

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM  
TASK S-20

U. S. DEPARTMENT OF COMMERCE  
MARITIME ADMINISTRATION

in cooperation with

BATH IRON WORKS CORPORATION  
700 Washington Street  
Bath, Maine 04530

FINAL REPORT ON  
A COMPENDIUM OF  
SHIPBUILDING STANDARDS

*NSRP# 93*

prepared by

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## PREFACE

This report summarizes research into standards for the design, testing, classification, and definition of components for shipbuilding as conducted under the task entitled "A Compendium of Shipbuilding Standards", a part of the ongoing National Shipbuilding Research Program sponsored jointly by the Maritime Administration and the U. S. shipbuilding industry.

Because of the shipbuilders involvement in the research, this report tends to address the impact that standards have on shipbuilding costs and risks. However it is very important for the reader to realize that owners, operators, designers, vendors, classification societies and regulatory bodies are similarly affected.

The study was managed by Bath Iron Works Corporation, with technical assistance from Corporate-Tech Planning, Inc., Portsmouth, New Hampshire.

# **SECTION 1**

## **EXECUTIVE SUMMARY**

## I. EXECUTIVE SUMMARY

### 1. INTRODUCTION

Research Task S-20 examined the standards which are incorporated by shipbuilders and owners in a ship construction contract. The standards discussed in this report are documents which describe materials, products, systems or services, such as those promulgated by the American Society for Testing and Materials (ASTM) . This report describes the results of that research.

There are three sections to this report. The first, printed on blue paper, is an executive summary outlining the findings and proposing a course of action. The second portion, printed on yellow paper, is comprised on a detailed description of the findings, including charts and data tables, as well as a more extensive explanation of the recommendations. The third subdivision, on white, contains the appendices.

### 2. REPORT OF FINDINGS

#### a. Economic Impact

Shipbuilding standards in the current collection have for the most part been developed without quantitative analysis of their economic impact. Although it is clearly less costly to build with the current body of standards than with no standards, there is little doubt that a retision of the present standards would make possible significant additional savings. In one of the rare instances where documentation of savings achieved through economically sensitive-standards exists, a major shipyard reported savings of 75% after adopting a standard engineer's day oil tank and a standard rag locker. European yards

report cost reductions of 25% in addition to shorter delivery times from vendors as a result of standardized outfit items.

b. A System For Managing U.S. Shipbuilding Standards Does Not Exist

The standards studied were written by thirty-seven unrelated organizations, many with conflicting objectives. Consequently, shipbuilders face conflicting, contradictory and vague requirements which their foreign counterparts do not have. Review, revision, and improvement are not taking place. Obsolescence exists. For example, a preview to this study uncovered a contract requirement to meet a standard that was thirty years old, so out-dated that no copy was on file at the originating organization.

c. Regulatory Bodies and Classification Societies Dominate

The standards which most affect the shipbuilding industry are heavily biased by the input of the regulatory bodies and the classification societies. Seventy-two percent of the U.S. shipbuilding standards analyzed originated with these sources. The remaining twenty-eight percent were developed by voluntary consensus standards organizations such as the American Society for Testing and Material (ASTM) and the American National Standards Institute (ANSI). Figure 1 lists the sources of the standards studied.

d. Shipbuilders are Confronted by a Confusion and Proliferation of Standards

The analysis and cataloging of approximately 3000 U.S shipbuilding standards revealed to the research staff a ponderous accumulation of specifications, often so intertwined and duplicated that a clarity of purpose could not be discerned. Since all of the standards studied were incorporated into a contract for a federally subsidized ship directly or by reference

CLASSIFICATION/REGULATORY			INDUSTRIAL		
	NUMBER	%		NUMBER	%
ABS	674	23	ABYCP	1	--
DOD	4	--	AGMA	2	--
DOL	4	--	AMCA	2	--
EPA	4	--	ANSI	140	5
FED	154	5	ASTM	374	13
IMCO	1	--	FCI	1	--
MARAD	910	31	HEI	7	--
MIL	117	4	HI	1	--
NBS	1	--	IEEE	128	4
PCC	3	--	IES	1	--
SCA	1	--	IPCEA	1	--
SOLAS	1	--	JIC	43	1
USCG	266	9	MSS	17	1
USDA	3	--	NAS	1	--
USN	2	--	NEMA	36	1
USPHS	1	--	NFPA	20	1
			OCIMF	2	--
			SNAME	9	--
			SSPC	1	--
			TEMA	1	--
			UL	57	2
SUBTOTAL	2146	72%		845	28%
TOTAL				2991	100%

FIGURE 1: MAJOR SOURCES OF U.S. SHIPBUILDING STANDARDS  
(Appendix A gives full name of organizations.)

it is immediately obvious that all of the standards must be adhered to in the ship's design and construction. This requirement represents a herculean undertaking for the shipyard. To begin with, the number of standards alone is dispiriting. MIL-D-1000, a military drawing standard, is incorporated into many commercial contracts; yet an informal study reports that an examination of MIL-D-1000 on Drawings identified 5000 other cited standards involving over 25,000 links! In bold contrast, European and Japanese shipyards operate with a total of 1000 standards or less (excluding classification rules).

In addition to the sheer awkwardness of so many standards, there are standards which are superfluous, standards which make reference to standards long out-dated or replaced, standards in which the language is so imprecise as to make them impossible to define. A lack of specified tolerances for "good shipbuilding practice" is an outstanding example. In other cases, there is no coverage at all. Standards listed by brand name without performance characteristics limit the options open to the shipbuilder.

The evidence points to the desperate need for an organization to oversee the writing of standards for the shipbuilding industry and to the wisdom in encouraging the main body of standardization to spring from the industry itself rather than from the groups charged with regulating the industry.

e. Standards Do Not Serve the Best Interests of All

The current shipbuilding standards do not contribute to the interests of the major users of standards; namely, the designers, owner/operators, shipbuilding yards, equipment vendors, and the regulatory/classification community. Each of these segments of the industry has an individual demand upon standards, and these unique purposes must be used as directives

by those who write standards. Currently some users benefit more than others. In some cases, users do not benefit as much as they could if standards were improved.

f. Standards are Vital

Although U. S. shipbuilding standards do suffer from the deficiencies outlined above, it must be emphasized that the present non-system of standards is better by far than no standards at all. The ecurrent body of standards does make it possible to write a ship construction It does provide a basis for understanding between the owner and the shipyard and for communication with the regulatory organizations. It does permit a ship to be designed and constructed. Standards are saving the U. S. maritime industry money and limiting risk.

However, the present system of standards desperately needs improvement. That is the single most important finding of this research.

3. IMPROVING U. S . SHIPBUILDING STANDARDS

The maritime industry is at a crossroads. Economic pres-  
sures are high; political attention is focused on the industry;  
dynamic new leaders have taken control of many yards; the  
actions of the regulatory bodies are being challenged. It is  
a propitious time to advocate a revision of shipbuilding  
standards. The required steps for improvement can be identified)  
and some measures have already been initiated. The necessary  
steps are:

a. Identify and codify the standards which apply to ship-  
building. This research task identified 3000 as a start, and  
a family of indices has been,published. See Appendix B for  
further detail.

b. Establish An organization to manage the standards. Other major American industries have recognized the need to participate in the development of the standards which affect their endeavors. This they have done through trade associations and through the voluntary consensus standards system. As a first move and at the request of the maritime industry, the American Society for Testing and Materials has established Committee F-25 on Shipbuilding. If the major elements of the industry will provide the needed assistance, it will be possible for the F-25 Committee to mitigate many of the problems which exist in the present situation. The challenge to the Committee in outline is:

- To co-ordinate the development of necessary standards of the right type which will assure cost and risk reduction.
- To evaluate existing standards with a determination to identify those which will assist the industry in a positive way, those which should be eliminated, those which can be improved through rewriting.
- To develop new standards where gaps in coverage are found.

