

Educational Competencies for Marine Science and Technology Occupations

*Marine Advanced Technology Education (MATE)
Center*



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1. The MATE Center

The Marine Advanced Technology Education (MATE) Center is a national partnership of educational institutions, businesses, government agencies, and other organizations working to improve marine technical education, and meet the workplace needs of the marine-related workforce and employers in the U.S. Headquartered at Monterey Peninsula College in Monterey, California, the MATE Center is one of sixteen Advanced Technological Education (ATE) Centers established with funding from the National Science Foundation's ATE Program.

The MATE Center is national in scope, but works through regional partnerships. With its partners, the MATE Center collects information from practicing marine technicians, employers, and educators, creates new curricula, and implements new methods for improving marine technology education.

We welcome questions, comments, and suggestions on this publication and on other aspects of the MATE Center. Please visit the MATE Center's web site and use the comment boxes there to give your comments on the MATE Center's products and services.

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2. Acknowledgements

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3. Introduction

A. An Overview of the MATE Center Strategy for Improving the Marine Technical Workforce

One of the major tasks of the MATE Center is to identify and define marine technical occupations, and the abilities that men and women need in order to perform well in these occupations. The major product that results from this work is a set of occupational knowledge and skill guidelines (KSGs) for technical marine occupations. These guidelines describe what workers need to know and be able to do in order to perform their jobs well. The KSGs are different for each occupation. The KSGs developed by the MATE Center include those for marine technicians, remotely operated vehicle (ROV) technicians, hydrographic survey technicians, aquarists, and aquaculture technicians. More information on these KSGs can be found at: <http://www.marinetech.org/marineworkforce>

The KSGs have been used to identify requirements, or competencies, that are common to two or more occupations. These competencies have then been grouped into educational subject areas in order to facilitate the efficient development of educational materials and programs that are based on occupational requirements. The competency areas developed so far include: safety and seamanship, computer systems, data processing, technical writing, oceanography, meteorology, marine biology, navigation, hydraulic equipment, electronics, surveying, submersibles, and geographic information systems (GIS). These competencies are contained in section 4 of this publication.

The competencies are a critical link between the workplace and the classroom, since they connect job requirements to educational subject areas. The competencies are the basis for the development of instructional materials, starting with assessments based on the competencies, and instructional modules based on the assessments. Assessments and modules are under development for a number of the competency areas listed above. The instructional materials are the foundation for MATE Center courses, student internships, and faculty development workshops, described in more detail at the MATE Center web site (<http://www.marinetech.org>).

A key element of all of these products is that they are based on KSGs that have been identified and validated by practicing marine technicians through workshops and surveys conducted by MATE Center staff. Educators then implement the KSGs, by way

skill (**skil**) *noun*

1. Proficiency, facility, or dexterity that is acquired or developed through training or experience.
2. **a.** An art, a trade, or a technique, particularly one requiring use of the hands or body. **b.** A developed talent or ability: *writing skills*.¹

from the American Heritage Dictionary of the English Language, Third Edition
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of the competencies, as they develop the MATE Center’s instructional materials, courses, and educational and career management programs. The overall process is shown in the accompanying flow chart (Fig. 1). This chart can also be found in an interactive form at the MATE Center web site (<http://www.marinetech.org/about/strategy.html>)

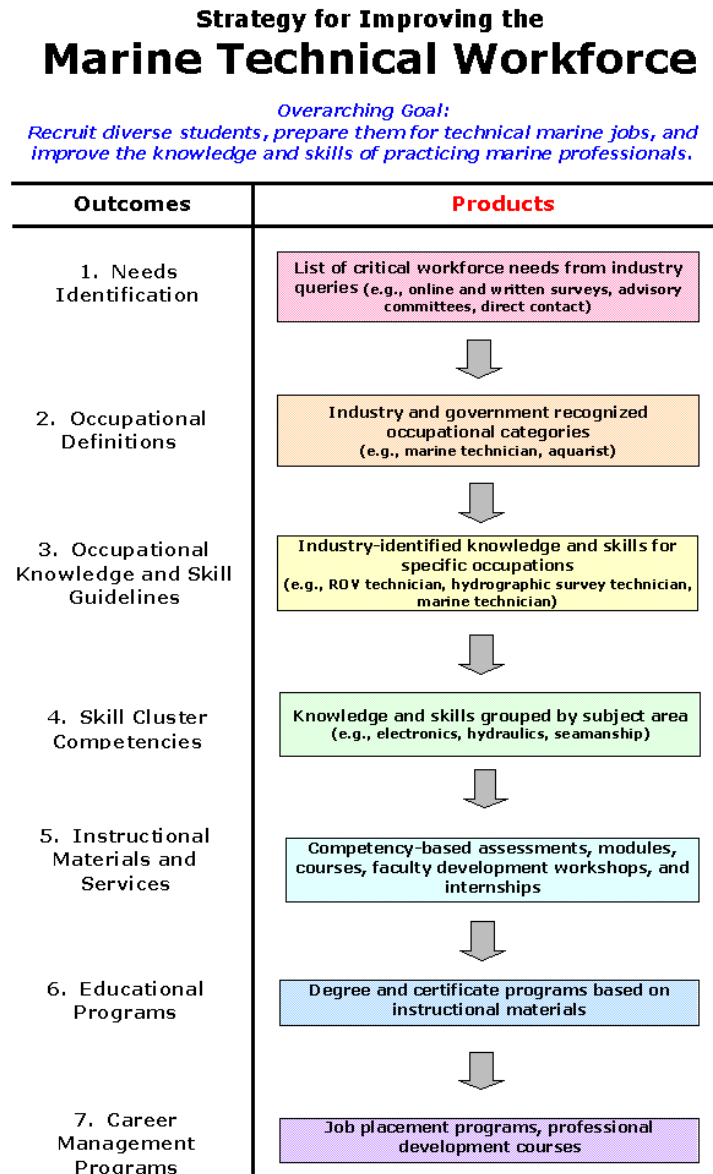


Figure 1. The MATE Center strategy for improving the marine technical workforce has seven major steps.

One of the MATE Center’s main goals is to create a foundation for marine technology education programs at a number of colleges across the country. This foundation will help align the different programs along a common set of employment based KSGs and competencies. This alignment will form the basis for a national network of certified MATE colleges. It will also help improve the communication between students,

educators, practicing technicians, and employers by providing common concepts and terminology for discussing how to improve marine advanced technology education.

B. The Process for Developing Competencies

1. Preliminary Steps

The process of developing a marine technical workforce that is well prepared for employment in marine technology occupations requires collaborating with a wide range of people and organizations. This involves working with practicing marine technicians, employers, and government agencies to identify and define existing and future occupations within marine technology, and to estimate the demand for people to work in these occupations. (See steps 1 and 2 of Fig. 1). The next step involves working closely with practicing technicians to identify the knowledge and skills needed to work in specific occupations (step 3 in Fig. 1). The results of this step are knowledge and skill guidelines (KSGs) for specific occupations. KSGs are also referred to by some authors as occupational guidelines, occupational standards, or skill standards.

To develop KSGs, the MATE Center uses procedures similar to those outlined in the Skill Standards Guidebook I developed by the Washington State Board for Community and Technical Colleges and others². In brief, we select a marine occupation based on responses to employer surveys, other labor market information, and the advice of experts in the field. A highly structured workshop is then conducted with a group of eight to twelve invited technical professionals who work in, or are otherwise very involved in, the selected occupation. The type of workshop we use is often called a modified developing a curriculum (DACUM) workshop --- or simply, a DACUM¹. The technical professionals work with a trained facilitator for one to two days to carefully define the job functions and tasks associated with the selected occupation. The information gathered during the workshop is used to develop draft guidelines that are then sent out for review and validation to dozens of technical professionals, representing large and small organizations from the public and private sector.

¹ Norton, R.E. 1996. DACUM Handbook. Center on Education and Training for Employment, College of Education, The Ohio State University, 1900 Kenny Road, Columbus, Ohio 43210

2. Identifying Competencies

The next step is to identify job requirements that are common to two or more occupations, and to link job requirements to educational subject areas (step 4 in Fig.1). The results of this step are the competencies.

The competencies are based on the MATE Center's KSGs and on a wide range of other resources. Existing occupational guidelines or skill standards developed by other organizations are especially useful supplements to the MATE Center's KSGs. Some of these organizations include other advanced technology education (ATE) centers, the U.S. Navy, and the International Hydrographic Organization. Guidelines and standards developed by organizations that are not specifically linked to marine technology can be very useful, especially in more general educational subject areas (e.g., computer systems, technical writing).

Position descriptions and job announcements are also very useful in identifying competencies. Descriptions for very different positions often list very similar qualifications, especially for the more fundamental qualifications. Existing teaching materials are also a good resource for developing competencies. Many course outlines, syllabi, and assessments contain elements of occupational competencies. This includes the material for both technical and academic courses taught at colleges and universities, technical schools (e.g., those run by the U.S. Navy), on the job courses, and courses taught by equipment manufacturers. A different set of resource materials was available for each competency area. These materials we used for each competency list are given in the references section at the end of each list (see section 4).

3. Competency Levels

Within each educational subject area, there is a wide a range of competencies, from the most elementary to the most advanced. For employees whose specializations lie within a competency area, a higher level of competency would be expected in that area. But outside that specialization, the expectations would generally be lower. For example, someone whose specialty is electronics might be expected to have a high level of competency in electronics, an intermediate level of competency in computer systems, and a basic level of competency in safety and seamanship. To account for these different expectations, we have defined three levels of competency, described below.

A. Basic Competencies - Skills most potential employees would be expected to possess.

Basic competencies address the most fundamental knowledge and skills. These fundamentals are typically learned in introductory courses or very early in a marine technician's career. An example of a basic competency from electronics is:

“Describe the differences between ac and dc voltage and current.”

