

The Status of Skilled Trades Training  
in U.S. Shipyards

U.S. DEPARTMENT OF TRANSPORTATION  
Maritime Administration

in cooperation with  
The University of Michigan

# Report Documentation Page

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THE STATUS OF  
SKILLED TRADES TRAINING  
IN U.S. SHIPYARDS

Prepared for  
NATIONAL SHIPBUILDING RESEARCH PROGRAM

by  
SOCIETY OF NAVAL ARCHITECTS & MARINE ENGINEERS  
SHIP PRODUCTION COMMITTEE  
EDUCATION AND TRAINING PANEL

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## FOREWORD

U.S. shipyards seeking to acquire commercial shipbuilding or repair contracts face competition from two fronts: other domestic shipyards and shipyards in foreign countries.

Ship owners are concerned with delivery time, costs, and quality of work. Japan and Korea, implementing technological advances and having lower wage scales (among the major factors), are currently enjoying a substantial market share of ship construction and repair. Concurrently, a number of smaller countries, such as Singapore and Sri Lanka (Ceylon), have ship repair facilities and are actively seeking to expand their share of this lucrative market.

These countries can offer advantages of low labor rates and relatively rapid work completion. In the area of labor costs, U.S. shipyards have essentially priced themselves out of the market. Thus, they must look for other means to achieve or maintain a competitive edge. Training affords just such a means.

Training of shipyard workers can affect many areas of productivity, such as the application of newer technologies, improved work quality, and more efficient time and material usage. Commercial yards are introducing new technologies through the National Shipbuilding Research Program, including Japanese technology and management ideas. Some of these technologies emphasize design and manufacturing integration; others emphasize detailed work organization and planning. The use of these methods opens up training needs for the new knowledge and skills at the apprentice, mechanic and managerial levels.

This report and the companion Directory of Skilled Trades Training Courses and Training Aids in U.S. Shipyards together list available training in U.S. shipyards and assess remaining opportunities for training.

Appreciation goes to the many individuals and organizations who contributed to the creation of this directory and report. Additionally, special thanks go to all those shipyards (as indicated in Appendix 2) which elected to participate by responding to the survey instrument (displayed in Appendix 3).

We wish to acknowledge the advice provided by:

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- Newport News Shipbuilding,
- Norfolk Naval Shipyard,
- Norfolk Shipbuilding and Drydock,
- Todd Shipyards/Los Angeles,
- and Todd Shipyards/Seattle.

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## I. INTRODUCTION

**Shipbuilding**, with its attendant conversion and repair operations, is an industry that relies heavily on modern technology and skilled labor. Training is necessary to introduce shipyard personnel to the fundamental skills and technological advances of each trade as they relate to shipbuilding and repair.

Training provides the shipyard with a vital link to efficient and high quality work performance. The apprentice is trained in the fundamental skills of a trader the journeyman receives training to upgrade those skills and remain aware of the relevant technological changes and the manager is trained to introduce and improve upon managerial skills as well as trade related issues.

However, due to the costs and manpower needed to administer such training programs, it appears that it is primarily the larger yards with Navy contracts (essentially having the Navy subsidize the training by allowing the yard to include it as overhead) that can afford to offer formal, systematic training programs to their trades employees at all levels.

### A. PURPOSES

The purposes of this project were twofold. The primary intent was to determine, through a survey, the status of trades training at all levels in private U.S. shipyards. In turn, the results of the survey were used to indicate where the need exists to improve training programs, primarily by level of training. A secondary purpose was to develop a directory of current trades training programs in private and Navy shipyards, to be made available to all shipyards.



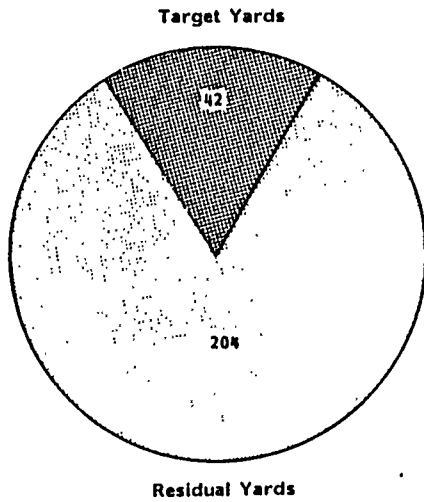
## B. PLAN OF ACTION

The trades training information was obtained primarily via a written survey instrument which is displayed in Appendix 3. The survey sample consisted of 246 shipyards in the United States, and was divided into a 'target' group and 'non-target' group, as shown in Figure 1. The target group was composed of 42 large yards, 35 of which were identified by the Navy as having capacities and/or special capabilities vital for mobilization. As shown in Figure 2, the target group was subdivided into 8 Naval shipyards, 12 "primary" shipyards (having the capacity to handle large vessels for construction and/or repair), and 15 "secondary" yards (having specialized capabilities). In order to broaden the target sample, 7 "additional" yards were added due to their specialized capabilities.

The non-target group included 204 private shipbuilding and repair yards that were identified in the document "Shipbuilding and Repair Facilities in the United States," published jointly in November, 1981 by the Department of Defense and the Maritime Administration. A complete description of the survey sample and design is presented in Appendix 1. Shipyards are listed in Appendix 2.

To identify specific directors of training, all 42 shipyards in the target sample were contacted prior to mailing the survey. To encourage response, telephone calls were placed to yards after the survey instrument was sent. This proved beneficial in increasing the number of participating yards. In addition, on-site visits were made to eight yards in the sample, in order to discuss the survey, to review their training programs, and to obtain applicable training information. Progress reports were made to members of the Ship Production Committee, Panel SP-9 (Education), throughout the project.

### SHIPYARD TRAINING SURVEY



Note: The shipyards were divided into two groups depending on size.

Figure 1. Classification of Shipyards Contacted

### SHIPYARD TRAINING SURVEY

#### TARGET SHIPYARDS

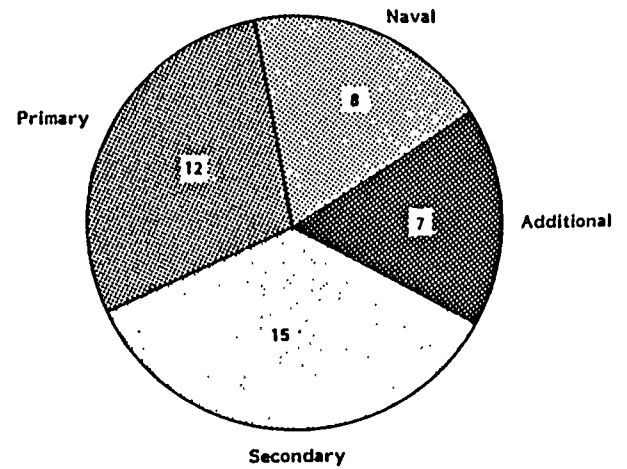


Figure 2. Target Shipyard Breakdown

## II. SURVEY RESPONSE LEVELS

Of the 246 shipyards in the total sample, 57 yards, or 23 percent, responded to the questionnaires sent them. However, out of the target sample of 42 yards, 27 shipyards elected to participate: a 64 percent response rate. The lower participation percentage from the non-target sample (15 percent, or 30 out of 204 yards) can be attributed to several factors. These yards were not given the personal attention (on-site visits, follow-up phone calls) that the target yards were given. Another cause for the lower response level is that the questionnaires were addressed to the "Director of Training" rather than specific individuals. Thus, some of the questionnaires might not have reached the appropriate individual, or might have been routed to an individual unable to provide the information. The smaller yards comprising the non-target sample were less likely to have training programs, and were less likely to respond to the survey.

Figure 3 displays the response of the target sample according to the four classifications. From this figure, it can be seen that 19 of the 27 responding yards (70 percent) within the target sample indicated that they have formal trades training programs. Five of the eight Naval shipyards responded, but it was determined that all eight had training programs. Eight of the eleven primary shipyards that responded had training programs, but only three of the secondary yards that responded provided training. Out of the seven additional shipyards, four responded and three had training. Of the 30 residual shipyards that responded, only seven (23 percent) provided training. In summary, formal training was provided at 26 shipyards, or 46 percent of the 57 yards that responded to the survey.

The following three subsections provide further analysis of the survey results based on the size of the shipyard, private vs. Naval shipyards, and reported course hours differential for training programs.

# SHIPYARD TRAINING SURVEY

Survey Response: 42 TARGET SHIPYARDS

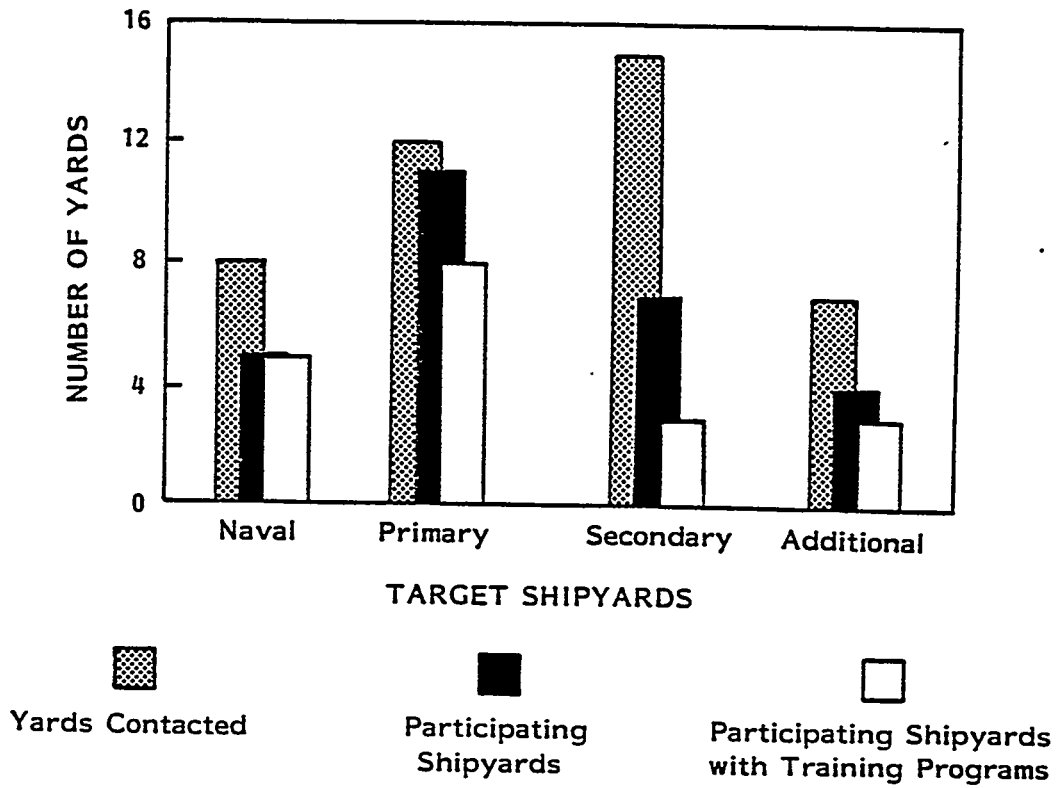


Figure 3. Response of Target Yards

#### A. SIZE OF SHIPYARD

The amount of training provided and the number of trades employed are generally related to the size of the shipyard. Training is an expense, and while having a vital impact on productivity and work quality, many smaller shipyards believe they cannot afford the cost. Thus, they are more inclined to rely on hiring skilled labor, or simply to depend upon on-the-job learning.

Total employment figures within the industry have been declining, and new hires have become less frequent in the 1980's. As a result, there is a growing pool of unemployed, skilled workers, available for hire when yard work flow peaks. This pool of unemployed workers reduces the need for larger systematic training programs, and many yards have either limited or suspended their training. Smaller yards, however, have been more likely through the years to hire already skilled labor rather than carry expensive training programs as an overhead item. Thus, they historically have not provided formal training programs, nor is there incentive for them to begin to train, given the current pool of unemployed tradesmen.

In late 1983, a common expression relating to shipbuilding was, "The Navy is the only game in town." The shipyards with Navy contracts for ship construction (and/or conversion and repair) tend to be larger yards or specialized shipyards. For example, shipyards such as Newport News Shipbuilding and General Dynamics/Electric Boat Division are assured of a continuing stream of Navy contracts because they have facilities to construct nuclear-powered vessels. The larger Navy contract yards, as well as Navy shipyards, are more active in training due to subsidized training programs and continuing work-load.

