NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 5-86
Electronic Version for Distribution Via the World Wide Web

Subj: Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels

1. PURPOSE. The purpose of this circular is to establish voluntary minimum standards for U.S. uninspected commercial fishing vessels.

2 DIRECTIVES AFFECTED: Navigation and Vessel Inspection Circulars No. 5-85, 6-85, 7-85, 8-85, and 9-85 are canceled.

3. BACKGROUND.

a. In response to the poor safety record of uninspected commercial fishing vessels the Commandant of the Coast Guard recommended a Fishing Vessel Safety Initiative to the Secretary of Transportation to reduce the number of casualties. The program was approved by the Secretary and became one of the Department of Transportation's' Safety Initiatives.

b. To develop the initiative, the Commandant formed a Fishing Vessel Safety Task Force. After visits to a number of port areas and soliciting advice and recommendations from industry representatives, government agencies and other Coast Guard personnel, it was determined that a voluntary program dealing with vessel standards and crew safety awareness and education was needed and could be effective in improving safety.

c. The safety awareness and education program was pursued by the Coast Guard in company with the North Pacific Fishing Vessel Owners' Association (NPFVOA). A looseleaf "Vessel Safety Manual" was published with chapters paralleling the vessel standards It is illustrated with pictures and diagrams and in a format tailored for fishermen. Persons interested in purchasing a copy of the guide may do so by writing to NPFVOA Safety Program Office, Suite 207, Building C3, Fishermen's Terminal, Seattle, WA 98U9 (206-283-0861).

d. The vessel standards program, which this NVIC addresses, originally consisted of a series of five NVICs; Stability (5-85), Radio and Shipboard Navigation Equipment (6-85), Fire Safety Measures (7-85), Lifesaving Equipment and Protection of the Crew (8-85), and Hull, Machinery, and Electrical Installations (9-85). Many of these NVICs contained specific operational and educational material for fishermen which could be used before the "Vessel Safety Manual" was published; therefore, some material previously contained in any one of the NVICs has been moved to the manual, although some overlap still exists.

e. Since input from the fishing industry and other interested parties was essential, we published NVICs 5-85 thru 9-85 as proposed standards and distributed them to over 230 individuals, groups and organizations throughout the U.S. who have an interest in fishing vessel safety. These groups included safety consultants, marine surveyors, naval architects, insurance underwriters, fishing vessel owners' associations, boat builders, fisheries unions, personnel associated with the National Oceanic and Atmospheric Administration Sea Grant program, and the National Marine Fisheries Service. Several sent -detailed comments; all expressed a favorable reaction to the standards. Other methods were also used to inform Coast Guard personnel and the public about the safety initiatives i.e. District Commander Conferences, District “M” Officer Conferences, Commandant Notice, Commandant's Bulletin, Fish Expo 85', industry sponsored fishing vessel safety seminars and conferences throughout the country, Federal Register notice, and articles in industry periodicals.

f. Enclosure (1) is a consolidation of NVICs 5-85 thru 9-85 taking into account the comments and recommendations received. For continuity, certain regulatory requirements (although not voluntary) have been included where appropriate.

4. DISCUSSION.

a. Commercial fishing activity has only limited federal regulations dealing with vessel safety. Of significance are existing regulations, found in Title 46 Code of Federal Regulations (CFR) Subchapter C, "Uninspected Vessels," which cover minimal lifesaving and firefighting equipment.

b. Enclosure (1) includes recommended voluntary standards intended to be used as guidelines for increased safety on board U.S. uninspected commercial fishing, fish processing, and fish tender vessels. Much of the material used to develop the standards already exists; however, it is scattered throughout several different foreign and domestic publications and documents. Enclosure (1) was assembled using a variety of sources including feedback received from persons having an interest in fishing vessel safety, classification society rules; the Code of Safety for Fishermen and Fishing Vessels prepared by the Food and Agriculture Organization of the United Nations (FAO), International Labor Organization (ILO) and the International Maritime Organization (IMO); Canadian and United Kingdom fishing vessel requirements; American Boat and Yacht Council's (ABYC) Safety Standards for Small Craft; Coast Guard Publications; applicable industry standards; and appropriate portions of federal regulations. This NVIC does not modify or supersede any existing or future laws or regulations.

c. This NVIC is one component of an overall safety program aimed at improving the safety record of commercial fishing vessels. The other components are the NPFVOA/USCG "Vessel Safety Manual" and industry sponsored training courses.

d. Whereas this NVIC focuses on the technical aspects of fishing vessel design, construction and equipment, the "Vessel Safety Manual" is specifically tailored for fishermen and addresses general operational concerns common to all commercial fishing vessels. Enclosure (2) is a copy of the general table of contents and each chapter index of the NPFVOA/USCG "Vessel Safety Manual". An order form is also included.

e. The "Vessel Safety Manual", as written, is a ready reference guide for masters and their crews operating a variety of vessels in different fisheries nationwide. Fishing vessel owners, operators, and masters will find that the principles presented in the manual can be adopted to establish safety practices aboard their vessels. Associations and other interested groups may wish to add to this manual especially if a specific fishery has safety concerns unique to what now exists in the manual. Those wishing to supplement the NPFVOA/USCG "Vessel Safety Manual" by developing specific local safety recommendations should contact Commandant (G-MTH-F/V), 2100 Second Street, S.W., Washington, DC 20593. Printing plates for the Vessel Safety Manual can be made available for such purposes.

f. The Vessel Safety Manual in combination with the voluntary vessel standards contained in this NVIC gives persons in the fishing industry the framework necessary to develop and implement safety programs on their own. These voluntary vessel standards coupled with the NPFVOAIUSCG "Vessel Safety Manual" and private industry training courses, provides the commercial fishing industry with an overall fishing vessel safety enhancement program that will significantly improve its safety record by reduction in the number of injuries and loss of lives and vessels.

5. ACTION. The Coast Guard recommends that vessel builders, marine surveyors, insurance underwriters, fishing vessel owners, operators, industry associations, and other interested parties:

a. Adopt and implement these voluntary vessel standards;

b. Develop regional specific safety recommendations and incorporate them into the NPFVOAIUSCG Vessel Safety Manual; and

c. Develop and implement regional training programs using the NPFVOAIUSCG “Vessel Safety Manual" as input into a curriculum outline and reference text.

J. W. KIME
Chief, Office of Marine Safety,
Security and Environmental Protection

End: (1) Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels
(2) General Table of Contents and Chapter Index from the NPFVOAIUSCG "Vessel Safety Manual"

NON-STANDARD DISTRIBUTION:

C:e Baltimore, Port Arthur, Puget Sound, Miami, Mobile, Norfolk, Jacksonville, Portland OR, Boston, Providence (75); Long Beach, Portland ME, Anchorage, San Diego (50); Alameda (40); Honolulu, Tampa, Juneau, Valdez, Charleston (35); Cleveland (12); Cincinnati, Louisville, Memphis, Nashville, Paducah, Pittsburgh, St. Louis, Savannah, San Juan, Galveston, Buffalo, Chicago, Detroit, Duluth, Milwaukee (10); Huntington, Wilmington, Corpus Christi, Toledo (5)

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VOLUNTARY STANDARDS
FOR
U.S. UNINSPECTED COMMERCIAL FISHING VESSELS

CHAPTER 1 - STABILITY

INTRODUCTION

Coast Guard statistics continue to indicate a disproportionate number of fishing vessel casualties in relation to the number of vessels in service. Improper loading and progressive flooding continue to be the primary causes in the capsizing, foundering and sinking of fishing vessels. Physical changes to vessels without consideration for their effect on stability and watertight integrity are also of major concern.

Fishing vessels are typically of small to moderate size and are operated in harsh environments. This is a major part of the reason for the high loss rate for fishing vessels, since a severe seaway can easily overwhelm the average fishing vessel. Combined with this are the following real world factors which also Rust be considered:

Some design features which are desirable from a stability point of view may be a hindrance to fishing on a day-to-day basis.

Shortened seasons for various fisheries result in economic pressures on the operator to overload the vessel to maximize the catch during the limited fishing season.

Modifications to vessels in service which are necessitated by a change of service or fishing practice usually result in degradation of vessel stability. The practice of using the same vessel in several different fisheries on a seasonal basis often results in a design which is perfectly acceptable for one fishery but marginal or unsafe for another.

Fishing vessel operators in general do not have an appreciation for the factors affecting the stability of their vessels, particularly those factors which can be significantly influenced by their operating practices.

Since all of these considerations must be reviewed to help assure the safety of the boat, fishing vessels are among the most difficult types of vessels to properly design from a stability standpoint. Nevertheless, consideration of each of these factors is a must for any designer or naval architect who becomes involved in fishing vessel design and modifications.

In June of 1985, the Coast Guard published Navigation and Vessel Inspection Circular (NVIC) 5-85, "Proposed Voluntary Stability Standards for Uninspected Commercial Fishing Vessels". The Coast Guard has received many comments on this NVIC regarding the proposed fishing vessel stability standards. This chapter of NVIC 5-86 revises the previous stability recommendations based on these comments and makes several additional changes. The major changes included the current circular are:

Revising the recommended IMO Severe Wind and Rolling Criteria so that the pressure factor is based on the height of the vessel's structure above the waterline;

Recommending that flooding protection be provided for all new fishing vessels over 79 feet; and Recommending a stability standard for fishing vessels when lifting over the side.

Much of the material previously presented in NVIC 5-85, "Graphical Presentation of Stability for Fishing Vessel Operators" has been incorporated in the Vessel Safety Manual, published by the North Pacific Fishing Vessel Owners Association and has been deleted from this NVIC. Fishing vessel operators and marine surveyors are referred to this manual for a discussion of vessel stability and those operational

factors which affect stability with illustrated examples. This manual may be ordered at the address below. The cost is $30.00.

NPFVOA
Vessel Safety Program
Room 207, C-3 Building
Fisherman's Terminal
Seattle, Washington 98119

The areas to be considered in these guidelines are outlined below. Each of the items in the outline is followed by a one letter code to indicate its suggested usage. The codes are:

R: Recommended
C: Should be Considered in the design process and/or the operation of the vessel where applicable

Intact stability criteria (R).

Damaged stability criteria (R).

Design characteristics which affect stability.

Inclining Experiment and Deadweight Surveys (R)
Method of Calculating Righting Arms (R)
Effect of Trim (C)
Recommended Loading Conditions (R)
Free Surface (R)
Treatment of Lifting Weights during Fishing Operations (R)
Ballasting (R)
Watertight Integrity (C)
Freeboard (C)

Environmental factors affecting stability.

Beam Seas (C)
Following Seas (C)
Icing (R)
Water on Deck (C)

Operating Information for Fishing Vessel Designers and Operators

Presentation of Stability Information to Fishermen (R).

The effects of Modifications on Fishing Vessel Stability (R).

Assessing the Combined Effects of Environmental Factors on Ice Accumulation (C).

Fishing vessel designers, owners, operators, industry associations, builders, marine surveyors, insurance underwriters and other interested parties are encouraged to adopt and implement these voluntary standards. The attached recommendations are intended for the improvement in design and operation of all

sizes and types of fishing vessels. The known limitations of these recommendations are addressed in each section. The Coast Guard believes that these recommendations are based on the best possible information currently available both domestically and internationally.

The Coast Guard invites comments on the guidelines presented, especially as they impact on the design and operational aspects of fishing vessels. The Coast Guard also welcomes information on other methods of evaluating stability which have been used successfully on vessels in service. Comments should be sent to Commandant (G-MTH-3), 2100 Second Street, S.W., Washington, DC 20593. Comments received will be evaluated for use in modifying these recommendations.

Recommend Intact Stability Criteria

A. General - In preparing this NVIC, much consideration was given to criteria which had been previously developed for fishing vessels. On pages 35 and 36, there is a summary of the many criteria which were considered pertinent to fishing vessels. Two criteria are proposed as voluntary standards for the U.S. fishing industry. They are the International Maritime Organization (IMO) Resolution A.168(ES.IV), more commonly known as the Torremolinos Convention Criteria, and the IMO Severe Wind and Rolling Criteria. There are many reasons for supporting these criteria, but the primary ones are these:

1. Since the criteria were first recommended by IMO, there have been few known instances in which vessels that allegedly met the criteria have been lost.

2. Most naval architects are familiar with righting energy, metacentric height (GM) and range of stability as parameters used in evaluating stability.

3. As an alternative, where there has. been successful operation over a long period of time (at least ten years) for vessels operating in a specific fishery or in particular waters, the stability characteristics of these vessels may be used by the designer to determine safe loading characteristics for the design vessel.

