have the same measured academic ability as high school graduates who do not attend college, they have the economic and social outcomes of otherwise similar dropouts without [GED] certification…" They (2007:7) conclude that "…GED recipients lack non-cognitive skills such as perseverance and motivation that are essential to success in school and in life….GED recipients attrite from the military at the same rate as other dropouts and they exit post-secondary schooling with nearly the same degree attainment rates of other dropouts who start with no credential." Compared, moreover, to high school graduates of similar cognitive ability, GED recipients have lower hourly wages. Heckman and Rubenstein conclude that "the GED is a mixed signal that characterizes its recipients as smart but unreliable (2001: 148)." The obvious implication of this research is that the high school diploma is a better indicator of likely success than the GED.

The military will take dropouts with GEDs; but only those with significantly higher AFQT scores. As Table 4 shows, the cutoff scores are significantly higher for those with a GED. For the Army and the Marine Corps, the gap in test scores is 19 and 18 percentiles, respectively. For the Air Force, the gap is 25 percentile points. The Navy demands 15 more points but also demands 15 hours of college credit. The size of these differences is an indicator of the value that the military places on the ability to complete high school.

Table 4: Minimum AFQT Percentile Scores in 2012 for Enlistment for those with a High School Diploma versus Those with a GED

Branch	HS Diploma	GED
Army	31	50
Marines	32	50
Navy	35	50 and 15 hours of college credits
Air Force	40	65

Cognitive Ability and Occupational Success

A great amount of research, much of it conducted for the military, finds that cognitive ability contributes to successful mastery of the tasks associated with an occupation and to subsequent performance in the occupation. This research consistently finds that those with higher scores on tests of cognitive ability perform better in their jobs (Gottfredson 1997). This is especially the case for the more complex and non-routine jobs that require the acquisition and synthesis of information to perform the work. The more demanding or challenging the tasks associated with a job, the greater the advantages of higher levels of measured cognitive ability.

The contribution of intelligence to job performance has implications for the jobs on the river. Most people in managerial positions appear to have IQs above average, that is, above 110. Pilots and especially towboat captains need managerial ability. This suggests that those with cognitive ability scores above 110 or the 75th percentile are more likely to perform well as pilots and captains. Technicians and mates probably need scores in the high average range to perform well, that is, scores above 105 or about the 60^{th} percentile.

But those with higher scores are likely to perform better than those with lower scores even when all pass a threshold score. Gottfredson (1997) reports that those with IQ scores greater than 116 are able to gather and synthesize information easily; and can infer information and reach appropriate conclusions from the job situation. Such skills apply to the challenges

confronting pilots and captains on the rivers, where conditions change rapidly and correct decisions must be made based on changing circumstances.

The military uses the results of the ASVAB to place its recruits in specific positions based on different combinations of test scores. These combinations, referred to as "line scores" have been found to predict success in specific occupations. Most occupations have only one line score; but some occupations require minimum scores in two fields.

Combinations of ASVAB Subtest Scores (Army Line Scores) Used to Place Enlistees in Occupational Fields

Field	Field Symbol	Subtests	Range of Minimum Scores for Positions in Field
Clerical	CL	Sum of Word Knowledge and Paragraph Completion + Arithmetic Reasoning + Mathematics Knowledge	86 90 95 101
Combat	CO	Sum of Word Knowledge and Paragraph Completion + Auto and Shop Information + Mechanical Comprehension	87
Electronics	EL	General Science + Arithmetic Reasoning + Mathematical Reasoning + Electronics Information	89 93 98 102 105 107 117
Field Artillery	FA	Arithmetic Reasoning + Mathematics Knowledge + Mechanical Comprehension	93 95 96 98
General Maintenance	GM	General Science + Auto and Shop Information + Mathematics Knowledge + Electronics Information	84 88 93 98
General Technical	GT	Sum of Word Knowledge and Paragraph Completion +Arithmetic Reasoning	105
Mechanical Maintenance	MM	Auto and Shop Information +Mechanical Comprehension +Electronics Information	87 99

Field	**Field Symbol**	**Subtests**	**Range of Minimum Scores for Positions in Field**
Operators and Food	OF	Sum of Word Knowledge and Paragraph Completion +Auto and Shop Information + Mechanical Comprehension	85
Surveillance and Communications	SC	Sum of Word Knowledge and Paragraph Completion + Arithmetic Reasoning + Auto and Shop Information + Mechanical Comprehension	89 98 105 92
Skilled Technical	ST	Sum of Word Knowledge and Paragraph Completion + General Science + Mechanical Comprehension + Mathematics Knowledge	91 91 95 96 101 107
Special Forces	SF	GT 107 CO 98	GT 107 to 110 CO 98

Section 3: Personality Traits and the Demands of Work on the River

Personality is a complex subject to study. There are literally hundreds of characteristics that can describe a person, and all people are unique in many respects. Nevertheless, people tend to have enduring traits that make them more or less likely to succeed at a given task. Over the past 50 years psychologists have identified five important personality traits that can influence the degree of fit between an individual and his or her occupation as well as their suitability for the related interpersonal and social demands. These traits are known as the Big Five (Digman 1990). They are:

1. Openness to experience, which is characterized by an appreciation for art, adventure, curiosity, emotion, and a variety of experience;
2. Extraversion or a tendency to seek stimulation in the company of others;
3. Neuroticism/emotional stability, which is evidenced by a tendency to experience such negative emotions as anger, anxiety, depression and emotional instability;
4. Conscientiousness or a tendency to show self-discipline, act dutifully, and engage in planned rather than spontaneous behavior; and
5. Agreeableness or a tendency to be cooperative rather than antagonistic toward others.

All these traits are a matter of degree and any individual can be described as possessing relatively more or less of each trait. Different jobs and occupations appear to call for individuals who are stronger on one or more of the five traits, although obviously, there are very few jobs that seek people with a tendency to experience negative emotions and anger. Regarding work in hazardous environments in general and work on towboats in particular, three of the traits seem particularly useful—conscientiousness, agreeableness, and the even temperament associated with low levels of neuroticism/ emotional instability.

Conscientiousness

The association between conscientiousness and successful job performance is intuitively appealing and much research supports it. For example, Heckman and LaFontaine (2007) report that conscientiousness (after IQ) is the personality trait that best predicts grades. Less intuitively obvious, conscientiousness predicts leadership ratings slightly better than IQ does. Perhaps more important for work on the river, conscientiousness is related to risk aversion.

Overall, “conscientiousness predicts job performance better than does any other big five factor, but not as well as IQ (r = .21; corrected r = .55).” These findings imply that more conscientious people will perform better than the less conscientious in all positions from the deck up to the wheelhouse. Clearly they are more likely to resist the temptation to take short cuts.

Agreeableness

The effect of agreeableness on job performance is smaller than that of conscientiousness and emotional stability (Nyhus and Pons 2005). But it seems likely that those inclined to be agreeable would follow safety rules and fit into the tow crew more.

Emotional Stability/ Neuroticism

According to Nyhus and Pons (2005), emotional stability predicts higher wages. Emotional stability has been shown by Hogan and Holland (2003) to predict job performance (r = .43 corrected for range restriction and reliability). This is true across all occupations, but it seems especially likely on board a towboat, where people must work and live together for a month at a time.

Section 4: Estimating the Future Demand for Waterways Transportation and Personnel

As reported, the Bureau of Labor Statistics (2012) predicts a substantial increase (above 20%) in the demand for waterborne occupations. Since they assume that the demand will be greater on the inland waterways, the best estimate is 25 percent for the inland waterways freight industry. The most straightforward method for estimating the future demand for mariners on the inland waterways—deckhands, mates, pilots, engineers, captains and others—is to assume a 25 percent increase over current levels of employment. Regrettably, a definitive count of the mariners working on towboats could not be obtained. Instead, there are varying estimates of total employment. The Bureau of Labor Statistics (BLS) has a specific employment category for inland water freight transportation, NAICS 483211. In that category it lists the average annual employment at 19,400 in 2010. This number is substantially smaller than the 30,000 plus employees said to be working on vessels by the American Waterways Operators.

It appears to be the case that the BLS excludes operators on the coasts. The Coast Guard tabulates the number of towboats and barges (see Table 4) and distinguishes between those on the Mississippi River System, which includes all rivers whose waters ultimately flow into the Mississippi, along with those on the Intracoastal waterways, and all other towboats and barges (see Table 5). As Table 4 shows, in 2010, there were 5,466 tow boats on all systems and 33,539 barges. In Table 5, we see that there were 3,561 towboats and 27,205 barges on the Mississippi River System and the Intracoastal waterways. The latter push the multi-barge tows on the inland rivers. Thus, a full 87 percent of all barges are on the Mississippi system and the Intracoastal waterways. On average, there are 7.6 barges per towboat on this system and only 2.2 barges per towboat on the other systems.