#### B. PRIVATE VS. NAVAL SHIPYARDS

While the private shipyards tend to vary training levels according to their size and work load, the Naval shipyards maintain training levels regardless of short-term work fluctuations.

Naval shipyards have developed extensive training programs for their skilled trades employees, especially apprentices (see Section IV for further information on apprentice training). The Naval shipyards not only have training programs, but also tend to share information and training programs with other Naval shipyards. Naval shipyards have an edge over the private shipyards in developing and administering skilled trades training programs because of continuity of financial support and essentially steady work force levels.

#### C. COURSE HOURS DIFFERENTIAL

The Directory of Courses (in the companion Directory of Skilled Trades Training Courses and Training Aids in U.S. Shipyards) indicates a wide variation of training hours in a specific trade between the various shipyards. For example, with the trade of painter, General Dynamics/Quincy has an 8,000 hour apprenticeship, while a sister company, General Dynamics/Electric Boat Division has a 432 hour apprenticeship program. Other yards vary from 126 hours to 6,144 hours for apprenticeship training in the same trade category. There are many low-hour training times listed, such as 2- or 3-hour blocks.

It appears that the vast difference in number of hours for various training programs is partially explained by the manner in which the individual shipyards elected to respond to the survey, e.g., whether the respondent indicated as one item an entire apprenticeship at 8,000 hours, or indicated the specific items of training within the 8,000 hour training, say a 4-hour course.

### III. IDENTIFICATION OF TRADES

Shipyards employ numerous skilled trades to construct and repair ships; and, because names of trades tend to vary between shipyards, an objective of this project has been to identify essential skilled trades that are common to the building and repairing of ships. A definition for 23 trades was provided in the survey questionnaire to bridge the gap of varying trade names, and respondents were asked to list and describe other trades they employ that were not included among those described.

#### A. DIRECTORY OF TRADES

Appendix 4 lists and defines the various trades identified during the project and included in the directories of the companion publication. The 23 trades described in the survey instrument are:

- |                          |                           |
|--------------------------|---------------------------|
| 1. A/C Equip. Mech.      | 13. Machinist (Inside)    |
| 2. Blaster               | 14. Machinist (Outside)   |
| 3. Boilermaker           | 15. Ordnance Equip. Mech. |
| 4. Carpenter             | 16. Painter               |
| 5. Chipper/Grinder       | 17. Pipefitter            |
| 6. Electrician (Inside)  | 18. Rigger/Crane Operator |
| 7. Electrician (Outside) | 19. Sheetmetal Mechanic   |
| 8. Electronics Mechanic  | 20. Shipfitter            |
| 9. Electroplate          | 21. Shipwright            |
| 10. Insulator            | 22. Tacker/Burner         |
| 11. Joiner               | 23. Welder                |
| 12. Loftsmen             |                           |

Based on the survey response, 6 additional trade training categories were identified and added to the directories:

- |                          |                     |
|--------------------------|---------------------|
| 1. Pipewelder            | 4. Molder (Foundry) |
| 2. Electrician (General) | 5. Patternmaker     |
| 3. Machinist (General)   | 6. All Trades       |

Training for "all trades" primarily contains courses relating to safety, shipyard Orientation, and general supervisory skills.

Figure 4 On the following page indicates the top trades in terms of number of employees per trade, based on the response of 14 different yards providing data on a total of 25 trades. This figure shows that the three trades highest in employment figures are welders, pipefitters, and shipfitters.

As mentioned previously, trades names can vary between shipyards, and certain trade descriptions can include tasks (in part or in whole) of other trades. For example, some shipyards differentiate between blasters and painters, while other yards treat these as one trade. Trade classifications are also determined by yard sizer where smaller shipyards are less likely to have categorized trades into highly specialized groupings (such as Navy categorizations) and by management preferences.

"Loftsman" was once a skilled trade involved with lay-out of ships to full scale, but has been replaced in most shipyards by Computer Aided Design (CAD). In addition, Computer-Aided Manufacturing (CAM) has reduced the number of layout people required in, for example, the steel fabrication areas and material control. The two fields are inter-related, and depending upon the extent of automation, can be fully integrated into a CAD/CAM system.

Long Beach Naval Shipyard, in an effort to broaden its trade designations and to expand the narrow trade/job focus, has now incorporated their chipper/grinder trades into the shipfitter trade, carpenters and joiners into the shipwright trade, and burner/tackers into the welding trade. At Newport News Shipbuilding, the four trades highest in terms of training are shipfitters, electricians, machinists, and pipefitters.

Figure 5 on page 11 indicates the number of yards out of the 57 responding yards which offer training programs for each trade listed. There is a wide variation in the number of training programs for various trades. For example, shipfitters are offered training by 16 of the 57 yards, but a formal electroplating training program is offered by only one of the 57 yards.



# SHIPYARD TRAINING SURVEY

MAJOR TRADES, 1983

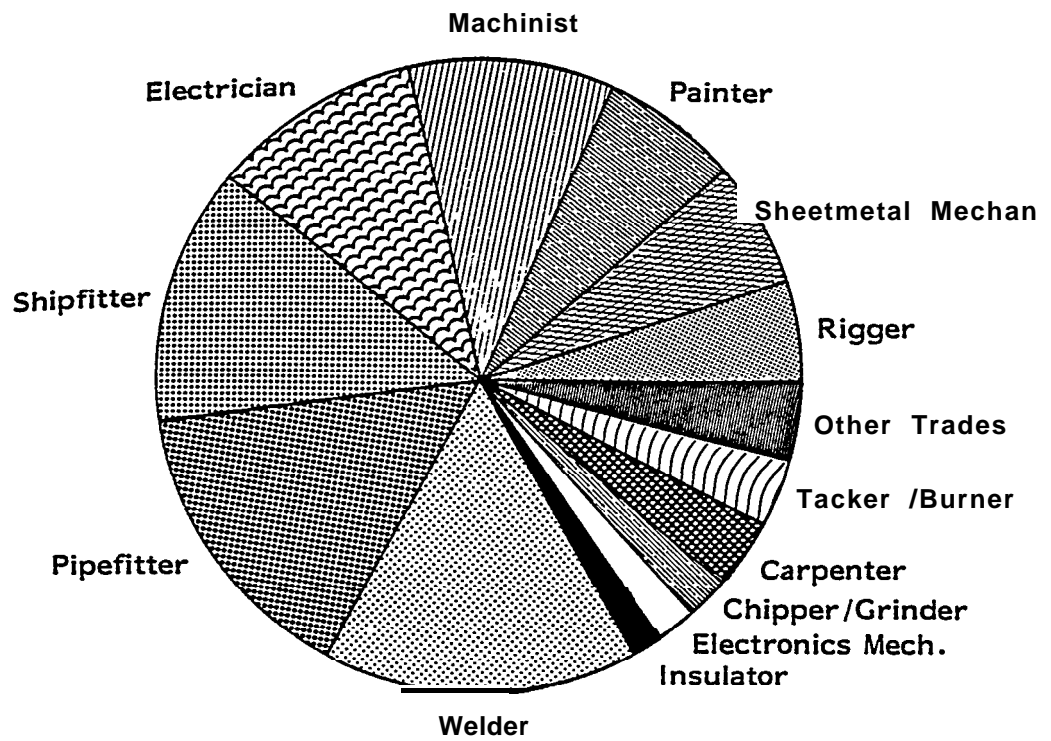


Figure 4. Relative Number of Employees Per Trade

# SHIPYARD TRAINING SURVEY

## TRADES TRAINING AT PARTICIPATING SHIPYARDS

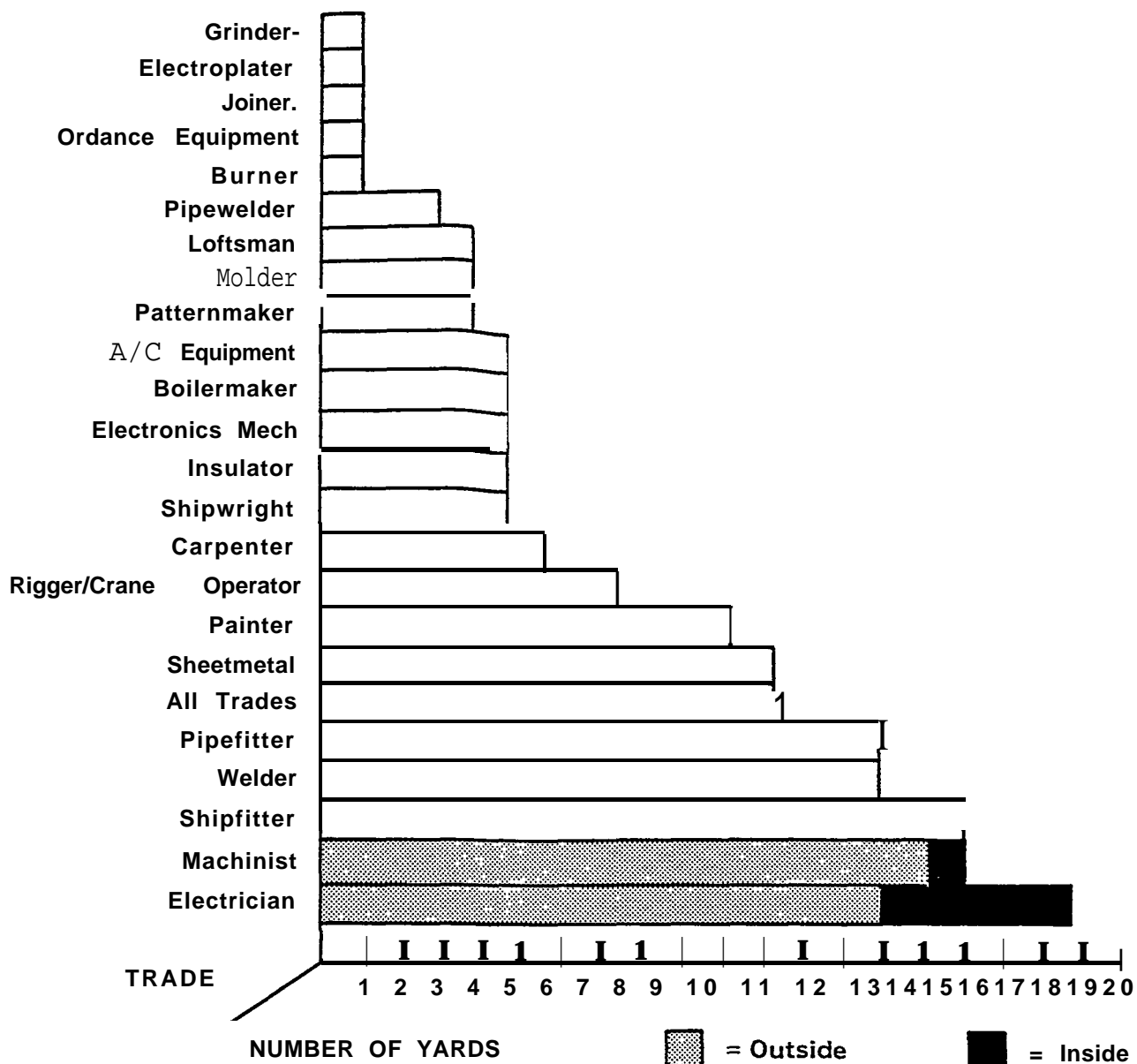


Figure 5. Formal Trades Training at 57 Responding Shipyards

When examining the Directory of courses and hours of training provided for each trade, some explanation and qualifications are needed. Although certain trades are typically provided with more training than other trades, two shipyards (Philadelphia Naval Shipyard and General Dynamics/Electri, goat Division) replied to the survey in a much more detailed fashion than did other responding shipyards. Thus, the trades for which these two organizations offer formal training have more extensive course listings (in the companion Directory of Skilled Trades Training Courses and Training Aids in U.S. Shipyards) than the other trades do. Appendix 6 provides information on directory trades for which these two organizations offer formal training programs.

To illustrate, some training programs teach skills common to more than one trade. Newport News Shipbuilding operates a separate Welding School. This school, which divides the trade of welding into over 200 tasks, serves not only the large number of welders at the yard, but also trains other trades which may require certain welding skills. For example, sheetmetal mechanics and shipfitters learn tack welding at the Welding School.