4. Although meeting these criteria is not an absolute guarantee of safety, the Coast Guard believes that if fishing vessels comply with these criteria in all conditions of loading, then a significant decrease in the number of stability-related fishing vessel casualties will result. In order to meet the criteria in all operating conditions, the designers must have a full understanding of the limits they impose.

B. Roll Period Test - The Coast Guard declines to endorse the use of a roll period test in IMO Resolution A/ES.IV/168 for several reasons.

1. First, a roll period test may be used by the operator to evaluate the vessel's stability while underway by operators who do not fully understand the limitations of measuring the roll period to evaluate stability. Measuring the roll period in still water is a case of free oscillation where the measured roll period is the vessel^{t} 5 natural roll period. This may or may not be the case when the vessel rolls in a seaway. If waves of a constant period act upon the vessel for a sufficiently long period of time, the measured roll period will be that of the waves. If waves of a constant period are not experienced, the measured roll period may be the natural period of the vessel or, more likely, a combination of the vessel's natural period of roll and the period of the seaway.

2. Second, the roll period is only indicative of the vessel's metacentric height (GM) and not the area under the righting arm curve or other important stability characteristics such as the maximum righting arm, the angle at which the maximum righting arm occurs or the range of stability.

3. Third, the data used to develop the nomogram shown in IMO Resolution A/ES.IV/168 was taken from European fishing vessels and coastal freighters. The Coast Guard is not convinced that the roll coefficients recommended are appropriate for U.S. fishing vessels considering the number of fisheries that U.S. fishermen are engaged in and the diversity of hull forms and arrangements used.

4. Finally, the Coast Guard is concerned that the roll coefficients do not accurately account for the changes in the roll gyradius as the vessel operates between full load and burned out conditions. A significant change in the roll gyradius means that the actual GM may be much different than that indicated from measuring the roll period and calculating the GM based in the equations given.

C. Torremolinos Convention Criterion Requirements - This criterion requires: (See Figure 1-1)

1. The area under the righting arm curve should not be less than 10.3 ft-degrees (0.055 meter-radians) up to an angle of heel of 30 degrees.

2. The area under the righting arm curve between the angles of heel of 30 degrees and 40 degrees or between 30 degrees and downflooding (q f) if downflooding occurs at less than 40 degrees, should not be less than 5.6 ft-degrees (0.030 meter-radians).

3. The area under the righting arm curve should not be less than 16.9 ft-degrees (0.090 meter-radians) up to an angle of heel of 40 degrees or the angle of downflooding (q f) if this angle is less than 40 degrees.

NOTE: This criteria requires that the sum of the area under the righting arm curve to 30 degrees and the righting arm curve between 30 degrees and 40 degrees or 30 degrees and the angle of downflooding be greater than 16.9 ft-degrees. This means that either or both of these areas must be greater than that specified in paragraphs (a) and (b).

4. The righting arm should be at least 0.66 feet (0.2 meters) at an angle of heel greater than or equal to 30 degrees.

5. The maximum righting arm should occur at an angle of heel preferably exceeding 30 degrees but not less than 25 degrees.

6. Initial GM should not be less than 1.15 feet (0.35 meters).

7. As an additional part of this criterion, the Coast Guard is recommending a minimum range of stability of 60 degrees. It is noted that the Federal Republic of Germany requires a 60 degree range and that the Norwegian government requires a 60 degree range of stability for existing vessels and an 80 degree range for new vessels.

8. Example - On page 1-37 is an example applying the Torremolinos -Convention Criteria to a fishing vessel (here a scallop boat) in a loaded condition. The calculation assumes that

the designer has access to a program which will calculate righting arms given a KG value and a set of hull offsets.

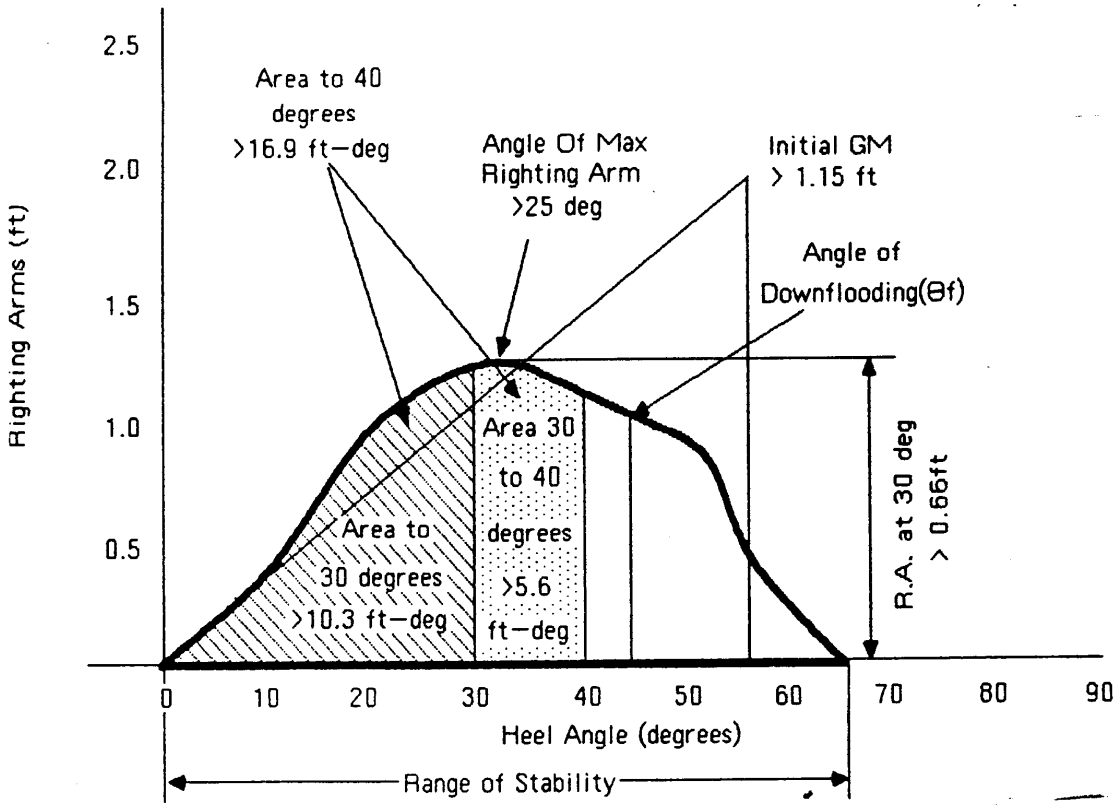


Figure 1–1.
Torremolinos Convention
Criteria for Fishing Vessels

D. Restrictions

1. In previous NVICs, designers were cautioned against the use of the criteria for vessels under 79 feet in length. The Coast Guard continues this caution. As smaller vessel designs are considered, certain adverse effects are magnified. For example, although righting arms are generally the reference, it is the magnitude of the heeling energy which must be dealt with. For a small vessel, the heeling energy in a given wave is greater relative to the total righting energy developed by the hull than it is for a larger vessel. Other effects which must be considered are:

   a. Freeboard becomes more critical (the chances of a given wave swamping the vessel increase with decreasing freeboard);

   b. Downflooding occurs earlier;

c. Significant changes in trim as the vessel heels become very important regarding downflooding and deck immersion; and

d. The location of the center of gravity of the vessel becomes far more critical and deck loads and fishing practices become the driving forces in a design.

2. Designers and operators alike should recognize that on a smaller vessel, it may be necessary to increase some of the Torremolinos Convention Criteria requirements in order to provide a level of safety equivalent to that of larger vessels. To date, there has not been adequate research to establish what these increased requirements should be for vessels less than 79 feet.

3. The designer should also realize that a small vessel may not be able to survive an extreme sea condition, regardless of the criteria it has been designed to.

4. The Coast Guard also warns that this criteria may not provide adequate stability for fishing vessels in the light condition. One vessel capsized in the light condition even though the stability of the vessel exceeded the Torremolinos Convention Criteria by 10 percent. It has been reported at recent meetings of the IMO Subcommittee on Stability, Load Lines and Fishing Vessel Safety that several vessels have capsized while in the light condition even though they supposedly met the Torremolinos Convention Criteria.

5. The Coast Guard believes that the Torremolinos Convention Criteria and the IMO Severe Wind and Rolling Criteria are the best that are currently available, but it must b& recognized that an accurate assessment of operational requirements which will affect a vessel's stability must also be made to supplement the criteria used.

6. The Torremolinos Convention Criteria recommend minimum values, but no maximum values. While it is important to design for a reserve of stability above the minimum, it is advisable to avoid excessive values, since these might lead to high accelerations resulting in excessively high forces on the vessel and may cause injuries to the crew.

E. IMO Severe Wind and Rolling Criteria Requirements - In conjunction with the Torremolinos Convention Criteria the Coast Guard also recommends that designers and naval architects apply the IMO Severe Wind and Rolling Criteria. This criteria is presented on the following pages. The reader should refer to Figure 1-2 when using this criteria. All units are in English and the metric equivalents are given in parenthesis.

1. This criteria measures the ability of the vessel to withstand the effect of beam winds and rolling.

a. The vessel is assumed to be subjected to a steady wind pressure acting perpendicular to the vessel's centerline which results in a steady wind heeling arm (L_{w_1}). The vessel heels to an angle of equilibrium, ϕ_0. The angle of equilibrium (ϕ_0) should not exceed 14 degrees.

b. From the resultant angle of equilibrium (ϕ_0), the ship is assumed to roll due to wave action to an angle of roll (ϕ_1) to windward.

c. The ship is then subjected to a gust wind pressure which results in a gust wind heeling arm (L_{w2}).

d. Under these circumstances, area "b" should be equal to or greater than area "a",

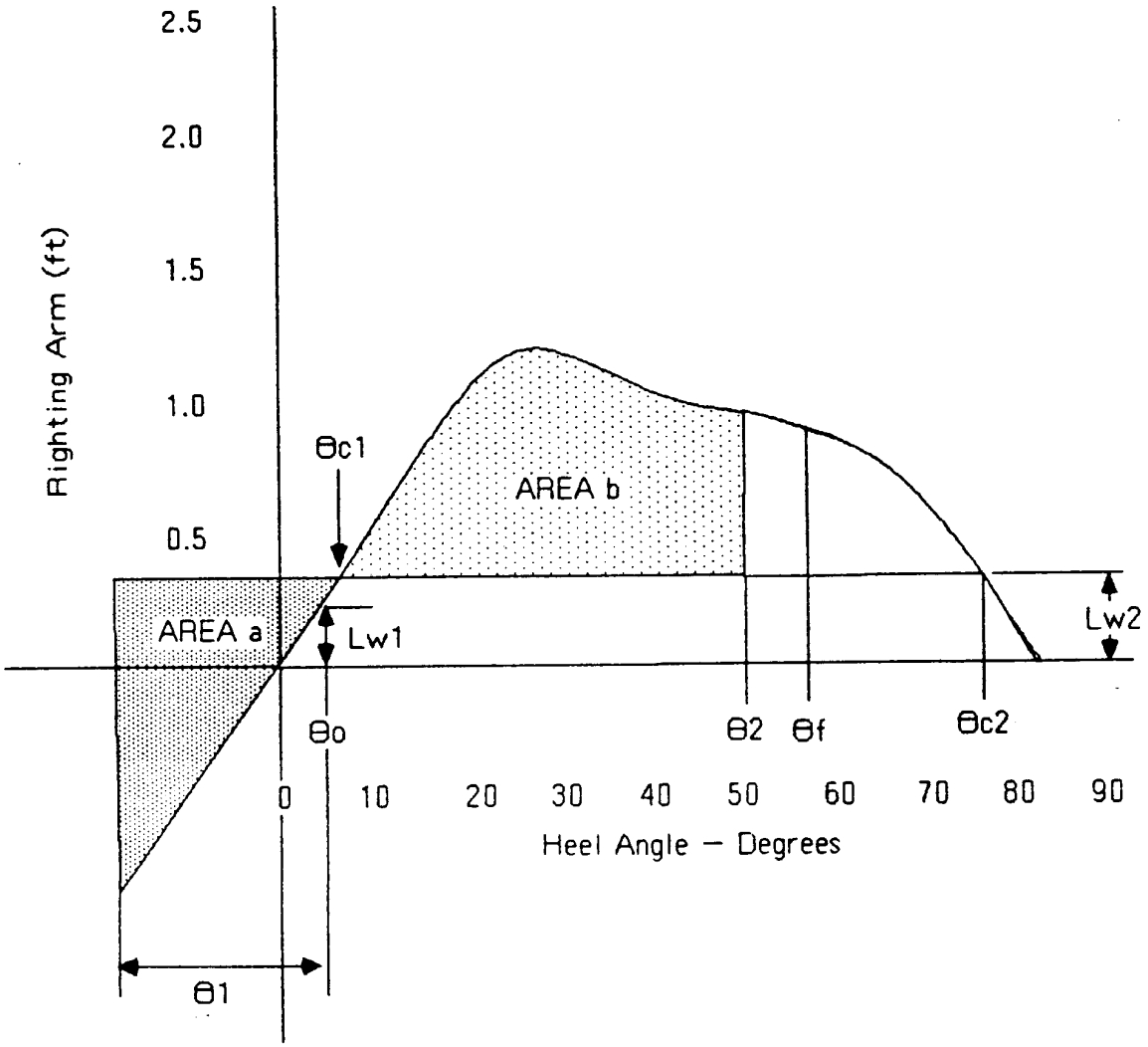


Figure 1–2.
IMO Severe Wind and Rolling Criteria

e. Free surface effects should be accounted for in the standard conditions of loading as discussed in Section E. on page 19.