Since May of 1978 when the ASTM committee F-25 on Shipbuilding was formed, significant progress toward these three goals has been made.<sup>1</sup> The Society of Naval Architects and Marine Engineers (SNAME) is providing further leadership and guidance through its Ship Production Committee and Panel SP-6, Standards and Specifications.

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<sup>1</sup> Detailed information is available from John C. Mason, Secretary of F-25, Bath Iron Works Corporation, 700 Washington Street, Bath, Maine 04530. Telephone 207-443-3311, extension 2550.

c. Achieve Industry Participation. Industry managers are urged to support the work of the F-25 committee by:

- Participating in its activities at a top management level, either directly or by designating a co-ordinator to represent the company on the Committee.
- Ž Identifying deficient standards for the Committee, and propose the corrective action (i.e., eliminate, replace, or rewrite).
- Ž utilizing new and improved standards when writing shipbuilding contracts.

A body of improved shipbuilding standards will undoubtedly reduce costs and risks for designers, builders, vendors, operators, regulators, and underwriters. In separate interviews, the managing directors from six North European yards confirmed that company resources' (typically, six engineers full-time) were committed to a standards development program precisely because the benefits far outweighed the costs. Moreover, they were so convinced of this fact that they did not exert time and money to collect specific cost vs. benefit data. Figure 2 illustrates the prospective relationship of cost to benefit over the next five years as a system of coherent<sup>1</sup> shipbuilding standards is developed.

The cost curve anticipates initial costs that are higher than sustaining costs. Because standards have been neglected by the private sector for so long, there is a huge backlog of work- to be done; hence a major initial outlay. As present standards are improved and new standards are written, the shipyard commitment reduces to a sustaining level.

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<sup>1</sup>The word "coherent" is used in its scientific sense to mean "characterized by an orderly or logical relation of parts that affords comprehension".

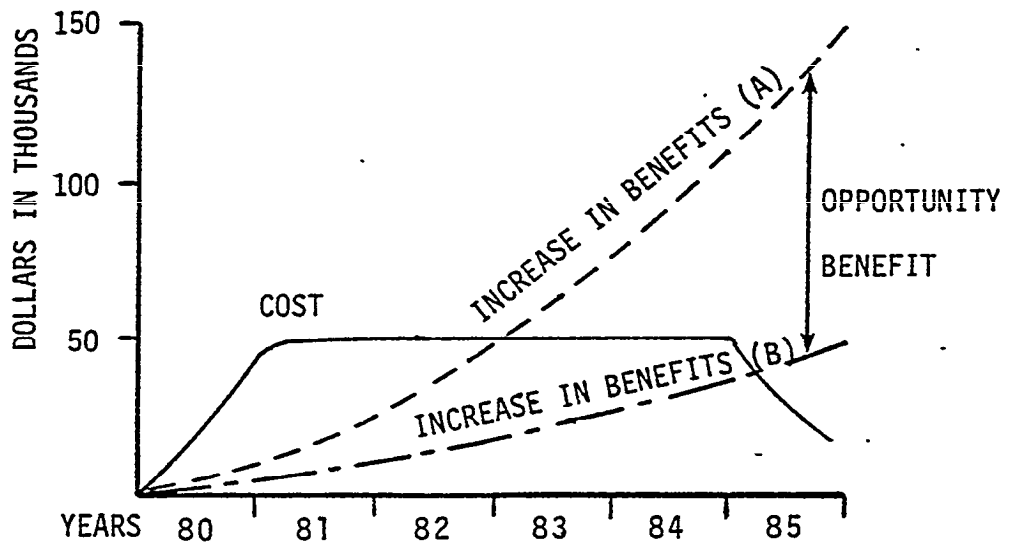


Figure 2: TYPICAL SHIPYARD COST AND BENEFIT CURVES FOR THE ASTM SHIPBUILDING STANDARDS PROGRAM.

The cost curve assumes a standards co-ordinator who will be able to devote half of his time to F-25 Committee endeavors. An additional cost allowance is included to fund the time which other engineering and production experts will contribute to the development and review of standards. Shipyards which intend to develop complete standards without F-25 Committee assistance should consider funding at four to six times this suggested level.

Two benefit curves are shown. The lower curve (B) foresees the savings which will be evidenced throughout the industry as a whole if standards are improved and if a system is maintained to manage the program. In dramatic contrast, the upper curve (A) demonstrates the tremendous advantage which would accrue to a shipyard aggressively pursuing the utilization of well-written standards. It represents an opportunity benefit available to the yard in which management resolutely uses good standards; it represents the financial reward to be attained through dedication and commitment to a positive standards program.

## **SECTION II**

### **FINDINGS AND RECOMMENDATIONS**

## II. FINDINGS AND RECOMMENDATIONS

### 1. HISTORICAL PERSPECTIVE

The national shipbuilding research program was initiated by the Maritime Commission in 1972 as a joint venture with the industry to find methods for reducing the cost of building ships. Standardization of methods and components (not whole ships) was identified as an area of significant potential for savings. Bath Iron Works, Inc. (BIW), the major builder of standardized Navy destroyers during World War II, agreed to cost share and manage the appropriate research. In 1973, key managers of the major United States yards and the major design agents met at Annapolis to identify the areas offering the greatest opportunities for cost and risk reduction. From this consensus of industry leaders, Bath Iron Works created the research program for shipbuilding standards.

The initial work<sup>1</sup> under this program clearly concluded that the use of standards by the maritime community would reduce cost and risk, and that the development of an indexed catalogue of domestic and foreign shipbuilding standards was the next step to be taken. This report is the outcome of taking that step and summarizes the path of the research. Details of the study are available in ten reports listed in Appendix B.

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<sup>1</sup>The results of the initial research tasks are reported in publications prepared by Bath Iron Works for the Maritime Administration and are listed in Appendix B.

2. PURPOSE OF RESEARCH TASK S-20 (A Compendium of Shipbuilding standards)

The purpose of this task was to identify and catalogue the standards that are being used by the shipbuilding industry in the United States and a representative sample of those used abroad. The task was divided into three subtasks:

Subtask I - Identify Existing U.S. Shipbuilding Standards

Subtask II- Identify Industrial Standards Used by U. S. Shipbuilders

Subtask III - Identify Foreign Shipbuilding Standards

In addition, special investigations were made into certain discrete facets of standards in response to the needs of SNAME<sup>1</sup> Panel SP-6 on Standards and of the Executive Subcommittee of the ASTM<sup>1</sup> F-25 Committee on Shipbuilding.

3. METHOD

Figure 3 summarizes the number of standards which were examined and cataloged as part of this task. The standards in Subtask I are considered to be in active shipbuilding use in the United States. They were found in contracts between owners and shipyards which involve Construction Differential Subsidy Funds. They are predominantly from the regulatory bodies and classification societies. The industrial standards in Subtask II are primarily from such voluntary consensus standards organizations as ASTM. All of the Subtask II standards were cited by reference from the Subtask I standards. The foreign standards in Subtask III were identified as "shipbuilding standards" in catalogues published by DIN, IEC, ISO,

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<sup>1</sup> Acronyms for the standards organizations are explained in Appendix A.