#### B. TRADES EXCLUDED FROM DIRECTORY

Additional trades which were identified by survey respondents but were excluded from the companion Directory of Skilled Trades Training Courses and Training Aids In U.S. shipyard are listed and described in Appendix 5. A majority of these were submitted by the Naval shipyards and are indicative of the highly specialized focus of their skilled tradesmen. Note that the trade classifications among Naval shipyards are similar due to the orientation of their responsibilities (repairing and maintaining vessels in a combat-capable posture) as well as to the uniformity required by the civil service rating system. As a result of the Navy's specialized focus, there is a need for certain skills that are not demanded in the private shipyard sector.

One shipyard submitted training information for the trade of drafter (one who prepares engineering drawings). This is an occupation common to shipyards, but it is assumed the other respondents placed it with the engineering group. The balance of these excluded trades are all very specialized. The various trades associated with the electrical group would likely be trained as part of the broader trade of 'electrician' in those shipyards that have a 3 or 4 year apprenticeship program for electricians. The same applies to 'milling worker, 'wharfbuilder, ' and 'woodcrafter' - all spin-off trades of carpenter. However, in the case of wharfbuilder, a fair amount of heavy machinery training and expertise may also be required.

#### C. VARIABLES AFFECTING TRADE REQUIREMENTS

Several factors affect the trade skills required by a given shipyard. One is whether the yard builds weapons systems on Naval ships, which would require an ordnance equipment mechanic. Type of construction or repair, as well as whether the shipyard deals with nuclear vessels, are all factors that affect what trade skills will be required.

As mentioned earlier, the number of trades employed and trained in a shipyard is affected by the yard's organizational structure. Some yards prefer highly specialized trade categories, thus opting for more trades, while other yards prefer less specialized, and therefore fewer, trades. Smaller yards tend to fall into the latter category, and non-union yards generally have less specific trade categories than the union shipyards.

#### IV. APPRENTICESHIP PROGRAM

The majority of the responses to this survey (86 percent) dealt with apprenticeship training and including both academic and trade theory courses. This response frequency is due to the focus of shipyards on entry-level training programs, and the apparent ready accessibility of information. While undoubtedly more training is done at the apprentice level, it is also, generally a more planned effort than perhaps sporadic upgrading, refresher, or management courses at the upper levels. It is also much easier to conduct training courses with newly hired employees, than to train a group of current employees by temporarily removing them from their productive positions.

##### A. NAVAL YARDS

The eight U.S. Naval yards all offer four-year apprentice training Programs for a variety of trades. There are currently about 7,000 apprentices employed in over 50 designated trades. The Navy is the largest apprentice trainer, and in 1983 spent about \$150 million on all training needs in the Naval shipyards (this figure includes training other than at the apprentice level). Naval shipyards in general provide their employees with more job security than private shipyards as they are part of the federal civil service system. As a result, there is greater employment stability, and the Navy can therefore afford to invest more heavily in formal training.

##### Training Modernization Program

In a massive effort to upgrade apprentice training (civilian workers) in U.S. Naval shipyards, the Training Modernization Program was initiated in 1981. The intent was to eliminate current training method deficiencies by focusing upon job requirements, and to ensure that all Naval shipyard training is

cost-effective, efficient, and job-related. The stated goal of Naval shipyard training is to assure that the immediate job at hand will be done correctly the first time to avoid costly and time-consuming rework, and to achieve a high degree of quality.

This Program falls under the Department of the Navy, Naval Sea systems Command (NAVSEA). The support structure is as follows:

- o 2 Training Support Centers
  - (Mare Island Naval Shipyard)
  - (Norfolk Naval Shipyard)
- o 2 Video Production Centers
  - (Pearl Harbor Naval Shipyard)
  - (Norfolk Naval Shipyard)
- o 1 Media Center
  - (Norfolk Naval Shipyard)

To develop model training packages, each of the eight Naval shipyards was assigned two trades (see below).

Portsmouth NSY	- Shipfitter
	- A/C Equipment Mechanic
Philadelphia NSY	- Machinist (Inside)
	- Insulator
Norfolk NSY	- Welder
	- Rigger
Charleston NSY	- Machinist (Outside)
	- Electroplate
Long Beach NSY	- Boilermaker
	- Electrician
Mare Island NSY	- Pipefitter
	- Fabric Worker
Puget Sound NSY	- Sheetmetal Mechanic
	- Shipwright
Pearl Harbor NSY	- Electronics Mechanic
	- Painter

(Louisville Naval Ordnance Station was assigned the trade of Ordnance Equipment Mechanic).

These 17 trades were selected for the initial program, based on the relative number of apprentices employed in each trade. Together, these 17 trades employ approximately 85 percent of the total apprentice population in the Naval shipyards.

The training approach used in this Program is Instructional Systems Development (ISD) - a systematic method for designing, developing, and evaluating training. Each trade is broken down according to relevant duties, then to the tasks applicable to those duties, and finally to the elements of each task. Each unit of training is based on a specific task (called 'training module'). Different trades may utilize the same task, and can use the same training module.

In developing their training modules, the training leader from each Naval shipyard is expected to have obtained information from all the other Naval shipyards pertaining to that particular trade. When completed, these training modules will have applicability in all the Naval shipyards, with the advantage of being able to mix and create modular packages for specific needs. The module training plans will include the apprentice training plan, trade theory lesson plans and syllabi, and applicable training aids.

It is estimated that 85 percent of the training modules for these 17 trades will be completed by 1986. When these become available, it will eliminate the need (and cost) for each Naval shipyard to develop training programs for each trade. Concurrently, with proper management, the training modernization program for apprentices will have the capacity to increase overall trade knowledge and skill competence, as well as coordinating the programs of 8 different shipyard entities.

#### B. PRIVATE SHIPYARDS

The larger of the private shipyards indicated apprentice training programs that rival those in the Naval shipyards. The Naval apprenticeship is a four-year program (8,000 hours), but Newport News Shipbuilding, General Dynamics/Quincy, and Dravo Corporation

all indicated that they offer some 8,000-hour apprenticeship programs. A three-year program (6,000) is also quite common, and illustrated by the response of Bath Iron Works, Ingalls Shipbuilding, and Bethlehem Steel/Sparrows Point. While these extensive apprenticeship programs are indicative of the larger private shipyards, they are not typical of most private shipyards, where little or no training is done.

Another source of apprentice training is through the unions. In the Seattle, Washington area, several shipbuilding unions provide training; for example, the International Brotherhood of Electrical Workers, Local #46 provides a three-year (6,000 hour) apprentice program in the electrician trade for employees of:

- Todd Shipyards/Seattle
- Lockheed
- Marine Power
- Duwarnish
- Marco Shipbuilding
- Foss Tug

Monies are set aside by these yards (2 cents per man-hour) to be applied to the apprentice training fund. (The union also provides upgrading courses at the journeyman level.)

#### Model Apprentice Program

Of all the private U.S. shipyards, Newport News Shipbuilding is regarded as having a superior apprentice training program and is detailed in Exhibit 1 for illustration. As one of four departments under the Newport News Training and Development Division, the Apprentice School has 15 full-time academic instructors and approximately 75 full-time craft instructors. Trades apprentices have a four-year (8,000 hour) training program, combining both academic and trade theory learning. Appendix 7 provides a list of Newport News trades with formal training at the apprentice level.



Apprentice training levels at Newport News Shipbuilding are currently being maintained, and this yard does not appear as affected as many shipyards in the general industry slump. Although commercial work has drastically diminished, Newport News Shipbuilding continues to benefit from its historic Navy orientation, as well as being one of the two private shipyards with nuclear capabilities. A significant point to remember when viewing the positive posture of Newport News Shipbuilding is that their training emphasis and capabilities enhance this shipyard's level of competitiveness - both in maintaining highly trained personnel to do the work, and in providing the technical expertise the training imparts for complicated vessel construction.

## V. MECHANIC TRAINING

The mechanic level (journeyman, leadman, etc.) is reached either upon completion of the apprentice program or by prior experience in the trade comparable to an apprenticeship. This level lies between the apprentice and manager (defined as first-line supervisors and up). Often, the mechanic helps in the training of apprentices through informal on-the-job assistance. In some cases, mechanics provide formal on-the-job training and supervision when an apprentice is assigned to work with him for a specified period of time.

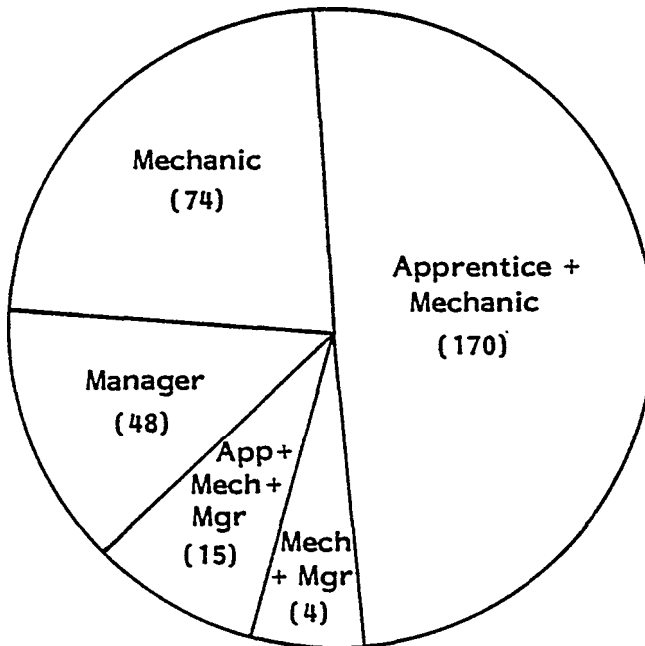
There is less need for a systematic program of training at the mechanic level than at the apprentice level, as it is assumed that the mechanic has an adequate grasp of the various skills required to perform his duties and is working productively while continuing to improve his skills.

Mechanic training includes refresher training, skills upgrading, or more general training (such as safety classes) provided in conjunction with the apprentice and manager-level training. Generally, the amount of skills upgrading training will depend on (1) the technological advances in the particular trade, (2) the introduction of these advances into the work cycle, and (3) how often other changes in shipbuilding methods are implemented. Once a mechanic has perfected his skills, the next step is to move into management, provided he has achieved the required knowledge and competency, and has the desire to assume further responsibilities.

<sup>1</sup>For the purposes of this report, the term 'mechanic' is employed to define that area of expertise between the apprentice and management levels. A mechanic is a master craftsman in any trade, and encompasses titles of journey man, leadman, master mechanic. This term was used in the survey to circumvent inconsistency of titles between the various shipyards.

## SHIPYARD TRAINING SURVEY

### BREAKDOWN OF MECHANIC AND MANAGEMENT COURSES



Total = 311 Courses

Figure 6. Formal Training Courses Above the Apprentice Level

Figure 6 provides a numeric summary of courses found in the Directory of Courses (part of the companion Directory of Skilled Trades Training Courses and Training Aids in U.S. Shipyards) which are not exclusively for the apprentice level. Four courses were listed as applicable to both mechanics and managers, while 15 were offered to all 3 levels: apprentices mechanics and managers.

The 170 courses given to apprentices and mechanics were provided by General Dynamics/Electric Boat and Philadelphia Naval Shipyard for the trades of carpenter, outside electrician, machinist, outside machinist, pipefitter, and welder. The 74 courses given exclusively for mechanics were provided by General Dynamics/Electric Boat for the trades of grinder, pipewelder, and shipfitter.

Because the number of shipyards providing information on mechanic training is small (see above paragraph ), it is difficult to assess the training needs in the various trades at this level. However, assuming that the reason so little information was provided regarding mechanic training is that there are relatively few programs or courses available at this level, then it would appear that training of mechanics is an area that needs upgrading. Since apprentices are trained in the basic skills, as well as in the technologies and techniques of newer, more advanced equipment, it is possible that in time apprentices might be more competently trained with new equipment and its operating procedures than the mechanics and managers who supervise them. Thus, a manager who received the bulk of his formal trade training 20 years ago could be at a disadvantage unless he has taken relevant refresher courses.