2. The angles in Figure 1-2 are defined as follows:

θ_0 - angle of heel under action of steady wind (i.e. the intersection of the wind heeling arm curve, Lw_{11} and the righting arm curve)

θ_1 - angle of roll to windward due to wave action

θ_2 - angle of downflooding (θ_f) or 50^0 or θ_{C2}, whichever is less

θ_{C1} - angle of first intercept of wind heeling arm curve, L_{w2}, and righting arm curve

θ_{C2} = angle of second intercept of wind heeling arm curve, L_{w2}, and righting arm curve

3. The wind heeling arms L_{w1} and L_{w2}, referred to above, are constant values at all angles of inclination and should be calculated as shown below (See Figure 1-3).

$$L_{w1} = M_{w1} / \Delta(ft)$$

$$L_{w2} = 1.5 L_{w1}(ft)$$

where

$$M_{w1} = \tfrac{1}{2} \rho C_d \sum_{n=1}^{N} (V_n^2 A_n Z_n)$$

ρ = air density = .0024 lbs./ft.^{3} (1.254 kg./m.^{3})

C_d = approximate non-dimensional drag coefficient - 1.2

A_n = projected lateral profile of element n (ft.^{2})

Z_n = length of wind lever between centroid of A_n to the center of the underwater lateral area or approximately to a point at one half the draft (ft.)

V_n = wind speed at centroid of lateral area A_n (ft./sec.)

= 85.3 (0.124 LN (0.3048 h_n) + 0.772) ft./sec.

= 26. (0.124 LN (h_n) + 0.772) m/sec

h_n = vertical distance from the center of the windage area

A_n to the waterline (ft.)

n = integer

N = number of elements of horizontal areas

Δ = displacement (lbs./kgs.))

4. The angle of roll (q_1)* should be calculated as follows:

$$q_1 = 109kX_1X_2\sqrt{rs} \text{ (degrees)}$$

Where: X_1 = factor as shown in Table 1-1

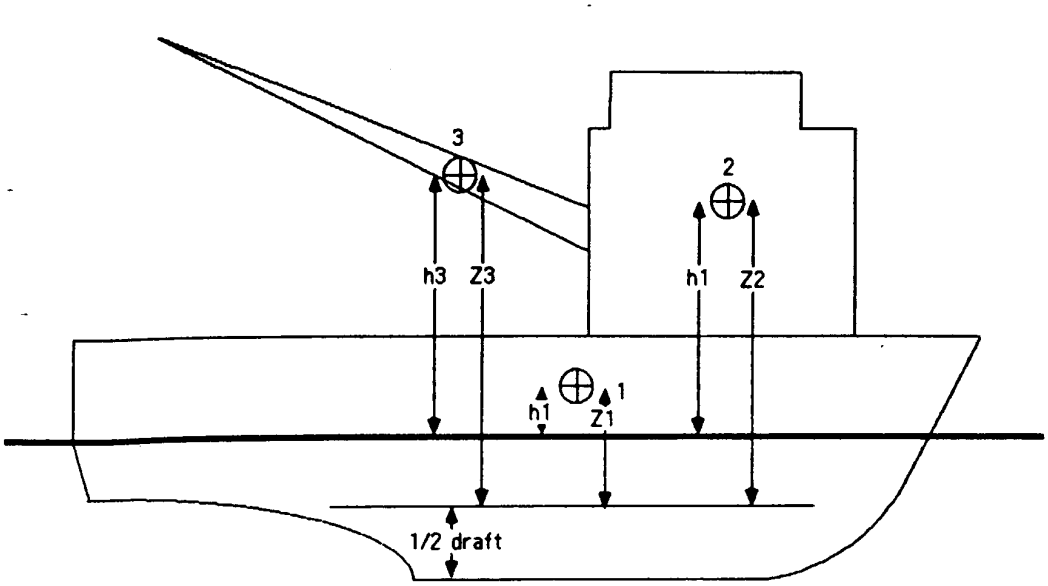


Figure 1–3.
Calculation of Wind Heel Moment

X_2 = factor as shown in Table 1-2

k = factor as follows:

k = 1.0 for round-bilged ship having no bilge or bar keels;

k = 0.7 for a ship having sharp bilges;

k = as shown in Table 1-3 for a ship having bilge keels, a bar keel or both

r = 0.73 + 0.6 OG/d

with: OG = distance between the center of gravity and waterline (m) (+ above, - below)

d = mean molded draft of the ship (m).

s = factor as shown in Table 1-4

Table 1-1

Values of factor X_1

B/d	X_1
≤ 2.4	1.0
2.5	0.98
2.6	0.96
2.7	0.95
2.8	0.93
2.9	0.91
3.0	0.90
3.1	0.88
3.2	0.86
3.3	0.84
3.4	0.82
≥ 3.5	0.80

Values of factor X_2

C_B	X_2
≤ 0.45	0.75
0.50	0.82
0.55	0.89
0.60	0.95
0.65	0.97
≥ 0.70	1.0

Table 1-3

Values of factor k

$\frac{A_k \cdot 100}{L.B}$	k
0	1.0
1.0	0.98
1.5	0.95
2.0	0.88
2.5	0.79
3.0	0.74
3.5	0.72
≥ 4.0	0.70

Values of factor s

T	s
≤ 6	0.100
7	0.098
8	0.093
12	0.065
14	0.053
16	0.044
18	0.038
≥ 20	0.035

(intermediate values in Tables 1-1 through 1-4 should be obtained by linear interpolation).

Rolling period $T = \frac{1.108CB}{\sqrt{GM}}$ (sec.)

$T = \frac{2.0CB}{\sqrt{GM}}$ (sec.) (Metric)

where: C = 0.373 + 0.023 (B/d) - 0.00131 L = 0.373 + 0.023 (B/d) - 0.043 (L/100) (Metric)

The symbols in the above tables and formula for the rolling period are defined as follows:

L = waterline length of the ship (ft.)

B = molded breadth of the ship (ft.)

d = mean molded draft of the ship (ft.

C_B = block coefficient

A_K = total overall area of bilge keels, or area of the lateral projection of the bar keel, or sum of these areas ($ft.^2$)

GM - metacentric height corrected for free surface effect (ft.)

* The angle of roll for ships provided with anti-rolling devices should be determined without taking into account the operation of these devices. For vessels with anti-roll tanks, the full free surface effect of the tanks should be used to determine the GM value used in calculating the angle of roll.

5 EXAMPLE: Page 1-37 is an example which demonstrates the application of the IMO Severe Wind and Rolling Criterion to a fishing vessel in a loaded condition.

RECOMMENDED DAMAGE STABILITY CRITERIA

A. General - No damage stability criteria has previously been applied to fishing vessels. However, 1983 casualty statistics indicate that of the 248 vessels lost, 139 vessels were lost as a result of collision, grounding or flooding, many of these as a result of minor side penetration. The Coast Guard believes that a damage stability standard may vastly improve the chances for fishing vessels to survive minor damage and recommends the following as a damage stability standard for new fishing vessels over 79 feet. It would be beneficial to modify existing fishing vessels so that they can withstand the flooding of at least the lazerette and the engine room spaces, taken separately, and still meet the survival criteria proposed for new vessels.

1. Each fishing vessel should have a collision bulkhead located between five and fifteen percent of the length of the vessel aft of the forward perpendicular. The forward perpendicular is defined as the intersection of the stem of the vessel and the designer's waterline. The collision bulkhead should not have watertight doors in it. Any penetrations or openings should be located as high and as far inboard as possible and should be capable of being made watertight in a short period of time in the event of flooding.

2. The vessel should meet a one compartment damage stability standard. That is, following the flooding of any one compartment as a result of damage or unintentional flooding, the vessel will still remain afloat with a minimum amount of residual righting energy.

B. Extents of Damage

1. The extent of damage to be applied should be:

   a. Longitudinal extent - 0.1 L.

   b. Transverse extent - 30 inches in from the side measured at right angles to the centerline at the level of the deepest load waterline.

   c. Vertical extent - from the baseline upwards without limit.

   d. Ho main transverse bulkheads should be considered damaged.

   e. Where the inboard longitudinal bulkheads are less than 30 inches from the side, the compartment inboard should be considered damaged also. Where these bulkheads are greater than 30 inches inboard, the compartment inboard should not be considered damaged.

2. Figures 1-4 and 1-5 indicate how the damage standard is applied.

C. Permeabilities - The permeabilities used should be 0.95 for tanks and quarters spaces; 0.85 for the engine room, pumprooms, etc.; 0.95 down to 0.50 for fish holds depending on the type and amount of catch, and 0.60 for stores areas, lazarettes, and other tightly packed areas.

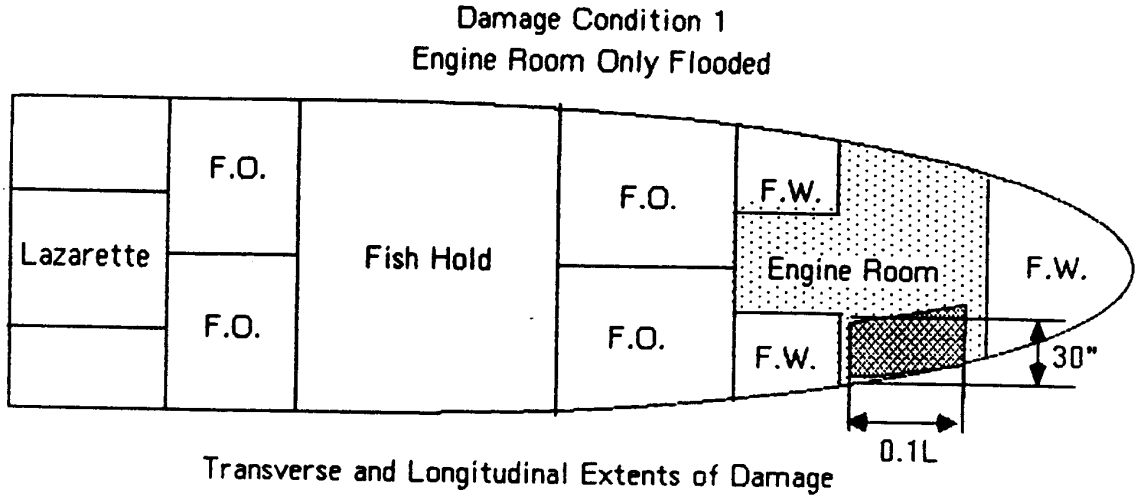


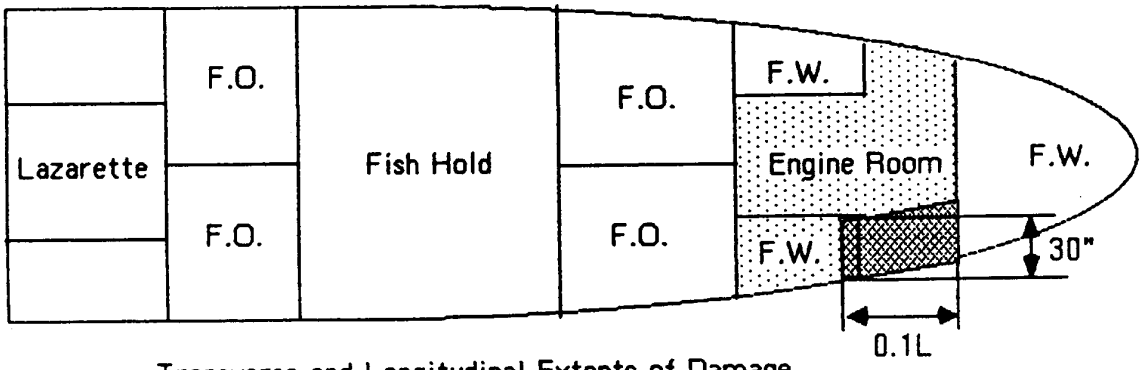
Figure 1—4.