B. Intermediate Competencies - Skills many potential employees would be expected to possess.

Intermediate competencies typically address the practical applications of basic competencies (skills) that employers are looking for. Intermediate competencies commonly involve applying more advanced knowledge and performing more advanced tasks. Intermediate competencies are generally gained by specializing as a student in that competency (e.g., electronics), or by 1-5 years of on-the-job experience. An example of an intermediate competency from electronics is:

“Conduct preventative maintenance on major electronic systems.”

C. Specialized Competencies - Skills some potential employees would be expected to possess.

Specialized competencies are typically acquired through advanced degrees, or by five or more years of work experience. An example of an advanced electronics competency is:

“Conduct calibration of sensitive test and operational equipment. Administer calibration laboratory.”

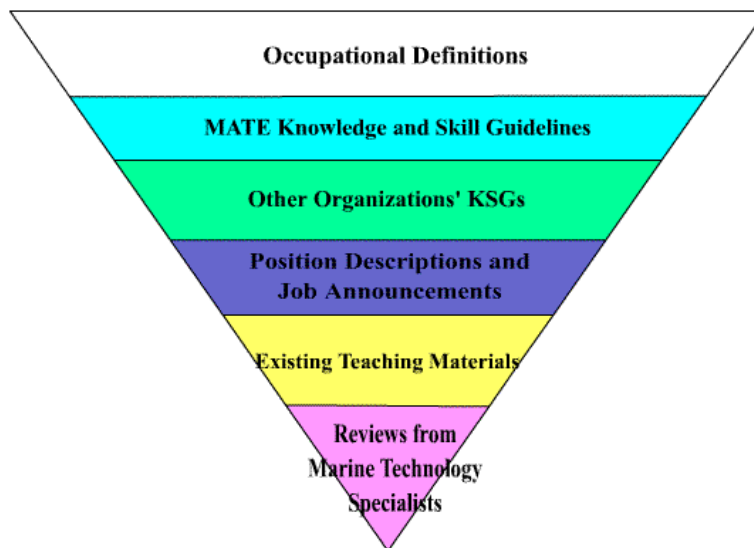


Figure 2. Information used to develop competencies.

<p>Basic Competencies: Fundamental abilities typically gained in beginning coursework and/ or OJT. Expected of most employees</p>
<p>Intermediate Competencies: Abilities typically acquired in advanced coursework or substantial OJT. Expected of many employees.</p>
<p>Specialized Competencies: Advanced abilities typically gained through major work experience, OJT, advanced coursework, and/or advanced degrees. Expected of some employees</p>

Figure 3. The three competency levels.

4. Review of the Competencies

Once a draft competency list is developed, it is reviewed by professionals working in the competency area. Their comments are then used to produce a draft for further review and circulation. At the end of this review process, the competencies are ready to be used in the development of instructional materials and services (see Fig. 1). However, we continually revise the competencies as new information and the comments of users come in.

C. Using the Competencies

These competencies are currently being tested and used by MATE staff, partners,, practicing technicians, employers, educators, and students. They are being extensively used by the MATE staff, partners, and education consultants to develop new teaching materials and improve existing materials. These competency-based materials will form the foundation for MATE-certified educational courses and programs. The competencies are also being used as guidelines for developing continuing education programs for practicing technicians. Marine technology students and their faculty advisors are using the competencies to help students evaluate their qualifications for different occupations, and to prepare themselves for work in different fields. As the competencies are tested and used, feedback is being collected and used to improve the competencies. This feedback is also being used to improve the process of developing new competencies

4. Competencies

Safety and Seamanship Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Demonstrate basic swimming skills.
2. Identify basic factors required for safe and efficient operation of vessels.
3. Safely handle and secure equipment and supplies at sea. Understand basic loading (stability) principles.
4. Identify critical environmental factors affecting vessel operations.
5. Safely operate small boats (12 meters and under) in near shore waters (within 5 kilometers of shore). Conduct emergency outboard motor troubleshooting.
6. Use proper marine communications procedures in both routine and emergency situations.
7. Demonstrate personal at-sea emergency procedures, including operation of personal safety and survival equipment.
8. Participate in basic vessel familiarization and safety drills (e.g., crew member overboard, collision, and fire emergency procedures).
9. Perform first aid, CPR, and other basic emergency medical procedures on the water.
10. Demonstrate basic vessel fire prevention and fire fighting techniques.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Exercise vessel watch keeping procedures and protocols for mission-related watch and/or lookout functions.
2. Identify basic vessel construction materials and maintenance procedures.
3. Describe basic marine propulsion systems strengths and limitations, and the main factors that affect their efficient operation.
4. Describe basic techniques for handling vessels over 12 meters in length.
5. Identify basic environmental factors affecting vessel operations (e.g., winds, waves, currents, tides, bottom topography) and procedures for mitigating the impacts of these factors.
6. Operate marine communications equipment. Demonstrate advanced communications procedures, including advanced emergency communications.

7. Apply group emergency procedures. Operate group safety and survival equipment.
8. Demonstrate knowledge of basic damage control techniques.
9. Identify pollution control regulations, dumping procedures, and methods for handling hazardous materials.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Oversee the operations of large vessels (e.g., handling and stowing of supplies, equipment, and cargo; vessel maintenance; crew and passenger organization and safety; emergency drills and training; legal requirements: shore support).
 2. Calculate vessel stability.
 3. Calculate vessel fuel use and efficiency.
 4. Demonstrate knowledge of special-purpose vessel operational strengths and limitations.
 5. Safely handle vessels with auxiliary equipment overboard (e.g., ROVs and other submersibles, towed arrays).
 6. Navigate vessels using dynamic positioning and computer aided control systems.
 7. Participate in vessel design, construction, maintenance, and repair.
 8. Organize multiple vessel operations in international settings, including coordinating multi-party emergency response.
 9. Oversee damage control party. Employ advanced damage control techniques.
 10. Oversee emergency medical response drills and operations.
 11. Demonstrate knowledge of national and international laws and agreements affecting vessel operations.
 12. Oversee shore support for marine operations, including legal and crewing requirements.
-

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.

3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1997; Standard of Competence for Hydrographic Surveyors - Guide Notes and Syllabi for Education and Training Programs (Eighth Edition,), The International Hydrographic Bureau, 4, quai Antoine ler, B.P. 445, Monaco, MC 98011 Cedex, MONACO 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
6. U.S. Navy Training Manual, Seaman (NAVEDTRA).
7. U.S. Navy Personnel Qualifications Standards for Deck Seaman, NAVEDTRA.

Computer Systems Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Identify computer components, peripherals and connections.
2. Trace data flow through hardware for basic computer operations and hardware troubleshooting.
3. Perform routine preventative maintenance (e.g., clean keyboard, ensure proper air flow, change printer cartridges, etc.).
4. Manipulate files on Win32, DOS, UNIX and MacOS machines. Understand fundamental differences among operating systems.
5. Demonstrate a working knowledge of commonly used email applications, word processors and spreadsheets.
6. Complete data entry tasks with minimum error.
7. Identify environmental conditions that will adversely affect computer operation and take appropriate mitigating measures (e.g. dust, high seas, high humidity, high temperatures).
8. Back up data using incremental back-up techniques on multiple media (e.g., CD, tape, diskette, and other common proprietary devices like Zip™ or Jaz™ drives).
9. Perform basic software troubleshooting.
10. Prepare hardware for shipping.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Perform advanced hardware troubleshooting (e.g., swapping boards, changing cables).
2. Upgrade existing hardware and install new hardware.
3. Install, uninstall and upgrade software packages.
4. Create and manipulate digital graphics using common graphics programs (e.g. XV, CorelDraw, Fireworks). Scan hard-copy graphics. Convert existing graphics between common graphical formats.
5. Demonstrate a working knowledge of file compression and encryption protocols (e.g., MIME, BINHEX) and commonly used programs (e.g., Outlook, WinZip).

6. Create and maintain a relational database using relational database theory and employing common database programs (e.g., MS Access, MySQL, Oracle).
7. Demonstrate proficiency with Computer Aided Design (CAD) software.
8. Create basic programs using common compiled languages (e.g., Fortran, Visual Basic, Basic, C, C++).
9. Create basic scripts using common scripted languages (e.g., Matlab, Ferret, Perl, PHP, HTML).
10. Demonstrate a working knowledge of Internet protocols for email, data transfer and web page display. Create web pages.
11. Exercise proper computer security (e.g., password selection, antivirus software, log in/out procedures).
12. Identify and eradicate computer viruses.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Create and manage a website.
2. Write special-function programs (e.g., CGI, thin client applications).
3. Administer a Local Area Network (LAN).
4. Set up file, print and TCP/IP servers, and other unique-mission machines.
5. Demonstrate knowledge of emerging computer technologies and trends.
6. Maintain an organizational Intranet.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1999; *Building a Foundation for Tomorrow, Skill Standards for Information Technology*, Northwest Center for Emerging Technologies, 3000 Landerholm Circle SE, N258, Bellevue, WA 98007-6484.

6. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
7. U.S. Navy Training Manual, *Radioman Training Series, Module 2 - Computer Systems* (NAVEDTRA 12846).
8. U.S. Navy Training Manual, *Radioman Training Series, Module 3 - Network Communications* (NAVEDTRA 12847).

Data Processing Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Create databases and spreadsheets using common platforms (Access, Oracle, Lotus 1-2-3, Excel).
2. Demonstrate knowledge of relational database theories. Apply relational database theory to database problems.
3. Compare and contrast databases and spreadsheets. Explain when one format would be advantageous over the other.
4. Demonstrate a basic working knowledge of common mathematical programs such as Matlab, MathCAD, and Maple.
5. Perform basic statistical analyses.
6. Input large amounts of data with minimal errors. Possess at least intermediate typing skills (e.g., >30WPM)
7. Possess a working knowledge of graphical formats (e.g., gif, tif, jpg). Compare and contrast between formats.
8. Demonstrate a familiarity with common scientific display programs (e.g., Ferret GRaDs).