## VI. MANAGEMENT TRAINING

On a typical career path, a tradesman in a shipyard will begin as an apprentice, where he learns the trade fundamentals; he then progresses to the mechanic level, where his trade skills are refined; and he may eventually move into a supervisory capacity. New skills, beyond knowledge of the trade, are required as the mechanic becomes a manager (first-line supervisor, etc.); training for these management skills should be provided to make the new manager more effective in his new capacity. A highly skilled painter does not necessarily make a good manager - but training can help bridge the gap. This vital training is not with courses such as "How to Write Memos" or "Ordering Office Supplies," but with more technical courses which enable a manager to stay abreast of technological/production changes, and become an effective motivator of the employees under his control.

### A. SURVEY RESULTS

Although the need for management training is clear, there appears to be relatively little formal training in this area in U.S. shipyards. In the entire Directory of Courses, there are only 67 courses offered to managers, as illustrated in Figure 5. Of these 67 courses, 15 are offered to all levels, and only 4 are offered to both mechanics and managers. A total of 48 courses in the directory are given exclusively to managers.

The information provided by the survey on management training does not appear to be totally inclusive, although it represents a gauge by which shipyard emphasis on managerial training can be measured. These results point to the inadequacy in U.S. shipyards of formalized training at the management level. A synopsis of some management training programs at principal shipyards is provided in the following section.

## B. PROGRAMS IN PLACE

Newport News Shipbuilding offers a one-year Industrial Management Program (approximately 60 academic quarter hours). This training is provided to a select number of graduates from the Apprentice School, approximately 25 each year. This is a fast-track program from the apprentice level to first-line supervisor.

Long Beach Naval Shipyard also has a training program dealing with management skills. This is the Shipyard Intern Program for Supervisors (SHIPS), which is a 15-week supervisory training course. The individuals are rotated through all shipyard departments, receiving both hands-on and academic experience.

The Department of the Navy, Naval Sea Systems Command (NAVSEA) is currently developing plans for a training program for managers similar to the Training Modernization Program for apprentices (see Section IV). The audience for this training will be the 6,600 supervisors in the Naval shipyards. The approach will be similar to the apprentice program, and will deal with manager's duties and tasks. The program is expected to be completed by 1987.

### Sample Program

Bath Iron Works has a one-week Management Development Program, offered to leadmen ("mechanic") in the various trades and is aimed at training leadmen to become efficient first-line supervisors. The program covers the topics on the following page.

Bath Iron Works  
Management Development Program  
Topics

1. Marine Marketing
2. Labor Systems/Time Cards
3. Labor Relations
4. Material Systems Control
5. Material Handling
6. Industrial Health Procedures
7. Cost Proposals/Estimating
8. Scheduling/Planning/Work Package Budgeting
9. Change Order Estimating
10. Purchasing
11. Lab and Testing
12. Engineering
13. Management
14. Material System Program
15. Tool Crib
16. Public Relations
17. Motivation/Leadership
18. Communications
19. Decision Making
20. Supervising
21. Safety
22. Budget
23. Quality Assurance/Inspection
24. Industrial Engineering
25. Employee Benefits

From the topics listed, it is apparent that training at Bath Iron Works for first-line supervisors consists not only of supervisory skills, but also includes budgets, materials, facilities, and work scheduling areas. The manager requires additional knowledge from that of the apprentice or mechanic. Appropriate training is an efficient means of imparting the necessary knowledge.

## VII. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSIONS

Based upon survey response and analysis, we find the following:

- Training in U.S. shipyards appears to be primarily oriented toward apprentice training rather than skills upgrading at the journeyman level or for management training. Of the 870 training courses identified in the survey, 729 courses, or 84 percent, were designed for apprentice programs.
- The Navy yards and the largest private yards, which are historically Navy oriented, have the more extensive skilled trades training programs, and are the yards which are maintaining trades training at the current time.
- The eight Naval shipyards are cooperating with the Naval Sea Systems Command in upgrading the apprentice training programs for 17 principal trades. This Training Modernization Program, initiated in 1981, can serve as a model for cooperative training for the National Shipbuilding Research Program.
- Smaller shipyards (as part of the non-target sample) responded to the survey of skilled trades training programs at a much lower rate (15 percent) than larger, target yards (64 percent), and only 23 percent of the smaller yards that responded provided training. This survey result underscores the low emphasis on training by the small, private yards in the industry.
- Currently, due to a cadre of unemployed skilled tradesmen which comprise a trained labor pool, smaller shipyards have reduced their need for training (commonly heavily oriented to the apprentice level) as they can obtain qualified workers even as new-hires.



- A total of 28 major shipbuilding trades were identified during the survey, but a number of other trades are utilized in the industry. In general, the trades required at a shipyard appears to be a function of the type of construction or repair done and the degree of specialization of trades identified in the yard's organizational structure.
  - Unions provide apprentice training for some private shipyards. Any consideration of upgrading the overall level of training in the shipbuilding industry should include the trade unions.
  - Few yards appear to have a systematic program for skills upgrading at the mechanic level.
- Ž There is an inadequate level of first-line management training programs in U.S. shipyards, especially given the introduction of new shipbuilding technologies and the need for first-line supervisors to understand budgets, materials, work scheduling, and management skills as well as their traditional trade skills.

## B. RECOMMENDATIONS

The National Shipbuilding Research Program can help commercial U.S. shipyards to improve upon their training capabilities at the apprentice, mechanic, and management levels by implementing the following recommendations.

1. As many curricula do not reflect the new shipbuilding technologies such as line heating or accuracy control, the National Shipbuilding Research Program should establish appropriate trade training curriculum to be made available to the commercial yards. This action can help many yards to upgrade some archaic training programs and take advantage of newer technologies.
2. In order to coordinate apprentice training among yards, and avoid costly redundancies, the National Shipbuilding Research Program should help develop a program to coordinate apprentice training within the industry. Such a cooperative effort can help support yards currently without training programs, and help other yards to upgrade their training.

3. The National Shipbuilding Research Program should develop model curricula for first-line supervisors in both management skills and for upgrading trade specific technical skills. This action will help the U.S. shipyards to improve job planning, coordination of trade tasks, and all the other facets of the first-line manager's position.

## APPENDIX 1

### SURVEY SAMPLE AND DESIGN

#### THE SURVEY SAMPLE

To gather trades training information in U.S. shipyards, 246 shipyards were surveyed. The total sample was broken down into a target group and a non-target group.

The target sample selected was based on the Naval Sea Systems Command's (NAVSEA) classifications of the most viable yards for military mobilization purposes. These are:

"Naval" Yards (8)

"primary" Yards (12): yards with the capacity to handle large size vessels for construction and/or repair.

"Secondary" Yards (15): including those yards with specialized capabilities.

"Additional" Yards (7): although not part of the NAVSEA principal classifications, these were added due to their specialized capabilities in order to broaden the target sample.

Of the total target sample (42 shipyards) 27 yards responded; a participation rate of 64%.

The additional 204 shipyards surveyed were identified through the publication "Shipbuilding and Repair Facilities of the United States" (Department of Defense and the Maritime Administration; November, 1981). This publication lists shipyard facilities in two sections according to the maximum vessel size each shipyard is capable of constructing and/or repairing. The two sections are designated as vessels over 400 feet in length, and vessels 150 to 400 feet in length. Refer to Appendix 2, Part B for the shipyards in this segment.

The survey was sent to the 204 shipyards in the non-target sample, addressed to the "Director of Training" although it was recognized that a proportion of these shipyards had neither formalized training programs, nor individuals designated as training directors. Thirty yards in this category participated, or a 15% response rate.

## **DESIGN**

The questionnaire (See Appendix 3) is the final draft of many versions and stages, reviewed by several groups. The survey requested information on training courses utilized from outside organizations (technical institutes, colleges, etc.) and for in-house (shipyard) training programs. The response indicated that the outside organizations are primarily regional junior colleges and private technical institutes used for the scholastic/academic portions of the apprentice training programs.

### Type of Course

The type of course, whether academic or trade theory where specific focus is on the elements of that trade), was one item requested. "Academic" refers to those courses, mostly offered at the apprenticeship level, which seek to improve general knowledge and abilities relative to the individual's profession, but are not necessarily shipyard or skill specific. For example, an english course falls into the academic category; english may be expected to improve the general reading ability. Blueprint Reading, however, will impart a specialized, trade-related ability; thus, it would be considered a trade theory course.

"Trade theory" encompasses classroom, laboratory, and field training aspects. Shipyards typically maintain on-the-job training in varying degrees of formality. The intention of this survey was to obtain information on formalized, structured programs which will, in some instances, include on-the-job training. However, some less structured training hours are likely to filter through, especially for those programs with a large number of training hours.

### Level of Training

This area, the level of training was used to identify whether the course is part of the apprenticeship training, skills upgrading for the mechanic or skill upgrading/new skill introduction for the manager. While "apprentice" is a shipyard universal term, "mechanic" and "manager" are employed and defined in the survey itself (see Appendix 4), so as to cover the range of different titles found in the shipyards.

The "Mechanic" level is found between apprentice and management levels. "Manager" covers those employees attached to a specific shop who have official supervisory positions, from first line supervisors on up. This is differentiated from the journeyman/mechanic who may occasionally 'supervise' a group of apprentices while they are acquiring mastery of their trade.

### Status of the course

The status of a course, whether it is current, planned, or suspended was another area on the questionnaire. The intention was to include the maximum number of training courses in the directory, and to make allowance for the current industry slowdown, which has caused many yards to shelve parts or all of their training. Additionally, although less likely to receive a response, courses presently in a planning stage were requested so as to make the initial directory less time-bound. This area was dropped from the directory as the response either noted "current", or was simply not indicated.

### Training Aids

The purpose of this section was to compile training aids information, both written and visual, to create a separate reference directory. The Directory of Training Aids will enable shipyards to reference training support materials to help supplement their existing training, or help initiate training programs. Hopefully, this directory will facilitate further cooperation between training staffers in the different shipyards.

APPENDIX 2

SECTION A: TARGET SAMPLE

SECONDARY SHIPYARDS

	SURVEY RESPONSE	TRAINING REPORTED
ALABAMA DRYDOCK & SHIPBUILDING CO.		
AMERICAN SHIPBUILDING COMPANY	YES	
BAY SHIPBUILDING CORPORATION	YES	
EQUITABLE SHIPYARD, INC.		
FMC CORPORATION		
HALTER MARINE, INC.	YES	YES
LIVINGSTON SHIPBUILDING COMPANY	YES	
MARINETTE MARINE CORP.		
MARYLAND SHIPBUILDING & DRYDOCK CO.		
NORFOLK SHIPBLDG. & DRYDOCK CORP.		
PETERSON BUILDERS, INC.	YES	YES
TACOMA BOATBUILDING COMPANY, INC.	YES	YES
TODD SHIPYARDS - GALVESTON DIVISION		
TODD SHIPYARDS - HOUSTON DIVISION		
TODD SHIPYARDS - SAN FRANCISCO DIV.	YES	

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ADDITIONAL SHIPYARDS

DRAVO CORPORATION	YES	YES
JACKSONVILLE SHIPYARDS, INC.	YES	YES
JEFFBOAT, INC.	YES	YES
MARATHON SHIPBUILDING COMPANY	YES	
MCDERMOTT SHIPYARD GROUP		
ST. LOUIS SHIP		
TRACOR MARINE, INC.		