	SUBTASK I U.S. SHIP- BUILDING STD.	SUBTASK II U.S. INDUS- TRIAL STD.	SUBTASK III FOREIGN SHIP- BUILDING STD.	TOTAL
NUMBER OF STANDARDS	2596	395	446	3437
PERCENT	75.5%	11.4%	13.1%	100%

FIGURE 3: A TOTAL OF 3437 SHIPBUILDING AND INDUSTRIAL STANDARDS WERE ANALYZED.

and JIS. In addition, some standards were included from a major German yard. There are no foreign regulatory standards in Subtask III. This fact should be kept in mind when comparing data from Subtasks I and II (American) with data from Subtask III (Foreign). Figures 4 and 5 show the distinction between standards selected for each subtask.

Once the standard was identified, it was analyzed by an engineer who codified it into a Ship Work Breakdown Structure (SWBS)<sup>1</sup> subgroup and assigned it to a subcommittee of the ASTM Committee F-25 on Shipbuilding. He determined the type of standard and the subjects (up to three) covered. This information with the standard's title, originating organization, and identifying number were key entered on magnetic tape and computer processed to provide listings of the information sorted four ways:

- Originating organization
- Navy Ship Work Breakdown Structure (SWBS) number
- Subject
- F-25 subcommittee assignment

<sup>1</sup> For a complete description of SWBS, see Ship Work Breakdown Structure, NAVSEA 0900-LP-039-9010.

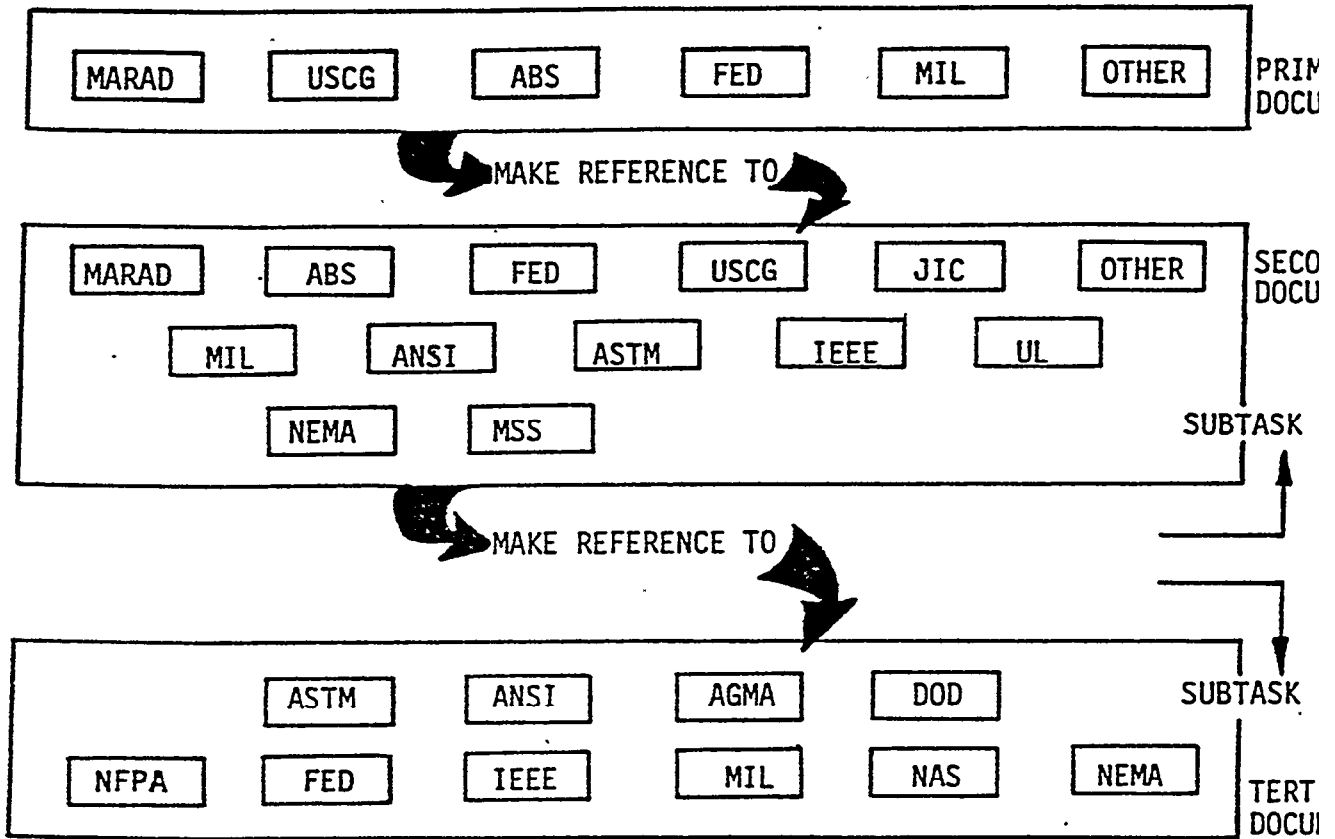


FIGURE 4: THE STANDARDS INCLUDED IN SUBTASK I AND SUBTASK II CAME FROM DOCUMENTS USED IN SHIPBUILDING CONTRACTS OR FROM SECONDARY AND TERTIARY DOCUMENTS REFERENCED BY THE PRIMARY DOCUMENTS.