Application of Damage
Bulkhead Spacing > 0.1L

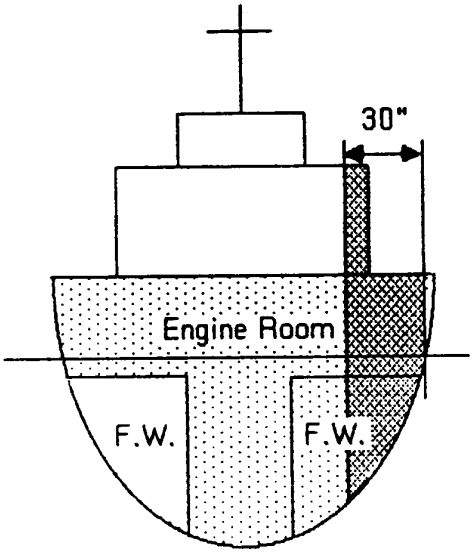
Flooded Volume

Damaged Volume

Damage Condition 2
Engine Room and Stbd F.W. Tank Flooded



Transverse and Longitudinal Extents of Damage



Vertical Extent
Upward without limit

Vertical and Transverse Extents of Damage

Figure 1—5.
Application of Damage
Bulkhead Spacing < 0.1L

Flooded Volume Damaged Volume

D. Survival Criteria

1. After the damage standard above has been applied to a vessel, it should have the following minimum stability characteristics:

   a. 20^0 residual range of stability.

   b. The angle of heel after damage should not be greater than 25^0.

   c. No downflooding points submerged within the 20^0 residual range of stability.

   d. The maximum righting arm should be at least 4 inches.

2. Figure 1-6 shows the survival criteria.

DESIGN CHARACTERISTICS WHICH AFFECT STABILITY

A. Lightship and the Inclining Experiment

1. The Coast Guard highly recommends that the first vessel in a class of vessels be inclined in every case. Because minor changes to smaller vessels may significantly affect their stability, the Coast Guard also recommends that deadweight surveys be conducted on each sister vessel to confirm the lightship characteristics. After accounting for known weight changes, if the deadweight survey shows the displacement differs by more than 3 percent from that of the lead vessel or if the longitudinal center of gravity (LCG) differs by more than 1 percent of the length between perpendiculars, the vessel should be inclined.

2. It has been reported that many fishing vessels are not built strictly in accordance with the lines plan. To insure an accurate stability analysis, the designer should verify that the vessel was actually built to the lines plan by checking the dimensions of the vessel at several locations at the time of the inclining.

3. NVIC 15-81, "Guidelines for Conducting Stability Tests," provides information on how to properly conduct stability tests. Designers should follow these guidelines to get the best test data results. It is important that when an inclining experiment is conducted on a hard chine vessel, the chine must be immersed at all times because of the rapid change in waterplane area and thus the height of metacenter, KM, if the chine emerges when the vessel is heeled.

B. Calculation of Righting Arms

1. The hull designs of most fishing vessels, with house forward and working areas aft, generally cause the vessel to change draft and trim significantly as it is heeled. The resulting change in the righting arms may be accounted for by using constant trimming moment calculations. In the past, constant trim (fixed trim) calculations were used to calculate righting arms since constant trimming moment (free trim) calculations required unreasonably lengthy calculations. This is no longer the case since most designers have access to computer programs which allow the righting arm curves to be calculated by the constant trimming moment technique. The computer program SHCP has options to calculate righting arms using either method.

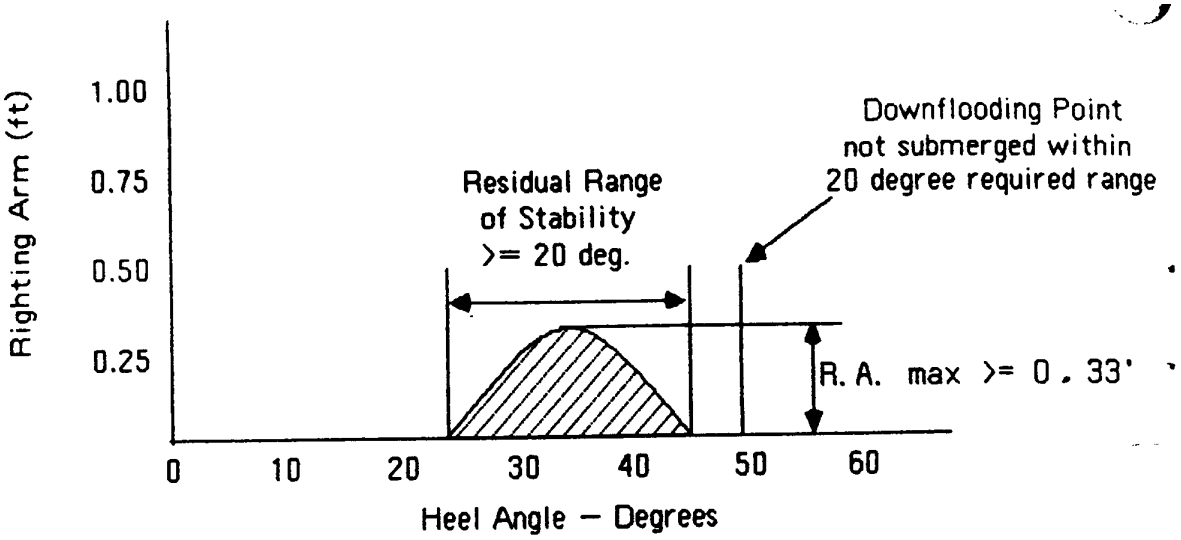


Figure 1—6.
Damage Stability
Survival Criteria

Another factor to consider is the increasing popularity of hard chine hull designs. These vessels can have rapid changes in waterplane area as a result of small changes in the angle of heel. In addition, fishing vessels normally have very low freeboards and relatively low downflooding angles. Thus it is important to know what the actual righting arms are. Because of the much greater accuracy in calculating the actual righting arms, the Coast Guard strongly recommends that the constant trimming moment method be used.

2. In calculating righting arms for loading conditions, designers should determine the sensitivity of the righting arms to trim. If the righting arms are affected by trim, then they should be calculated for the actual trim for each loading condition, instead of using the zero trim righting arms for all loading conditions.

3. Deckhouses should be included in the buoyant volume only if:

   a. They are of substantial construction so that they can withstand the impact forces of waves,

   b. They have internal access to the spaces below; otherwise it should be assumed that the exterior doors will be used for access, thus disrupting the buoyant envelope watertight integrity.

   c. All openings in the sides of the deckhouse are weathertight. (NOTE: Joiner doors should not be considered as weathertight.),

d. All windows have deadlight covers.

4. Stern ramps should be deducted from the buoyant volume.

5. Bulwarks should not be included in the buoyant volume.

6. In general, volumes which are watertight and of sufficient strength are fully effective. The Coast Guard recommends that all fully effective volumes be included in the buoyant volume for the righting arm calculations. Although the exclusion of these volumes may be more conservative, using the allowed buoyant volumes permits a more accurate assessment of the vessel's stability characteristics.

C. Effect of Trim

1. Trim is the difference between the drafts forward and the draft aft. Some vessels have a designed drag, that is, the hull slopes down aft. The amount of drag is the greater designed draft aft minus the designed draft forward. The trim of a vessel with designed drag is the difference in drafts in excess of the designed drag.

2. Righting arms are calculated for a vessel assuming an initial trim of the vessel. As noted above, changes in trim may result in -substantial changes in the righting energy a vessel can develop. Changes in trim occur when:

   a. Changes in buoyancy distribution result as the vessel heels due to the hull form.

   b. The loading conditions being evaluated have a different initial trim.

3. The designer must be sure to consider the effect of trim that large buoyant volumes at one end of the vessel can cause. A large number of vessels with deckhouses forward trim substantially when heeled due to the higher distribution of reserve buoyancy at the bow. Vessels with deckhouses aft tend to fair better in this regard because most of these vessels have forecastles forward to balance this distribution.

4. Where the trim in the loading conditions is different from that for which the righting arms were calculated, additional righting arms must be calculated for these loading conditions.

5. In addition, the designer must also consider that as a vessel trims, there may be a change in the position of the point of downflooding relative to the waterline, thus allowing downflooding to occur sooner than expected. The designer should account for this in determining the point of downflooding in applying the stability criteria.

6. Excessive trim has other detrimental effects. Too much trim by the bow means the vessel will tend to collect water on deck and will also encounter increased sea spray, increasing the susceptibility to icing. Too much trim by the stern increases the likelihood of a stern wave breaking over the transom and swamping the vessel. Excessive trim may also cause the vessel to handle poorly.

D. Recommended Loading Conditions

1. As a minimum, the naval architect should evaluate the loading conditions discussed below:

   a. Departure condition from port with full fuel, water, stores, ice, fishing gear, etc.;

b. Arrival at the fishing grounds with reduced fuel, water, and stores and no catch (the amount of fuel, water and stores should be based on the distance to the fishing area);

c. At the fishing grounds with reduced fuel, water and stores and 50% catch;

d. Departure from the fishing grounds with reduced fuel, water, and stores and full catch;

e. Arrival at home port with 10 percent fuel, water and stores, and full catch (be sure to account for any weights to be lifted or suspended and their effects on stability in a turn); and

f. Arrival at home port with 10 per cent fuel, water, and stores and 20 percent of full catch.

2. The naval architect should also consider other loading conditions in which the vessel may be operated, such as other partial catch and tank loading combinations, with deck loads, using boxes to store fish, while lifting, in ballast and during periods of icing. The sensitivity of the hull to each of these factors must by considered if the design is to be worthwhile.

3. Important considerations to be made in assessing loading conditions.

a. In addition to the loading conditions noted above, loading conditions should be calculated for any other unusual loads or operating practices not considered by the criteria which may have an effect on the vessel being designed.

b. The designer should warn of operating conditions which may seriously impair the stability of the vessel and recommend practical corrective measures in the stability information to the operator.

c. When calculating operating conditions, the weight of all fishing gear on deck in that condition, i.e., wet nets, tackle, pots, traps, etc., should be included.

d. The cargo may be assumed to be homogeneous unless this is inconsistent with practice,

e. Deck cargo must be included.

f. Free water in ballast tanks or fish wells should be included if it is present in normal operations.

g. If normal practice is to stow fish so that one end of the hold loaded higher, then the increase in VCG should be accounted for.

E. Free Surface Effects

1. Free surface effect is a major consideration on a large portion of the fishing vessel fleet. Because of this, the Coast Guard recommends the following to account for free surface effects:

    a. For all conditions, the initial metacentric height and righting arm curves should be corrected for the effect of free surfaces of liquids in tanks by calculating the following:

        (1) For each type of consumable liquid, the free surface effect of at least one transverse pair of wing tanks or a single centerline tank having the greatest free surface effect.

        (2) The free surface effect of each partially filled tank containing other than consumable liquids.

NOTE: This assumes that only one pair of wing tanks or one centerline tank of each type of liquid will be carried slack at any time. The naval architect should make this very clear in the stability information to the operator, since the operator may severely reduce stability unintentionally by having more than this maximum number of tanks slack.

    b. Either the standard free surface calculation, based on the moment of inertia of the tank, or the moment of transference method may be used.

    c. Because of the large free surface moment, vessels with large fish wells should maintain these veils in either an empty or fully pressed up condition. A check of the transition period at sea should be completed if ballasting at sea is the practice of the operator.

    d. The free surface correction for pairs of tanks fitted with cross connection piping but without valves should be calculated assuming the tanks are one common tank.

F. Treatment of Lifting Weights and Heeling Moments Due to Fishing Gear

1. The lifting of weights is a commonplace occurrence in fishing but it has also led to a number of capsizings. When a weight is lifted from the deck, the weight then acts at the tip of the boom. Designers should account for this effect by adjusting the VCG and the righting -arm curves. Designers can minimize the chances of capsizing as a result of lifting by:

    a. Ensuring they have a thorough understanding of the fisherman's operating (eg. lifting, dragging) procedures;

    b. Ensuring that the operator is aware of the effects of the lifting actions;

    c. Ensuring that boom and power block heights are optimal and not excessively high; and

    d. Ensuring that boom and power block structures are not so overdesigned that an excessive increase in KG results.