APPENDIX 2

SECTION A: TARGET SAMPLE

NAVAL SHIPYARDS

	SURVEY RESPONSE	TRAINING REPORTED
CHARLESTON NAVAL SHIPYARD	YES	YES
LONG BEACH NAVAL SHIPYARD	YES	YES
MARE ISLAND NAVAL SHIPYARD		
NORFOLK NAVAL SHIPYARD		
PEARL HARBOR NAVAL SHIPYARD	YES	YES
PHILADELPHIA NAVAL SHIPYARD	YES	YES
PORTSMOUTH NAVAL SHIPYARD	YES	YES
PUGET SOUND NAVAL SHIPYARD		

PRIMARY SHIPYARDS

AVONDALE SHIPYARDS, INC.	YES	
BATH IRON WORKS CORP.	YES	YES
BETHLEHEM STEEL CORP.	YES	YES
GENERAL DYNAMICS - ELECTRIC BOAT	YES	YES
GENERAL DYNAMICS - QUINCY SB DIV.	YES	YES
INGALLS IRON WORKS CO.	YES	YES
LOCKHEED SHIPBUILDING & CONST. CO.		
NATIONAL STEEL & SHIPBUILDING CO.	YES	YES
NEWPORT NEWS SHIPBLDG & DRYDOCK CO.	YES	YES
PENN SHIP	YES	
TODD SHIPYARDS - LOS ANGELES DIV.	YES	YES
TODD SHIPYARDS - SEATTLE DIV.	YES	

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY RESPONSE</u>	<u>TRAINING REPORTED</u>
ALABAMA MARITIME CORPORATION	YES	YES
ALGIERS IRON WORKS & DRYDOCK CO.		
ALLIED REPAIR SERVICE, INC.		
ALLIED SHIPYARD, INC.		
AMERICAN MARINE CORP.	YES	
AMERICAN SHIPBUILDING CO.		
ASSOCIATED NAVAL ARCHITECTS	YES	
ASTORIA MARINE CONSTRUCTION CO.	YES	
ATLANTIC DRY DOCK CORP.		
AVONDALE SHIPYARDS/HARVEY QUICK REPAIR DIV.		
BAKER MARINE CORP.	YES	YES
BALEHI MARINE, INC.		
BARBOUR BOAT WORKS, INC.	YES	
BEAN CORP.		
BERG MARINE CONSTRUCTION & REPAIR CO.		
BERGERON INDUSTRIES, INC./LOUISIANA		
BERGERON MARINE, INC./MISSISSIPPI		
BERWICK SHIPYARD CORP.		
BETHLEHEM STEEL CORPORATION/BEAUMONT YARD		
BETHLEHEM STEEL CORPORATION/BOSTON YARD		
BETHLEHEM STEEL CORPORATION/HOBOKEN YARD		
BLOUNT MARINE CORP.	YES	
BLOUNTSTOWN YARD		



APPENDIX 2

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SECTION B: NON-TARGET SAMPLE

SURVEY  
RESPONSE  
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TRAINING  
REPORTS  
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BLUDWORTH BOND SHIPYARD, INC.  
BOEING MARINE SYSTEMS, INC.  
BOLLINHER MACHINE SHIP & SHIPYARD  
BOURG DRYDOCK & SERVICE CO., INC.  
BRASWELL SHIPYARDS, INC.  
BREAUX'S BAY CRAFT, INC.  
BROWNARD MARINE, INC.  
BUNDER SHIPBUILDING & REPAIR COMPANY, INC.  
BURGER BOAT CO., INC.  
BURTON SHIPYARD, INC.  
CADDELL DRYDOCK & REPAIR CO., INC.  
CALIFORNIA SHIPBUILDING & DRYDOCK CO., INC.  
CALUMET DIVISION  
CAMCRAFT, INC.  
CAMDEN SHIP REPAIR CO., INC.  
CAMPBELL INDUSTRIES, INC.  
CARUTHERSVILLE SHIPYARD  
CHESAPEAKE SHIPBUILDING &  
CHICKASAW DIVISION  
COASTAL DRY DOCK & REPAIR CORPORATION  
COASTAL IRON WORKS, INC.  
COASTAL SHIPBUILDING  
COLBERG, INC.

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY RESPONSE</u>	<u>TRAINING REPORTED</u>
COLONNA'S SHIPYARD, INC.		
COMMERCIAL MARINE SERVICES, INC.		
CONRAD INDUSTRIES, INC.		
CRESCENT CITY MARINE WAYS & DRYDOCK CO., INC.		
DELTA CONCRETE CO.		
DELTA SHIPYARD		
DERECKTOR OF R.I., INC.	YES	YES
DETYENS SHIPYARDS, INC.		
DIAMOND MFG. CO., INC.		
DILLINGHAM MARINE & MFG. CO./PORTLAND		
DILLINGHAM SHIPYARD, INC./HONOLULU	YES	
DORCHESTER INDUSTRIES, INC.		
DRAVO STEELSHIP CORP.		
DUWAMISH SHIPYARD, INC.		
ELIZABETH CITY YACHT YARD		
ELLICOTT MACHINE CORP.	YES	
FISHING VESSEL OWNERS MARINE WAYS, INC.		
FOSS TUG & LAUNCH CO.		
FRASER SHIPYARDS, INC.	YES	
FREDEMAN SHIPYARD, INC.		
FULTON SHIPYARD, INC.		
GALVESTON SHIPBLDG./WEST GULF MARINE WORKS DIV.		
GALVESTON SHIPBUILDING COMPANY		

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY RESPONSE</u>	<u>TRAININ REPORTE</u>
GARAGE SHIPBUILDING CO.		
GAMAGE SHIPBUILDING, INC.		
GARBOR BOAT & YACHT CO.		
GENERAL DYNAMICS CORP./CHARLESTON		
GENERAL SHIP CORPORATION		
GENERAL SHIP REPAIR CORP.		
GEOSOURCE, INC./MARINE SERV. DIV.		
GLADDING-HEARN SHIPBUILDING CORP.		
GOUDY AND STEVENS		
GREENVILLE SHIPBUILDING CORP.		
GRETNA MACHINE & IRON WORKS, INC.		
GULF-TAMPA DRYDOCK CO.		
GUNTERT & ZIMMERMAN CONSTR. DIVISION, INC.		
HAWAIIAN TUNA PACKERS		
HBC BARGE, INC.	YES	YES
HENDRY CORPORATION		
HMI, INC.		
HOUMA FABRICATORS, INC.		
HUDSON SHIPBUILDING, INC.		
INGALLS SHIPBUILDING DIVISION/LITTON SYSTEMS, INC.		
INLAND MARINE CONSTRUCTORS, INC.		
INTERCOASTAL CITY DRYDOCK & SHIPBLDG., INC.		
INTERCOASTAL SHIPYARD, INC.		

APPENDIX 2  
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SECTION B: NON-TARGET SAMPLE

	SURVEY RESPONSE -----	TRAINING REPORTED -----
JACKSON ENGINEERING COMPANY		
JAKOBSON SHIPYARD, INC.		
JAMES & CO., T.L.		
KAISER STEEL CORP.		
LAKE UNION DRYDOCK CO.		
LARSON'S BOAT SHIP		
LEMONT SHIPBUILDING & REPAIR CO.		
LOCKPORT DIVISION		
LOUISIANA DOCK CO., INC./ILLNOIS		
LOUISIANA DRYDOCK, INC.		
LYON SHIPYARD & REPAIR CO.		
M/G TRANSPORT SERVICES, INC.		
MAIN IRON WORKS, INC.		
MARATHON LE TOUREAU CO./GULF MARINE DIVISION		
MARATHON SHIPBUILDING CO./VICKSBURG, MS		
MARCO SEATTLE	YES	
MARINE CONCRETE STRUCTURES, INC.	YES	
MARINE CONSTRUCTION & DESIGN CO.		
MARINE POWER & EQUIPMENT CO.		
MARINE WAYS CORP.	YES	
MARINE WELDING & REPAIR WORKS	YES	
MARTINAC SHIPBUILDING CORP.		
MAXON MARINE INDUSTRIES, INC.	YES	

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY RESPONSE</u>	<u>TRAINING REPORTED</u>
MERRILL-STEVENS DRYDOCK CO.		
METAL TRADES, INC.		
MIAMI SHIPYARDS CORP.		
MISENER INDUSTRIES	YES	YES
MISSISSIPPI MARINE TOWBOAT CORP.		
MISSOURI DRYDOCK & REPAIR CO.		
MODERN MARINE POWER, INC		
MORGAN CITY SHIPYARD		
MOSS POINT DIVISION		
MOSS POINT MARINE, INC.		
MUNRO DRYDOCK, INC.		
NABRICO (NASHVILLE BRIDGE CO.)		
NASHVILLE BRIDGE CO.		
NATIONAL MARINE SERVICE CO./ILLNOIS		
NATIONAL MARINE SERVICES, INC./LOUISIANA		
NATIONAL SEA PRODUCTS, INC.		
NEW IBERIA SHIPYARD		
NEWPARK SHIPBUILDING & REPAIR CO.	YES	
NEWPORT SHIPYARD, INC.		
NICHOLS BROS. BOAT BUILDERS, INC.		
NICHOLSON TERMINAL & DRYDOCK CO., INC.		
NORTHWEST MARINE IRON WORKS		
OFFHORE TRAWLER, INC.		

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY RESPONSE</u>	<u>TRAINING REPORTED</u>
OFFSHORE Shipbuilding INC.		
OMNI FABRICATORS, INC.		
ORANGE SHIPBUILDING, INC.		
PACECO , INC.		
PACIFIC DRYDOCK & REPAIR CO.	YES	
PACIFIC FISHERMAN, INC.		
PARKER BROTHERS & CO., INC.		
PERTH AMBOY DRYDOCK CO.	YES	
PETERSON BOATING CO., INC.		
PLATZER SHIPYARD, INC.		
PORT ALLEN MARINE SERVICES, INC.		
PORTSMOUTH DOCKING CO., INC.		
QUALITY SHIPBUILDERS, INC.	YES	
QUALITY SHIPYARDS, INC.		
RELIANCE MARINE TRANSPORTATION & CONSTR. CORP.		
REYNOLDS SHIPYARD CORP.	YES	
RICHMOND DRYDOCK & MARINE REPAIR, INC.		
RIVERWAY <b>SHIPYARD CO.</b>		
ROANOKE ISLAND STEEL & BOAT WORKS, INC.	YES	
RODERMAN INDUSTRIES, INC.		
ROWE MACHINE WORKS, INC.		
RUMSEY MARINE & DRYDOCK CO.		
RYSCO SHIPYARDS, INC.		

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	SURVEY RESPONSE	TRAINING REPORTED
SAN JUAN SHIPYARDS, INC.		
SAUCER MARINE SERVICE, INC.		
SAVANNAH SHIPYARD COMPANY		
SBA SHIPYARDS, INC.		
SCULLY BROS. BOAT BUILDERS, INC.		
SEA-TAC ALASKA SHIPBUILDING CO., INC.		
SEAWARD BOAT WORKS, INC.		
SERVICE ENGINEERING CO.		
SERVICES MACHINE GROUP, INC.	YES	
SOUTH PORTLAND SHYPD & MARINE RAILWAYS CORP.		
SOUTHERN OREGON MARINE	YES	YES
SOUTHERN SHIPBUILDING CORP.		
SOUTHWEST MARINE, INC./SAN DIEGO	YES	
SOUTHWEST MARINE, INC./SAN PEDRO		
SWIFTSHIPS, INC.		
SWIFTSHIPS-FREEPORT		
SWYGERT SHIPYARD, INC.	YES	
TEXAS GULFPORT SHIPBUILDING CO.		
THAMES SHIPYARD & REPAIR CO.		
THERIOT-MODEC ENTERPRISES, INC.		
THERIOT-MODEC ENTERPRISES, INC.		
THUNDERBOLT MARINE INDUSTRIES		
TIDEWATER EQUIPMENT CORP.		

APPENDIX 2

SECTION B: NON-TARGET SAMPLE

	<u>SURVEY</u> <u>RESPONSE</u>	<u>TRAINING</u> <u>REPORTED</u>
TODD SHIPYARDS CORPORATION		
TRACOR MARINE, INC.		
TRIPLE "A" MACHINE SHIP, INC.		
TRIPLE "A" SOUTH		
TWIN CITY DRYDOCK & REPAIR CO.		
TWIN CITY SHIPYARD, INC.	YES	YES
U.S. COAST GUARD		
U.S. STEEL CORP./FABRICATION DIVISION		
UNION DRYDOCK & REPAIR CO.	YES	
UNIVERSAL IRON WORKS, INC.		
VEMAR, INC.		
VINETTE CO.		
WALKER BOAT YARD, INC.		
WASHBURN & DOUGHTY ASSOC.		
WESTERN MARITIME, INC.		
WILBO INDUSTRIES, INC.		
WILEY MANUFACTURING CO./EQUIP. SYS. DIV.		
WILMINGTON SHIPYARD, INC.		
ZIDELL EXPLORATIONS, INC.		
ZIGLER SHIPYARDS, INC.		



T0: Director of Training  
From: Linda L. Jaekel, Deputy Executive Director LLJ  
Institute of Applied Technology  
Date: May 13, 1983  
Subject: Shipyard Skilled Trades Training Survey

The Institute of Applied Technology is working with the National Shipbuilding Research Program (an industry sponsored program) to compile information on skilled trades training courses in U.S. shipyards.

The result of this effort will be a directory of training programs and training aids utilized by U.S. shipyards. This will include a list of courses (with relevant training materials) offered by trade area at the apprentice, mechanic, anti management levels.