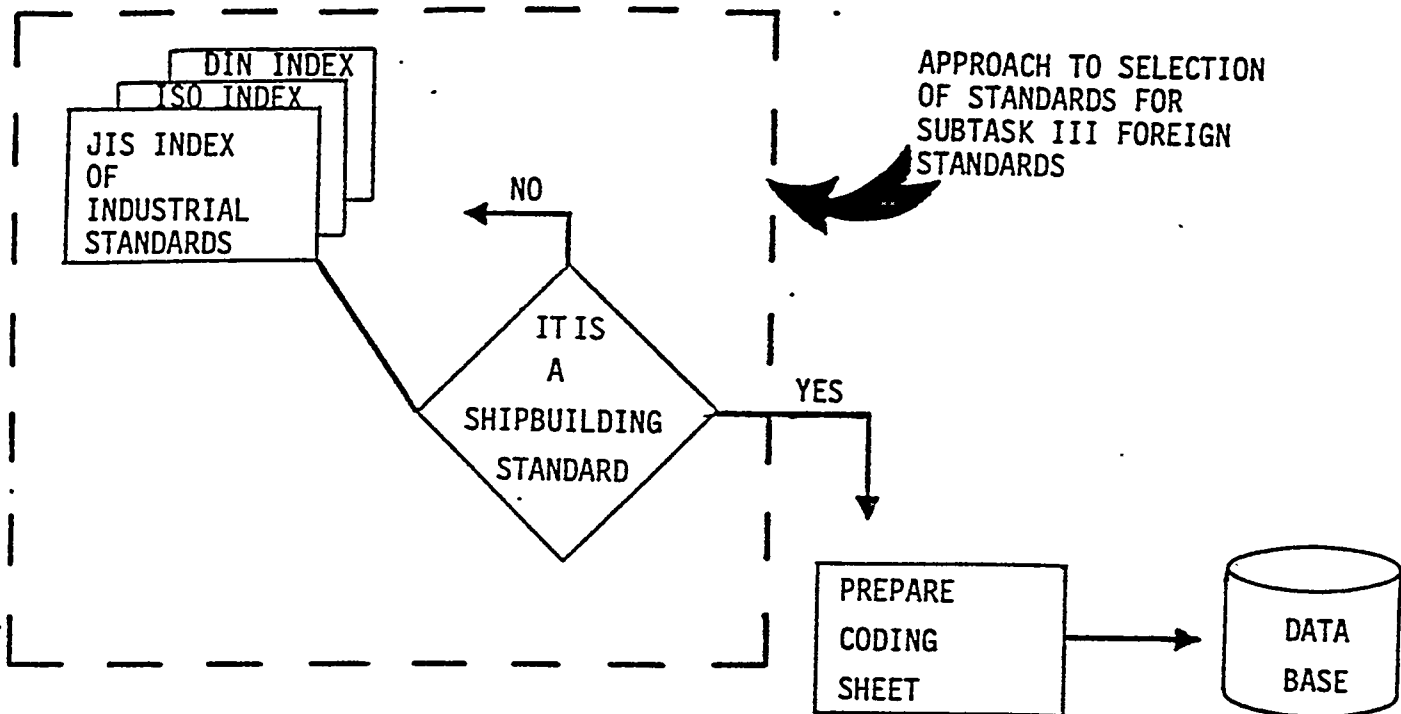


FIGURE 5: FOREIGN SHIPBUILDING STANDARDS FOR SUBTASK III WERE SELECTED FROM PUBLISHED INDICES.

The processing of the information by the engineer which resulted in the computer print-out is illustrated in Figure 6 and is described in detail in the "User's Guide" of Appendix C. The computer print-outs have been distributed to the members of SNAME Panel SP-6 and to the Executive Subcommittee of F-25 and are available. Appendix B contains a list of the print-outs and instructions for ordering.

#### 4. FINDINGS

##### a. Present Standards are not Sensitive to Economic Impact

The collection of standards which exists today has in large part been developed by those who are removed from the economic pressures of shipbuilding. Often the objectives of the standards' writers are dictated by legislative action such as directives to promote safety at sea. There has been little

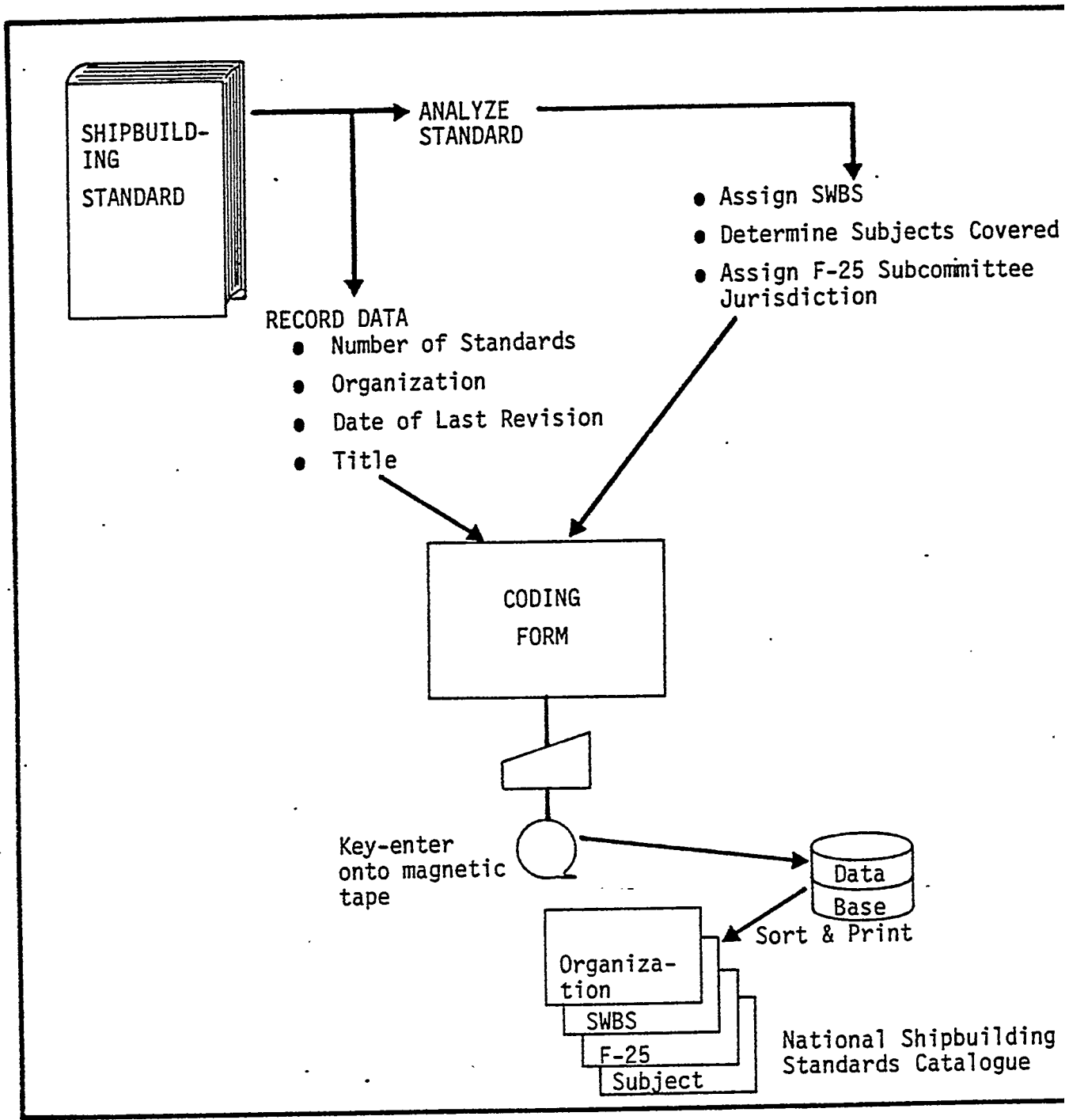


FIGURE 6: STANDARDS WERE CODIFIED AND INFORMATION ENTERED ONTO A DATA BASE FOR SORTING AND PRINTING OF VARIOUS LISTS.

or no pressure put upon the writers to take into account the complex economics of designing, building, and operating a ship for profit. Because cost figures are considered to be confidential within each shipyard, no industry-supported forum has existed in the past which would have provided an opportunity for shipyard representatives with cost knowledge to participate in the development or approval of standards.

It is fortunate at this juncture that a recognition of this problem has prompted the regulatory bodies to seek more industrial input, and that the formation of the ASTM F-25 Committee on Shipbuilding has attracted a broad membership which includes designers, builders, owners, operators, regulatory bodies, classification societies and vendors. These new forces, with encouragement, can see to it that standards reflect the vital need to be economically in tune.

b. A System for Managing U.S. Shipbuilding Standards Does Not Exist

The examination of the current state of standards in the American shipbuilding arena reveals an unwieldy situation lacking co-ordination and direction. Aside from the most elemental territorial claims, there appear to be no co-operative efforts, there is much duplication, a maze of complex interrelationships survives unaided by an audit trail, and research uncovers a rather frightening evidence of unacknowledged obsolescence. To exemplify, Section 52-5 of the Marad Standard Specification makes reference to 440 standards written by 13 different organizations in six levels of citations; further, some of the cited standards have been revised, thus effectively changing the Marad Standard Specification without Marad's knowledge or agreement. In other cases, tracing cited standards led to the discovery that some standards had been revoked years ago. (MARAD 17-MA-03 and 18-MA-03 stand as examples. ) Figure 7 shows the age of American standards to be significantly greater

DOMESTIC SHIPBUILDING		FOREIGN SHIPBUILDING
REGULATORY STANDARDS	INDUSTRIAL STANDARDS	
6 YEARS	4 YEARS	3 YEARS

FIGURE 7: AVERAGE AGE OF STANDARDS

than the foreign counterparts, a disparity which results from a lack of regular review of domestic standards.