Table 4. Towboats and Barges on All Systems over Time and Percent Change 1990 to 2010

	On All Systems in 1990	On All Systems in 2000	On All Systems in 2010	% Change on All Systems from 1990 to 2010
Towboats	5,210	4,995	5,466	4.9%
Horsepower of Towboats	8,709,914	9,347,780	11,060,513	26.9%
Average Horsepower of Towboats	1,672	1,871	2,024	21.1%
Barges, Dry Cargo	29,287	27,342	26,816	-8.4%
Barges, Tanker	4,252	3,985	4,564	7.3%
Total Barges	33,539	31,327	31,380	-5.4%

Table 5. Number and Percent of All Towboats and Barges on the Mississippi River System and the Intracoastal Waterways in 2010

	Number on Mississippi and Intracoastal	% on Mississippi and Intracoastal
Towboats	3,561	65.2%
Barges, Dry Cargo	23,291	79.5%
Barges, Tanker	3,914	92.1%
Total Barges	27,205	81.1%

Tows can vary greatly in size from one or a few barges to 40 on the lower Mississippi River. Many tows are on the small rivers and upper Mississippi River. Even on the Ohio River, tows rarely exceed 15 barges and tows of tanker barges on the Intracoastal are limited to six barges. The necessity of tows with fewer barges on most river segments (as well as the fact that

there are only 7.6 barges per towboat) suggests that the average tow is probably between 10 and 15 barges. It also suggests that many towboats and barges are not on the river at any one time.

Table 6 estimates the number of employees needed to work the waterways based on the number of barges on the Mississippi River system and the Intracoastal waterways in 2010. The Coast Guard reported that the number of barges was 27,205. Assuming that only 70 percent of the barges are moving on the rivers and Intracoastal at any given moment, there would be 19,044 barges on the rivers. The number of employees needed to move the tows would be a function of the number of barges in the average tow. In Table 6,we provide estimates for average tow sizes of ten, twelve and fifteen barges. As the average tow size goes down, the number of tows on the rivers goes up and the number of employees working on the inland waterways increases. It also goes up with the average size of a crew, which we estimate as 8 crew members or 10 crew members. However, these numbers must be doubled because at any given moment half the workforce is on duty for approximately30 days and the other half is off-duty for same amount of time. Thus the number of employees needed is 16 or 20 for each active tow. The final estimate multiplies 16 or 20 by the estimated number of tows active on the rivers. We add 1000 employees to this because at any given moment, there will be towboats, supply boats, and other craft operating in the harbors in support of the various activities of the inland freight industry.

The estimates range from a low of 21,300 when the average tow is 15 barges and the total crew size 16 to a high of 39,080 when the average tow is 10 barges and total the crew size 20. Five of the six estimates are greater than 26,000, which suggests that the number of people working the rivers is closer to the AWO estimate of 30,000 than the Bureau of Labor Statistics estimate of 19,400.

Table 6: Estimated Number of Mariners in Workforce on the Mississippi River System and the Intracoastal Waterway in 2010 by Crew Size and Tow Size

% of 27,205 Barges Active in Tows on Rivers and Intracoastal	# of Barges Active in Tows on Rivers and Intracoastal	# of Barges in Average Tow	# of Active Tows on the Rivers	Total Crew Size (on duty and off Duty Combined)	Total Crew Needed to Serve on Tows	Total Workforce Assuming 1,000 More on Other Vessels	Total Workforce Assuming a 25% Increase by 2040
70%	19,044	10	1,904	16	30,464	31,464	39,330
70%	19,044	10	1,904	20	38,080	39,080	48,850
70%	19,044	12	1,587	16	25,392	26,392	32,990
70%	19,044	12	1,587	20	31,740	32,740	40,925
70%	19,044	15	1,270	16	20,320	21,320	26,650
70%	19,044	15	1,270	20	25,400	26,400	33,000

Thus, if the demand for inland mariners increases by 25 percent, the industry will employ (based on the AWO 30,000) approximately 37,500 in 2040. At least, 20 percent or 7,500 of the 37,500 will serve as captains and pilots and 3,750 as engineers—the rest as deckhands, mates, and cooks.

Ethnicity and the Percent Earning a High School Diploma

The ethnic composition of the nation and its workforce is changing with the large influx of Hispanic immigrants. We noted above that job candidates with high school diplomas are more likely to possess the cognitive abilities and personality traits that lead to occupational success in the various positions on the rivers. Unfortunately, Hispanics are less likely than Whites to obtain a high school diploma. As Table 7 indicates, only 59 percent of Hispanic males born in the United States have a high school diploma and those born outside the U.S. are even less likely to earn a diploma—50 percent. Moreover, dropout rates are rising, especially for males. Heckman and LaFontaine (2008) report the drop in graduation rates was 7 percent for males but only 1 percent for females. Heckman and LaFontaine conclude that the high school graduation rate peaked at around 80 percent in the late 1960s and then declined by 4-5 percentage points and that the actual high school graduation rate is substantially lower than the 88 percent completion rate estimated by the National Center for Education Statistics (NCES). One reason for the difference in the estimate of the rates is that the NCES counts people with a GED as high school graduates. This closes the gap between whites and minorities, as minority males are about twice as likely as

white males to possess a GED certificate. However, many pass the test while in prison, as 10 percent of all GEDs are issued to inmates.

Table 7: Percent with High School Diploma by Ethnicity

Ethnicity	All	Males
White	81	78
Black	66	61
Native Born Hispanic	63	59
Hispanic Immigrant		50

These declines in graduation rates will present some difficulties for the inland waterways. All else equal, high school graduates are preferable to dropouts with a GED and the latter are preferable to dropouts without a GED.

The Opportunity Provided by the Growing Number of Veterans Leaving the Military

Due to the military's selection practices, almost all veterans will possess a high school diploma and have measured levels of intelligence in the normal range. Moreover, they have successfully completed their tour of duty and have been accustomed to working in a dangerous and demanding environment. Tables 8, 9 and 10 show that there were more than 4.5 million veterans in the age range of 17 to 44. Since most tow crew members are male, we present the number of male and female veterans separately and combined. As military engagements appear to be declining and the defense budget is reduced, we can expect to see substantial growth in the number of veterans, especially growth in those in the age range of 17 to 44.

Table 8. Age Distribution of Male Veterans Based on VetPop2011 Estimate of 20,451,602 Male Veterans

Age Range	Percent of Male Veterans	Estimated Number of Male Veterans
17-24	1.3	265,871
25-34	5.8	1,186,193
35-44	9.4	1,922,451
45-54	14.1	2,883,676
55-64	24.3	4,969,739
65-74	21.7	4,437,998
75 and up	23.4	4,785,675

National Center for Veterans Analysis and Statistics

Table 9. Age Distribution of Female Veterans Based on VetPop2011 Estimate of 2,224,547 Female Veterans

Age Range	Percent of Female Veterans	Estimated Number of Female Veterans
17-24	4.2	93,431
25-34	16.8	373,724
35-44	20.3	451,583
45-54	26.0	578,382
55-64	16.7	371,499
65-74	6.3	140,147
75 and up	10.1	224,679

Table 10. VetPop 2011 Age Distribution of Male and Female Veterans Combined

Age Range	Male and Female in Age Range	Percent in Age Range	Cumulative Percent
17-24	359,302	1.58	1.58
25-34	1,559,917	6.88	8.46
35-44	2,374,034	10.47	18.93
45-54	3,462,058	15.26	34.19
55-64	5,341,238	23.55	57.74
65-74	4,578,145	20.18	77.92
75 and up	5,010,354	22.09	100.01
Total	22,685,048	100.01	

At this time, the ultimate number of uniformed military employees that will result from these changes is not known. But, it seems likely that, due to the federal budget sequester currently in effect, the cuts in uniformed personnel could be substantially greater than those in the budget proposal of 2012. To be sure, with the ongoing federal budget deficits and reduction in engagements, there are frequent calls for a return to the force levels of 2005 for the Army and Marine Corps. All four branches of the military either have or are expected to shrink from their peak levels. The President's proposal for the 2012 budget called for troop cuts by 2017 in the active duty Army of 27,000 and in the active duty Marine Corps of 20,000. The Navy and Air Force would have smaller cutbacks, but, as Table 11shows, they have downsized significantly since 2000, while the Army and Marine Corps increased their force level in response to the recent engagements. If the cuts go through as planned, the Army would have approximately 512,000 soldiers in 2017 and the Marines would have 176,000 on active duty.