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Import and convert data between common database platforms (e.g., Access, Oracle, ASCII).
2. Create complex relational database with multiple tables, queries, forms, reports and indices. Verify quality of data.
3. Import and convert data between common spreadsheet programs (e.g., Excel, Lotus 1-2-3).
4. Create simple graphs from database and/or spreadsheet data.
5. Perform calculations on large datasets using mathematical programs such as Matlab, MathCAD, and Maple.
6. Write scripts to open files, edit contents, and re-write data using a scripting language such as Matlab, PERL, or a compiled language (e.g., FORTRAN).
7. Create complex figures using mathematical programs (e.g., Matlab, MathCAD, Maple) and with scientific data display programs such as Ferret and GRaDs.

8. Ingest and manipulate common model output format into display programs (e.g., Ferret, GRaDs).
9. Export figures created in mathematical or display programs into multiple formats for web and/or paper publication.
10. Demonstrate familiarity with common scientific data formats and sources (NetCDF, NCEP).

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Prepare raw or processed data in a format suitable for web publication (e.g., dynamically generated figures).
2. Write programs to simplify, streamline, and error-check data entry or manipulation.
3. Perform advanced statistical analyses.
4. Perform advanced database administration such as user management, error checking, and incremental back-ups.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1999; *Building a Foundation for Tomorrow, Skill Standards for Information Technology*, Northwest Center for Emerging Technologies, 3000 Landerholm Circle SE, N258, Bellevue, WA 98007-6484.
6. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
7. U.S. Navy Training Manual, *Radioman Training Series, Module 2 - Computer Systems* (NAVEDTRA 12846).
8. U.S. Navy Training Manual, *Radioman Training Series, Module 3 - Network Communications* (NAVEDTRA 12847).

Technical Writing Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Demonstrate knowledge of grammar, readability, and usability standards for different types of writing and different audiences.
2. Use style manuals and composition preparation guidelines for selecting and implementing appropriate style and composition.
3. Demonstrate knowledge of outlining and conceptualizing techniques. Communicate concepts in oral, written, and graphic form.
4. Perform basic document editing using common word processors e.g., (Word, WordPro, WordPerfect).
5. Demonstrate understanding of basic computer operations, file manipulation, and troubleshooting techniques.
6. Gather information to identify customer and audience requirements.
7. Demonstrate knowledge of interview techniques, including the preparation of questionnaires.
8. Conduct library research using common formats (e.g., print, photographic, video, online) . Demonstrate knowledge of common library classification systems (e.g., Library of Congress, Dewey Decimal).
9. Identify appropriate resources. Prioritize resources by relevance.
10. Conduct online searches using search engines, and other commonly available Internet search utilities.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Evaluate grammar, style, consistency, and relevance of written and graphic materials.
2. Demonstrate ability to apply numerous writing styles. Identify writing styles that are consistent with document purpose and audience.
3. Apply advanced editing principles.
4. Obtain and apply critical reviews of composition, overall content, technical accuracy, usability, presentation.
5. Prepare composition plans.

6. Tailor composition and layout for delivery media.
7. Demonstrate working knowledge of scientific, engineering, and technical documentation procedures and protocols.
8. Adhere to copyright laws. Obtain appropriate permissions when using copyrighted material.
9. Conduct advanced library searches including database searches, and information mining services.
10. Conduct live, email, or questionnaire interviews with subject matter experts.
11. Prepare documents using common desktop publishing and graphics software packages (e.g., PageMaker, Quark).
12. Select and use graphics to communicate relevant points consistent with composition tone.
13. Demonstrate advanced knowledge of graphics preparation and formats.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Create templates for scientific, engineering, and technical content, including Internet publishing.
2. Consult with web designers for composition style, layout, proofing and graphical presentation of web pages.
3. Prepare documents for web publishing. Understand advantages and limitations of web publishing.
4. Transfer previously prepared compositions to advanced media (e.g., interactive CD-ROM, web page, presentation software).
5. Produce, edit, and publish organization periodicals (e.g., newsletter, journal, web site).
6. Coordinate composition production specifications and proofing with printer and/or media producer.
7. Supervise production of complex documents, including planning, research, writing, editing, obtaining critical reviews, conducting usability tests, and distribution.
8. Provide advice on appropriate media, style, and delivery for various technical documents. Demonstrate understanding of the advantages and limitations of media and methodologies.
9. Teach or mentor subordinates or students in advanced technical writing.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
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6. 1997; Standards of Competence for Hydrographic Surveyors - The International Hydrographic Bureau, Eighth edition
7. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
8. 1994; Reep, Diana C. *Technical Writing: Principles, Strategies, and Readings*, 2nd Ed. Boston: Allyn and Bacon.
9. 1982; Lannon, John M., *Technical Writing*. Boston: Little Brown.
10. Course outlines for technical writing courses at Chabot College, College of the Desert, College of the Sequoias, De Anza College, Diablo Valley College, Foothill College, Golden West College, Grossmont College, Hartnell College, Irvine Valley College, Ohlone College, Orange Coast College, Pasadena City College, Pierce College, Rio Hondo College, Sacramento City College, Saddleback College, San Joaquin Delta College, Sierra College, Southwest College, and Victor Valley Community College.

Oceanography Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Identify oceans, seas, basins, and land masses by name. Label major coastal and seafloor features (e.g., peninsulas, trenches, and rises).
2. Classify ocean sediments by origin, size, and location. Understand major sediment removal, transport, and deposition mechanisms.
3. Explain the major processes that shape coastal topography.
4. Describe the major characteristics of water (e.g., molecular structure, bonding properties, thermal properties, role as solvent, pressure, buoyancy) and seawater (e.g., salinity, density layering, corrosive properties).
5. Name major water masses, source locations, and transport mechanisms.
6. Describe the major features of the global wind system and the processes that create winds.
7. Label primary wind-driven and density-driven currents and ocean fronts, and describe the processes that produce them.
8. Describe major wave features, generation mechanisms, characteristic motions (e.g., propagation, reflection, refraction, breaking), and the conditions that govern wave behavior.
9. Demonstrate knowledge of tidal features (e.g., semidiurnal tides, spring and neap tides, tidal currents) and tide-generating factors.
10. Identify regions of upwelling and downwelling and the forces involved in producing vertical motion.
11. Explain basic turbulence processes and describe impacts of turbulence.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Operate common bottom sampling devices. Collect and process bottom samples.
2. Identify coast-modifying processes involved with formation of bars, deltas, headlands, barrier islands, and atolls.
3. Measure light penetration and water clarity with a variety of instruments (e.g., Secchi disk, photometer).
4. Operate common water-sampling equipment (e.g., Nansen bottles, CTD rosette).
5. Determine salinity through chemical titration and conductivity methods.

6. Identify and measure common water mass tracers (e.g., dissolved oxygen).
7. Accurately estimate sea and swell height.
8. Make tide forecasts using tide tables and tide generating software. Deploy and recover tide gauges.
9. Explain the major processes by which the atmosphere modifies local oceanographic conditions.
10. Evaluate effects of topography and atmospheric pressure on sea surface height.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Measure currents using current meters and acoustic Doppler current profilers.
2. Classify water masses by salinity, depth, tracers or other methods.
3. Identify major ocean features (e.g., temperature, wave heights, ocean color, currents, fronts, eddies, fronts) from analyses of observational data (e.g., from bucket, intake temperature, satellite imagery) and model predictions (e.g., of winds, atmospheric pressure, wave heights, currents).
4. Predict sediment transport and coastal zone modification.
5. Forecast changes in ocean conditions (e.g., waves, sea heights, breaker heights, currents, fronts, rip currents).
6. Predict changes in upwelling/downwelling (vertical motion) regimes and their effects on the biota.
7. Identify effects of climatic events on oceanographic conditions (e.g., El Nino/La Nina).

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
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6. 1998; Course outline for Marine Science Research Techniques (MS 100), Saddleback College.
7. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
8. 1987; Course outline for Introduction to Ocean Engineering (OCEA 232), Fullerton College, Available from Articulation Office, Fullerton College, 321 E. Chapman Ave, Fullerton, CA 92832-2095.
9. 1987; Course outline for Ocean Sampling (OCEA 231), Fullerton College, Available from Articulation Office, Fullerton College, 321 E. Chapman Ave, Fullerton, CA 92832-2095.
10. 1986; *Black*, John A., Oceans and Coasts, An Introduction to Oceanography, Wm. C. Brown Publishers.

Meteorology Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Describe the basic composition and vertical structure of the atmosphere (e.g., the major layers of the atmosphere).
2. Describe the main atmospheric heat transfer mechanisms (e.g., conduction, convection, radiation, advection, latent heat).
3. Define the elements of weather (e.g., temperature, dew point, pressure, wind speed and direction, clouds, visibility). Convert between Fahrenheit and Celsius scales.
4. Describe the primary air masses and their characteristics, origins, locations, and boundaries.
5. Identify the locations and seasonal variations of the major global wind systems and semi-permanent pressure systems.
6. Explain the basic relationship between atmospheric pressure and winds.
7. Describe the weather associated with high and low pressure systems.
8. Identify the major cloud types, and their formation and dissipation mechanisms.
9. Interpret the symbols on weather maps.
10. Identify the formation and dissipation mechanisms for severe weather conditions (e.g., severe winter storms, tropical cyclones, thunderstorms).
11. Describe the mechanisms for the formation, dissipation, and advection of fog and other restrictions to visibility.
12. Calculate true wind speed and direction.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Sketch typical temperature profiles for common atmospheric conditions.
2. Identify the major jet streams and describe their contribution to surface weather conditions.
3. Describe the typical sequence of winds, clouds, and precipitation associated with midlatitude frontal systems and severe weather conditions.
4. Describe current weather conditions from raw observations, satellite imagery, and weather maps.