It becomes obvious that the key to managing a standards program is co-ordination to avoid duplication and complexity, coupled with a constant attention to methods and technology.

c. Regulatory Bodies and Classification Societies Dominate U.S. Shipbuilding Standards

As noted in describing the purpose of this research task, the 2596 standards examined in Subtask I were directly cited or referenced in contracts for subsidized ship construction. Eighty percent of these standards were from a regulatory body such as MarAd or from a classification society. The standards comprising the remainder were developed by such industrial groups as IEEE. Because regulatory standards tend to be cumbersome and insensitive to expediency and economy, and because industrial standards on the whole tend to address qualitative and quantitative specifics more generically, it is disturbing to find so few industrial standards at the primary contract level. It is only as citations are followed out of the contract that the incidence of non-regulatory standards becomes more frequent. Figure 8 verifies this point.

No regulatory standards were studied in Subtask III, Foreign Shipbuilding Standards, for two reasons. First the

STUDY SUBTASK	SOURCE OF STANDARDS		TOTAL
	REGULATORY	INDUSTRIAL	
I U.S. SHIPBUILDING STANDARDS IN USE	2069	527	2596
11 RELATED INDUSTRIAL	77	318	395
III FOREIGN	0	446	446
TOTALS	2146	1291	3437

FIGURE 8: SOURCE OF STANDARDS BY SUBTASK

standards to be analyzed came from standards indices as opposed to contract documents; second, foreign yards have developed a major portion of their standards through national standards organizations, thus limiting regulatory specifications to strength of design and safety items. Foreign yards are capable of building to ABS rules but no document comparable to the Marad Standard Specification for Merchant Ship Construction, with its 372 items manufactured by 144 Companies, was in evidence. It is customary for foreign companies to list such items as part of the "standard outfit" which is negotiated with the prospective ship owner. Whereas the Marad Standard Specification tells the U.S. builder to supply a LAMSON 6512 Grapefruit Knife (or equal), the foreign shipbuilder would have negotiated a long-term "frame" agreement with a reputable vendor for all of the galley equipment. (The term "frame" refers to the sliding time frame which is a usual condition of such an agreement, providing for automatic contractual extensions from the initial period as long as the vendor continues to meet the standards for quality and performance at a competitive price.) In seeking a purchase agreement of this sort, a

performance standard for each item in the purchase group would have to be met by the vendor.

It is evident that the foreign shipbuilder has capitali on his greater freedom to use industrial standards, while the American yard finds itself using standards written by government agencies because standards were not available to the agencies or to the shipyards when they were needed.

d. Shipbuilders are Confronted by a Confusion and Profusion of Standards

The next three areas of commentary are so closely interrelated that in covering the subjects there will be considerable overlap. The evidence from the study of domestic standards suggests (1) that there are more standards than are required for adequate coverage (the number is a five-digit unknown); (2) that in some categories there is irrelevant or inadequate coverage; and (3) that many standards are very cumbersome to use. These hindrances have their genesis in the origin of the majority of U.S. shipbuilding standards by the regulatory bodies who create standards with little regard for their end use or economic impact and without direction from a standards management organization.

By contrast, foreign yards appear to function effective with a much smaller number of standards (about 1000), and they attempt to write standards which are more versatile.

It must be understood that although these findings are valid for many of the standards examined, the standards taken as a whole are far from homogeneous. The lack of a clearing house for standards and the diverse interests of the writing organizations guarantee confusion and a lack of organization. Individual standards may not stand the test of each finding, but certainly the overall message is clear.

As standards were analyzed and assigned to SWBS groups, it became obvious that large numbers of domestic standards were Federal Specifications addressed to minor items such as wooden mallets, asbestos gloves, flour sifters, while the larger percentage of foreign standards was concerned with more significant components, leaving most of the small items to be dealt with at a shipyard level. This phenomenon can be seen in Figure 9 showing the distribution within SWBS Group 600 on Outfit and Furnishings.

SWBS SUBGROUP OR ELEMENT NO.	SWBS TITLE	DOMESTIC		FOREIGN	
		NO.	%	NO.	%
601	General Arrangement - Outfit and Furnishing Drawings	0	0	4	6
602	Hull Designating and Marking	20	5	5	8
610	Ship Fittings	0	0	4	6
611	Hull Fittings	7	2	5	8
612	Rails, Stanchions and lifelines	4	1	5	8
613	Rigging and Canvas	7	2	3	5
623	Ladders	9	2	23	37
625	Airports, Fixed Portlights and Windows	7	2	6	10
631	Painting	32	8	1	2
634	Deck Covering	13	3	0	0
635	Hull Insulation	13	3	0	-0-
640	Living Spaces	77	19	1	2
644	Sanitary Spaces and Fixtures	13	3	0	0
651	Commissary Spaces	37	9	1	2
665	Workshops, Labs, Test Areas (Including Portable Tools and Equipment)	98	24	0	0
600-699	All Other Not Included Above	67	17	4	6
	TOTAL	406	100%	62	100%

FIGURE 9: DISTRIBUTION OF DOMESTIC AND FOREIGN STANDARDS WITHIN SWBS GROUP 600-699, OUTFIT AND FURNISHINGS.

It is also of interest to note that while each of the four foreign industrial organizations studied indicated a number of the applicable standards to be shipbuilding standards written expressly for that industry, IEEE was the only American industrial association out of those making any noticeable contribution to a body of shipbuilding standards per se. Figure 10 charts the numbers. The five domestic standards writing groups listed in Figure 10 provide almost 90% of the industrial standard examined in this research task, and all of the standards are included in shipbuilding contracts. However, only 16% of the 778 total were written with the assistance of shipbuilding personnel. At the opposite pole, foreign shipbuilders assisted in the development of all foreign shipbuilding standards.

STANDARDS ORIGINATING ORGANIZATION	NUMBER OF STANDARDS	NUMBER CLASSIFIED AS SHIPBUILDING STANDARDS	PERCENT SHIPBUILDING STANDARDS
ISO	5703	59	1
IEC	738	68	9
JIS	7700	512	7
DIN	13640	118	1
SUBTOTAL FOREIGN	27781	757	3%
ASTM	5000	1	0
ANSI	9700	3	0
IEEE	340	1	0
NEMA	250	0	0
UL	1500	4	0
SUBTOTAL DOMESTIC	16790	9	.05%

FIGURE 10: COMPARISON OF NUMBER OF SHIPBUILDING STANDARDS DEVELOPED BY MAJOR FOREIGN AND DOMESTIC INDUSTRIAL STANDARDS WRITING ORGANIZATIONS.

A significant number of standards caused enough difficulty in this research to make it very certain that the use of them by the industry must be exasperating at best. Four kinds of problems predominate.

The first problem is one of vague references. One standard will invoke another series of standards without specifying which section of the latter is applicable. A standard will state "in accordance with regulatory body requirements" without stating which regulation is intended. Some standards make reference to cancelled or superseded standards.

A second stumbling block involves imprecise descriptions. "In accordance with good shipbuilding practices" appears over and over again. What constitutes "good shipbuilding practice"? Can it be measured? One of the important major gaps in the current body of standards is the lack of specified tolerances. (Japanese standards, developed under JIS jurisdiction, universally give tolerances for shipbuilding practices. JIS standards specify the dimension with tolerance for the new condition and sometimes even for the limit of service.)