Table 11. Active Duty Personnel by Military Branch in 2000, 2005, 2008, 2013

Branch	2000	2005	2008	2011	2012	Increase or Decrease 2000-2012	Percent Change 2000-2012
Army	482,000	493,000	544,000	565,000	539,000	+57,000	+11.8%
Marine Corps	173,000	180,000	199,000	201,000	196,000	+23,000	+13.3%
Air Force	356,000	354,000	327,000	333,000	333,000	-23,000	-6.7%
Navy	373,000	363,000	332,000	325,000	317,000	-44,000	-11.8%

The planned cutbacks in the armed forces will reduce Reserve and National Guard membership as well as that of active duty personnel. By the end of 2017, the Pentagon plans to cut 67,100 active, reserve and National Guard soldiers; 15,200 active and reserve Marines; while reductions in the active and reserve personnel in the Navy and Air Force would be smaller—8,600 and 1,700 respectively. This sums to a total reduction of 92,400 over a five year span or approximately an annual reduction in total force level of 18,500. In 2009, 296,505 individuals enlisted in the active military, reserves or National Guard. We can assume that approximately 295,000 will muster out of the military each year between now and the end of 2017. With the expected reductions added to the usual numbers who leave the military each year, we can expect that the annual number of veterans returning to civilian life will be, on average, in the vicinity of 313,000 each year through 2017.

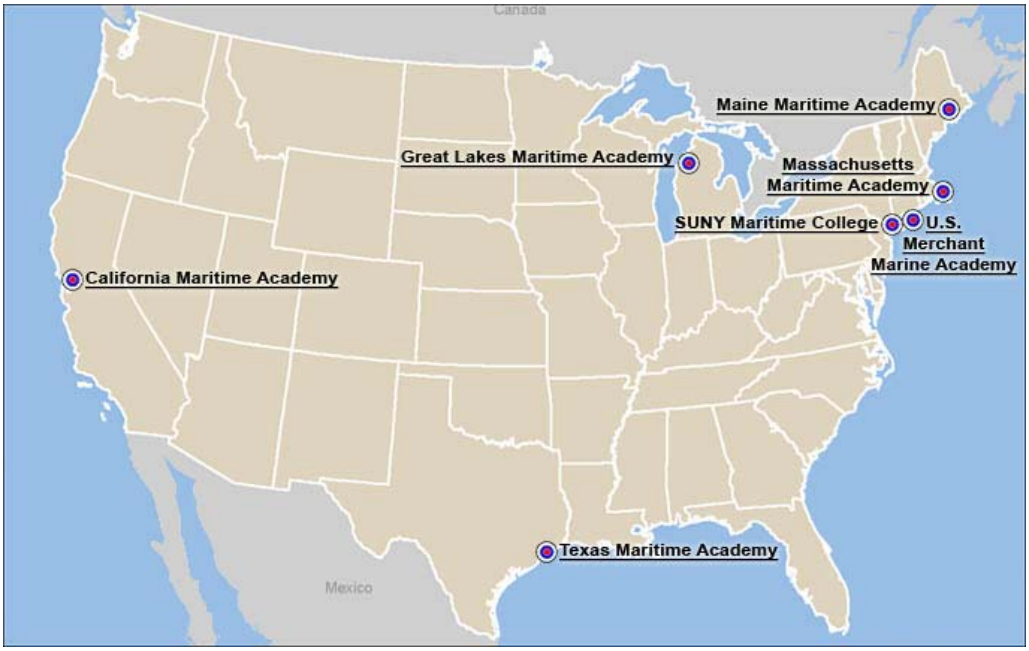
Section 5: Training Opportunities outside Employer-Operated Programs

Much of the training for the various occupations on the inland river system is provided by employers after employment. Some skills are acquired on the barges over time (e.g., the training of pilots); and much is acquired on shore during the lengthy time between stints on the water (e.g., fire-fighting, diesel repair, and first aid). But some training occurs at community colleges (e.g., cooks and engineers and to a lesser extent pilots and on shore personnel) and at various training centers that provide Coast Guard approved courses (e.g., radar and communications). With the projected shortage of pilots and captains, some barge companies are turning to the maritime academies for potential pilots. This section will offer brief descriptions of the training available from the maritime academies and the community colleges and will also offer a discussion on the role of simulators in the training of pilots.

Maritime Academies

There are seven maritime academies the United States: the US Merchant Marine Academy at Kings Point, NY and six regional academies (see Appendix3). These academies offer maritime degrees featuring a robust educational curriculum with hands-on maritime training. The schools are partially supported by the US Maritime Administration (MarAd), a modal unit of the US Department of Transportation (DOT). On par with the other military academies, the US Merchant Marine Academy is a federally funded institution. The six regional maritime academies are funded as state universities, with MarAd providing the funds for training vessels and equipment.

Figure 1: Location of Maritime Academies (Map from MarAd Website)



A. Maritime Curriculum

The primary curriculum at the maritime academies is focused on ocean going, blue water maritime training. The maritime academies have Great Lakes and inland waterways courses. However, most of the focus of these courses is on the Great Lakes and intra-costal waterways. Introductory courses are offered in tow and tug operations and barging operations. Students are allowed to take an inland waterway internship to meet a portion of their waterborne requirements. Logging internship time on the inland rivers is an option that is not as popular as blue water internships. Those who do take tow-tug internships usually work with intra-costal towing companies.

B. Academy Graduates

The maritime academies have two tracks of study relevant to the inland rivers—navigation and engineering. Graduates with an emphasis in navigation have the ability to reach the rank of captain very quickly. On blue water vessels, it may take only two years for an academy graduate to become a ship's captain. Given the local knowledge required, an academy graduate may have to spend two years as a steersman prior to being promoted to pilot on the inland rivers. It will then take several years as a pilot before becoming a captain. The time disparity in promotions for those working on blue water compared to the inland rivers is seen as a barrier to recruiting academy graduates for inland waterways.

Engineering graduates from the academies meet the criteria to immediately sit for their engineering licensures and certifications. Engineers working on blue water and Great Lake

vessels are required to hold a Coast Guard engineering license, situating engineering academy graduates in a position to quickly assume the role of chief engineer on an open water vessel. Certifications are not required for engineers on inland river tows. Without this requirement, employing certified engineers is a luxury for inland barge companies. For their part, academy engineers often find employment opportunities with inland barge carriers less lucrative than positions on blue water and Great Lake vessels.

C. Job Opportunities

Most academy graduates enter the blue water maritime industry after completing their education. However, with fewer American flagged vessels operating trans-ocean shipping routes, graduates are beginning to consider new employment options. Recently, academy graduates are being employed in the off-shore oil industry. The increase of oil production in the Gulf of Mexico requires pilots and captains for tender ships, supply vessels and platform navigation. Some academy graduates are given command of a ship in the Gulf within a year.

Graduates will need to seek job opportunities in other modes of maritime transportation as fewer blue water jobs exist. With the need for pilots and captains on the inland waterways, it is likely that more academy graduates begin to consider working in the barge industry. Inland barge companies are beginning to actively recruit maritime academy graduates. Given the needs of both academy grads and the barge industry, it is a possibility that the number of academy graduates on the inland waterways and gulf intra-coastal will increase in the near future.

D. Transitioning to the Inland Waterways Industry

Recently, the inland waterways industry has shown an interest in putting a greater emphasis on river navigation in the maritime academy curriculums, including internships on tows along the inland rivers. The interest in training a new generation of pilots and captains stems from the projected shortfall of pilots and captains on the inland waterways.

Advantages for Maritime Academy Graduates:

There are advantages for maritime academy graduates who choose to work in the inland waterways industry. Perhaps the biggest advantage is the work schedule. Most barge companies have a regular crew rotation, which results in crew members being on board a vessel about 7 months of each year. While the specific number of days fluctuates from company to company, the standard crew shift is approximately one month on the river followed by one month off the river. These regularly scheduled crew changes provide stability and consistency to life on shore. According to some barge industry human resource specialists, this work schedule is considered more desirable by academy graduates that have families.

Another advantage related to work schedule is the longevity of a career as a river pilot. Many pilots and captains navigating the inland waterways have long careers, while blue water captains have shorter careers. The long trips and intense workload – with some blue water

companies mandating 10 months a year aboard ship – tend to lead to higher turnover rates. With a more stable and moderate schedule on the inland rivers, pilots and captains have lower rate of turnover and longer careers.

Disadvantages for Maritime Academy Graduates:

While there are currently disadvantages to academy graduates taking employment on the inland rivers, the inland waterways industry is working to address those issues. Academy graduates may only spend a few months as deckhands, in an effort to learn shipboard operations. However, they will likely spend two years as a steersman before ascending to the pilot position. This time frame moves much slower than the promotion schedule for blue water navigation.