We would like you to complete and return the enclosed forms to the Institute of Applied Technology by June 17, 1983. A self addressed envelope is provided for your convenience.

This directory will be available to your shipyard as a reference tool. Its utilization by the shipbuilding and repair industry will support training efforts to reduce costs and increase productivity. We will be sending you information on how to obtain this publication in the next few months, and expect it to be ready by early 1984.

Your cooperation in helping to compile this directory is appreciated. We look forward to hearing from you.

Encls: Definitions of Terms  
Initial information Form  
Instruction Sheet  
Section A: Outside Training  
Section B: In-House Training

## DEFINITIONS OF TERMS

### A. TRADES

1. Air-Conditioning Equipment Mechanic

Installs, maintains, and repairs refrigeration and air/conditioning equipment.

2. Blaster

Prepares surfaces for painting by abrasive blasting. Can be combined with painter in some yards.

3. Boilermaker

Assembles boilers, tanks, vats, and pressure vessels. Uses power tools and hand tools.

4. Carpenter

Fabricates and assembles wooden structures, gratings, keel blocks, and shorings.

5. Chipper/Grinder

Grinds and chips weld splatter, high spots, burrs, weld slag, and rust from metal surfaces of ships to improve their appearance or prepare them for painting.

6. Electric (inside)

Installs and maintains wiring, fixtures, and equipment for shipyard facilities.

7. Electrician (outside)

Installs and repairs wiring, fixtures, and equipment for all electrical services aboard ship.

8. Electronics Mechanic

Works on various types of electronic equipment to put it in repaired operating condition.

9. Electroplater

Sets up, operates, and maintains metal plating baths to deposit metallic plating for protective purposes, decorative purposes, and to build up worn surfaces.

10. Insulator

Installs insulation in designated areas and on piping aboard ship.

11. Joiner

Installs finished panels, floor grouting, and tiling to living quarters.

12. Loftsmen

Lays out lines of ship to full scale on mold-loft floor and constructs templates and molds to be used as patterns and guides for layout and fabrication of various structural parts of ships.

13. Machinist (inside)

Sets up and operates machine tools as well as fits or assembles parts to make or repair metal parts, tools, or machines.

14. Machinist (outside)

Installs ship machinery such as propulsion machinery, auxiliary motors, pumps, ventilating equipment, and steering gear.

15. Ordnance Equipment Mechanic

Repairs machinery and mechanical equipment such as cranes, pumps, motors, and conveyor systems associated with weapons systems.

16. Painter

Mixes and applies paint or other coating materials for protective and decorative purposes by means of spray gun, brush, roller, or immersion. May also perform surface preparation (blasting).

17. Pipefitter

Fabricates, lays out, installs, and maintains ships' piping systems, such as steam heating, water, hydraulic, air pressure, and lubrication systems. Uses handtools and shop machines.

18. Rigger/Crane Operator

Installs and repairs rigging and weight-handling gear. Attaches hoists and handling gear to rigging and operates cranes to lift, move, and position machinery, equipment, structural parts, and other heavy loads aboard ships.

19. Sheetmetal Mechanic

Fabricates, assembles, installs, and repairs sheet-metal.

20. Shipfitter

Lays out and fits up metal structural parts (such as plates, bulkheads, and frames) and maintains them in position for welding.

21. Shipwright

Constructs or repairs wooden ships or ship sections, following blueprints or ship's plans.

22. Tacker/Burner

Cuts steel plate by burning. Washes welds and applies temporary welds to position metals for final welding.

23. Welder

Makes or repairs structures or parts, using gas or electric welding equipment, soldering equipment, gas or electric cutting equipment etc..

24. Other: A trade not included above for which your yard offers formal training. Please list and describe each.

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B. SKILL LEVELS

1. Apprentice

An entry-level employee in the process of learning the range of skills of a trade through a formal, structured training program, both on the job and in the classroom.

2. Mechanic

An employee who is proficient in the basic job skills. (e.g., Journeyman, etc.)

3. Manager

An employee who is proficient in the job skills and supervises others in the trade. (e.g., Foreman, General Foreman, etc.)

c. TYPE OF COURSE

1. Academic

Instruction which provides knowledge essential to the ability to learn trade skills or trade principles. (e.g., English, Math, etc.)

2. Trade Theory

Classroom or structured on-the-job training dealing with specific job skills (and including safety instruction) .

D. OTHER DEFINITIONS

1. Formal Training

A structured, planned program for employees to gain or improve skills in a specific occupation.

2. Trainer

A person who teaches academic or trade theory classes to employees (full-time or part-time work).

3. Course

A unit of instruction which covers a specific subject matter.



INSTRUCTION SHEET FOR COMPLETING LONG FORMS

- SECTION A
- SECTION B

1. "Trade": Please insert the name of the appropriate trade (trade definitions can be found in "Definitions of Terms"). If 'other', please write in the name of the trade for which you have training.

2. "Course Title": Write in the formal name of the course, and any other identification used.

3. "Organization" (Section A only):  
Please give the name of the outside organization which offers this course.

4. "#Hours": How many hours of training are included in this course?

5. "Type": Please refer to "Definitions of Terms" for definition of 'Trade Theory' and 'Academic'. Check the appropriate box.

6. "Level": Please refer to "Definitions of Terms" for definition of 'Apprentice', 'Mechanic', and 'Manager'. Check the appropriate box.

7. "Status" (section B only):  
- 'Current' means a course that is currently being offered by your yard.  
- 'planned' means a course being developed by your yard but which has not yet been implemented.  
- 'Suspended' means a course which has been offered by your yard in the past and for which all the materials are still available for future use.  
Please check the appropriate box.

8. "Aids": Refer to the list of aids in the upper right hand corner on the long form. Check either 'Written' or 'Visual'. There are three spaces for aids descriptions under each course title. Please use any other space available should you have more than three aids per course.

9. "Code#": This item refers again to aids. Check the list in the upper right hand corner and write in the number which corresponds to your type of aid.

10. "Title of Aid": Indicate any formal title you might have. For example, the title of a book or the name of a videotape.

11. "Source of Aid": Please indicate how to obtain this visual aid or written aid. For example, the name and address of the publisher or other source. If it was developed by your own yard, please indicate that in this space.

S E C T I O N    A

OUTSIDE   TRAINING   COURSES   USED  
FOR   SKILLED   TRADES   IN   THE   SHIPYARD

SHIPYARD SKILLED TRADES TRAINING SURVEY

INSTITUTE OF APPLIED TECHNOLOGY    4/83

2. Please fill in the information on those organizations you use for outside training.

Organization: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Contact person: \_\_\_\_\_

Title: \_\_\_\_\_

Organization: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Contact person: \_\_\_\_\_

Title: \_\_\_\_\_

Organization: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Contact person: \_\_\_\_\_

Title: \_\_\_\_\_

Organization: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Contact person: \_\_\_\_\_

Title: \_\_\_\_\_

SECTION A

Outside Training Courses  
Shipyard Skilled Trades Training Survey

General Information

1. What is the total number of courses, by trade, that your shipyard subscribes to from other organizations?

<u>TRADE</u>	<u># of Courses</u>
A/C Equipment Mechanic	_____
Blaster	_____
Boilermaker	_____
Carpenter	_____
Chipper/Grinder	_____
Electrician (inside)	_____
Electrician (outside)	_____
Electronics Mechanic	_____
Electroplate	_____
Insulator	_____
Joiner	_____
Loftsman	_____
Machinist (inside)	_____
Machinist (outside)	_____
Ordnance Equip. Mechanic	_____
Painter	_____
Pipefitter	_____
Rigger/Crane Operator	_____
Sheetmetal Mechanic	_____
Shipfitter	_____
Shipwright	_____
Tacker/Burner	_____
Welder	_____
Other _____	_____
Other _____	_____
Other _____	_____



**SECTION A: OUTSIDE TRAINING PROGRAMS**

Shipyards Skilled Trades Training Survey  
 Institute of Applied Technology 4/83

**AIDS (CODES)**

- |                |                    |
|----------------|--------------------|
| <u>Written</u> | <u>Visual</u>      |
| 1. Books       | 6. Slides          |
| 2. Workbooks   | 7. Transparencies  |
| 3. Articles    | 8. Movies          |
| 4. Manuals     | 9. Videotapes      |
| 5. Other       | 10. Charts/Posters |
|                | 11. Other          |

	TRADE	COURSE TITLE	ORGANIZATION	# HRS.	TYPE						AIDS	CODE #	TITLE OF AID	SOURCE OF AID
					Academic	Trade Theory	Apprentice	Mechanic	Manager	Written				
1														
2														
3														
4														
5														
6														
7														
8														

SECTION B

IN-HOUSE SKILLED TRADES TRAINING COURSES

SHIPYARD SKILLED TRADES TRAINING SURVEY

INSTITUTE OF APPLIED TECHNOLOGY 4/83

SECTION B

In-House Training Courses  
 Shipyard Skilled Trades Training Survey

General Information

1. What is your shipyard's approximate total number of in-house trainers? \_\_\_\_\_
2. What is your shipyard's approximate total number of in-house training courses? \_\_\_\_\_
3. Please fill in the average number of skilled trades employees and the average annual turnover rate by trade.

<b>TRADE</b>	<b>EMPLOYEE(#)</b>	<b>TURNOVER (%)</b>
A/C Equipment Mechanic	_____	_____
Blaster	_____	_____
Boilermaker	_____	_____
Carpenter	_____	_____
Chipper/Grinder	_____	_____
Electrician (inside)	_____	_____
Electrician (outside)	_____	_____
Electronics Mechanic	_____	_____
Electroplate	_____	_____
Insulator	_____	_____
Joiner	_____	_____
Loftsman	_____	_____
Machinist (inside)	_____	_____
Machinist (outside)	_____	_____
Ordnance Equip. Mechanic	_____	_____
Painter	_____	_____
Pipefitter	_____	_____
Rigger/Crane Operator	_____	_____
Sheetmetal Mechanic	_____	_____
Shipfitter	_____	_____
Shipwright	_____	_____
Tacker/Burner	_____	_____
rWelder	_____	_____
Other _____	_____	_____
Other _____	_____	_____
Other _____	_____	_____

**SECTION B: IN-HOUSE TRAINING PROGRAMS**

Shipyards Skilled Trades Training Survey  
Institute of Applied Technology

**AIDS (CODES)**

- |                |                    |
|----------------|--------------------|
| <u>Written</u> | <u>Visual</u>      |
| 1. Books       | 6. Slides          |
| 2. Workbooks   | 7. Transparencies  |
| 3. Articles    | 8. Movies          |
| 4. Manuals     | 9. Videotapes      |
| 5. Other       | 10. Charts/Posters |
|                | 11. Other          |

	TRADE	COURSE TITLE	# IRS.	TYPE					LEVEL			STATUS			AIDS		SOURCE OF AID	CODE #	TITLE OF AID
				Academic	Trade Theory	Apprentice	Mechanic	Manager	Current	Planned	Suspended	Written	Visual	Academic	Mechanic	Manager			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			

## APPENDIX 4

### DEFINITIONS OF DIRECTORY TRADES

ALL TRADES \*

Encompasses all shipyard skilled trades.

AIR CONDITIONING EQUIPMENT MECHANIC

Installs, maintains, and repairs refrigeration and air/conditioning equipment.

BLASTER

Prepares surfaces for painting by abrasive blasting. Is combined with painter in some yards.

BOILERMAKER

Assembles boilers, tanks, and-pressure vessels. Uses power tools and hand tools.

CARPENTER

Fabricates and assembles wooden structures, gratings, keel blocks, and shorings.

CHIPPER/GRINDER

Grinds and chips weld splatter, high spots, burrs, weld slag, and rust from metal surfaces of ships to improve their appearance or prepare them for painting.

ELECTRICIAN \*

Installs, repairs, and maintains wiring, fixtures, and equipment for shipyard facilities and aboard ship - to include all general electrical work. This includes the trade of 'Marine Electrician' in some yards.

ELECTRICIAN (INSIDE)

Installs and maintains wiring, fixtures, and equipment for shipyard facilities.

ELECTRICIAN (OUTSIDE)

Installs and repairs wiring, fixtures, and equipment for all electrical services aboard ship.

ELECTRONICS MECHANIC

Works on various types of electronic equipment to put it in repaired operating condition.