2. If a vessel is in an already tender condition due to overloading, the moment caused by the lifting of a fishing net filled with catch is often sufficient to heel the vessel past its limited range of stability.

3. Heeling Moments Due to Fishing Gear

   a. Fishing gear can impose extremely high loads on a vessel, particularly when things go wrong. This is another of those areas in which the designers knowledge of the fisherman's operating practices is crucial. The normal heeling moments imposed by trawling or seining for instance, should be evaluated by the designer and included when doing the stability analysis.

   b. Recent IMO papers addressed the moments which would be experienced by a side trawler in common trawling as well as when the vessel was attempting to clear a trawl which was snagged or fastened to the bottom. The moment caused by a common trawl is reasonably small, given a trawl wire length of 2.5 to 3 times the water depth. The Coast Guard recommends that a residual righting area between the heeling arm curve and the righting arm curve be at least 15 foot-degrees to the least of the following angles:

      (1) angle of maximum righting arm;

      (2) angle of downflooding; and

      (3) 40 degrees.

   c. In addition, the static angle of heel should not exceed 10 degrees.

   d. This is illustrated in Figure 1-7. The heeling moment is the maximum generated based on the allowed combinations of hook load and radius. The heeling arm curve is defined by

      HA = Maximum heeling moment x cosine θ / Δ

   e. In calculating the righting arm curve, the designer must remember to account for the increase in VCG due to the lifting of the weight.

   f. The designer should also consider the effect of a trawl snagging on the bottom. When the trawl becomes snagged the potential heeling moment can exceed the righting moment. Figure 1-8 shows a family of heeling moment curves for a given propeller thrust and vessel trawl geometry imposed on a righting arm curve. The illustration is not intended to be numerically specific, but is instead presented to show how operational practices must be considered by the designer. Note how the heeling moment increases for decreasing trawl angles (a), where a is the angle which the trawl wire makes with the vertical. The magnitude of the heeling moment is a function of the trawl angle, which is in turn a function of the wire length and the water depth. Since normal practice is to shorten up on the trawl wire and use power to break the trawl free, the angle at which the wire trails can be significantly reduced as the vessel moves towards the location of the snag. Designers should consider the need for quick-release devices on winches and other

lifting equipment. Designers should also warn the operators that attempting to release a fastened trawl by rapidly increasing the engine thrust or suddenly increasing the power on the winch may cause the vessel to capsize.

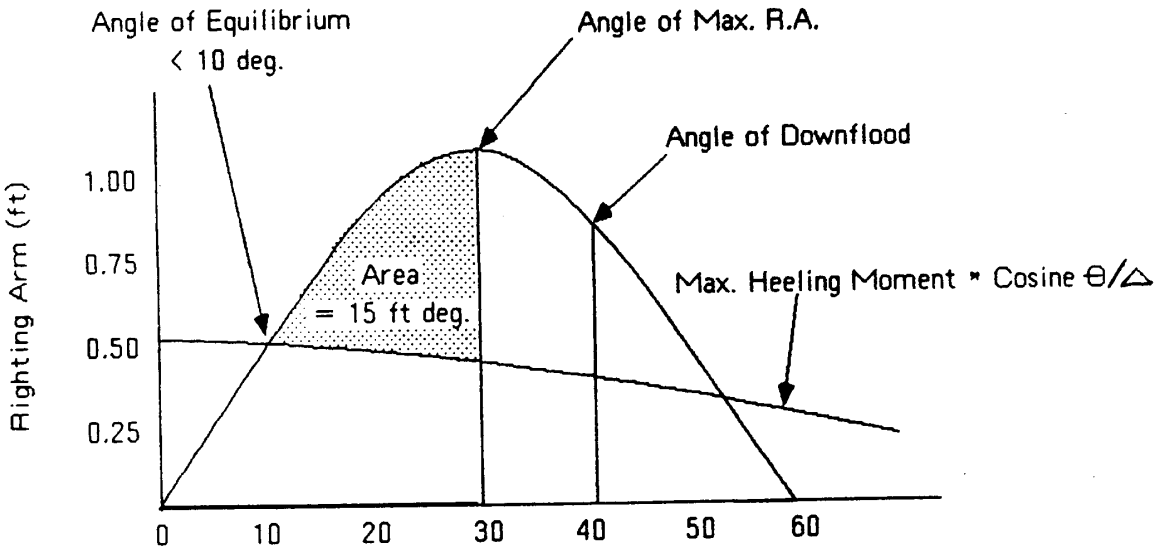


Figure 1–7.
Lifting Criteria

G. Ballast

1. Ballast is normally used to improve the stability of the vessel. However, depending on the location of the ballast, it can either raise or lower the center of gravity of a vessel. Ballast may also decrease the reserve buoyancy of a given vessel and can adversely change the trim of the vessel.

2. Additionally, if liquid ballast is used, it can adversely affect stability by contributing a large free surface effect. When directing fishing vessel operators to ballast, designers must consider the free surface effect which will exist during the interim period until the ballast tank is pressed up.

3. If permanent ballast is installed it should not be removed without first evaluating the effect on stability.

H. Watertight Integrity and Flooding

1. The importance of providing watertight closures that can be quickly closed and easily maintained cannot be overemphasized. The painstaking effort taken in developing a hull which can meet or exceed the stability criteria and provide an efficient fishing platform is a wasted effort if the vessel downfloods at a low angle of heel because of ineffective closures.

2. All closures which must be opened at sea should be kept as far inboard and as high as possible in order to maximize the angle at which downflooding occurs. Doors to fo'c'sles and poops are often located at the side of the vessel and so may be immersed at a low angle of heel. If these could be kept closer to the centerline, then the angle of downflooding is considerably increased with a resultant increase in safety.

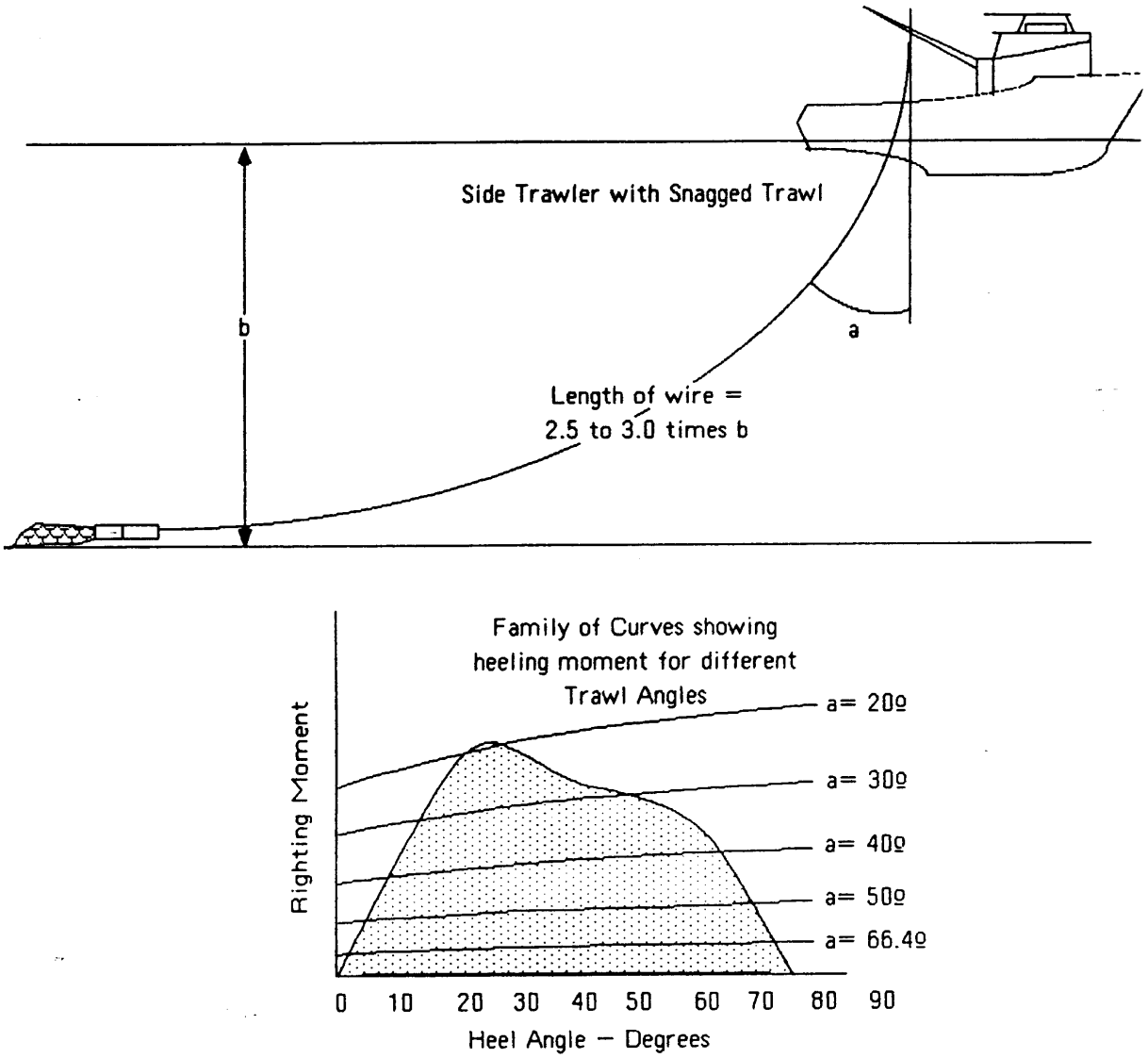


Figure 1–8.

Calculating the Effect of a Fastened Trawl

3. Instructions to the master should be provided to keep all watertight closures closed except when actually being used. These closures should be clearly labeled "KEEP CLOSED". The Coast Guard also recommends that a diagram showing the location of all watertight closures be placed aboard the vessel in the stability information provided to the operator. An example of this is shown in Figure 1-9. Recommendations on other aspects of watertight integrity are offered below.

   a. Main Deck Hatches - Openings in the main deck accessing the engine room, hold, pumproom, or lazarette are among the most common sources of downflooding. It is understood that many of these locations require frequent access. Hatches that must remain open for long periods during the fishing evolution should be capable of being closed rapidly and be of substantial construction to withstand the pounding of large waves.

   b. Watertight and Weathertight Doors - To maintain a deckhouse as a buoyant volume, doors into the deckhouse should be quick acting weathertight doors. Multiple dog doors are too slow to be effective when the water is already coming in. Joiner doors or doors of light construction can be easily warped by pounding seas and may fail to prevent water from entering the vessel at crucial times. Quick-acting watertight doors should be used below the main deck when access between spaces is required. Preventing progressive flooding can provide the needed reserve buoyancy to keep the vessel afloat. Marking the doors with distinctive labels saying "KEEP CLOSED" serves as a helpful, lifesaving reminder.

   c. Deadlight Covers - Port glass and window glass on oceangoing vessels should be of substantial construction. However, even heavy windows and ports can be damaged by the repeated pounding of heavy seas, so deadlight covers and portable storm covers of substantial construction should be provided for the ports and windows. Directions to the operators to secure these covers in heavy weather should be included in the stability information to the operator.

   d. Bulkheads - Bulkheads needed for damage stability or subdivision must be maintained watertight. In practice, it is a good idea to design and maintain all bulkheads watertight. Access through bulkheads should be provided only where absolutely necessary, such as from the engine room to the quarters, and then only by quick acting doors. Doors which must be secured by bolts or the action of dropping weights should not be used. Where a compartment has only the door as a means of ventilation, alternate means of ventilation should be provided and the door kept closed. Bolted manhole covers should not be used for access between spaces. Electrical cable penetrations should run through stuffing boxes. Piping penetrations should be arranged near the centerline and as high as practicable, and provided with bulkhead stop valves.

   e. Bilge Alarms - The Coast Guard highly recommends that remote unmanned spaces should be provided with alarms warning of high water levels. Sending units should be mounted near the bilge in the engineroom, lazarette, dredge pump room, shaft tunnel or any other normally unmanned space where flooding can occur from within (piping, packing glands) or from the deck (hatches left carelessly open). Indicating panels should be located in the pilothouse and/or normal operating

station where early warning of flooding will allow the operators to take corrective action.