Historically, barge carriers recruited from states adjacent to inland rivers and required pilots and captains to live within driving distance of crew change sites. In recent efforts to attract new pilots and captains – especially from the maritime academies – barge companies are beginning to reconsider these internal requirements.

Advantages to Inland Barge Companies:

Attracting maritime academy graduates is advantageous to barge companies. Incorporating graduates into the industry creates a more educated workforce with greater diversity. The wheelhouse of inland tows are almost exclusively staffed with older white males. The academies have a large percentage of female students and more cultural diversity than current river tow crews.

Recruiting more maritime academy graduates will help to ensure that the industry is able to replenish the large number of pilots and captains that are reaching retirement age. The maritime academy educational experience reduces the training time for new employees to make the rank of pilot. This is important to meet the needs of future inland navigation workforce.

Community Colleges and Education Centers

Currently there are two community colleges that have maritime education programs focused on inland waterways – West Kentucky Community and Technical College (WKCTC) in Paducah, Kentucky and Mountwest Community and Technical College in Huntington, West Virginia. A few other maritime education centers offer college courses, such as Seattle Central Community College in Washington and Paul Hall Center for Maritime Education in Piney Point, Maryland. However these centers are focused on blue water training and education.

The two inland waterways focused community college programs are summarized below. (See appendix 2) for a complete list of curriculum requirements for each program. Many of the courses offered at WKCTC and Mountwest have the option to be taken online, in an effort to accommodate the on-river work schedule of most of the students.

West Kentucky Community and Technical College:

WKCTC offers an Associates of Applied Science (AAS) in marine technology, with the choice of three concentration clusters: (1) wheelhouse management, (2) marine engineering, and (3) marine logistics and operations. The program also offers maritime technology business and maritime industry certificates. The AAS curriculum consists of 15-18 hours of general core courses, 24 hours of technical maritime courses and 21-24 hours of courses in one of the three concentration tracks.

There are two categories of students in this program – students currently working on the rivers and land-side administrative staff. With many of the major US barge companies having a national or regional headquarters in Paducah, some administrative staff members who have not worked on the rivers enroll in the program to better understand the waterways industry.

WKCTC does not offer stand-alone Coast Guard certified training courses. The program is designed for degree seeking students, who must obtain their training courses for licensing elsewhere.

Mountwest Technical and Community College:

Mountwest offers an Associates of Applied Science (AAS) in transportation technology with an emphasis in maritime studies. This curriculum requires 15 hours of online core courses, 18 hours of online general transportation and logistics courses and a minimum of 21 hours of maritime training courses. Many of the maritime course requirements can be met with on-the-job training or time logged on the water and lead directly to a Coast Guard certification. Most students at Mountwest take the Coast Guard certification courses without being enrolled in the degree program.

Private Training Courses

The Coast Guard is the federal agency that regulates the training requirement and certification process for US mariners. While the Coast Guard issues the licenses, such as the steersman and pilots licenses, the requisite training courses are done by third party trainers. Both the trainers and the courses must be certified by the Coast Guard, which regulate course content to ensure it meets the requirements for a specific license. The third party trainers are often small private companies that offer a few Coast Guard certified courses (see appendix 3).

Role of Maritime Simulators in Waterways Training and Education

There are several types of maritime simulators for both blue water and inland waterways training. While this section focuses on the training role of simulators, it is important to note that maritime simulators play an important role in site design for bridges and ports. This allows site designers to ensure that pilots can safely navigate the channel without being impeded by bridge piers or dock structures.

A. Types of Inland Waterway Simulators

Maritime simulators generally fall into one of two categories - simulator instructional content and simulator technological capability. The form and function of each simulator varies based on the resources at an institute and the desired training outcome.

The most commonly used inland waterways simulators provide training content in four areas: navigation, radar, engine room, and tankerman. These simulators come in a variety of forms: full bridge simulation rooms, virtually augmented hands-on simulators, three dimensional wall projections, small multiple monitors simulators and single monitor computer training.

Navigation simulators have an important role in maritime training and education, allowing steersman, pilots and captains to train in a safe environment. The goal of simulator training and education is to allow pilots an opportunity to manage several repetitions of difficult scenarios in an effort to build the skills and confidence necessary to deal with actual problems on the rivers.

Simulators also provide a means for training and testing for required Coast Guard certifications. For example, river pilots are required to have a Coast Guard radar observation certification. Both training and testing for the licensing is conducted with the use of simulation software.

B. Seaman's Church Institute

The Seaman's Church Institute (SCI) has the only full mission simulator dedicated to inland waterways training in the country. SCI has simulator centers in Paducah, KY and Houston, TX. The Paducah location focuses on inland river navigation training, while the Houston location specializes in intracoastal navigation training and site design simulator work.

SCI Paducah has four full mission bridge simulators that are used to teach 'rules of the road' courses and is contracted by private barge companies to provide refresher courses for their current pilots. SCI is the benchmark for inland navigation training in the United States. In 2012, SCI used the simulator to train 609 individuals in advanced pilothouse management course work. SCI also trained 69 radar renewal participants and 16 mariners seeking Coast Guard certifications for promotion to mates and steersman. SCI has also lead 265 students through firefighting courses and training sessions. In total, SCI has conducted over 1,400 hours of inland waterway training courses.

Section 6: Conclusions, Implications, and Next Steps

In this study, we interviewed a wide range of individuals in the barge freight industry on the inland waterways and observed mariners at work and in training. We also interviewed instructors and various officials at community colleges and other institutions to obtain information on the skills needed to succeed in the various positions on the rivers. Two

conclusions are inescapable: (1) the rivers present a dangerous and cognitively challenging environment in which to work and (2) the jobs on the river are best filled by conscientious people who can work well with others and have sufficient cognitive ability to cope with the safety and other challenges that arise with some regularity.

We also observed that most promotions come from within, as the vast majority of employees start as deckhands and work their way into the more skilled and cognitively demanding positions. Clearly the jobs above deckhand require more cognitive ability and more capacity for leadership. Thus, only a subset of those who succeed as deckhands can move on to the more complex and difficult positions of mate, engineer, pilot or captain.

The industry faces a human resources crisis and must recruit more people who can make the transition to effective execution of the skilled positions. By 2040, it is predicted that the barge companies will need 25 percent more employees in each position. But it confronts a more pressing threat—the looming retirement of a large percentage of its current pilots and captains as they reach retirement age.

We reviewed the research on job performance that finds cognitive ability is the best predictor of job performance and especially so in the more complex jobs. Piloting a barge tow is a complex task and serving as a captain is even more so.

We noted the tendency for the less cognitively able to drop out of high school. Therefore, requiring applicants for a deckhand position to possess a high school diploma increases the likelihood that they will perform well as deckhands. It also increases the likelihood that some of them will be able to move into the higher skilled positions in the engine room and wheelhouse. The same is true of those with a GED. However, we observed that while dropouts with a GED are as cognitively able as those with a diploma who do not attend college, they tend to lack the personality traits, such as conscientiousness, emotional stability, and agreeableness, associated with job success. In short, when it comes to hiring a person likely to succeed at the entry level and subsequently at a higher level, a person with a high school diploma is preferable to a dropout with a GED and the latter is preferable to a dropout without a GED.

However, even a high school graduate may have below average cognitive ability, which is why the military relies on a test of cognitive ability to ensure that all its recruits have measured intelligence in the normal range or above. They also want a high school diploma. Combined, these two screening devices improve the odds for success in the armed forces. Thus, the average veteran with an honorable discharge is more likely to have the traits conducive to occupational success in the more complex occupations on the rivers. Given this reality, the industry can profit from finding new methods for reaching out to veterans, many of whom have little or no knowledge of the numerous benefits of a career on the inland rivers.

While most training is still provided by employers after employment, the industry is interested in hiring more people with training at the maritime academies and the community colleges. At present the training for the inland waterways is limited and the industry and the

educational institutions need to develop a more integrated approach in which employees and aspiring employees learn some skills in the schools and some at work in a structured sequence that improves training and expedites advancement. Employees who succeed in academic settings are more likely to possess the attributes both cognitive and personality-related to succeed in the higher level positions. Some companies are devising programs to recruit graduates of the maritime academies and fast track them into the steersman programs to become pilots. It may be possible to place some of this training into the academic programs, so that a new graduate would only need to spend one year after graduation rather than two to earn a pilot's license. The same is probably true for the career path for engineers. For their part, the community colleges could, with some development of their course offerings, play a greater role in training pilots and engineers. At this time, for instance, community college students appear to get few of the benefits from the use of sophisticated simulator programs such as the one at Seaman's Church Institute. In Europe, simulators are used to accelerate training of river pilots, an approach to training that seems applicable to the development of inland river pilots in the United States.