5. Plot current and predicted location of weather systems from issued warnings.
6. Operate weather monitoring equipment (e.g., marine barometer, wind speed recorder).
7. Make, record, and transmit weather observations.
8. Operate weather radio-fax and satellite equipment.
9. Research and evaluate sources of weather related information.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Plan and execute radiosonde launches, and record, transmit, and archive results.
2. Analyze surface and upper level charts and identify major features (e.g., pressure systems, fronts, jet streams, severe weather).
3. Analyze output from weather fax, numerical weather prediction models, issued warnings, and other operational aids to provide on-scene, short-term weather forecasts.
4. Identify conditions that are likely to produce significant coastal and marine weather events (e.g., land/sea breezes, coastal fog, extreme winds and waves, nor'easters).
5. Interpret deteriorating weather conditions and recommend safe courses of action (e.g., identify safe vessel routes and storm havens when operating near severe weather systems).
6. Identify the effects of climatic events (e.g., mistral periods, monsoon transitions, El Niño and La Niña events) on marine and coastal weather.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.

6. 1991; Ahrens, Donald, A., *Meteorology Today: An Introduction to Weather, Climate, and the Environment*. West Publishing Company, St Paul.

Marine Biology Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Differentiate between the major marine and coastal habitats (e.g., pelagic, sandy beach, rocky shore, coral reefs, sea floor vents, abyssal plains, estuaries) and their characteristic features.
2. Describe the major photosynthetic and chemosynthetic organisms of the ocean, and their habitats, life cycles, and roles in marine ecosystems.
3. Compare and contrast the major marine invertebrate groups, their habitats, life cycles, and roles in marine ecosystems.
4. Explain food webs, trophic levels, and nutrient and energy cycling.
5. Describe the roles of light, temperature, salinity, and other water chemistry factors on the marine and coastal ecosystems.
6. Define tidal processes and their impacts on marine organisms.
7. Name major currents, and major upwelling and downwelling regions. Describe their effects on marine ecosystems.
8. Classify major estuaries. Contrast their characteristics, and the main physical factors that impact estuarine organisms.
9. Compare and contrast modern theories regarding the evolution of organisms.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Classify the main cell types. Identify the primary cell structures and bodies and their functions.
2. Describe the main plant and animal tissue types and their functions.
3. Identify the structures and functions of the main systems of marine macro-organisms (e.g., vascular, reproductive, nervous, muscular systems).
4. Describe the major physical properties of sea water (temperature, salinity, pressure, turbidity, light transmission and absorption, dissolved oxygen, dissolved organic carbon), the main techniques for measuring them, and their impacts on marine life.
5. Describe the major regions of the upper ocean (e.g., intertidal zone, photic zone, thermocline, nutricline) and identify them using common measurement techniques (e.g., tidal gauges, Secchi disk, photometer, thermistor chain).

6. Operate common water-sampling equipment (e.g., Nansen bottles, CTD rosette). Process collected samples.
7. Operate common biological sampling (e.g., bottom trawl, plankton tow) equipment. Process collected organisms.
8. Identify the major impacts of humans on the marine environment and organisms.
9. Identify the major management and conservation practices applied to marine and coastal species, especially commercially exploited species.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Collect marine life in accordance with all laws. Obtain pertinent permits.
2. Safely capture, tag, monitor, and release organisms under investigation.
3. Conduct aquarium tasks such as plant and animal selection, husbandry, and disease detection and treatment.
4. Conduct observational studies of organisms to determine major species and population patterns (e.g., patterns of reproduction, migration, population dynamics, and general species health).
5. Measure and analyze the effects of pollution on ecosystems.
6. Apply modern mariculture techniques and technology.
7. Care for and train marine mammals.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
6. 1994; Course outline for Marine Aquarium Science (MS 120), Orange Coast College.

7. 1989; Course outline for Marine Biology (MS 180), Orange Coast College.
8. 1988; Course outline for Mariculture (MS 141), Orange Coast College.
9. 1989; Course outline for Marine Mammals (MS 187), Orange Coast.
10. 1987; Course outline for Aquaculture (OCEA 134), Fullerton College, Available from Articulation Office, Fullerton College, 321 E. Chapman Ave, Fullerton, CA 92832-2095.
11. 1987; Course outline for Ocean Sampling (OCEA 231), Fullerton College. Available from Articulation Office, Fullerton College, 321 E. Chapman Ave, Fullerton, CA 92832-2095.
12. 1998; Course outline for Marine Science Research Techniques (MS 100), Saddleback College 1986
13. 1986; Black, John A., Oceans and Coasts, An Introduction to Oceanography, Wm. C. Brown Publishers.

Navigation Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Read and interpret navigation charts and marine reference publications such as NOAA, DMA, Canadian Hydrographic, British Admiralty charts, chart catalogs, tide and current tables, light lists, sailing directions, etc.
2. Apply dead reckoning positioning techniques. Evaluate position using navigation aids.
3. Read magnetic and gyro compasses. Apply appropriate corrections.
4. Fix the position of a vessel on marine charts using visual and aural aids to navigation and compasses.
5. Explain navigational procedures for periods of reduced visibility.
6. Produce and plot a navigational voyage plan.
7. Apply the Nautical Rules of the Road.
8. Define the duties of a lookout. Apply appropriate lookout communication techniques.
9. Interpret nautical visual and audible navigation and warning signals.
10. Correctly apply both true and relative bearing systems in navigational situations.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Apply and evaluate information obtained from electronic navigational tools (e.g., GPS/DGPS, LORAN-C, radar/ARPA, depth sounders, and radio beacons).
2. Apply appropriate chart correction procedures.
3. Demonstrate proper procedure for determining compass error and make appropriate corrections.
4. Operate electronic charting equipment.
5. Operate computer-integrated navigation systems at a basic level.
6. Demonstrate knowledge of basic survey variables including datum, ellipsoid and UTM options.
7. Apply positioning and route oversight for offshore voyages (to 25 miles offshore) and in all visibility conditions.

8. Apply advanced Nautical Rules of the Road while operating in marine traffic.
9. Demonstrate search and rescue patterns and procedures.
10. Maintain navigation logs.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Demonstrate knowledge of the history, theory and practice of celestial navigation.
2. Fix current position using celestial navigation techniques and instruments.
3. Operate computer-integrated navigation systems at an advanced level.
4. Operate USBL, survey and other alternative and/or operation-specific navigational input systems.
5. Plan a global voyage.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
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6. 1997; Standard of Competence for Hydrographic Surveyors - Guide Notes and Syllabi for Education and Training Programs (Eighth Edition), The International Hydrographic Bureau, 4, quai Antoine Ier, B.P. 445, Monaco, MC 98011 Cedex, MONACO.
7. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
8. 1977; Bowditch, Nathaniel The American Practical Navigator. Reprint Services Corp.
9. U.S. Navy Personnel Qualifications Standards for Ships Control and Navigation, NAVEDTRA 43492-2C.
10. USCG, Navigation Rules for International and Inland Waters, Pub. 169.

11. U.S. Navy Training Manual NAVEDTRA 10120-J1, Seaman.
12. U.S. Navy Training Manual NAVEDTRA 10157, Quartermaster 3.

Hydraulic Equipment Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Explain characteristics of liquids at rest and in motion, and factors that affect them. Compute force, pressure and area.
2. Compare and contrast force transmission for liquids and solids.
3. Describe multiplication of force and common mechanisms for achieving it.
4. Describe the operation of basic hydraulic components (e.g., reservoir, pump, lines, valves).
5. Compare and contrast fluids in terms of their density, viscosity, lubricating power, chemical stability, pH, flashpoint, and foaming tendency.
6. Identify qualities of fluids acceptable for hydraulic systems. Compare and contrast common hydraulic fluid types.
7. Explain safety precautions for handling potentially hazardous fluids, liquid contaminants, and control of contaminants.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Identify hydraulic pump classifications (e.g., nonpositive displacement, positive displacement, fixed displacement) and types (e.g., rotary, gear).
2. Compare and contrast construction fundamentals for different pump types.
3. Define required characteristics of line materials used in hydraulic systems. Name common line materials.
4. Describe the purposes of line types used in hydraulic systems. Identify standard sizes and weights of tubular products.
5. Fabricate and replace hydraulic lines. Safely bend tubing.
6. Identify classifications (e.g., flow control, pressure control, and directional control), types, and operation of valves used in the control of flow, pressure, and direction of flow.
7. Compare types and purposes of sealing devices used in fluid power systems.
8. Describe the types of seals used in fluid systems (V-rings, O-rings, T-rings).
9. Safely replace rings.

10. Read and interpret pressure measurement and control devices (e.g., gauges, indicators).
11. Describe the types and construction of pressure and temperature gauges and switches.
12. Compare the functions and types of reservoirs, strainers, and filters, and their uses in fluid power systems.
13. Discuss the types and operation of accumulators used to create mechanical force from hydraulic motion.
14. Read and interpret diagrams used for hydraulic systems.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Perform overhauls on hydraulic systems.
 2. Assist in the design and construction of hydraulic systems for use in marine technology applications.
 3. Perform and oversee preventative maintenance on large or multiple hydraulic systems.
 4. Operate, maintain, and repair remotely operated vehicle (ROV) hydraulic systems.
-

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
3. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
4. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
5. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
6. U.S. Navy Training Manual, *Fluid Power*, NAVEDTRA 12964.