A third complexity results from multi-level interdependency, or chaining. Often the reference path from one standard to another turns back in on itself or leads to a never-ending series of citations, many of which are in part irrelevant to the standard at hand. The maze can befuddle the most dedicated standard-user. Figure 11 is a simplified illustration of the chaining effect.

The fourth impracticability is caused by specifications that are too precise or restrictive. In an attempt to define a standard product, the product is specified by brand name and then universalized by adding "or equal". It is presumed that "or equal" will allow a shipyard to buy the named item from a

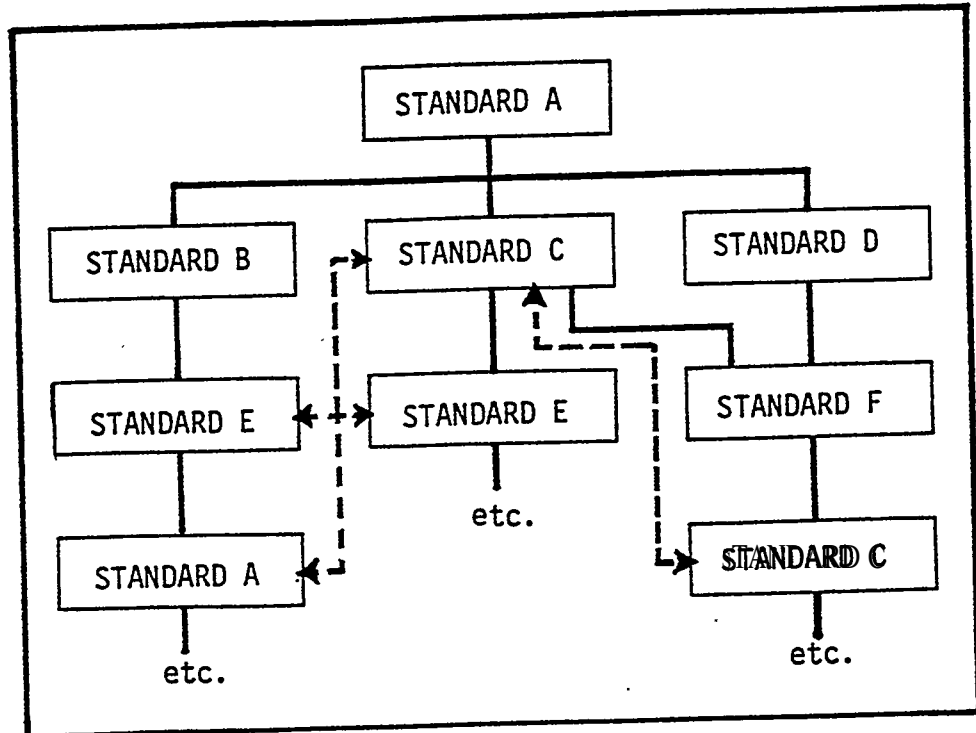


FIGURE 11: MULTILEVEL INTERDEPENDENCY OF STANDARDS ON CHAINING.

different manufacturer as long as the substituted item is equivalent to the specified one in every way. Proving equality is the shipyard's obligation and is very difficult, because the specification by brand name constitutes all the information given. Without knowing what qualities or performances are relevant, an "or equal" product substituted is not easily defended. Such restrictive and uninformative standard writing can result in limited cost alternatives for the shipbuilder, since the vendor bias is not easily balanced in such a small industry.

e. ~~Standards do not Serve the Best Interests of All~~

In order to deliver a ship, standards must be used through the shipbuilding process by the designer, the builder, the owner, and operator; by the suppliers and vendors; and by those who regulate the industry. Clearly, each of the above

makes a different contribution to the finished product, and consequently each faction has a unique use for a standard. These individual requirements can be illustrated by considering an hydraulic pump. The designer needs to know the characteristics of the pump. The builder must see that it will interconnect with all mating equipment. The owner/operator is concerned with a reliable, maintenance-free pump which will have a low life cycle cost. The supplier must meet the performance level and tests used to measure that performance. The regulatory body is concerned with insuring the safety of the pump. The writer of standards must address these needs, but many of the present standards do not demonstrate such recognition. Taken as a whole, the ABS Rules appear to have a reasonable sensitivity to use and purpose, whereas long lists of products by brand name "or equal" seem to lack such awareness.

f. Standards are Vital

The most important common denominator to this research report must be emphasized: a ship could not realistically be built without standards. This is a very simplistic statement, but its essence is the foundation upon which all discussion and critique of shipbuilding standards takes place. The rest is a matter of degree. Without standards, there could be no steel plate to use (composition? tensile strength? dimension?), the fittings would not fit the pipes nor the nuts the bolts, the propulsion system could not function without a condenser mated to the boiler, there could be no warrant against defects. In spite of all the difficulties found in the present situation, it is inconceivable to image building a ship with no standards at all.

Even the present non-integrated shipbuilding standards affect savings for all. A custom design without benefit of standards would be prohibitive. Even the custom builder of hand crafted dinghies uses standards to advantage.

The challenge is, therefore, to expedite an efficient) well-managed system within which standards are written and promulgated and used in order to achieve optimum quality at a competitive price.

5. RECOMMENDATIONS FOR IMPROVING U.S. SHIPBUILDING STANDARDS

a. An Integrated Family of Standards Should Be Developed

The shortcomings of both the system of standards and of individual standards which presently persist and were highlighted in the findings of this research task can be largely eliminated by the establishment of a family of shipbuilding standards. Such a body of standards specifically addressed to the singular business of building ships must exhibit the following characteristics:

- Sensitivity to costs and risks
- Protection for the interests of all parties
- Adequate coverage
- Coherent relationships between standards
- Codification for the convenience of all users
- Built-in mechanism for up-dating

b. A Standards Management Organization is Essential

In order to achieve the objective of a well-integrated family of standards, a standards management committee with full industry support is a must. It should be organized in order to oversee the implementation of these six action steps:

- Review existing standards with an eye to the quality of the standard, appropriateness of the subject material, relationship to other standards. Usually this review should take precedence over writing new standards.

Ineffective standards should be withdrawn, obsolete standards up-dated. The standard should display sensitivity to its intended use. Figure 12 presents a flow diagram for the review of standards.

- •Develop procedures to provide for interaction on a regular basis among the groups that write standards. (The 36 writing groups identified in this research task offer a jumping-off place!)  
A set of mutually acceptable ground rules needs to be negotiated with the publishers of standards relative to satisfactory reasons for requesting that a standard be revised or dropped. The ground rules will have a definitive effect upon the review action.
- 1 Simplify the relationships between standards.  
Complex chains or interstandard dependencies are not necessary. Every effort should be made to keep citations within bounds. A specification tree can be a helpful tool. The interposing of limits on references and citations may be in order.
  - 1 Identify voids in standard coverage. New standards will be advantageous in some areas to fill the "holes". The elimination of several conflicting standards may create a void best filled by a new standard. The development of new standards should be a planned activity, scheduled and monitored by the standards management organization.
  - 1 Insist on well-written standards. The need for standards to be well-written has been a concern of the major standards management groups such as ASTM.