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Appendix 1

MOS, ASVAB Minimum Score, and Job Title for Positions in Clerical Field

(VE [Word Knowledge + Paragraph Comprehension] + Arithmetic Reasoning + Mathematics Knowledge)

MOS	Minimum ASVAB Score	Job Title
56M	CL 95	Chaplain's Assistant
71D	CL 110	Legal Specialist
71L	CL 95	Administrative Specialist
73C	CL 95	Finance Specialist
73D	CL 105	Accounting Specialist
75B	CL 95	Personnel Administration Specialist
75H	CL 95	Personnel Services Specialist
77F	CL 90 & OF 90	Petroleum Supply Specialist
88N	CL 100	Transportation Management Coordinator
91G	CL 95	Patient Administration Specialist
91J	CL 95	Medical Supply Specialist
92A	CL 95	Automated Logistical Specialist
92Y	CL 95	Unit Supply Specialist

MOS, ASVAB Minimum Score, and Job Title for Positions in Combat Field

(Arithmetic Reasoning + Coding Speed + Auto and Shop Information + Mechanical Comprehension)

MOS	Minimum ASVAB Score	Job Title
11B	CO 90	Infantryman
11C	CO 90	Indirect Fire Infantryman
11X	CO 90	Infantry Enlistment Option
11Z	N/A	Infantry Senior Sergeant
19D	CO 90	Cavalry Scout
19E	CO 90	M48/M60 Armor Crewman
19K	CO 90	M1 Armor Crewman
19Z	N/A	Armor Senior Sergeant
21B	CO 90	Combat Engineer
21C	CO 90	Bridge Crewmember

MOS, ASVAB Minimum Score, and Job Title for Positions in Electrical Field

(General Science + Arithmetic Reasoning + Math Knowledge + Electronics Information)

MOS	Minimum ASVAB Score	Job Title
13W	EL 95	Field Artillery Meteorological Crewmember
15N	EL 95	Avionic Mechanic
21Q	EL 95	Transmission and Distribution Specialist
21R	EL 95	Interior Electrician
25R	EL 110	Visual Information Equipment Operator Maintainer
27E	EL 110	Land Combat Electronic Missile System Repairer
27G	EL 95	Chaparral and Redeye Repairer
27M	EL 95	Multiple Launch Rocket System Repairer
27T	EL 100	Avenger System Repairer
27X	EL 110	Patriot Missile Repairer
31L	SC 90 and El 90	Cable Systems Installer Maintainer
31P	EL 110	Microwave Systems Operator – Maintainer
31R	EL100 & EL 100	Multichannel Transmission Systems Operator-Maintainer
35B	EL 110	Land Combat Support System Test Specialist
35D	EL 105	Air Traffic Control Equipment Repairer
35E	EL 110	Radio and Communication Security Repairer
35F	EL 105	Special Electronic devices Repairer
35H	EL 110	Test, Measurement and Diagnostic Equipment Support Specialist
35J	EL 110	Telecommunications Terminal Device Repairer
35L	EL 100	Avionic Communications Equipment Repairer
35M	EL 110	Radar Repairer
35N	EL 100	Wire Systems Equipment Repairer
35R	EL 100	Avionic Radar Repairer

35W	N/A	Electronic Maintenance Chief
35Y	EL 110	EL Integrated family of of test equimpment Operator and Maintainer
35Z	N/A	Senior Electronic Maintenance Chief
39B	EL 110	Automatic Test Equipment Operator and Maintainer
45G	EL 95	Fire Control System Repairer
91A	EL 110	Medical Equipment Repairer
96R	EL 85 & SC 95	Ground Surveillance Systems Operator

MOS, ASVAB Minimum Score, and Job Title for Positions in Field Artillery Field

(Arithmetic Reasoning + Coding Speed + Math knowledge + Mechanical Comprehension)

MOS	Minimum ASVAB Score	Job Title
13B	FA 95	Cannon Crewmember
13C	FA 95	Tactical Automated Fire Control Systems Specialist
13D	FA 100	Field Artillery Tactical Data Systems Specialist
13E	FA 95	Cannon Fire Direction Specialist
13F	FA 100	Fire Support specialist
13P	FA 100	Multiple Launch Rocket System Operations/ Fire Direction Specialist
13Z	N/A	Field Artillery Senior Sergeant

MOS, ASVAB Minimum Score, and Job Title for Positions in General Maintenance Field (General Science + Auto and Shop + Math Knowledge + Electronics Information)

MOS	Minimum ASVAB Score	Job Title
21D	GM 100, GT or ST 110	Diver
21E	GM 90	Heavy Construction Equipment Operator
21F	GM 90	Crane Operator
21G	GM 95	Quarrying Specialist
21H	GM 95	Construction Engineering Supervisor
21J	GM 90	General Construction Equipment Operator
21K	GM 90	Plumber
21M	GM 90	Firefighter
21N	GM 90	Construction Equipment Supervisor
21V	GM 90	Concrete and Asphalt Equipment Operator
21W	GM 90	Carpentry and Masonry Specialist
21X	N/A	General Engineering Supervisor
21Y	N/A	Topographic Engineering Supervisor
21Z	N/A	Combat Engineering Senior Sergeant
44B	GM 90	Metal Worker
44E	GM 100	Machinist
45B	GM 90	Small Arms/ Artillery Repairer
45D	GM 100	Self-propelled Artillery Turret Mechanic
45K	GM 100	Armament Repairer
52C	GM 100	Utilities Equipment Repairer
52D	GM100	Power Generation Equipment Repairer
52F	GM100	Turbine Engine Driven Generator Repairer
52X	N/A	Special Purpose Equipment Repairer

55D	GM105	Explosive Ordnance Disposal Specialist
57E	GM85	Laundry and Shower Specialist
77W	GM90	Water Treatment Specialist
88H	GM90	Cargo Specialist
91H	GM100	Optical Laboratory Specialist
92M	GM90	Mortuary Affairs Specialist
92S	GM85	Fabric Repair Specialist

MOS, ASVAB Minimum Score, and Job Title for Positions in General Technical Field (VE [Word Knowledge + Paragraph Comprehension] + Arithmetic Reasoning)

MOS	Minimum ASVAB Score	Job Title
18B	GT 110 & CO 100	Special Forces Weapons Sergeant
18C	GT 110 & CO 100	Special Forces Engineer Sergeant
18D	GT 110 & ST 100	Special Forces Medical Sergeant
18E	GT 100 & SC 100	Special Forces Communications Sergeant
18F	N/A	Special Forces Assistant Operations and Intelligence Sergeant
18Z	N/A	Special Forces Senior Sergeant
46Q	GT 110	Journalist
46R	GT 100	Broadcast Journalist
79R	GT 110	Recruiter NCO
79S	GT 110	Retention NCO (Active Component)
79T	GT 110	Recruiting and Retention NCO Army National Guard
79V	GT 110	Retention and Transition NCO R

MOS, ASVAB Minimum Score, and Job Title for Positions in Mechanical Maintenance Field (Numerical Operations + Auto and Shop + Mechanical Comprehension + Electronics Information)

MOS	Minimum ASVAB Score	Job Title
14E	MM 105	Patriot Missile System Enhanced Operator/Maintainer
14J	MM 100 & GT 100	Early Warning System Operator
15B	MM 105	Aircraft Powerplant Repairer
15D	MM 105	Aircraft Powertrain Repairer
15F	MM 105	Aircraft Electrician
15G	MM 105	Aircraft Structural Repairer
15H	MM105	Aircraft Pneudraulics Repairer
15J	MM 105 & EL 100	OH-58D Armament/Electrical/Avionics Systems Repairer
15K	N/A	Aircraft Components Repair Supervisor
15M	MM 105	Utility Helicopter Repairer
15R	MM 100	AH-64 Attack Helicopter Repairer
15S	MM 100	OH-58D Helicopter Repairer
15T	MM 105	UH-60 Helicopter Repairer
15U	MM 105	Medium Helicopter Repairer
15X	MM 100 & EL 105	AH-64AArmament/ Electrical Systems Repairer
15Y	MM 105 EL 100	AH-64D Armament /Electrical/Avionics repairere
45N	MM 100	M60A1/A3 Tank Turret Mechanic
62B	MM 90	Construction Equipment Repairer
63A	MM 100	M1 Abrams Systems Maintainer
63B	MM 90	Light Wheel Vehicle Mechanic
63D	MM 105	Artillery Mechanic