Electronics Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. State the meanings of and the relationship between matter, element, nucleus, compound, molecule, mixture, atom, electron, proton, neutron, energy, valence, valence shell, and ion.
2. Describe the relationship between kinetic energy, potential energy, photons, electron orbits, energy levels, and shells and subshells.
3. Compare and contrast a conductor, an insulator, and a semiconductor in terms of valence. List materials that make good conductors and insulators.
4. State the definition of static electricity and explain how static electricity is generated.
5. List six methods for producing a voltage and state the operating principles of and the uses for each method. Describe the relationship of current to voltage.
6. Define resistance and conductance, and explain how the temperature, contents, length and cross-sectional area of a conductor affect its resistance and conductance values. List the physical and operating characteristics of and the symbols, ratings, and uses for various types of resistors.
7. Define a battery, and identify the methods of combining cells to form a battery.
8. Identify the components in a circuit from a simple schematic diagram.
9. Write the equation for Ohm's law and describe the effects on current caused by changes in a circuit.
10. Compute circuit and component power in series, parallel, and combination circuits. Compute the efficiency of an electrical device.
11. Compute resistance, current, voltage, and power in voltage dividers.
12. Recognize the safety precautions associated with the hazard of electrical shock.
13. Describe the differences between AC and DC voltage and current.
14. Define inductance and capacitance and describe the role of inductors and capacitors in AC and DC circuits.
15. Identify the physical characteristics of a transformer, including the basic parts, common core materials, and main core types.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Identify the benefits and limitations of common circuit protection devices and label the schematic symbols for each type.
2. Define common circuit control devices. Identify the operating principles and schematic symbols of a switch, a solenoid, and a relay.
3. Apply safe wiring techniques.
4. Interpret electrical diagrams.
5. Compare and contrast generator and motor construction, types and uses.
6. Identify printed circuit boards, diodes, transistors, and the various types of integrated circuits. Describe the fabrication techniques of these components. Describe microelectronic component repair techniques.
7. Describe the operation and construction of servos and synchros.
8. Describe the purpose, construction requirements of common gyros types. Explain special considerations of gyro maintenance (e.g., rigidity, procession, torque).
9. Demonstrate proficiency using common test equipment (e.g., multimeter, transistor tester).
10. Conduct preventative maintenance on major electronic systems.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Conduct calibration of sensitive test and operational equipment. Administer calibration laboratory.
2. Set-up, troubleshoot, and operate GPS and other satellite equipment.
3. Operate, repair and test sonar and radar equipment.
4. Assist in developing, operating and testing specialized electronic systems (e.g., data collection and recording).
5. Assist in the development, repair and operation of fiber optic systems.
6. Construct electrical components from technical drawings.
7. Oversee the maintenance of a wide array of electronic systems.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.

2. 2000; Technical Knowledge and Skills for Environmental Technology Careers, Advanced Technology Environmental Education Center
3. 1999; *Building a Foundation for Tomorrow, Skill Standards for Information Technology*, Northwest Center for Emerging Technologies, 3000 Landerholm Circle SE, N258, Bellevue, WA 98007-6484.
4. 1999; U.S. Department of Commerce Vacancy Announcement (NOAA), Position Title: Electronics Technician. Available from <http://www.rdc.noaa.gov/~hrmo/va-status.htm>.
5. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
6. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
7. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
8. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
9. U.S. Navy Training Manual, Navy Electricity and Electronics Training Series, NAVEDTRA 11100-A.

Submersibles Competencies

NOTE: The submersibles competencies are a relatively applied set of skills which build on more focused competencies in areas such as computer systems, hydraulic equipment, and electronics.

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Demonstrate knowledge of pressure-depth effects on materials and substances used in submersible vehicles.
2. Explain the physics involved in depth control and underwater movement problems.
3. Demonstrate a working knowledge of common computer operating systems.
4. Identify the components of a remotely operated vehicle (ROV) system.
5. Interpret technical documents, such as blueprints and wiring diagrams.
6. Demonstrate the ability to work well in small groups and contribute to a common goal.
7. Explain the problems involved in underwater photography and videography and how to deal with them.
8. Express thoughts well in writing. Write technical reports.
9. Possess a basic understanding of underwater acoustics (e.g. ray tracing, wave propagation, pressure effects).
10. Interpret nautical charts and maps.
11. Identify missions for which ROVs are advantageous.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Build and operate a simple ROV.
2. Identify common ROV systems used in commercial and research objectives.
3. Possess a working knowledge of launch and recovery systems (LARS). Participate safely and efficiently in launch and recoveries.
4. Troubleshoot electrical, mechanical, and hydraulic failures.
5. Demonstrate proficiency operating ancillary systems, such as manipulators, cameras, and lighting.
6. Evaluate and assess environmental conditions affecting the use of ROVs (e.g., weather, seas, currents, bottom topography and type, water clarity).

7. Navigate ROVs in uncontrolled conditions.
8. Perform preventative maintenance on ROVs and associated equipment (LARS, TMS).
9. Operate small watercraft.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Repair mechanical, electrical, and hydraulic failures on most ROV systems.
2. Supervise ROV operations, including maintenance, launch and recovery, and mission actions.
3. Calibrate and align instruments.
4. Write detailed reports (e.g., mission accomplishment reports, technical reports). Update technical documentation.
5. Participate with engineers in design and modification of ROV systems.
6. Build and design mechanical, electrical, and hydraulic systems for ROV use.

References:

1. 2001; Bohm, Harry and Vickie Jensen, *Subsea Technology for Everyone*, in press.
2. 2000; *MATE's Summer Institute 2000: ROVing the Oceans*. MATE Center Quarterly Newsletter (2000). Volume 2, Issue 4 - Fall.
3. 1999; *Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians* - MATE Center.
4. 2000; Bohm, Harry, *Introduction to Submersible Technology*, The MATE Center.

Surveying Competencies

NOTE: The surveying competencies are a relatively applied set of skills which build on more focused competencies in areas such as computer systems, navigation, and electronics.

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Perform basic acoustic ray tracing for sea water.
2. Demonstrate a basic knowledge of spherical and plane wave propagation.
3. Determine sound velocity from temperature and salinity measurements.
4. Demonstrate strong skills in geodesy. Explain geodetic terms such as ellipsoid, geoid, datums, orthometric height, dynamic height and geometric height, etc. Explain the role of gravity in determining position.
5. Describe the role of satellites in positioning, navigation, and altimetry.
6. Explain orders of accuracy desired in surveying.
7. Compare and contrast commonly used datums (e.g., WGS-84, Tokyo).
8. Transform positions between datums.
9. Compare and contrast common map projections (e.g., mercator, transverse cylindrical equidistant).
10. Produce simple maps using common GIS display software (e.g., Arcview).

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Identify sources of acoustic noise that may interfere with bathymetric measurements.
2. Compare and contrast various acoustic devices, (e.g., transponder beacons, pingers, tripping devices, sound velocity meters).
3. Compare the strengths and weaknesses of transducer types (e.g., narrow beam, wide beam, parametric, electrostrictive, piezoelectric).
4. Operate digital and analog bathymetric and survey data recording equipment.
5. Interpret echo sounder records.
6. Operate side scan sonar equipment.

7. Interpret side scan sonar results. Plot contacts. Determine size and height of bottom obstructions. Perform image enhancement. Identify signatures of wrecks, pipelines, organisms, etc.
8. Identify sources of systematic and transient positioning errors.
9. Fix land position using a theodolite from an existing station or baseline. Correct for errors. Explain additional corrections needed when surveying at sea.
10. Fix position using satellite navigation equipment (GPS). Correct for errors.
11. Compute at-sea elevation from observed data corrected for curvature and refractions.
12. Explain how heave and orientation is detected and compensated for. Demonstrate familiarity with sensors.
13. Plan coastal, construction, and large scale hydrographic surveys. Include consideration of swath, fix interval, interlines, cross lines, positional accuracy, data quality control, and cost.
14. Using collected survey data, produce grid sheets, track charts, texture tracings, contour sheets, digital terrain models, and/or survey reports.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Calibrate sounding equipment by bar check and velocimeter.
2. Plan coastal zone management surveys for dredging, hydraulics, and pollution monitoring.
3. Plan offshore surveys for pipeline and cable surveys as well as other seismic and geomagnetic applications.
4. Produce 3D renderings using survey data.
5. Oversee the chart compilation process.
6. Supervise all aspects of data collection, management storage, and quality control for a survey platform.
7. Incorporate use of ROVs into survey activity.
8. Place mobile rigs using GPS or telemetry.
9. Conduct flood plain mapping.

References:

1. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.
2. 2000, Course outline for Cartography / Hydrographic Survey (MSC 256), Cape Fear Community College
3. 2000, Course Outline for Applied Marine Science Technology (ESSP 433), California State University, Monterey Bay.
4. 1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
5. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
6. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
7. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
8. 1997; Standard of Competence for Hydrographic Surveyors - Guide Notes and Syllabi for Education and Training Programs (Eighth Edition,), The International Hydrographic Bureau, 4, quai Antoine Ier, B.P. 445, Monaco, MC 98011 Cedex, MONACO

Geographic Information Systems Competencies

NOTE: The geographic information systems (GIS) competencies are a relatively applied set of skills which build on more focused competencies in areas such as computer systems, data processing, and navigation.

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Compare and contrast commonly used map projections (e.g., Mercator, cylindrical equidistant). Describe applications where different projections are advantageous.
2. Define the ellipsoid and geoid. Explain their relation to one another and their role in hydrography, cartography, marine surveying, and GIS.
3. Compare and contrast conventional mapping technology to GIS automated technology.
4. Identify applications of GIS in marine science and technology.
5. Explain the sources and history of various datums. Compare and contrast historical datums with WGS datum.
6. Explain the strengths and weaknesses of the Global Positioning System (GPS). Explain how the GPS works.
7. Identify sources of coastal and offshore data available from marine survey and remote sensing sources.
8. Compare and contrast the pros and cons of vector and raster data structures.
9. Calculate data precision and accuracy limitations. Explain accuracy limitations of data and sources of error. Explain error propagation and magnification.
10. Import and perform basic manipulation on data (e.g., datum conversion, chart display, orientation, overlays, scale)
11. Identify common chart symbols.