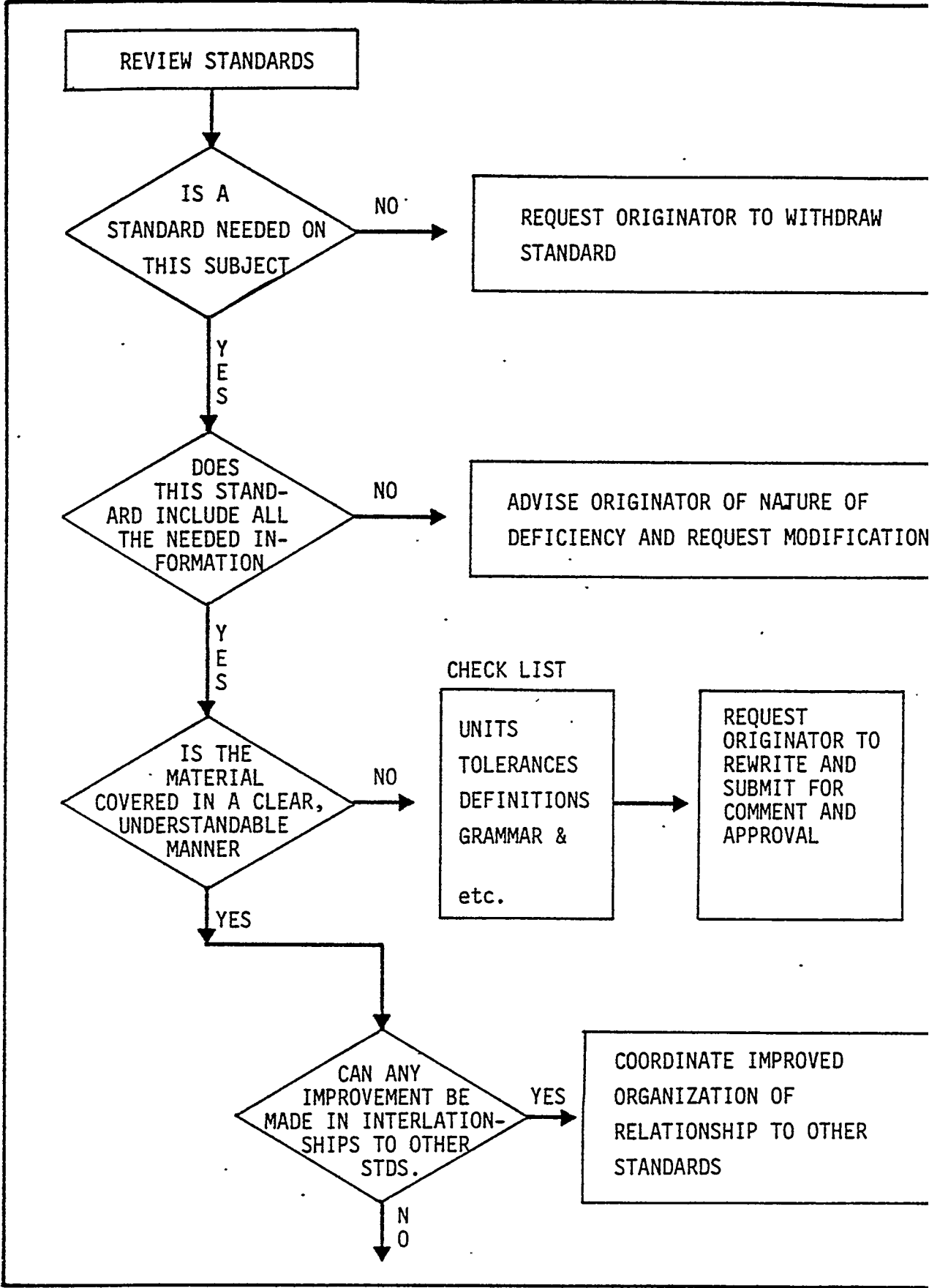


FIGURE 12: FLOW DIAGRAM FOR THE REVIEW OF EXISTING STANDARDS

The Society published a style manual intended as a standard for linguistic quality for the writers of standards. In the case of shipbuilding standards an additional quality check should be made because of inexperience in writing marine standards for general use. With a tradition of very limited participation in standards development, the maritime industry could easily lose time and inertia with costly false starts. A brief quality assurance guide should be developed to assist in the selection of subjects for standards and in the determination of valuable attributes to be incorporated into the standards. The guide should address the technical content of the standard as an adjunct to the style manual.

- Ž •Provide for cyclical review of all standards.  
The family of standards must be kept up-to-date, and therefore a pattern for periodic review of each standard is a necessity. The interval between reviews should not exceed five years. In addition, provision for review of a standard in mid-cycle is called for to allow for a response to specific significant deficiencies. An index of the relationships between standards would assist in this effort to maintain standards which are current, as it would enable the reviewer to determine the effect of changing a standard on those standards which depend upon the changed standard.

## 6. IMPLEMENTATION OF RECOMMENDATIONS

In order to develop and maintain an integrated family of standards, the following steps (which have already been initiated) should be vigorously pursued.

A shipbuilding standards management organization has been formed within the American Society for Testing and Materials. This is the ASTM F-25 Committee on Shipbuilding. The chairman is Mr. Robert J. Taylor from Exxon International. The vice-chairmen are Mr. N.S. Smith from Bethlehem Steel and Captain C.B. Glass USCG from the Coast Guard. Mr. John Mason from Bath Iron Works Corporation serves as secretary.

The Committee includes an Executive Subcommittee with management responsibilities and 13 technical sub-committees generally oriented to coincide with traditional shipbuilding lines such as hull structure or deck machinery. Four other sub-committees provide the required staff support.

Thus a complete standards management organization is now in existence.

The efforts of the F-25 Committee are being enthusiastically supported by SNAME Panel SP-6 on Standards and Specifications. This panel is auditing research work such as this Task S-20 and its members are engaging their respective shipyards in the conduct of research which is resulting in draft standards for ASTM F-25 Consensus Review. The progress which has been made in the past year would not have been made without the active participation of the SP-6 Panel members and their chairman,

Further assistance has come from the Office of Advance Ship Development of the Maritime Commission. They have provided matching funds for applied research into ship producibility and have promoted the development of standards as a primary vehicle for converting research results into practicable cost savings.

The Naval Ship Engineering Center (NAVSEC) has a major program underway to review Navy standards for non-combatant ships and is making a determined effort to co-ordinate this project with the develop of commercial shipbuilding standards.

However, the F-25 Committee must face from the onset the liatsonwork immediately required because a large number of organizations are already in the maritime standards writing business and may well resist the Committee's efforts to suggest revision and/or elimination of their creations, There is no question but that some of the groups may sincerely protest that they, keep close watch over their standards and would at any time make improvements which they deemed desirable,

Progress will come with an unanimity of purpose and a persistent dedication to improved opportunities through standardization. There is a predictable ratio between support for the challenge before the F-25 Committee and cost reduction in American shipyards.

#### EPILOGUE

A COHERENT FAMILY OF STAND@DS IS VITAL TO ANY BUSINESS AS COMPLEX AS SHIPBUILDING. THE EXISTENCE OF A SYSTEM FOR DEVELOPING, MAINTAINING, AND CODIFYING STANDARDSIS.MORE CRITICAL THAN IS THE EXISTENCE OF ANY INDIVIDUAL STANDARD. INDUSTRY LEADERS CONCERNED ABOUT THE FUTURE ARE ENCOURAGED TO SUPPORT ACTIVELY THE PRESENT EFFORT TO DEVELOP A STANDARDS SYSTEM.

## SECTION III

## APPENDIX

# CORPORATE-TECH PLANNING INC.

## APPENDIX A

This list gives the names of the organizations (and their acronym) and documents upon which this report is based. The following domestic organizations were classified as a regulatory agency or a classification society.