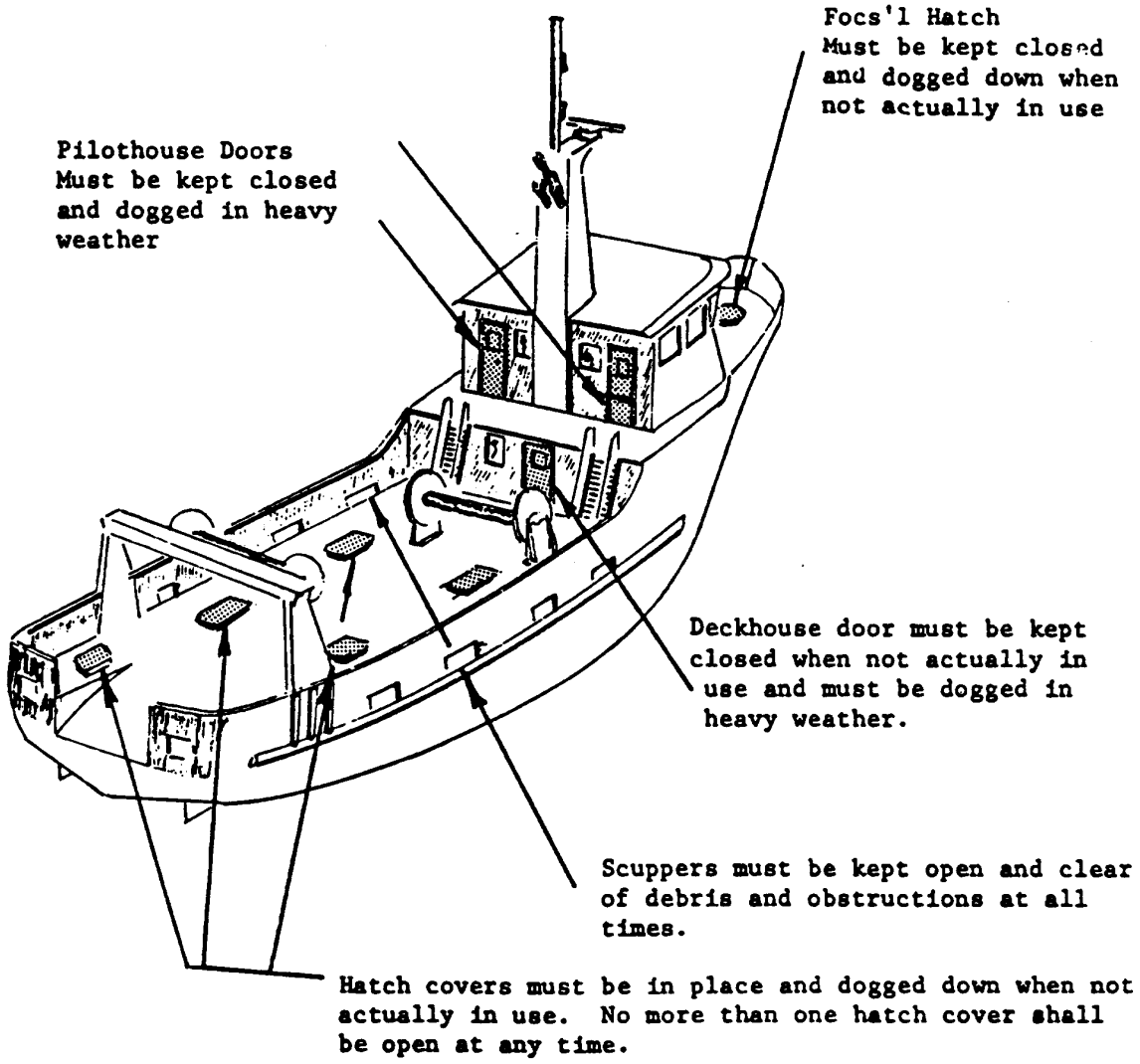


Figure 1—9.

Diagram of Key Watertight Closures

f. Check Valves at Circulating Pumps for Fish Tanks - Some vessels have fish holds which are actually tanks filled with sea water. Circulating water is continuously pumped in from the sea. The water is pumped into the tank bottom, flows up through the tank and goes out onto the deck through a discharge in the hatch

coaming and then goes overboard. There have been a number of casualties on these vessels because of the sudden failure of a pump. The fuse or circuit breaker kicks out and the pump stops. The machinery spaces are normally unmanned and the crew generally doesn't detect it. If there is no check valve in this system, the water flows in the reverse direction through the pump and out the seachest. When this happens, the level of water in the fish tank drops below the hatch coaming and there is a full free surface in tanks served by that pump, which can lead to capsizing. These vessels should be provided with check valves at the discharge pump to prevent the water level dropping down below the coaming upon failure of the pump.

I. Freeboard

1. Fishing vessels loaded with catch generally display very little freeboard. Freeboard is beneficial to stability because it allows the vessel to develop additional righting energy. The effects of a reduction in freeboard are:

   a. The deck area becomes more susceptible to waves allowing water to be trapped on deck and causing downflooding to occur more easily, particularly if there are openings on deck.

   b. Stability is reduced and the vessel is more likely to capsize.

2. As previously mentioned, consideration of freeboard is extremely important on small vessels. Even moderate seas can result in the entrapment of water on deck and in deck edge immersion.

TREATMENT OF ENVIRONMENTAL FACTORS

A. Beam Seas - Operating a vessel in beam seas can have two adverse effects on vessel operations. One is that the vessel ships water on deck more readily. The other is that the vessel can be rolled past its range of positive stability. Careful design of freeing ports as discussed in a following section can help eliminate the water on deck effect. The effect of rolling in the trough can be mitigated by maintaining a large range of stability in all conditions. The effect of being caught in the trough of a breaking wave can be mitigated by avoiding the use of high solid bulwarks in the after part of the vessel. High bulwarks present a large impact area to the high energy in the crest of a breaking wave. Providing a large roll moment of inertia by re-arranging the weight distribution can also lessen the effects of a breaking wave by absorbing much of the roll energy from the wave. However, other weight and center of gravity considerations would have to be carefully balanced with this.

B. Following Seas

1. The greatest concern when operating in following seas is that at speeds in which the vessel is fixed on a wave and the wave is located with the crest amidship and a trough at either end, there is a substantial reduction in righting energy which cannot be practically compensated for in design. The reduction in righting energy is related to hull form and the configuration as to house location and type (e.g. hard chine, ship shape, etc.). Depending on the hull form, the available righting energy may be further reduced due to the dynamic effects caused by the vessel moving through the water and disturbing the wave profile.

2. An additional problem in following seas is that when the vessel travels slightly faster or slower than the wave and alternately climbs and falls off the waves, it can be forced into a rolling motion which is synchronous with its natural roll period. Continued operation in this mode can result in increased rolls until the vessel capsizes. As a vessel either perches on a wave or climbs over it, the rudder and propeller may come out of the water and the operator can lose steerage. The designer should also be concerned that in a following sea, it is more likely that a vessel will be in a condition where the stern is lifted by a wave and any water on deck will run forward.

3. The solution here is to caution fishing vessel operators against this condition and to recommend that they avoid it by changing speed or course so that they remain on the crest of a wave for as short a time as possible.

C. Icing

1. The effect of icing on a vessel is a reduction in stability due to an increase in displacement and a rise in vertical center of gravity (VCG). In addition, a heeling moment may also develop due to an off-center accumulation of ice. Designers should be aware of the dependency of ice accumulation on vessel heading. The need for the operator to make good a specific course can greatly influence the symmetry or asymmetry of ice accumulation.

2. Designers should consult with operators as to the amounts of icing experienced in the intended operating areas. Where a vessel operates in areas where icing is known to be more severe than that proposed below, the designer should account for it. Operators should be strongly reminded that icing increases with the amount of time spent in icing conditions. Therefore, the icing loads used in design may be quickly exceeded during actual operation if the operator remains too long under icing conditions.

3. The following guidance, which is derived from IMO, is offered for consideration:

   a. The vessel's stability should be calculated in the worst possible conditions of loading.

   b. If the vessel operates north of latitude 66-30 N or south of latitude 60-00 S, the following weights of ice should be assumed:

      (1) The weight of ice per square foot on all horizontal surfaces should be at least 6.14 lbs per square foot (30 kg/m2),

      (2) The weight of ice per square foot of the projected vertical area above the waterline should be at least 3.07 lbs per square foot (15 kg/m^2).

   c. The weight of ice for other geographical areas should be assumed to be one half of these values.

   d. The height of the center of gravity of the accumulated ice should be calculated according to the position of the corresponding horizontal surfaces (decks and gangways) and other continuous surface on which ice can reasonably be expected to accumulate. The projected lateral area of small discontinuous surfaces such as

rails, spars, and rigging with no sails can be accounted for by increasing the calculated area by 5 percent and the static moments of the area by 10 percent.

e. To minimize the effects of icing, the naval architect should, where possible, create a design that:

(1) Is kindly to a minimum of spray and water on deck, such as using high bulwarks or spray shields in the forward part of the vessel and bow flare; and

(2) Uses a minimum of high structure.

D. Water on Deck

1. Water on deck should be viewed as a liability which is to be avoided if at all possible. Water on deck has four detrimental effects on a vessel's stability:

a. It adds to the displacement of the vessel;

b. It raises the VCG;

c. It creates a free surface; and

d. It may increase the rolling acceleration and the roll angle.

2. The actual effect of water on deck should be determined based on the volume involved, freeing port area and design, freeboard and anticipated sea conditions.

a. Results of research - As with other complex aspects in vessel design, there is little agreement in the industry as to how to treat water on deck. Numerous studies have looked at various parts of this problem, yet a simple Bet of rules to accurately account for the effects of water on deck has not been developed. Still the results of these studies are useful and the significant conclusions of the studies surveyed are presented below.

(1) Ships with lower freeboard, have worse performance in stormy weather and are more seriously affected by water on deck;

(2) Smaller vessels are worse off in that the probability of complete flooding is great and the volume which can be flooded is quite large relative to the total volume of the vessel;

(3) Water on deck causes unsymmetrical rolling (the vessel rolls further into the wave than away from it) as well as additional list;

(4) The amplitude of the vessel's roll relative to the sea surface approaches a constant magnitude for higher sea states. This implies that if the freeboard is high enough, deck edge immersion may not occur, regardless of how severe the seaway;

(5) Small ships require much greater freeboard to prevent deck edge immersion than large ships;

(6) Sloshing of. water on deck can cause roll motion to be decreased or increased, depending on the wave height and frequency and the volume of water entrapped;

(7) Hard chine hulls have a higher roll damping coefficient than round bottom ones but the dramatic changes in waterplane area which occur with these hull types cause other deleterious effects on the stability of vessels;

(8) Bilge keels and bar keels can contribute significantly to roll damping. The roll damping coefficient for a hull with bilge keels can be four to eight times larger than that for a hull without them; and

(9) Large flows of water onto and off the deck decrease the effectiveness of water as a damper. This is due to phase shifts between the water flow and the rolling of the vessel. Large flows can actually increase the amplitude of the rolls.

b. Water on deck is a complex issue which is affected by many factors. The following considerations, although simplistic, are worth repeating regarding their effects on water on deck.

(1) Effect of Freeboard - As the freeboard is increased, the amount of water likely to collect on deck will be significantly reduced. If the water on deck is kept to a minimum, the effect of water on deck on the roll motion of the vessel will be limited.

(2) Effect of Bulwark Height - High bulwarks provide protection for the crew when working on deck. High bulwarks may also serve as a shield against sea spray during conditions when icing is likely. In severe weather, however, high bulwarks can trap relatively large amounts of water and increase the roll moment. Rails combined with low bulwarks should be considered on small vessels instead of high bulwarks. Where it is necessary to use bulwarks to contain the catch, an alternative may be to fit gratings over the lower half of the bulwarks.

(3) Effect of Sheer and Deck Camber - Sheer and deck camber are essential in removing water from the deck. Deck camber is also effective in reducing roll amplitude in moderate waves for small amounts of water trapped on deck. Sheer and deck camber are affected by other design considerations and thus must be determined for each vessel.

(4) Freeing ports also serve to drain water from the deck. The Coast Guard recommends the following, taken from the ABS Rules for Steel Vessel Under 61 Meters (200 Feet) in Length, as minimum freeing port areas:

(i) For each well less than 66 feet in length, the minimum freeing port area, A, <u>on each side of the vessel</u> should be

A = 7.6 + 0.115 1

(ii) When the bulwark length exceeds 66 feet, the minimum freeing port, A, on each side of the vessel should be

A = 0.231 1

where A = freeing port area in square feet

where 1 = the length of the bulkwark in feet

(iii) Freeing ports should be located to allow rapid clearing of water in all probable conditions of list and trim. This means they should be located far enough forward so that water can still run off in the event that the vessel trims by the bow.