63G	MM 105	Fuel and Electrical Systems Maintainer
63H	MM 90	Track Vehicle Repairer
63J	MM90	Quartermaster and Chemical Equipment Repairer
63M	MM 105	M2/3 Bradley Fighting Vehicle System Repairer
63N	MM 100	M60A1/A3 Tank System Mechanic
63S	MM 105	Heavy-Wheel Vehicle Mechanic
63W	MM 90	Wheel Vehicle Mechanic
63Y	MM 105	Track Vehicle Mechanic
63Z	N/A	Mechanical Maintenance Supervisor
67G	MM 105	Utility Airplane Repairer
68J	MM 100 & EL 95	Aircraft Armament / Missile System Repairer
88K	MM 100	Watercraft Operator
88L	MM105	Watercraft Engineer
88P	MM 100	Railway Equipment Repairer
88T	MM90	Railway Section Repairer
88U	MM95	Railway Operations Crewmember

MOS, ASVAB Minimum Score, and Job Title for Positions in Operators and Food Field (VE [Word Knowledge + Paragraph Comprehension] +Numerical Operations + Auto and Shop + Mechanical Comprehension)

MOS	Minimum ASVAB Score	Job Title
3M	OF 105	Multiple Launch Rocket Systems Crewmember
14M	OF 90	Man portable Air defense Crewmember (R)
14R	OF 100	Bradley Linebacker Crewmember
14S	OF 90	Avenger Crewmember
14T	OF 100	Patriot Launching Station Enhanced Operator/Maintainer
14Z	N/A	Air Defense Artillery Senior Sergeant
88M	OF 90	Motor Transport Operator
91M	OF 100	Hospital food Service Specialist
92G	OF 90	Food Service Specialist

MOS, ASVAB Minimum Score, and Job Title for Positions in Surveillance and Communications (VE [Word Knowledge + Paragraph Comprehension] +Arithmetic Reasoning + Auto and Shop + Mechanical Comprehension)

MOS	Minimum ASVAB Score	Job Title
13R	SC 100	Field Artillery Firefinder Radar Operator
31C	SC 100 & EL 100	Radar Operator—Maintainer
31F	SC 105 & EL 105	Network Switching Systems Operator-Maintainer
31L	SC 90 & EL 90	Cable Systems Installer—Maintainer
31R	SC 100 & EL 100	Multi-channel Transmission Systems Operator - Maintainer
31U	SC 95 & EL 95	Signal Support Systems Specialist
31W	N/A	Telecommunications Operations Chief
31Z	N/A	Senior Signal Sergeant
74C	SC 90 & EL 90	Petroleum Supply Specialist
96H	SC 95 & ST 105	Common Ground Station Operator
96U	SC 105	Tactical Unmanned Aerial Vehicle Operator
96Z	N/A	Intelligence Senior Sergeant

MOS, ASVAB Minimum Score, and Job Title for Positions in Skilled Technical Field (VE [Word Knowledge + Paragraph Comprehension] + General Science + Mathematics Knowledge + Mechanical Comprehension)

MOS	Minimum ASVAB Score	Job Title
13S	ST 95	Field Artillery Surveyer
15P	ST 95	Aviation Operations Specialist
15Q	ST 100	Air Traffic Control Operator
21L	ST 85	Lithographer
21P	ST 110	Prime Power Production Specialist
21S	ST 95	Topographic Surveyor
21T	ST 95	Technical Engineering Specialist
21U	ST 100	Topographic Analyst
25M	ST 95 & EL 95	Multi-media Illustrator
25V	ST 95 & EL 95	Combat Documentation/ Production Specialist
31B	ST 95	Military Police
31D	ST 110	Criminal Investigation Special Agent
31E	ST 100	Corrections Specialist
33W	ST 115	Military Intelligence Systems Maintainer/ Integrator
37F	ST 105	Psychological Operations Specialist
38A	ST 100	Civil Affairs Specialist
55B	ST 100	Ammunition Specialist
74B	ST 100	Information Systems Operator-Analyst
74D	ST 95	Chemical Operations

		Specialist
74Z	N/A	Information Systems Chief
77L	ST 95	Petroleum Laboratory Specialist
91D	ST 95	Operating Room Specialist
91E	ST 95	Dental Specialist
91K	ST 110	Medical Laboratory Specialist
91P	ST 110	Radiology Specialist
91Q	ST 95	Pharmacy Specialist
91R	ST 100	Veterinary Food Inspection Specialist
91S	ST 105	Preventive Medicine Specialist
91T	ST 95	Animal Care Specialist
91V	ST 105	Respiratory Specialist
91W	ST 95	Healthcare Specialist
91X	ST 105	Mental Health Specialist
96B	ST 105	Intelligence Analyst
96D	ST 95	Imagery Analyst
96Z	N/A	Intelligence Senior Sergeant
97B	ST 105	Counter Intelligence Agent
97E	ST 95	Human Intelligence Collector
97L	ST 95	Translator/ Interpreter
97Z	N/A	Counter Intelligence/ Human Intelligence Senior Sergeant
98C	ST 105	Signals Intelligence Analyst
98G	ST 95	Cryptologic Linguist
98H	ST 95	Communications Locator/ Interceptor
98J	ST 105	Electronic Intelligence

		Interceptor/ analyst
98K	ST 95	Signals Collection / identifications Analyst
98XL	N/A	Signals/ Foreign Language Enlistment Option
98Z	N/A	Signals Intelligence Senior Sergeant

ASVAB and Marine Corp Jobs

MOS, ASVAB Minimum Score, and Job Title for Positions in Clerical Line Scores

(VE [Word Knowledge + Paragraph Comprehension] + Arithmetic Reasoning + Mathematics Knowledge)

MOS	Minimum ASVAB Score	Job Title
0121	CL 100	Personnel Clerk
0151	CL 100	Administrative Clerk
0161	CL 90	Postal Clerk
3043	CL 110	Supply Administration and Operations Clerk
3051	CL 90	Warehouse Clerk
3052	CL 80	Packaging Specialist
3112	CL 90	Traffic Management Specialist
3361	CL 90	Subsistence Supply Clerk
3432	CL 110	Finance Technician
3451	CL 110	Fiscal Budget Technician
6046	CL 100	Aircraft Maintenance Administration Specialist
7041	CL 100	Aviation Operations Specialist

MOS, ASVAB Minimum Score, and Job Title for Positions in General Technical Line Scores

(VE [Word Knowledge + Paragraph Comprehension] + Arithmetic Reasoning)

MOS	Minimum ASVAB Score	Job Title
0231	GT 100	Intelligence Specialist
0311	GT 80	Rifleman
0313	GT 90	LAV Crewman
0321	GT 105	Reconnaissance Man
0331	GT 80	Machine Gunner
0341	GT 80	Mortarman
0351	GT 80	Assaultman
0352	GT 90	Antitank Assault Guided Missileman
0411	GT 100	Maintenance Management Specialist
0431	GT 100	Logistics/Embarkation and Combat Service Support Specialist
0451	GT 100	Air Delivery Specialist
0481	GT 95	Landing Support Specialist
0511	GT 110	MAGTF Planning Specialist
0612	GT 90	Field Wireman
0811	GT 90	Field Artillery Cannoneer
0842	GT 105	Field Artillery Radar Operator
0844	GT 105	Field Artillery Fire Control Man
0847	GT 105	Artillery Meteorological man
0861	GT 100	Fire Support Man
1361	GT 100	Engineer Assistant
1812	GT 90	M1A1 Tank Crewman
1833	GT 90	Assault Amphibious Vehicle

2311	GT 100	Ammunition Technician
2542	GT 110	Communication Center Operator
2621	GT 100	Communications Signal Collection/Manual Morse Operator/ Analyst
2631	GT 100	Electronic Intelligence (ELINT) Intercept Operator Analyst
2651	GT 100	Class = “shaded” Special Intelligence system Administrator/Communicator
2671	GT 105	Arabic Cryptologic Linguist
2673	GT 105	Korean Cryptologic Linguist
2674	GT 105	Spanish Cryptologic Linguist
2676	GT 105	Russian Cryptologic Linguist
3381	GT 90	Food Service Specialist
4066	GT 110	Small Computer Systems Specialist
4067	GT 110	Programmer - ADA
4341	GT 105	Combat Correspondent
4611	GT 100	Combat Illustrator
4671	GT 100	GT 100
5711	GT 110	Nuclear, Biological and Chemical (NBC) Defense Specialist
5811	GT 100	Military Police
5831	GT 100	Correctional Specialist
6511	GT 105	Aviation Ordnance Technician
6531	GT 105	Aircraft Ordnance Technician
6541	GT 105	Aviation Ordnance Systems Technician
6821	GT 105	Weather Observor
7212	GT 90	Low Altitude Air Defense (LAAD) Gunner
7234	GT 105	Air Control Electronics Operator
7242	GT 100	Air Support Operations Operator