Produce charts with the appropriate scale and coordinate systems using ArcView.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Identify common electronic navigation systems and the GIS requirements of each.
2. Demonstrate a working knowledge of the major procedures and technologies used in collecting hydrographic survey data.
3. Conduct surveys using conventional and GPS survey techniques.

4. Prepare nautical charts using raw, tabular survey data.
5. Digitize existing charts into raster and vector charts. Explain accuracy limitations and potential sources of error.
6. Prepare scenario-driven charts in a data sparse environment using publicly available data.
7. Employ quality control procedures when creating charts.
8. Convert chart products into multiple graphic formats.
9. Enter geospatial data into a database. Ensure data relationships are maintained. Manipulate and maintain database.

Apply and manipulate metadata where appropriate. Demonstrate a working knowledge of metadata conventions.

C. Specialized Competencies - Skills some potential employees would be expected to possess.

1. Apply quality controls to a GIS data acquisition operation.
2. Design and implement a GIS database system.
3. Perform detailed GIS data analysis, including detailed comparisons of GIS products with products from other sources.
4. Supervise the creation and dissemination of GIS products.
5. Advise customers on the design of GIS products and data collection projects.
6. Teach or mentor subordinates or students in GIS.

References:

1. 2000, Course Materials for Introduction to GIS, GPS, and Cartography (MATE 10), Monterey Peninsula College.
2. 2000, Course Materials for Spatial Analysis and Advanced GIS Techniques (MATE 11), Monterey Peninsula College.
3. 2000, Course Materials for Remote Sensing and Image Processing (MATE 13), Monterey Peninsula College.
4. 2000; Surveying Skill Competencies, MATE Center,
5. 2000; Navigation Skill Competencies, MATE Center.
6. 2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.

7. 1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.
8. 1999; Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center.
9. Denise, C and Terryll Baily, 1999: GIS Technician, Environmental/Natural Resource Technology Skill Standards Manual, Northwest Natural Resource Technologies Consortium.
10. 1998; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center.
11. 1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.
12. 1997; Standards of Competence for Hydrographic Surveyors - The International Hydrographic Bureau, Eighth edition.
13. 1997; Clarke, K. C., Getting Started with Geographic Information Systems. Prentice-Hall.
14. 1997 de Mers, M Fundamentals of Geographic Information Systems, John Wiley & Sons.
15. Internet job listings for GIS Technician at <http://www.gjc.org/jobs>.
16. The NCGIA Core Curriculum in GIScience, http://ncgia.ncgia.ucsb.edu/giscc/cc_outline.html.
17. The NCGIA GIS Core Curriculum for Technical Programs, Example GIS Course Curricula and Certificate Programs, http://www.ncgia.ucsb.edu/cctp/resources/example_courses/examples.html.

Mathematics and Statistics Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Apply simple formulas for calculating volume, perimeter, circumference, surface area, and cross-sectional areas.
2. Perform calculations involving exponents and roots. Manipulate numbers using exponents and roots.
3. Solve or manipulate algebraic equations.
4. Apply ratios and proportions to solve problems.
5. Calculate the slope of a line.
6. Extrapolate data relationships.
7. Distinguish between geometric and arithmetic relationships.
8. Calculate mean, median, mode, standard deviation, standard error, and range.
9. Interpret the characteristics of a normal statistical bell curve.
10. Explain confidence intervals.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Simplify large numbers using scientific notation and exponents.
2. Interpret and apply linear and exponential relationships.
3. Perform calculations involving logarithms.
4. Relate the slope of the line to gradients on topographic and hydrographic maps.
5. Draw a histogram to represent frequency distributions of data.
6. Use random sampling chart and random number generation methods.
7. Extrapolate trends in data.
8. Calculate and graph probability relationships.
9. Calculate flux or flow rates.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

7. Perform statistical analysis on large datasets using analysis software (e.g., Surfer, MATLAB, Maple). Graph statistical values and relationships.
 8. Correlate datasets.
 9. Calculate safe fuel and cargo capacities (volumes and weights) based on craft limitations and capacities.
 10. Assess quality of collected data through determination of confidence intervals and deviation from the mean.
 11. Accurately and quickly calculate speed, distance and intersecting problems without the use of calculator or computer.
 12. Instruct others in mathematics and statistics as it applies to marine technicians.
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References:

1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center,.

1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.

2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.

1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.

2000; Math Knowledge and Skills for Environmental Technology Careers, The Advanced Technology Environmental Education Center, <http://www.ateec.org/>

Teamwork/Interpersonal Relationships Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Listen to the ideas of other team members. Build on or contribute to the ideas of others.
2. Question other team members without insulting or demeaning. Pose questions aimed at spawning constructive discussion.
3. Persuade team members. Encourage team members to exchange, defend, and rethink ideas.
4. Respect the opinions of team members. Encourage and support the efforts and ideas of others.
5. Help team members. Offer assistance to other team members and accept assistance when needed.
6. Share ideas and resources with other team members. Report findings to team members.
7. Participate in work groups toward a common project/goal. Embrace common group goals.
8. Recognize the value of diversity of individual strengths.
9. Accept suggestions and guidance of team leaders. Accept direction without grumbling.
10. Contributes individual expertise or experience toward achieving group goals.
11. Cultivate growth in personal conduct and capabilities.
12. Evaluate information without distortions, personal bias or conflicts of interest.
13. Respect confidentiality.
14. Recognize the utility of professional ethical standards and behaves accordingly.
15. Adhere to personal appearance appropriate for the work environment.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Functions as a team member in emergency situations such as man overboard, fire, or equipment failure.

2. Remain a productive team member despite adverse situations such as family separation, high seas, or shift working.
3. Recognize the importance of routine safety precautions or drills and conduct them professionally.
4. Manage stress and adapt to unusual demands with composure.
5. Accept professional development as a life-long endeavor.
6. Focus team efforts on both the process and desired outcomes.
7. Continually suggest improvements in team efficiency and quality.
8. Seek team consensus where appropriate.
9. Consider the impact of individual actions on the team.
10. Coach or mentor team members in appropriate circumstances.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Motivate team members to achieve excellence.
2. Facilitate the resolution of conflict among the team.
3. Chairs teams or committees with positive outcomes.
4. Celebrate and recognize successful team performance.
5. Focus on meeting team objectives and finding ways to collaborate and exchange ideas or resources within the team or between other teams.
6. Recognize when team morale is low and addresses the situation before problems arise.
7. Consider contingencies and anticipates future development and leverage them toward team success.
8. Facilitate the free expression and constructive activities of others.
9. Consider and encourages unconventional approaches and solutions to problems.
10. Express ideas or team direction clearly.

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC, 1995.

Water Quality Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Describe the chemical properties of water.
2. Calculate flow velocity.
3. Describe and measure salinity.
4. Describe pH and the effect of acidity. Explain the pH scale. Describe the effect of pH on humans and aquatic life.
5. Describe common dissolved solids found in sea water and fresh water supplies.
6. Identify common biological contaminants found in water supplies. Describe their effects on humans and aquatic life.
7. Name inorganic substances found in fresh and sea water.
8. Identify common aquifers in the United States.
9. Demonstrate familiarity with the Environmental Protection Agency standard for drinking water.
10. Describe detergents, and their effect on aquatic life.
11. Compare and contrast contaminant filtering and neutralization methods.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Describe the hydrogeological characteristics of aquifers.
2. Describe common situations leading to groundwater contamination and prevention measures both physical and legislative.
3. Identify common radionuclides in ground water, their modes of decay, and potential health risks.
4. Measure pH.
5. Conduct tests for dissolved solids.
6. Measure and describe turbidity.
7. Measure dissolved oxygen content of water.
8. Classify water samples by hardness.
9. Determine the chloride level in water samples.

10. Test water samples for harmful organisms.
11. Filter and treat water to safe standards.
12. Identify current technology in water property sampling.
13. Identify common hazardous waste sources and clean-up methods.
14. Explain the characteristics of water found in estuaries. Compare and contrast water in estuaries with fresh and sea water.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Maintain rigorous sampling schedule over a study water supply.
2. Quality control measurements conducted by other water quality technicians.
3. Instruct others in water quality fundamentals.
4. Apply latest technology in water sampling equipment. Maintain sensitive water sampling equipment.

References:

1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center,.

2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.

1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.

1987; The Conservation Foundation, *Groundwater Protection, Groundwater: Saving the Unseen Resource, The final report of the National Groundwater Policy Forum and A guide to Groundwater Pollution: Problems, Causes and Government Responses.*

2000; The Environmental Protection Agency; Quality of our Nation's Water; <http://www.epa.gov/OWOW/305b/>

Small Boat Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Identify safety precautions to be observed during boat operations in regard to weather, sea conditions, and hazards to navigation
2. Explain safety precautions to be observed while fueling a vessel from a fuel dock, fuel barge, and ship at anchor
3. Demonstrate procedures for recovering a person from the water.
4. Demonstrate the use of portable firefighting equipment
5. Explain safety precautions to be observed when hoisting and lowering a boat.
6. Identify the safe operating limits of small boats with regard to sea conditions, cargo, passengers and equipment.
7. Demonstrate safety precautions for coming alongside large vessels.
8. Demonstrate proper anchoring and docking procedures.
9. Perform proper engine start-up and shutdown. Perform emergency shutdown.
10. Identify common small boat classes, types and functions.
11. Demonstrate proper procedures for handling underway emergencies (e.g., fire, flooding, man overboard)

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Possess a strong grasp of the Rules of the Road including whistle signals, lights, day shapes, and meeting situations.
2. Interpret common navigation chart symbols.
3. Describe the five basic buoy shapes.
4. Describe the buoys and discuss their purpose including lateral marks, special purpose, preferred channel, cardinal, safe water, and daymarkers.
5. Identify the two IALA buoyage systems and regions covered, and state the significant differences.
6. Perform engine repairs inport. Perform preventative maintenance. Prepare maintenance records.