American Bureau of Shipping  
Department of Labor  
Environmental Protection Agency  
Federal Specifications  
Intergovernmental Marine Consultive Organization  
Maritime Administration  
National Bureau of Standards  
Panama Canal Company  
Suez Canal Authority  
International Convention of Safety on Life at Sea  
United States Coast Guard  
United States Department of Agriculture  
United States Public Health Service  
United States Navy

The remaining organizations were classified as industrial standards writing groups.

SHIPBUILDING" STANDARDS, ACRONYMS AND ORGANIZATIONS OR DOCUMENTS

ABS	American Bureau of Shipping Rules for Building and Classing Steel Vessels
AM 01	Nondestructive Inspection of Hull Welds
ABS 02	Approved Welding Electrodes Wire-Flux and Wire-Gas Combinations
MS 03	Offshore Mobile Drilling Units
ABS 04	Steel Barges for Offshore Service
ABS 05	Bulk Carriers for Service on the Great Lakes
ABS 06	River Rules '71
ABS 07	Inert Gas Installations on Vessels Carrying Oil in Bulk
ABS 08	Certification of Cargo Containers
ABS 09	Manual for Making Bronze Propeller Repairs
ABS 10	Repair,Welding, Cladding and Straightening of Tail Shafts
ABS 11	Burning Crude Oil and Slops in Main and Auxiliary Boilers
ABS 12	Steel Floating Dry Docks
ABS 13	Undewater Inspection in Lieu of Dry Docking Survey
ABS 14	Construction of Shipboard Elevators
ABS 15	Certification of Construction and Survey of Cargo Gear on Merchant Vessels
ABS 16	Certification of Self-unloading Cargo Gear on Great Lakes Vessels
ABS 17	Single Point Moorings

## CORPORATE-TECH PLANNING INC.

ABS 18	Aluminum Vessels
ABS 19	Classification of Nuclear Ships
ABS 20	Submersible Vessels
ABYC	American Boat and Yacht Council, incorporated
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
DOL	Department of Labor
EPA	Environmental Protection Agency
FCI	Fluid Controls Institute, Incorporated
FED	Federal Specification
HEI	Heat Exchange Institute
HI	Hydraulic Institute
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IES	Illuminating Engineering Society
IMCO	Intergovernmental Maritime Consultative Organization
IPCEA	Insulated Power Cable Engineers Association
JIC	Joint Industrial Council
<b>MARAD</b>	Maritime Administration
MASS	MARAD Standard Specification
MASSD	MARAD Standard Specification - Diesel
MIL	Military Specification
MSS	Manufacturers Standardization
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

OCMIF	Oil Companies international Marine Forum
PCC	Panama Canal Company
SCA	Suez Canal Authority
SNAME	Society of Naval Architects and Marine Engineers
SOLAS	Safety of Life at Sea, International Convention of
SSPC	Steel Structures Painting Council
TEMA	Tubular Exchanger Manufacturing Association
UL	Underwriters Laboratories, Incorporated
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USN	United States Navy

FOREIGN STANDARDS

BV	Bremer Vulkan Schiffbau und Maschinen Fabrik (German Shipbuilder)
DIN	Deutsches Institute fur Normung (German Standards Institute)
HDW	Fachnormenausschuss Schiffbau (A committee of DNA, a shipbuilders' association)
<b>HMN</b>	Hivirich Mohr Elmsworn (deck hardware vendor)
IEC	International Electrotechnical Commission
ISO	International Standards Organization
JIS	Japanese Standards Association (JIS Standards for Japanese Industrial Standard)
RNS	Rheinstahl Nordseewerke Gmb. H.Emden (deck hardware vendor)
<b>WWN</b>	Wemormer (abbreviation used in purchase orders to describe product standard)

APPENDIX B

Reports available from Task S-20

The reports listed below have been completed as a part of the National Shipbuilding Standards Program, Task S-20, a Compendium of Shipbuilding Standards. Copies may be obtained by contacting:

Mr. John C. Mason  
Manager, MarAd R&D Program  
Bath Iron Works Corporation  
700 Washington Street  
Bath, Maine 04530  
(207) 443-3311 ext. 2550

1. Subtask I Report

An analysis of 2596 U.S. shipbuilding standards, derived from regulations, classification society rules and voluntary consensus industrial standards cited by the regulations and rules. 51 pages plus appendix.

2. Subtask I Standards Catalogue

Four listings of 2596 U.S. shipbuilding standards sorted by Originating Organization, Navy Ship Work Breakdown Structure (SWBS), Subject, and ASTM F-25 Subcommittee on Shipbuilding.

3. Subtask II Report

An analysis of 395 U.S. industrial standards which are cited by the Subtask I standards. 28 pages plus appendix.

## CORPORATE-TECH PLANNING INC.

4. Subtask II Standards Catalogue

Four listings of 395 U.S. industrial standards sorted by Originating Organization, Navy Ship Work Breakdown Structure (SWBS), Subject, and ASTM F-25 Subcommittee on Shipbuilding.

5. Subtask III Report

An analysis of 446 foreign shipbuilding standards, mainly ISO, IEC, JIS and DIN. 29 pages plus appendix.

6. Subtask III Standards Catalogue

Four listings of 446 foreign shipbuilding standards sorted by Originating Organization, Navy Ship Work Breakdown Structure (SWBS), ASTM F-25 Subcommittee on Shipbuilding.

7. Report on Proprietary Standards

Results of Mail Survey of ten designers and 21 shipyards to determine the extent to which they had developed proprietary standards. 7 pages plus appendix.

8. Notes on Fiberglass Reinforced Pipe

Synopsis of examination of regulations concerning maritime use of glass reinforced resins in rigid plastic pipe. 3 pages.

9. Information in support of the questionnaire forwarded by the Ad Hoc Planning Group of ASTM Committee F25.10 on Electrical and Electronic Shipbuilding Standards.

Monograph on incongruities in electrical standards. 14 pages

10. Consolidated Pilot Phase Report

An introduction to Task S-20 and methodology to be used for Subtasks I, II, and III. 19 pages plus appendix.

11. List of Standards Cited in Maritime Administration Standard Specification for Merchant Ship Construction

List by organization of all references in MarAd Standard Specification to other standards. 71 pages "- originally published as Appendix E of Consolidated Pilot Phase Report.

SHIP PRODUCIBILITY RESEARCH PROGRAM PUBLICATIONS

A manual for Planning and Production Control for Shipyard use.  
IMPROVED PLANNING AND PRODUCTION CONTROL (TASK 0-2)

- Final Reports
- Executive Summary
- Literature Search
- Burning Rate Tables
- Welding Current Tables
- Weld Cost vs Fit Gap Tables
- Production and Scheduling Standards
  - Burning
  - Layout
  - Fitting (Fabrication Area Only)
  - Welding (Fabrication Area Only)

FEASIBILITY OF SHIPBUILDING STANDARDS (TASK S-15)

- Report of Castine Conference
  - 1 Executive Summary

CORPORATE-TECH PLANNING INC.

ADVANCED PIPE TECHNOLOGY (TASK S-4)

- Final Report
- Executive Summary

IMPROVED DESIGN PROCESS (TASK D-2)

- Final Report
- Executive Summary

FEASIBILITY OF PROPULSION PLANT STANDARDS (TASK S-1)

- Final Report
- Executive Summary

SIMPLIFIED HULL FORMS AND SERIES PRODUCTION (TASKS P-1/0-1)

- Final Report
- Executive Summary

STANDARD STRUCTURAL ARRANGEMENTS (TASK S-8)

- Final Report

PROCEEDINGS FOR SHIPBUILDING INDUSTRIAL/PRODUCTION ENGINEERING WORKSHOP.