(iv) In general, the smaller the vessel, the greater the need to drain water more rapidly; thus, the freeing port area should be increased for smaller vessels. The freeing port area should also be increased when higher bulwarks are used. If a bulwark is more than 48 inches high, the freeing port should be increased by 0.04 square feet per foot of length of well for each 12 inch difference in height. If a bulwark is less than 36 inches in height, the freeing port area may be decreased by the same ratio. In vessels with no sheer, the calculated area should be increased by 50%.

(v) Covers placed over freeing ports reduce the outflow. When covers are used, the freeing port area should be increased to compensate. If hinged covers are used, the hinges should be placed well above the middle of the covers. If not, then mechanical means must be used to prevent rotation which can result in almost total closing of the freeing ports. Research has shown that the outflow may be increased by positioning a horizontal plate above the freeing port area.

7. Recommendations on Handling Water on Deck in the Design Process

a. The Coast Guard recommends that designers use the IMO Guidance as a means of evaluating the residual stability of the vessel with water on deck.

b. This Guidance proposes that the area above the righting arm curve and below the heeling arm curve (caused by water on deck) should be equal to or exceeded by the area which represents the residual righting energy to forty degrees or downflooding, whichever is less. The Guidance also suggests that the area required should be factored by a K value, whose effect is to increase (for smaller vessels) or decrease (for larger vessels) the amplitude of the heeling energy which must be matched. The IMO Guidance is repeated below.

8. Guidance on a Method of Calculation of the Effect of Water on Deck

a. The ability of the vessel to withstand the heeling effect due to the presence of water on deck should be demonstrated by showing that with the vessel in the worst operating condition, the ratio of area "b" to area "a" shown in Figure 1-10 should not be less than 1.0. That is, it satisfies the following equation in the worst operating condition:

$$C_{WOD} = \frac{area"b"}{area"a"} \geq 1.0$$

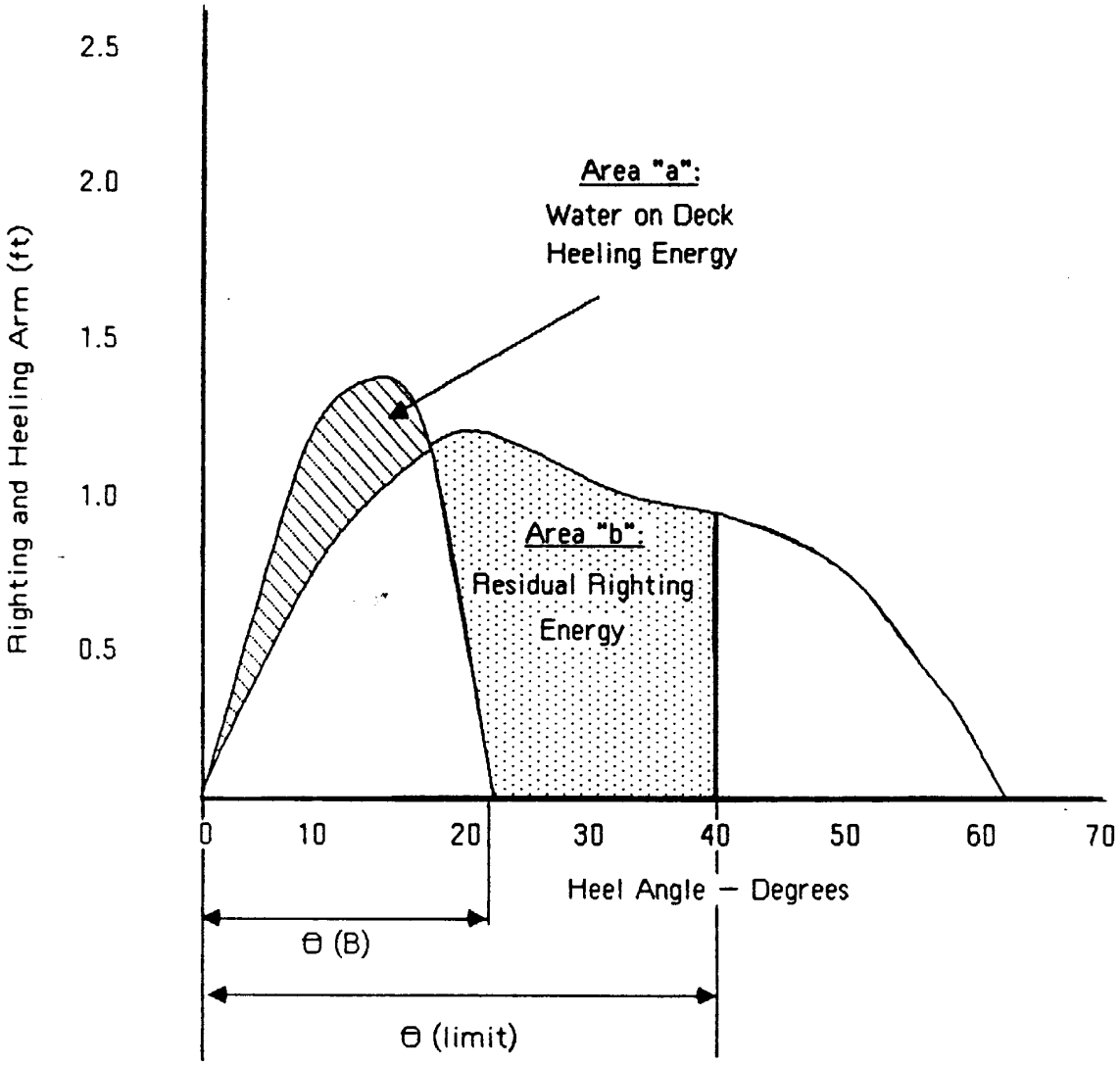


Figure 1–10.
Suggested Method
For Treatment of Water on Deck

b. The angle which limits area "b" should be equal to the downflooding angle θ_f or 40 degrees whichever is less.

c. The value of the heeling moment M_{wod} (or the corresponding heeling arm) due to the presence of water on deck should be determined assuming that the deck well is filled to the top of the bulwark at its lowest point and the vessel heeled up to the angle at which this point is immersed (See Figure 1-11).

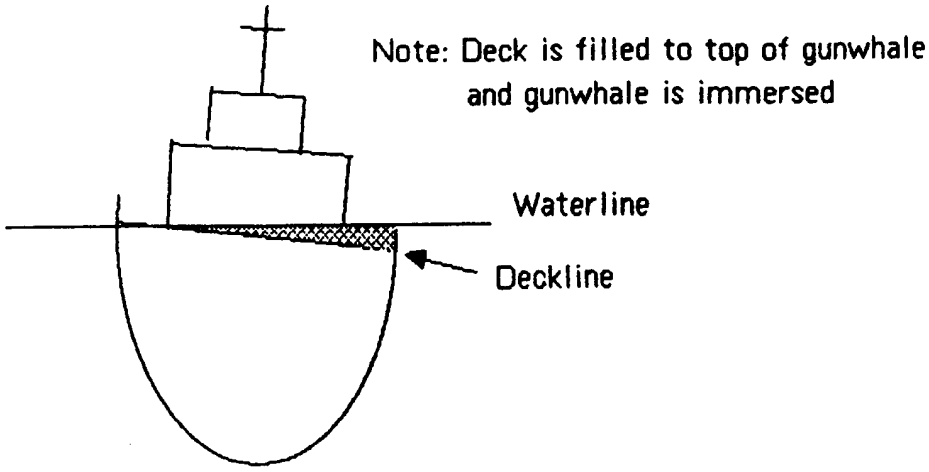


Figure 1—11.
Volume of Water to be included in calculating Effect of Water on Deck

d. Alternatively, the following formula may be used to calculate M_{wod}:

$M_{wod} = KM_w$

where

M_w = static heeling moment due to water on deck

K = coefficient

(1) If M_{wod} is determined by a static approach K = 1.0 may be applied.

(2) If M_{wod} is determined by a quasistatic approach, then K may take into account the rolling period of the vessel and the dynamic effect of the water flow, including the effect of the disposition and configuration of deck

wells and deckhouses. The value of K should be satisfactory, taking into account the type of vessel, area of operation, etc. For vessels where the angle of deck edge immersion θ_D is between 10 and 15 degrees, or the angle of bulwark top immersion θ_B is between 20 and 25 degrees, a value for K greater than 1.0 may be applied. When θ_D is greater than 20 degrees or θ_D is greater than 30 degrees, a value for K less than 1.0 may be applied.

e. When calculating M_w the following assumptions should be made:

(1) At the beginning the vessel is in upright condition;

(2) During heeling, trim and displacement are constant and equal to the values for the vessel without the water on deck;

(3) The effect of freeing ports should be ignored.

f. The above provisions may be adjusted, taking into account the seasonal weather conditions and sea states in the areas in which the vessels will operate, the type of vessel and its mode of operation.

g. Other methods for the calculation of the effect of water on deck using the dynamic approach may be adopted.

COMPARISON OF FISHING VESSEL STABILITY CRITERIA

REQUIREMENT → / CRITERIA ↓	1 Min. Area Under GZ Curve up to 30° heel	2 Min. Area Under GZ Curve up to 40° or the Downflood Angle (θ_f) if θ_f is less than 40°	3 Min. Area Under GZ Curve between 30° and 40° or from 30° to θ_f if θ_f is less than 40°	4 Min. GZ at 30° Heel	5 Min. Heel Angle for max GZ
IMO Res. A. 168	0.055 meter-radians	0.090 meter-rads	0.030 meter-rads	200 mm	25°
ENGLISH	0.066 meter-radians	0.108 meter-rads	0.036 meter-rads	240 mm	25°
GERMAN	Same as IMO	Same as IMO	Same as IMO	200 mm - 250 mm for vessels with bottom drag gear	Same as IMO
NORWEGIAN	Same as IMO	Same as IMO	Same as IMO	Same as IMO	Same as IMO
SOVIET UNION NO Allowance for Icing				250 mm for L < 80m 200 mm for L > 105m Interpolate for L between	25° for first Max GZ & B/D < 2 for B/D > 2, see *1
Allowance for Icing					25°
RAHOLA	.08 m-rads to max GZ			200 mm	30°

	6 Min GZ at heel angle of max GZ	7 Minimum Initial GM Single Deck Vessels	8 Minimum Initial GM for L ≥ 70m or with Full Superstructure	9 Minimum Range of Positive Stability	10 Minimum Angle of Static Heel
IMO A. 168		350mm	150mm		
IMO A. 207		see *2			
ENGLISH		420mm	420mm		
GERMAN		350mm	150mm		
NORWEGIAN	GZ ≥ .1 m @ 40° - 65° see *3			80° see *3	
SOVIET UNION					
NO Allowance for Icing	200mm for L > 20m	0.05m or 0.003B	0.05m or 0.003B	60°; for L < 20m a min of 40°	The lesser of 10° or deck immersion see *4
Allowance for Icing	200 mm			55°	
JAPANESE		see *5			
ROORDA		.06 X B see *6			

NOTES OF STABILITY CRITERIA TABLE

LOADING CONDITIONS Most countries use the IMO Loading Conditions:

a. Departure for the fishing grounds with full fuel, stores, ice fishing gear, etc.

b. Departure from fishing with full catch

c. Arrival at home port with full catch and 10% consumables

d. Arrival at home port with 20% of full catch and 10% consumables

The SOVIET UNION adds a provision that the departure from the fishing grounds condition be with the vessel loaded down to the maximum allowable draft.

*1. The SOVIET UNION has a system for an allowable reduction in this angle for beamier vessels

*2. IMO Resolution A. 207 recommends:

$GM_{min} = 0.53 + 2B[.075 - .37(f/B) + .82(f/B)^2 - .014(B/D) - .032(l/L)]$

where f = mm freeboard, B = beam, D = mm depth, 1 = length superstructure, and L = waterline length

This formula is applicable to vessels having:

a. f/b between .02 and .20
b. l/L smaller than .60
c. B/D between 1.75 and 2.15
d. a minimum value of sheer given in complicated terms
e. height of superstructure not less than l.8m.

*3. This is a requirement for new vessels of greater than 15m LOA but less than 45m LBP

*4. For vessels less than 20m LBP, the loading condition for determining this angle is with nets at the maximum outreach of the boom.

*5. The Japanese requirements for GM for seiners are:

$GM_r = B/23 + .8858$ or $L/120 + .8858$, whichever larger

for other Fishing Vessels:

for B less than 22.97 FT, GM is to be the larger of:

$B/25 + .3937$ or $L/150 + .3937$

for B greater than or equal to 22.97 FT, GM is to be the larger of

B/12 - .602 or L/42 + 1.123

*6. Roorda's formula is a rule of thumb based on European Fishing Vessel practice.