ELECTROPLATER

Sets up, operates, and maintains metal plating baths to deposit metallic plating for protective purposes, decorative purposes, and to build up worn surfaces.

PIPEFITTER

Fabricates, lays out, installs, and maintains ships' piping systems, such as steam heating, water, hydraulic, air pressure, and lubrication systems. Uses handtools and shop machines.

PIPEWELDER \*

Installs, repairs and maintains shipboard piping systems by means of applicable welding processes.

RIGGER/CRANE OPERATOR

Installs and repairs rigging and weight-handling gear. Attaches hoists and handling gear to rigging and operates cranes to lift, move, and position machinery, equipment, structural parts, and other heavy loads aboard ships.

SHEETMETAL MECHANIC

Fabricates, assembles, installs, and repairs sheet-metal.

SHIPFITTER

Lays out and fits up metal structural parts (such as plates, bulkheads, and frames) and maintains them in position for welding.

SHIPWRIGHT

Constructs or repairs wooden ships or ship sections, following blueprints or ship's plans.

TACKER/BURNER

Cuts steel plate by burning. Washes welds and applies temporary welds to position metals for final welding.

WELDER

Makes or repairs structures or parts, using gas or electric welding equipment soldering equipment, gas or electric cutting equipment, etc..

\* Trades added to initial list in questionnaire by respondents.

APPENDIX 5

ADDITIONAL TRADES IDENTIFIED BY RESPONDENTS \*

AUTOMOTIVE MECHANIC - Portsmouth Naval Shipyard

BLACKSMITH - Charleston Naval Shipyard  
Portsmouth Naval Shipyard  
Pearl Harbor Naval Shipyard  
Shapes metal bars, rods and other stock into the many items  
needed in the repair and overhaul of naval ships.

BOILER PLANT EQUIPMENT MECHANIC - Charleston Naval Shipyard  
Portsmouth Naval Shipyard  
Overhauls, maintains, repairs and installs various types of  
heat and power producing systems used in industrial equipment  
and non-industrial locations.

DRAFTER - Ingalls Shipbuilding Division

ELECTRONIC EQUIPMENT INSPECTOR - Portsmouth Naval Shipyard

ELECTRICAL EQUIPMENT REPAIRER - Charleston Naval Shipyard  
Overhauls, modifies, tests, and troubleshoots electrical  
motors, generators, transformers, alternators and other  
electro-magnetic devices.

ELECTRIC POWER CONTROLLER - Charleston Naval Shipyard  
Portsmouth Naval Shipyard  
Controls operation of steam turbines to provide electric power  
to the shipyard.

ELECTRONIC MECHANIC FIRE CONTROL - Long Beach Naval Shipyard

ELECTRONIC IND. CONTROLS MECH. - Charleston Naval Shipyard  
Pearl Harbor Naval Shipyard  
Installs, maintains, repairs and overhauls the electronic  
equipment and electronically controlled machinery used by  
other shops in their production work.

ELECTRONICS INTEGRATED SYSTEMS MECH. - Portsmouth Naval Shipyard

ELECTRONICS MEASURER EQUIPMENT MECH. - Charleston Naval Shipyard  
Repairs, overhauls, maintains and tests all instruments and  
equipment used to troubleshoot and test shipboard electronics  
systems.

EQUIPMENT MECHANIC - Philadelphia Naval Shipyard

\* Definitions, where applicable, provided by Charleston Naval  
Shipyard.

FABRIC WORKER - Charleston Naval Shipyard  
 Long Beach Naval Shipyard  
 Portsmouth Naval Shipyard  
 Pearl Harbor Naval Shipyard  
 Manufactures and installs all manner of products from canvas,  
 fiberglass, plastics and other materials.

FORGER/HEAT TREATER - Charleston Naval Shipyard

HEAVY METAL FABRICATOR - Newport News Shipbuilding

HEAVY MOBILE EQUIPMENT MECHANIC - Charleston Naval Shipyard  
 Portsmouth Naval Shipyard  
 Works systems such as manual and automatic transmissions,  
 brakes, cooling, hydraulic, electrical and ignition systems,  
 overhaul and tune gas and diesel engines on such equipment as  
 mobile cranes, bulldozers, road graders and locomotives.

HEAVY MOBILE EQUIP REPAIR INS - Portsmouth Naval Shipyard

INDUSTRIAL ELECTRONICS CONTROL - Portsmouth Naval Shipyard

INSTRUMENT MECHANIC - Charleston Naval Shipyard  
 Portsmouth Naval Shipyard  
 Repairs, overhauls and modifies many devices and equipments  
 such as meters, tachometers, solid state amplifiers, magnetic  
 amplifiers and temperature indicators.

LEAD BONDER - General Dynamics/Electric Boat

MAINTENANCE - R.E. Derektor of R.I., Inc.  
 General Dynamics/Electric Boat

MAINTENANCE MACHINIST - Long Beach Naval Shipyard

MARINE MACHINERY MECHANIC - Portsmouth Naval Shipyard  
 Pearl Harbor Naval Shipyard

MELTER - Charleston Naval Shipyard  
 Operates and maintains electric furnaces in order to melt and  
 refine a large variety of alloys to rigid specifications in  
 order to be used in the making of castings.

METALS INSPECTOR - Charleston Naval Shipyard  
 Long Beach Naval Shipyard  
 Portsmouth Naval Shipyard  
 Pearl Harboz Naval Shipyard  
 Inspects material and workmanship for flaws during alteration  
 and overhaul of submarines and surface ships.



MILLING WORKER - Charleston Naval Shipyard  
 Sets up and operates various types of portable and fixed woodworking power tools. Cuts lumber to stock sizes, finishes stock and manufactures special wooden shapes as required by the woodworking and other trades.

MILLWRIGHT - Newport News Shipbuilding

OPTICAL INSTRUMENT REPAIRER - Charleston Naval Shipyard  
 Repairs, modifies, adjusts, tests and calibrates various types of optical equipment such as binoculars, periscopes range finders, etc.

PIPECOVERER - General Dynamics/Electric Boat

PIPEHANGER - General Dynamics/Electric Boat

PLASTIC FABRICATOR - Long Beach Naval Shipyard

PLASTIC MOLDER - Portsmouth Naval Shipyard

PRODUCTION MACHINERY MECHANIC - Charleston Naval Shipyard  
 Portsmouth Naval Shipyard  
 Installs, repairs, overhauls and removes all machinery and equipment belonging to the shipyard, both in buildings, shops and outside locations performing all tasks concerned with the mechanical elements of this equipment.

TOOLMAKER - Charleston Naval Shipyard  
 General Dynamics/Electric Boat  
 Portsmouth Naval Shipyard  
 Manufactures, repairs and overhauls tools used in certain machine metal-working processes.

TOOLROOM MECHANIC - Pearl Harbor Naval Shipyard

WHARFBUILDER - Charleston Naval Shipyard  
 Maintains and repairs wharfs, piers and pier accessories by driving piles, cutting, handling and placing large, heavy timber. Also builds forms, pours concrete and does concrete finishing for foundations, walkways and roads, repairs build up roofs as well as railroad tracks and switches.

WOODCRAFTER - Charleston Naval Shipyard  
 Constructs various items from wood as well as applying a wide range of covering materials to the interior hull and deck of ships.

WOOD AND PLASTIC INSTALLER - Portsmouth Naval Shipyard  
 Pearl Harbor Naval Shipyard

APPENDIX 6

DIRECTORY TRADES TRAINING:  
PHILADELPHIA NAVAL SHIPYARD and  
GENERAL DYNAMICS/ELECTRIC BOAT

PHILADELPHIA NAVAL SHIPYARD  
-----

38 - Carpenter	62 - Electrician
42 - Machinist	43 - Molder
87 - Painter	89 - Patternmaker
31 - Pipefitter	14 - Sheetmetal Mechanic
7 - Shipwright	

TOTAL: 9 trades = 413 courses

GENERAL DYNAMICS/ELECTRIC BOAT  
-----

1 - Tacker/Burner	16 - Carpenter
20 - Electrician	20 - Electrician/Outside
2 - Electronic Mechanic	11 - Welder
1 - Machinist/Inside	28 - Machinist/Outside
6 - Painter	25 - Pipefitter
15 - Pipewelder	3 - Sheetmetal Mechanic
1 - Rigger	29 - Machinist
18 - Shipfitter	

TOTAL: 15 trades = 196 courses

APPENDIX 7

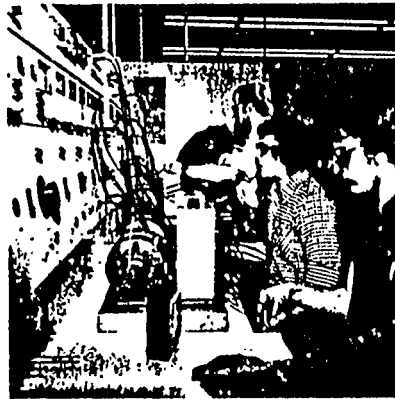
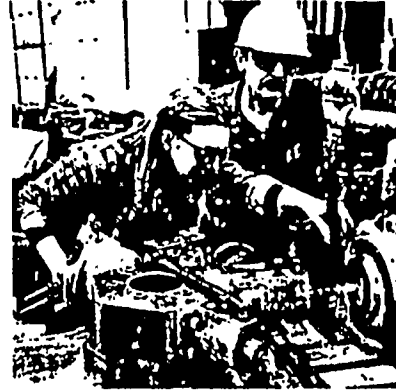
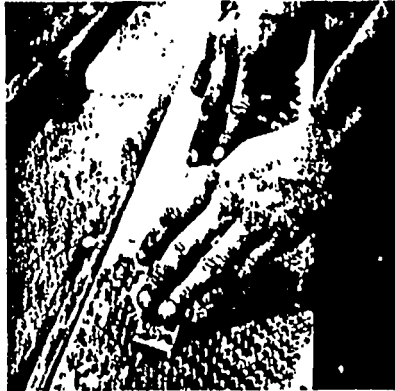
NEWPORT NEWS APPRENTICE TRADES TRAINING

NEWPORT NEWS - TRADES WITH FORMAL TRAINING

-----

- |                              |                                |
|------------------------------|--------------------------------|
| 1. Electrician               | 11. Molder                     |
| 2. Electrician (maintenance) | 12. Outside Machinist          |
| 3. Forger/Heat Treater       | 13. Painter/Decorator          |
| 4. Heating, Ventilation, A/C | 14. Pipefitter                 |
| 5. Heavy Metal Fabricator    | 15. Rigger                     |
| 6. Insulation Worker         | 16. Sheetmetal Worker          |
| 7. Joiner                    | 17. Shipfitter                 |
| 8. Machinist                 | 18. Welder                     |
| 9. Millwright                | 19. Welding Equipment Repairer |
| 10. Mold Loftsman            | 20. Patternmaker               |

**APPENDICES**



# ACADEMIC CURRICULUM

THE APPRENTICE SCHOOL

Newport News Shipbuilding   
A Tenneco Company

## COMMUNICATIONS

**C231 Technical Communications 20 Hours 2 Credits**

Methods of providing technical information to superiors, peers and subordinates through oral briefings, informal discussion, written and oral summaries and written memoranda and reports.

## OPTIONAL ADVANCED HONORS COURSES

ACADEMIC	
SUBJECT	7
MATHEMATICS AND ENGINEERING	ENGINEERING TECHNICAL MATH MATH K 22 (I) 30 HOURS 5 CREDITS*
DRAFTING	ENGINEERING DRAFTING FUNDAMENTALS DRFT 152 (I) 50 HOURS 3 CREDITS
NAVAL ARCHITECTURE AND MARINE ENGINEERING	ADVANCED NAVAL ARCH. I N233 20 HOURS 2 CREDITS
COMMUNICATIONS	
SHIPBUILDING OPERATIONS	
TOTAL	100 HOURS 10 CREDITS

## SHIPBUILDING OPERATIONS

**O232 Advanced Shipbuilding 20 Hours 2 Credits  
Operations I**

Investigation of interrelationships of trades in the ship construction cycle. Erection schedules. Introduction to critical path methods in planning and control of ship construction projects.

**O343 Advanced Shipbuilding 20 Hours 2 Credits  
Operations II**

Manpower estimates, material and cost control, bidding.