7. Perform the corrective action that must be taken underway for common malfunctions including loss of lube oil pressure, loss of fuel pressure, insufficient air intake, high lube oil temperature, leaking exhaust, and loss of steering.
8. Safely operate small boat without supervision in protected and unprotected waters.
9. Demonstrate procedures for exterior maintenance both above and below the waterline.
10. Demonstrate the proper procedures for maintaining and stowing lifeboats.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Supervise major maintenance on small boats including engine overhauls, resurfacing, etc.
2. Supervise maintenance and operation of multiple craft.
3. Instruct students in small boat maintenance and operation.

References:

1999; Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center,.

1999; Knowledge and Skill Guidelines for Remotely Operated Vehicles (ROV) Technicians - MATE Center.

2000; Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center.

1995; Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC.

U.S. Navy Training Manual, *Personnel Qualification Standard – Small Boat Operations* (NAVEDTRA 43152-E).

COMDTINST M16672.2C, Navigation Rules-International Inland

Dutton’s Navigation and Piloting, 14 th Edition.

United States of America Nautical Chart Symbols Abbreviations and Terms, Chart
No.1

Physics Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

16. Convert quantities between units of measure.
17. Distinguish between scalar and vector values. Describe vector quantities and their utility. Perform vector addition and subtraction.
18. Describe motion in one dimension using position, displacement, velocity, acceleration and momentum. Solve basic problems of motion.
19. Solve problems of relative and projectile motion in two dimensions.
20. Diagram the forces acting on a body at rest and in uniform motion. Describe the component forces and solve basic force problems. Quote Newton's Laws.
21. Describe the origin of gravity, its mathematical representations, and solve basic gravity problems.
22. Compare and contrast weight and force normal. Describe static and kinetic friction.
23. Describe the kinematic properties of a body in circular motion (e.g., angular position and displacement, centripetal and tangential acceleration, angular velocity, acceleration. Solve problems involving centripetal velocity and acceleration.
24. Explain rotation dynamic forces on a body including torque, moment of inertia, center of gravity, and angular momentum.
25. Define work and power.
26. Describe conservation theories. Solve conservation problems.
27. Describe simple harmonic motion using Hooke's Law, stress, strain, reference circle, dampening and resonance.
28. Discuss the physical properties of fluids. Explain Pascal's Principle, the Archimedes Principle, and the Bernoulli Equation.
29. Demonstrate familiarity with properties of heat transfer including latent heat, heat capacity, thermal expansion, convection, conduction and radiation.
30. Describe the behavior of gases using the Ideal Gas Law. Define Molecular mass, the mole, and Avogadro's number.

31. Explain the Zeroth, First, Second and Third Laws of Thermodynamics. Solve heat engine problems.
32. Describe wave and wave motion in terms of wavelength, period, transverse or longitudinal, diffraction and interference (constructive or destructive). Explain sound intensity, the decibel, and the Doppler Effect.
33. Describe the behavior of charged objects and the forces they exert. Compare and contrast conductors and insulators, charging mechanisms. Draw electric field lines.
34. Define electric potential energy, equipotential surfaces, electric fields, capacitors, dielectrics, current, electromotive force, and resistivity.
35. Describe electromagnetic waves in terms of their spectrum. Define reflection, refraction, diffusion, diffraction and polarization.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Measure gravity. Describe the earth's gravitational field and factors that influence it. Explain some real-world effects of non-uniform gravity.
2. Calculate stress, strain and torque. Theorize breakage or deformation.
3. Calculate electrical power requirements.
4. Calculate fluid motion properties such as volume flow and rate of flow in channels and in the ocean.
5. Measure heat transfer including by convection, conduction or radiation
6. Measure ocean surface waves. Describe their generation mechanisms in terms of forces and energy transfer.
7. Draw simple circuits. Calculate the required current, voltage, and resistance for a usable circuit
8. Differentiate among alpha, beta, and gamma radiation and describe their relative penetration through various materials.
9. Determine the pressure in a fluid as a function of depth in the fluid.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Assist in measurement of sensitive physical parameters in a laboratory on board research vessels.

2. Assist in practical design of physical/physical oceanographic experiments.
 3. Maintain and/or calibrate sensitive measuring equipment
 4. Instruct others in practical physics for marine technicians.
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References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

2001; U.S. Department of Commerce Vacancy Announcements (NOAA), Available from <http://www.rdc.noaa.gov/~hrmo/va-status.htm>

Physics 5th Edition, Johnson and Cutnell, John Wiley & Sons; 2000

Physics 1, <http://www.mcasco.com>, 2001

Chemistry Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

5. Perform unit conversions using dimensional analysis (including English/metric, C/F, kg/lbs, gpd/MGD, etc).
6. Compare and contrast solvents and solutes. Describe solubility and the properties of solutions.
7. Compare and contrast elements, compounds and mixtures.
8. Describe the components of modern atomic structure (e.g., isotopes, atomic numbers and mass numbers)
9. Demonstrate familiarity with the periodic table of elements.
10. Compare and contrast molecules and ions.
11. Compare and contrast organic and inorganic compounds.
12. Demonstrate familiarity with notation found in chemical equations.
13. Explain the First Law of Thermodynamics and forms of energy.
14. From a macroscopic and microscopic level, define and differentiate the states of matter: solid, liquid, and gas.
15. Solve problems using the ideal-gas equation. Describe the gas laws.
16. Describe various types of chemical bonds (e.g., ionic and covalent).
17. Define physical properties such as turbidity, conductivity, vapor pressure, vapor density, solubility, boiling point, melting point, specific gravity, and particle shape/size.
18. Define acids, bases, and salts in term of their properties, reactivities, and corrosivities.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Calibrate, maintain, and safely use lab equipment (glassware, balances, meters, electrodes, etc).
2. Perform typical laboratory procedures such as heating, cooling, filtration, glassware set-up, distillation, weighing, measuring, and preparation and standardization of reagents.
3. Demonstrate safe techniques for mixing various chemicals.

4. Predict the solubility of given liquids and solids.
5. Interpret and evaluate laboratory analysis or experiment results.
6. Read and follow laboratory and field procedures.
7. Determine accuracy and precision.
8. Perform the following chemical analyses such as volumetric, gravimetric, titrametric, colorimetric, calorimetric, distillation, spectrometric, chromatographic, electrochemical, atomic absorption, and pH.
9. Evaluate compounds by determining their conductivity, vapor pressure, vapor density, solubility, boiling point, melting point, specific gravity, and particle shape/size.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Experimentally determine chemical equation coefficients.
2. Manage most practical aspects of a full-scale chemical laboratory.
3. Determine the exact salinity of seawater by chemical titration.
4. Organize large numbers of samples for further analysis and storage under field conditions.
5. Maintain and calibrate sensitive, specialized chemical analysis equipment.
6. _____

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC, 1995.

Oceans and Coasts, An Introduction to Oceanography, John A. Black, Wm. C. Brown Publishers, 1986

Chemistry, The Central Science, Brown & LeMay, Prentice Hall, 1988

Instrumentation Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Identify units of mechanical, thermodynamic, and fluid flow measurements.
2. Identify sources of measurement standards, both foreign and domestic.
3. Conduct uncertainty analysis. Define accuracy and precision, repeatability; modelling of errors, Gaussian normal distribution.
4. Conduct basic data manipulation skills using spreadsheets, plotting graphs, conversion of data formats.
5. Compare and contrast static and dynamic measurements.
6. Model instrument response using basic time series depictions.
7. Discuss state-of-the-art data acquisition software simulation systems.
8. Identify the key characteristics electrical measurements including current, voltage, power, power factor, peak, RMS values, single and three-phase
9. Compare and contrast various types and applications of meters.
10. Discuss the application of oscilloscopes.
11. Define methods for quantifying and minimizing measurement error.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Discuss the use of transducers for measuring force, strain, displacement, pressure, temperature, flow rate and flow velocity.
2. Apply transducers to measure angular and linear velocity and displacement, torque, acceleration.
3. Compare and contrast transduction mechanisms such as potentiometric, laser holography, infrared, ultrasonic, microwave/radar, piezoelectric, thermal electromagnetic, radiation, and Doppler.
4. Discuss methods for excluding unwanted signals using filters, amplifiers, and signal conditioners.
5. Apply digital analytical techniques to collected data.
6. Assemble measuring devices for most frequently measured oceanographic parameters.

7. Predict the accuracy limits of designed measuring devices.
8. Deploy and recover measuring devices under controlled conditions.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Construct custom measuring devices based on user specifications of accuracy and precision.
2. Deploy and recover sensitive measuring/monitoring devices safely, with minimal instrument failure under field conditions.
3. Instruct other marine technicians in the construction of measuring devices and instrumentation.