7251	GT 105	Air Traffic Controller
7257	GT 105	Air Traffic Controller
7314	GT 105	Unmanned Aerial Vehicle (UAV) Air Vehicle Operator
7371	GT 110	Aerial Navigator
7381	GT 110	Airborne Radio Operator/ Inflight Refueling Observer/Loadmaster

MOS, ASVAB Minimum Score, and Job Title for Positions in Electronics Line Scores

(General Science + Arithmetic Reasoning + Mathematics Knowledge + Electronics Information)

MOS	Minimum ASVAB Score	Job Title
0261	EL 100	Geographic Intelligence Specialist
0613	EL 90	Construction Wireman
0614	EL 100	Unit Level Circuit Switch (ULCS) Operator/Maintainer
0621	EL 90	Field Radio Operator
0622	EL 100	Mobile Multichannel Equipment Operator
0624	EL 100	High Frequency Communication Central Operator
0626	EL 100	Fleet SATCOM Terminal Operator
0627	EL100	Ground Mobile Forces SATCOM Operator
1141	EL 90	Electrician
1142	EL 100	Electrical Equipment Repair Specialist
2811	EL 115	Telephone Technician
2818	EL 115	Personal Computer (PC)/Tactical Office Machine Repairer
2822	EL 115	Electronic Switching Equipment Technician
2831	EL 115	Multichannel Equipment Repairer
2841	EL 115	Ground Radio Repairer
2844	EL 115	Ground Communication Organizational Repairer
2846	EL 115	Ground Radio Intermediate Repairer
2847	EL 115	Telephone Systems/personal Computer Intermediate Repairer
2871	EL 115	Test Measurement and Diagnostic Equipment Technician
2881	EL 115	Communication Security Equipment Technician
2887	EL 115	Counter Mortar Radar Repairer
5937	EL 105	Aviation Radio Repairer

5942	EL 105	Aviation Radar Repairer
5952	EL 105	Air Traffic Control navigation Aids Technician
5953	EL 105	Air Traffic Control Radar Technician
5954	EL 105	Air Traffic Control Communications Technician
5962	EL 105	Tactical data Systems Equipment Repairer
5963	EL 105	Tactical Air Operations Module Repairer
6311	EL 105	Aircraft Communications/Navigation/Electrical/Weapon Systems Technician
6312	EL 105	Aircraft Communications/Navigation/Weapon Systems Technician-AV-8
6314	EL 105	Unmanned Aerial Vehicle Avionics Technician
6316	EL 105	Aircraft Communications/Navigation Systems Technician KC-130
6317	EL 105	Aircraft Communications/Navigation/Weapon Systems Technician F/A-18
6322	EL 105	Aircraft Communications/Navigation/Electrical/Weapon Systems Technician CH-46
6323	EL 105	Aircraft Communications/Navigation/Electrical/Weapon Systems Technician CH-53
6324	EL 105	Aircraft Communications/Navigation/Electrical/Weapon Systems Technician U/AH-1
6326	EL 105	Aircraft Communications/Navigation/Electrical/Weapon Systems Technician V-22
6331	EL 105	Aircraft Electrical Systems Technician--Trainee
6332	EL 105	Aircraft Electrical Systems Technician—AV-8
6333	EL 105	Aircraft Electrical Systems Technician—EA-6
6336	EL 105	Aircraft Electrical Systems Technician--KC-130
6337	EL 105	Aircraft Electrical Systems Technician—F/A-18
6386	EL 105	Aircraft Electronic Countermeasures Systems Technician-EA-6B

MOS, ASVAB Minimum Score, and Job Title for Positions in Mechanical Maintenance Line Scores

(Numerical Operations + Auto & Shop Information + Mechanical Comprehension + Electronics Information)

MOS	Minimum ASVAB Score	Job Title
1161	MM 105	Refrigeration Mechanic
1171	MM 85	Hygiene Equipment Operator
1181	MM 85	Fabric Repair Specialist
1316	MM 95	Metal Worker
1341	MM 95	Engineer Equipment Mechanic
1345	MM 95	Engineer Equipment Operator
1371	MM 95	Combat Engineer
1391	MM 85	Bulk Fuel Specialist
2111	MM 95	Small Arms Repairer Technician
2131	MM 95	Towed Artillery Systems Technician
2141	MM 105	Assault Amphibious Vehicle Repairer/ Technician
2146	MM 105	Main Battle Tank Repairer/ Technician
2147	MM 105	Light Armored Vehicle Repairer Technician
2161	MM 105	Machinist
2171	MM 105	Electro-Optical Ordinance Repairer
3521	MM 95	Organizational Automotive Mechanic
3531	MM 85	Motor vehicle Operator
3533	MM 85	Logistics Vehicle Operator
6048	MM 105	Flight Equipment Technician
6061	MM 105	Aircraft Intermediate Level hydraulic/ Pneumatic Mechanic
6071	MM 105	Aircraft Maintenance Support Equipment Mechanic
6072	MM 105	Aircraft Maintenance Support Equipment Hydraulic/ Pneumatic Structures Mechanic

6073	MM 105	Aircraft Maintenance Support Equipment Electrician/ Refrigeration Mechanic
6074	MM 105	Cryogenics Equipment Operator
6091	MM 105	Aircraft Intermediate Level Structures Mechanic
6092	MM 105	Aircraft Intermediate Level Structures Mechanic
7011	MM 95	Expeditionary Airfield Systems Technician
7051	MM 95	Aircraft Firefighting and Rescue Specialist

Appendix 2

West Kentucky Community and Technical College
Paducah, KY

Marine Technology

Source: http://westkentucky.kctcs.edu/en/academics/academic_divisions/at/marine_technology.aspx

Program Requirements:

CORE COURSES

Computer Literacy 0-3
ENG 101 Writing I.....3
MAT 116.....Technical Mathematics.....3
GEO 251 Weather and Climate.....3
GEN 140 Development of Leadership.....3
Heritage/Humanities/Foreign Language.....3

TECHNICAL CORE COURSES

MRN 100 Introduction to Marine Technology.....3
MRN 101 Anatomy of a Towboat.....3
MRN 102 Basic Marine Safety.....3
MRN 199.....Co-Op Experience I.....6
MRN 299 Co-Op Experience II.....6
BA 160 Introduction to Business.....3

Concentrations Track Options

WHEELHOUSE MANAGEMENT

MRN 200 Shipboard Deck Operations.....3
MRN 201 Rules of the Road.....3
MRN 202 Piloting and Navigation.....3
MRN 203 Environmental Protection Rules.....3
BA 274 Human Resources Management.....3
BA 283 Principles of Management.....3
BA 293 Principles of Finance.....3

MARINE ENGINEERING

MRN 204 Marine Electrical Systems I.....3
MRN 205 Marine Electrical Systems II.....3
MRN 206 Marine Diesel I.....3
MRN 207 Marine Diesel II.....3
FPX 100 Fluid Power.....3
FPX 101 Fluid Power Lab.....2
ACR 100 Refrigerator Fundamentals.....3
ACR 101 Refrigerator Fundamentals Lab.....2

MARINE LOGISTICS AND OPERATIONS

BA 283 Principles of Management.....3
BA 293 Principles of Finance.....3
BA 289 Operations Management.....3
MRN 208 Inland River Systems 3
MRN 209 Applied Marine Operations.....3
MRN 210 Intermodal Transportation.....3
CJ 210 Physical Security Technologies & Systems.....3

Certificate Programs

MARINE TECHNOLOGY BUSINESS

Computer Literacy.....0-3
BA 160 Introduction to Business.....3
BA 283 Principles of Management.....3
BA 293 Principles of Finance.....3
BA 289 Operations Management.....3
MRN 208 Inland River Systems.....3
MRN 209 Applied Marine Operations.....3
MRN 210 Intermodal Transportation.....3