QUARTERS		
8	9	10
MECHANICS I (Statics) ENGR 151 (I) 40 HOURS 4 CREDITS	MECHANICS II (Strength of Materials) ENGR 152 (I) 30 HOURS 3 CREDITS	
	DESCRIPTIVE GEOMETRY DRFT 136 (I) 40 HOURS 2 CREDITS	
ADVANCED MARINE ENGR. I N234 20 HOURS 2 CREDITS	ADV. NAVAL ARCH. & ADV. MARINE ENGR. II N335 20 HOURS 2 CREDITS	ADV. SHIPBUILDING DESIGN PROJECT N346 80 HOURS 4 CREDITS
TECHNICAL COMMUNICATIONS C231 20 HOURS 2 CREDITS		
ADV. SHIPBUILDING OPERATIONS I O232 20 HOURS 2 CREDITS		ADV. SHIPBUILDING OPERATIONS II O343 20 HOURS 2 CREDITS
100 HOURS 10 CREDITS	90 HOURS 7 CREDITS	100 HOURS 6 CREDITS

NOTE: (I) Course taught by TNCC faculty.

# COURSE DESCRIPTIONS FOR BASIC TECHNICAL EDUCATION CURRICULUM

Apprentices in all trades must successfully complete these courses.

## MATHEMATICS

### M111 Algebra 40 Hours 3 Credits

Fundamental operations, factoring, special products, linear equations, quadratic equations, word problems, scientific notation, exponents and radicals, simultaneous equations, algebraic fractions, solution of literal equations (formulas), graphs.

### M112 Geometry 40 Hours 3 Credits

Elements of plane and solid geometry; congruence of angles and triangles; parallel lines; similar polygons; Pythagorean theorem; perimeters, surface areas, and volumes of various geometric figures and solids.

### M113 Trigonometry 30 Hours 3 Credits

Trigonometric functions of acute angles, tables of trigonometric functions, solutions of right triangles, word problems involving right triangles, related angles, radian measure, applications of the laws of Sines and Cosines to solutions of oblique triangles, vectors, and equilibrium resulting from concurrent forces on an object.

### M124 Applied Math 20 Hours 2 Credits

Resolution of forces, summation of forces, summation of moments, calculate stress and strain, design of riveted, bolted and welded connections.

## DRAFTING

### D111 Drafting I 40 Hours 3 Credits

Fundamentals of drafting covering engineering lettering, principles of orthographic projection, freehand sketching, pictorial drawing and plane analysis, using the scale and drafting instruments, geometrical construction for marine and shipbuilding use.

### D112 Drafting II 40 Hours 3 Credits

Using drafting instruments, principles of dimensioning, interpretation of conventional practices and drawing sectional and auxiliary views for marine and shipbuilding use.

## NAVAL ARCHITECTURE AND MARINE ENGINEERING

### N111 Steel Hull Construction 20 Hours 2 Credits

The student acquires a working knowledge of the following items: basic terminology and definitions used in shipbuilding, the types of structural elements and assemblies used in the construction of modern ships, the primary methods of fabricating the structural elements and assemblies, the welding symbols which are used.

### N112 Marine Engineering 30 Hours 3 Credits

The basic propulsive drive train and the basic steam propulsion cycle for conventionally and nuclear powered ships are studied. Some of the components and systems which go together to form the drive train and steam cycle of modern ships are as follows: reduction gears, propellers, rudders, bearings, turbines, boilers, condensers, reactors, steam generators, main steam system, main condensate system, main feed system, main coolant loop.

## PHYSICAL SCIENCE

### P121 Interaction of Matter & Energy 40 Hours 3 Credits

Scientific measurement, force and motion; work, energy, and power; basic machines, friction; uniform circular motion, centripetal and centrifugal force; torque and power transmission.

### P122 Properties of Matter 40 Hours 3 Credits

Composition of matter; kinetic theory; cohesion, adhesion; density, specific gravity; Pascal's Principle, Archimedes' Principle, Bernoulli's Principle; Boyle's Law, Charles' Law, Dalton's Law.

### P123 Properties of Engineering Materials 40 Hours 3 Credits

Properties of metals and non-metals; cooling curves, constitution diagrams; heat treatment methods, case hardening methods, corrosion; Young's modulus, bulk modulus.

## SHIPBUILDING OPERATIONS

**O111 Shipbuilding Operations I** 20 Hours 2 Credits

The basic overall organization, operation and layout of the shipyard are studied: the basic classification and types of ships, compartment identification, the uses of computers in shipbuilding, the effects of research on shipbuilding, the various types of welding and testing techniques used in shipbuilding.

### MINIMUM

SUBJECT	ACADEMIC QUARTERS	
	1	2
MATHEMATICS	ALGEBRA M111 40 HOURS 3 CREDITS	GEOMETRY M112 40 HOURS 3 CREDITS
DRAFTING	DRAFTING I D111 40 HOURS 3 CREDITS	DRAFTING II D112 40 HOURS 3 CREDITS
NAVAL ARCHITECTURE AND MARINE ENGINEERING		STEEL HULL CONSTRUCTION N111 20 HOURS 2 CREDITS
PHYSICAL SCIENCE		
SHIPBUILDING OPERATIONS	SHIPBUILDING OPERATIONS I O111 20 HOURS 2 CREDITS	
SAFETY		
TRADE THEORY	SEE PAGE 6 FOR COURSE LISTING	
TOTALS	100 HOURS 8 CREDITS	100 HOURS 8 CREDITS

## SAFETY

**S121 Accident Investigation & Prevention** 20 Hours 2 Credits

Covers the importance of safe conditions, basic philosophy of accident occurrence and prevention, safety factors and practices of ship, shop, equipment, tools, at home and driving.

### ACADEMIC REQUIREMENTS

ACADEMIC QUARTERS			
3	4	5	6
TRIGONOMETRY M113 30 HOURS 3 CREDITS		APPLIED MATH M124 20 HOURS 2 CREDITS	
MARINE ENGINEERING N112 30 HOURS 3 CREDITS			
	INTERACTION OF MATTER & ENERGY P121 40 HOURS 3 CREDITS	PROPERTIES OF MATTER P122 40 HOURS 3 CREDITS	PROPERTIES OF ENGINEERING MATERIALS P123 40 HOURS 3 CREDITS
	ACCIDENT INVESTIGATION & PREVENTION S121 20 HOURS 2 CREDITS		
60 HOURS 6 CREDITS	60 HOURS 5 CREDITS	60 HOURS 5 CREDITS	40 HOURS 3 CREDITS 420 HOURS 35 CREDITS



## **ADDITIONAL ADVANCED/ HONORS PROGRAM**

Qualified apprentices may choose to continue their academic training beyond the minimum requirements for graduation through the Advanced/Honors Program. These apprentices receive a greater insight into the principles of design, planning, and construction of iron ships through higher level courses in math, drafting, engineering and shipyard operations. The Advanced/Honors Program is taught by a joint faculty, composed of instructors from the Apprentice School and Thomas Nelson Community College. Students who complete the Advanced/Honors Program will be able to transfer 55 credit hours into Thomas Nelson's Mechanical Technology curriculum. Through a program of evening study with tuition paid by the Company, you may complete the additional 55 hours of course work required for Associate's Degree in Mechanical Technology with emphasis on Marine Engineering Technology.

## **THEMATICS AND ENGINEERING**

**231 Engineering Technical Math 30 Hours 5 Credits**  
(Taught by TNCC faculty.) Completion of this course plus the Basic Technical Education Curriculum Math Sequence is equivalent to Math 112 & 122, Engineering Technical Math I & II, in the TNCC Mechanical Technology Curriculum. Course covers trigonometric curve sketching, complex numbers, logarithmic and exponential functions, solutions to arithmetic equations, logarithmic and exponential curve sketching and solutions to equations in quadratic form.

**GR 151 Mechanics I (Statics) 40 Hours 4 Credits**  
(Taught by TNCC faculty.) Principles and applications of free body diagrams for force systems, shear and moment diagrams, deflection of beams by numerical integration and determination of section properties.

**GR 152 Mechanics II 30 Hours 3 Credits**  
**(Strength of Materials)**  
(Taught by TNCC faculty.) Strength of materials concepts. Stress and strain analysis, both elastic and plastic, with emphasis on elastic analysis of axially loaded members, connectors, beams and columns.

## **DRAFTING**

**DRFT 152 Engineering Drawing 50 Hours 3 Credits**  
**Fundamentals**

(Taught by TNCC faculty.) Theory and application of dimensioning, tolerancing, thread and fastener forms and nomenclature, inking practices, auxiliary view construction and preparation of assembly and working drawings.

**DRFT 136 Descriptive Geometry 40 Hours 2 Credits**  
**for Drafting**

(Taught by TNCC faculty.) The analysis and graphic presentation of the space relationship of fundamental geometric elements, point, line, plane, curved surfaces, development and vectors.

## **NAVAL ARCHITECTURE AND MARINE ENGINEERING**

**N 233 Advanced Naval 20 Hours 2 Credits**  
**Architecture I**

Determine ship displacements, hull form coefficients, curves of form, centers of gravity and initial intact stability. Lines drawings, tables of offsets, Simpson's First Rule, first and second moment of areas and appropriate equations will be used.

**N 234 Advanced Marine 20 Hours 2 Credits**  
**Engineering I**

A study of some of the auxiliary systems which appear on most ships such as the distilling plant, diesel engines, air conditioning and auxiliary steam (steam driven pumps). A comparison of the various types of marine propulsion systems such as steam turbines, diesel engines and gas turbines.

**N 335 Advanced Naval Architecture 20 Hours 2 Credits**  
**& Marine Engineering II**

An examination of the design requirements of a ship's power train. Model testing, propulsion resistances, reduction gears, shafting and propellers will be considered.

**N 346 Advanced Shipbuilding 80 Hours 4 Credits**  
**Design Project**

Completion of project in design of a shipbuilding structure or system.

## SHIPBUILDING OPERATIONS

**O111 Shipbuilding Operations I** 20 Hours 2 Credits

The basic overall organization, operation and layout of the shipyard are studied: the basic classification and types of ships, compartment identification, the uses of computers in shipbuilding, the effects of research on shipbuilding, the various types of welding and testing techniques used in shipbuilding.

**MINIMUM**

SUBJECT	ACADEMIC QUARTERS	
	1	2
MATHEMATICS	ALGEBRA M111 40 HOURS 3 CREDITS	GEOMETRY M112 40 HOURS 3 CREDITS
DRAFTING	DRAFTING I D111 40 HOURS 3 CREDITS	DRAFTING II D112 40 HOURS 3 CREDITS
NAVAL ARCHITECTURE AND MARINE ENGINEERING		STEEL HULL CONSTRUCTION N111 20 HOURS 2 CREDITS
PHYSICAL SCIENCE		
SHIPBUILDING OPERATIONS	SHIPBUILDING OPERATIONS I O111 20 HOURS 2 CREDITS	
SAFETY		
TRADE THEORY	SEE PAGE 6 FOR COURSE LISTING	
TOTALS	100 HOURS 8 CREDITS	100 HOURS 8 CREDITS

## SAFETY

**S121 Accident Investigation & Prevention** 20 Hours 2 Credits

Covers the importance of safe conditions, basic philosophy of accident occurrence and prevention, safety factors and practices of ship, shop, equipment, tools, at home and driving.

**ACADEMIC REQUIREMENTS**

ACADEMIC QUARTERS			
3	4	5	6
TRIGONOMETRY M113 30 HOURS 3 CREDITS		APPLIED MATH M124 20 HOURS 2 CREDITS	
MARINE ENGINEERING N112 30 HOURS 3 CREDITS			
	INTERACTION OF MATTER & ENERGY P121 40 HOURS 3 CREDITS	PROPERTIES OF MATTER P122 40 HOURS 3 CREDITS	PROPERTIES OF ENGINEERING MATERIALS P123 40 HOURS 3 CREDITS
	ACCIDENT INVESTIGATION & PREVENTION S121 20 HOURS 2 CREDITS		
60 HOURS 6 CREDITS	60 HOURS 5 CREDITS	60 HOURS 5 CREDITS	40 HOURS 3 CREDITS 420 HOURS 35 CREDITS

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SHIP PRODUCE  
FACILITIES MI  
OUTFITTING AND I  
INDUSTRIAL ENGINEERING F  
SHIPBUILDING S7  
DESIGN/PRODUCTI  
COMPUTER AIDS F(  
SURFACE PREPARATIO  
FLEXIBLE A  
TECHNOLO  
EDUCATION  
WEL