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

2001; U.S. Department of Commerce Vacancy Announcements (NOAA), Available from <http://www.rdc.noaa.gov/~hrmo/va-status.htm>

Technical Writing Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Understand basic computer operations, file manipulation, and troubleshooting techniques. (overlap statement with computer systems).
2. Demonstrate knowledge of grammar, readability and usability standards that are consistent with design.
3. Perform basic document editing using commonly used word processors.
4. Gather information to identify customer and audience requirements.
5. Demonstrate knowledge of interview techniques, including questionnaire preparation.
6. Demonstrate knowledge of outlining and conceptualizing techniques. Communicate concepts graphically and orally.
7. Conduct library research. Demonstrate knowledge of Dewey Decimal System.
8. Identify appropriate resources. Prioritize resources by relevance.
9. Conduct online keyword searches using search engines, and other commonly available Internet search utilities.
10. Consult with style manuals or composition preparation guidelines for composition format.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Prepare composition using common desktop publishing and graphics software packages (e.g., Pagemaker, Quark).
2. Demonstrate advanced knowledge of graphics preparation and formats.
3. Conduct advanced library searches including database searches, and information mining services.
4. Prepare composition plan.
5. Conduct live, email, or questionnaire interviews with subject matter experts.
6. Evaluate relevance and consistency of written material.
7. Demonstrate working knowledge of scientific documentation procedures and protocols.
8. Adhere to copyright laws. Obtain permission when using copyrighted material.
9. Demonstrate ability to apply numerous writing styles. Identify appropriate writing style that is consistent with composition purpose and audience.
10. Select and use graphics to communicate relevant points consistent with composition tone.
11. Apply advanced editing principles.
12. Tailor composition and layout for delivery media.
13. Obtain feedback on composition usability, presentation and technical accuracy.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Coordinate composition production specifications and proofing with printer and/or media producer.
2. Supervise production of composition including planning, research, writing, obtaining feedback, conducting usability tests, and distribution.
3. Provide advice on appropriate composition media, style and delivery. Understand the technical advantages and limitations of media and methodologies.
4. Create templates for marine technology content, including Internet publishing.
5. Prepare composition for web publishing. Understand technical advantages and limitations of web publishing.
6. Consult with web designers for composition style, layout, proofing and graphical presentation of web pages.
7. Transfer previously prepared compositions to advanced media (e.g., interactive CD-ROM, web page, presentation software).
8. Produce, edit and publish periodical organization newsletter or journal.

Machining and Fabrication Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Explain safety procedures applied to machine shop. Identify safety equipment including eye protection, apron, hearing protection, and respirator.
2. Identify safe procedure in the event of a fire or hazardous liquid spill.
3. Demonstrate proper conduct in a machine shop. Demonstrate safe operating procedures for all hand tools and power tools.
4. Demonstrate knowledge of technical drawings using fractional, dual or metric dimensioning. Identify types of drawings (e.g., detail, assembly, exploded).
5. Define tolerances and associated drawing symbols.
6. Demonstrate the proper use of a steel rule, caliper and other precision measuring devices. Demonstrate familiarity with precision measuring/inspecting devices such as gages, calipers, optical flats, micrometer, and lasers.
7. Demonstrate the proper use of hand tools such as vises, pliers, wrenches (including torque limiting wrenches), screwdrivers, striking tools, files, saws, taps, etc..
8. Demonstrate knowledge of various types of machine screws and bolts. Demonstrate use of other nonthreaded fastening devices including dowel pins, cotter pins, retaining rings, rivets and keys.
9. Demonstrate the safe and proper use of commonly employed adhesives.
10. Demonstrate the utility of open, closed and box jigs.
11. Compare and contrast types of cutting fluids including mineral oils, emulsifiable oils, chemical and semichemical fluids, and gaseous fluids.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Demonstrate the proper use of drilling machines including a drill press, a hand drill, radial drill press and magnetic drills. Demonstrate the proper procedure for countersinking, tapping, spotfacing, reaming and counterboring
2. Demonstrate use of various types of grinders such as a belt grinder, grinding wheels, dry and wet grinders.

3. Demonstrate the safe use of reciprocating, circular and band cutoff saws. Select the proper blade and set up machine for correct cut.
4. Safe turn stock to an exact standard using a lathe. Select proper cutting tools. Maintain and sharpen cutting tools.
5. Cut threads, tapers, bores, knurls, using a lathe.
6. Demonstrate knowledge of various types of milling machines such as fixed-bed and column and knee type. Discuss the types of milling cutters. Complete milling project to an exact tolerance.
7. Safely use the band saw. Perform for both internal and exterior cuts.
8. Demonstrate familiarity with machine numerical control and other computer-aided machining technology.
9. Describe the use of robotics and other advanced manufacturing tools in automated machining.
10. Demonstrate knowledge of metal types and properties. Compare and contrast the utility of various metals for machined application.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Produce high accurate machined pieces to exact standards in minimal time.
2. Manage a machine shop including safety, machine upkeep and operation.
3. Instruct other marine technicians in machining.
4. Conduct nondestructive quality control inspections on machined pieces. Use latest quality control tools such as X-ray, LASER, optical and fluorescent penetrants.

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

2001; U.S. Department of Commerce Vacancy Announcements (NOAA), Available from <http://www.rdc.noaa.gov/~hrmo/va-status.htm>

Machining Fundamentals, Walker, Jophn R., The Goodheart-Willcox Company, Inc.;
2000

Fluid Dynamics Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Describe fluid properties in terms of temperature, pressure, density, viscosity, and compressibility.
2. Describe the properties of flows in terms of pressure distribution and conservation of mass, momentum, and energy.
3. Calculate the forces exerted on curved and planar flow containers with relative flow motion and without.
4. Describe the steady state continuity equation and the Reynolds transport theorem.
5. Calculate flow velocity and volume rate of flow.
6. Describe fluid angular and volume deformation associated with rotation.
7. Compare and contrast the calculation of acceleration in Lagrangian and Eulerian frames of reference.
8. Utilize the control volume concept to solve steady state flow problems.
9. Calculate volume, flow, energy and momentum flux.
10. Calculate conduit boundary stress and the effects of conduit friction.
11. Compare and contrast laminar and unsteady flows.
12. Describe the behavior of liquid in the boundary layer.
13. Discuss useful dimensionless parameters used in fluid mechanics (e.g., Reynolds Number, Froude Number, Mach Number).
14. Describe flow characteristics around temperature, density, or salinity boundaries.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Predict and describe flow around bodies (streamlines, drag, lift).
2. Use the Pi theorem to derive dimensionless numbers.
3. Describe and predict points at which flow will become turbulent.

4. Predict the effects of channel shape, depth change, and the effects of upstream and downstream obstructions on open channel flow.
5. Determine the free surface profile of open channel flow.
6. Calculate open channel resistance.
7. Predict flow properties in given conduit size shape and material.
8. Measure properties of flow such as velocity, temperature, pressure, volume rate of flow, etc. Compare with predicted results.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Predict equipment performance including pumps and turbines.
2. Describe the design and use of common current meters and other ocean flow measuring devices.
3. Deploy, monitor, and maintain flow measurement devices (e.g., current meters, pressure sensors, ADCP)
4. Assist in the design of controlled flow systems such as channels, pipe systems and aqueducts.
5. Instruct other marine technicians in basic fluid dynamics.

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

2001; U.S. Department of Commerce Vacancy Announcements (NOAA), Available from <http://www.rdc.noaa.gov/~hrmo/va-status.htm>

Fluid Mechanics Fundamentals, Debler, W.R., Prentice Hall; 1990

U.S. Navy Training Manual, *Fluid Power*, NAVEDTRA 12964.

Propulsion Systems Competencies

A. Basic Competencies - Skills most potential employees would be expected to possess

1. Name common classifications of marine propulsion systems.
2. Compare and contrast diesel, boiler, and gas turbine engines.
3. Identify the practical and necessary components found in all marine systems.
4. Identify the following terms associated with boilers; Operating pressure, psia and psig, Natural circulation, Atomization, Saturated steam, Conduction, Flash point, British thermal unit (Btu)
5. Describe the safety precautions to be observed when lighting off a boiler.
6. State the four phases of the basic steam cycle.
7. Explain the two methods of chemical treatment for waste heat boilers.
8. Describe the protective function of each of valves, expansion joints, shutters and shutoff devices.
9. Describe schematically a split plant diesel engine propulsion system.
10. Describe the concept behind engine cycles two and four stroke engines), compression, ignition, and displacement.
11. Describe methods and devices for engine control and monitoring.
12. Describe types of air intake silencer/cleaner commonly used with marine engines.
13. Describe starting mechanisms associated with diesel engines such as electric, hydraulic, and air starting.
14. Identify common heat exchangers (coolers) used with marine classes of engines.
15. Discuss types of governors associated with common marine systems such as mechanical and hydraulic governors.
16. Discuss methods for introducing fuel into marine propulsion systems.
17. Describe the following terms associated with an engine air system: back pressure, exhaust stroke, intake stroke, scavenging, supercharging, and turbocharging.

B. Intermediate Competencies - Skills many potential employees would be expected to possess

1. Demonstrate good housekeeping practices of engineering spaces.

2. Demonstrate safety precautions to be followed when working with rotating machinery.
3. Practice the proper handling and storage of hydraulic fluids and synthetic lubricants aboard a vessel.
4. Describe precautions take in the engineering spaces during heavy weather.
5. Demonstrate firefighting procedures for an engineering space fire. Demonstrate precautions take in the event of a fuel leak.
6. Safely demonstrate methods for lubricating marine systems and associated machinery (e.g., reduction gears).
7. Identify routine maintenance using common maintenance tracking systems.
8. Closely monitor safe operating temperatures of engineering spaces.
9. Conduct planned maintenance on major components of common marine systems.
10. Compare and contrast commonly used propulsion systems used in the U.S. merchant and research fleets.

C. Specialized Competencies - Skills some potential employees would be expected to possess. These competencies are skills acquired primarily through experience or advanced education.

1. Plan and oversee major overhauls on propulsion systems.
2. Oversee the planned/preventative maintenance program for vessel propulsion systems.
3. Supervise all aspects of a vessel's engineering spaces including primary and secondary propulsion.
4. Supervise engineering activities of multiple vessels including primary and secondary propulsion.
5. Instruct other marine technicians in maintaining propulsion systems.

References:

Knowledge and Skill Guidelines for Marine Technicians Who Work Aboard Research Vessels - MATE Center, 1998.

Knowledge and Skill Guidelines for Hydrographic Survey Technicians - MATE Center, 2000.

Knowledge and Skill Guidelines for Aquaculture Technicians- MATE Center, 1999.

Knowledge and Skill Guidelines for Oil Spill Response Technician - MATE Center and ATEEC, 1995.