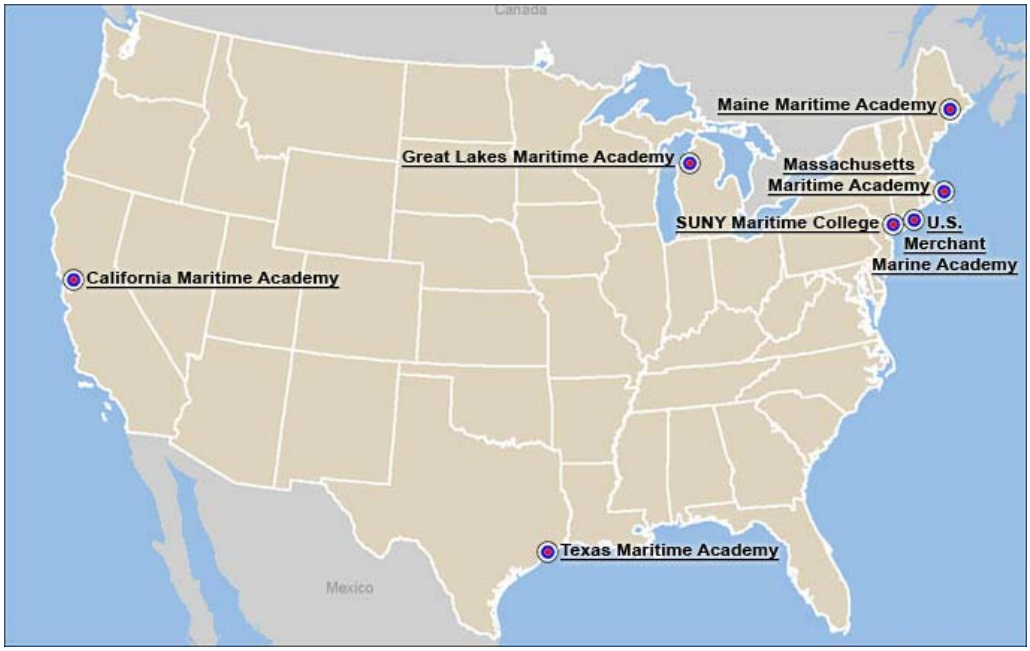
MARINE INDUSTRY

Computer Literacy.....0-3
MRN 100 Introduction to Marine Technology.....3
MRN 101 Anatomy of a Towboat.....3
MRN 102 Basic Marine Safety.....3
MRN 203 Environmental Protection Rules.....3
MRN 208 Inland River Systems.....3

Total.....15-18

Appendix 3

Maritime Academies



(Map from MARAD Website)

California Maritime Academy
200 Maritime Academy Drive
Vallejo, CA 94590
(707) 654-1000
http://www.csum.edu/

Great Lakes Maritime Academy
1701 East Front Street
Traverse City, Michigan 49686
(877) 824-7447
http://www.nmc.edu/maritime/

Maine Maritime Academy
Pleasant Street
Castine, ME 04420-5000
(800) 464-6565 (In state)(
800) 227-8465 (Out of State)
http://www.mainemaritime.edu/

Massachusetts Maritime Academy
101 Academy Drive
Buzzards Bay, MA 02532
(508) 830-5000
http://www.maritime.edu/

SUNY Maritime College
6 Pennyfield Avenue
Throggs Neck, New York 10465
(718) 409-7200
http://www.sunymaritime.edu/

Texas Maritime Academy
P.O. Box 1675
Galveston, Texas 77553
http://www.tamug.edu/corps/index.html

US Merchant Marine Academy

Location: Kings Point, New York
Website: http://www.usmma.edu/
Affiliations: US Maritime Administration, US Department of Transportation
Enrollment: 1,000 Midshipmen

Degree(s): Bachelors of Science (B.S.)

Majors:
Marine Transportation
Maritime Operations and Technology
Logistics and Intermodal Transportation
Marine Engineering
Marine Engineering Systems
Marine Engineering and Shipyard Management

Core Curriculum:
Mathematics, Science, English, Leadership and Ethics, Comparative Literature and History, Naval Science, Physical Education and Ship's Medicine, Internship, Sea Year

Certificates/Licensing:
Merchant Marine Officer Licensing from USCG
Military Training; Eligible for Armed Forces Reserve Commission

Accreditation:
Middle States Association of Colleges and Schools
Engineering Accreditation Commission (EAC) of ABET

Global Maritime and Transportation School (GMATS)

Location: Kings Point, New York (at USMMA)
Website: http://gmats.usmma.edu/

Affiliations: US Maritime Administration, US Department of Transportation
Enrollment: 4,000 program participants

Degree(s): Continuing Education and Professional Development Programs

Program Divisions:
Nautical Science
Engineering Programs
Security & Transportation
Research & Special Projects
Military Training
Technology Training

Certificates/Licensing:
Merchant Marine Officer Licensing from USCG
Military Training; Eligible for Armed Forces Reserve Commission

Accreditation:
Middle States Association of Colleges and Schools
Engineering Accreditation Commission (EAC) of ABET

Great Lakes Maritime Academy

Affiliations:
Northwestern Michigan College (NMC)
US Maritime Administration

Location: Traverse City, MI
Website: http://www.nmc.edu/maritime/

Degrees:
Associate in Applied Science (NMC)
Bachelors of Science in Business Administration (Ferris State University/NMC University)

Occupational Specialty Programs:
Maritime Deck Officer (AAS-NMC; BS Ferris State University)
Maritime Engineering Officer (AAS-NMC; BS Ferris State University)
Power Plant Facilities Operator (AAS)

California Maritime Academy

Affiliations:
California State University
US Maritime Administration

Location: Vallejo, CA
Website: http://www.csum.edu/

Degrees:
Business Administration /International Business and Logistics (BS)
Facilities Engineering Technology (BS)
Global Studies and Maritime Affairs (BA)
Marine Engineering Technology (BS)
Marine Transportation (BS)
Mechanical Engineering (BS)

*All majors include U.S. Coast Guard-issued unlimited license

Maine Maritime Academy

Affiliations:
US Maritime Administration

Location: Castine, ME
Website: http://www.mainemaritime.edu/

Majors:
Marine Engineering Operations
Marine Engineering Technology
Marine Systems Engineering - License Track
Marine Systems Engineering - Non-license Track
Power Engineering Technology
Power Engineering Operations
Marine Transportation Operations
Vessel Operations & Technology
Small Vessel Operations
Small Craft Design
Small Craft Systems
International Business & Logistics
Marine Biology
Marine Science (with Secondary Education Teaching Certification Option)
Marine Biology and Small Vessel Operations (5 year)
Marine Science and Small Vessel Operations (5 year)

Massachusetts Maritime Academy

Affiliations:
US Maritime Administration

Location: Cape Cod/Buzzards Bay, MA
Website: http://www.maritime.edu/

Degrees: B.S. and M.S.
- Energy Systems Engineering
- Emergency Management
- Facilities Engineering
- International Maritime Business
- Marine Engineering
- Marine Safety & Environmental Protection
- Marine Transportation

Graduate Programs (M.S.):
- Emergency Management
- Facilities Management

SUNY Maritime College

Affiliations:
State University of New York
US Maritime Administration

Location: Throggs Neck, NY
Website: http://www.sunymaritime.edu/

Degrees:
Associates in Applied Science
Marine Technology/Small Vessel Operation –Limited Deck License or Limited Engine License

Bachelors of Engineering
Electrical Engineering - Deck License
Electrical Engineering – Engine License
Electrical Engineering – Intern Option
Facilities Engineering – Engine License
Facilities Engineering – Intern Option
Marine Engineering –Engine License
Mechanical Engineering – Engine License
Mechanical Engineering – Intern Option
Naval Architecture – Deck License
Naval Architecture – Engine License
Naval Architecture – Intern Option

Bachelors of Science
International Transportation & Trade – Intern Option
International Transportation & Trade / Intermodal and Maritime Security Minor – Intern Option
Marine Business and Commerce with a Humanities Study Area Concentration – Deck License
Marine Environmental Science / Marine Biology Minor– Deck License
Marine Environmental Science / Marine Biology Minor– Intern Option
Marine Environmental Science / Meteorology & Oceanography Minor– Deck License
Marine Environmental Science / Meteorology & Oceanography Minor – Intern Option
Marine Operations –Deck License
Marine Operations –Engine License
Marine Transportation –Deck License
Marine Transportation / Ship Management Minor –Deck License
Maritime Studies –Intern Option

Master of Science
International Transportation Management
International Transportation Management / Graduate License Program – Deck License
International Transportation Management / Supply Chain Management Certificate

Texas Maritime Academy

Affiliations:
Texas A&M University at Galveston
US Maritime Administration

Location: Galveston, TX
Website: http://www.tamug.edu/corps/index.html

Degrees:
Undergraduate Programs:
Marine Biology - biological sciences with ocean emphasis
Marine Sciences - oceanography, marine chemistry, marine geology
Marine Engineering Technology - electro/mechanical engineering
Marine Transportation - ship operations
Marine Fisheries - aquaculture, mariculture
Maritime Systems Engineering - ocean/civil engineering
Maritime Administration - international trade, port operations
Maritime Studies - liberal arts, nautical archaeology
University Studies - maritime policy and pre-law
Ocean and Coastal Resources - environmental marine sciences

Graduate Programs:
Marine Biology - Masters (thesis and non-thesis) and Ph.D.
Master of Marine Resources Management (MARM)
Master of Maritime Administration and Logistics (MMAL)