ASSESSMENT OF A TYPICAL LOADING CONDITION FOR THE F/V DIANE L. USING THE TORREMOLINOS CRITERIA - The following is an example of how to use the Torremolinos Criteria in evaluating the stability of a fishing vessel. The loading condition is that for the 78 foot fishing vessel DIANE L. with full catch and partially loaded fuel oil and potable water tanks. The vessel carries 55 tons of catch and meets or exceeds all of the requirements of the Torremolinos criteria

1. The condition of the vessel is as follows:

Item Description	Weight	VCG	Moment	LCG	Moment
	TONS	FT	FT-TON	AFT OF FP	FT-TON
Lightship	98.2	9.8	962.4	37.7	3702.1
Forepeak F/W Tank	0.0	8.9	0.0	4.2	0.0
#1 P/S F/W Tanks	7.6	4.5	34.2	16.3	123.9
#1 P/S Fuel Oil Tanks	11.8	4.0	47.2	26.5	312.7
#2 P/S Fuel Oil Tanks	0.0	9.6	0.0	57.3	0.0
Lube Oil tank (Port)	0.3	5.8	1.7	25.7	7.7
Hyd. Oil Tank (Stbd)	0.5	4.5	2.3	25.2	12.6
Fish hold (full)	55.0	9.1	500.5	42.6	2343.0
Deck load	5.0	14.0	70.0	47.9	239.5
Total	178.4	9.1	1618.3	37.6	6714.5

Draft Molded at LCF	8.8	FT
Transverse Metacenter above LCF	12.5	FT
VCG	9.1	FT
Metacentric Height (uncorrected for Free Surface)	3.4	FT
Metacentric Height (Corrected for Free Surface)	3.1	FT

2. Figure 1-12 shows a profile view of the subject vessel indicating the loading condition. The lower part of the figure shows the righting energy calculated based on the righting arms. The figure details how the vessel meets or exceeds each of the requirements of the Torremolinos Criteria.

ASSESSMENT OF A TYPICAL LOADING CONDITION FOR THE F/V DIANE L. USING THE IMO SEVERE WIND AND ROLLING CRITERIA - The following is an example of how to use the IMO Severe Wind and Rolling Criteria in evaluating the stability of the F/V DIANE L. as loaded in the previous example. See Figure 1-13

Calculate L_{w1}:

$$L_{W1} = \frac{M_{W1}}{\Delta} = \left(0.5 * \mathrm{r} * C_d * \sum_{n=1}^{N} V_n^2 * A_n * Z_n \right) / \left(Displ. * 2240 \right)$$

$r = .0024 lbs./ft^3$

Table of blocked areas showing summation method: (See Figure 1-35)

Block #	h_n	V_n	A_n	Z_n	$V_n^2 * A_n * Z_n$
1	2.0	60.6	450.	6.5	10742000.
2	2.8	64.2	180.	7.3	5416000.
3	3.1	65.2	75.	7.6	2427000.
4	7.8	75.0	150.	12.3	10381000.
5	12.1	79.6	45.	16.6	4740000.
6	5.3	70.9	95.	9.8	4683000.
7	8.6	76.0	15.	13.1	1136000.
				Sum =	39525000.

L_{w1} = (0.5 * 0.0024 * 1.2 * 39525000.0) 1(178.4 * 2240) = 0.142

$L_{w2} = L_{w1} * 1.5 = 0.214$

Next calculate q_1:

$$q_1 = 109 * k * x_1 * x_2 * \sqrt{r * s}$$

k = 0.7 because the vessel is hard chined along its length

B/d = 22.7/8.8 = 2.6

X_1 = 0.96 by interpolation of Table 1-1

C_b = 0.493,

X_2 = 0.81 by interpolation of Table 1-2

r = 0.73 + .6 * (OG/d); where OG = 0.12 = 0.73 + .6 * (0.12/8.8) = 0.738

Calculate T to obtain a from Table 1-4

$$T = (1.108 * C * B) / \sqrt{GM}$$

C = 0.373 + 0.023 *(B/d) - 0.000131 * L = 0.373 + 0.023 * (22.7/8.8) - 0.00131 * 78.0 = = 0.422

B= 22.7 ft.

GM_{corr} = 3.1 ft.

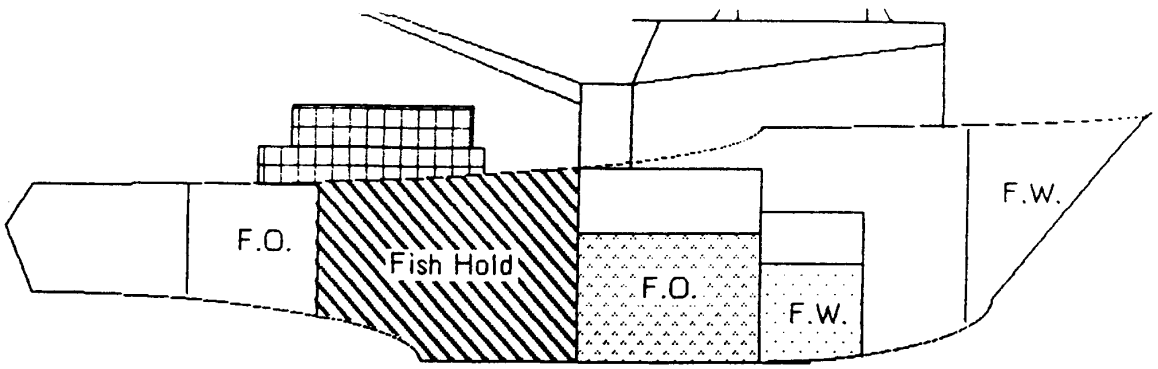
$$T = (1.108 * 0.442 * 22.7) / \sqrt{3.1} = 6.03 \text{sec.}$$

S = .1 by interpolation of Table 1-4

θ_1 = 109 * 0.7 * 0.96 * 0.81 * 0.738 * 0.1 = 16.1 degrees

θ_2 = 50.0 degrees, which is the minimum angle

Now the plot can be drawn and the areas “a” and "b" calculated. Figure 1-13 shows that area “a” is 6.4 ft-deg., while area “b” is 14.3 ft-deg. We can see that for this particular case the IMO Severe Wind and Rolling Criteria has been satisfied.



F/V DIANE L. (LOADING CONDITION A)

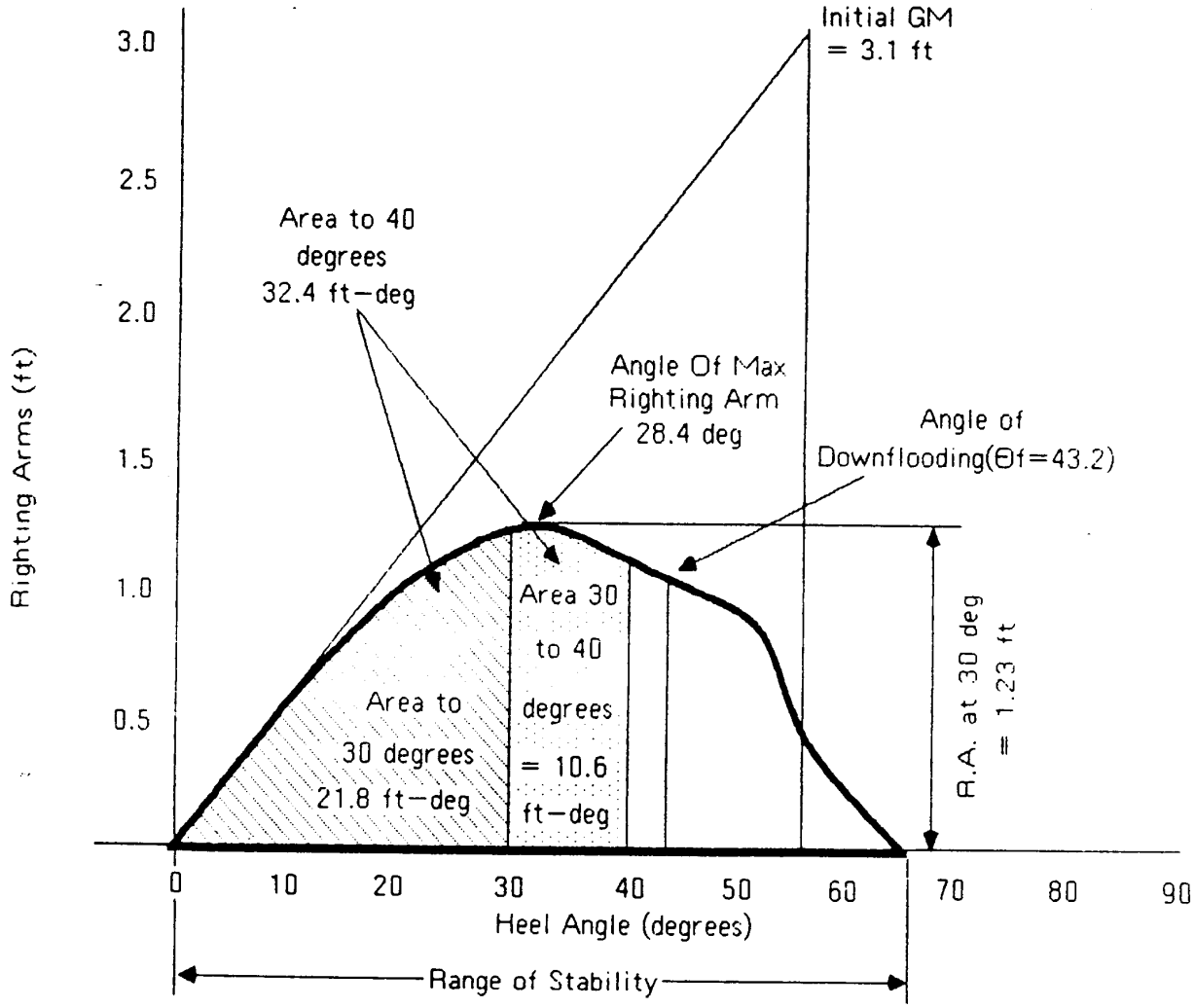
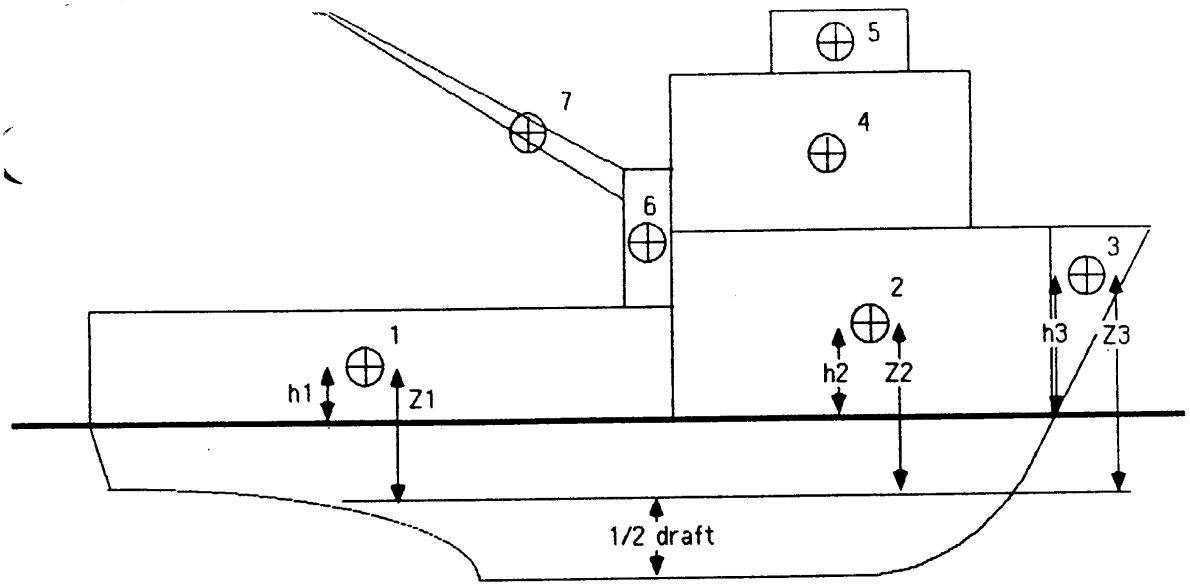


Figure 1−12.

Evaluation of F/V DIANE L. using the Torremolinos Criteria



Blocked Areas of Wind Profile
Showing distance of centroid from the waterline and 1/2 draft

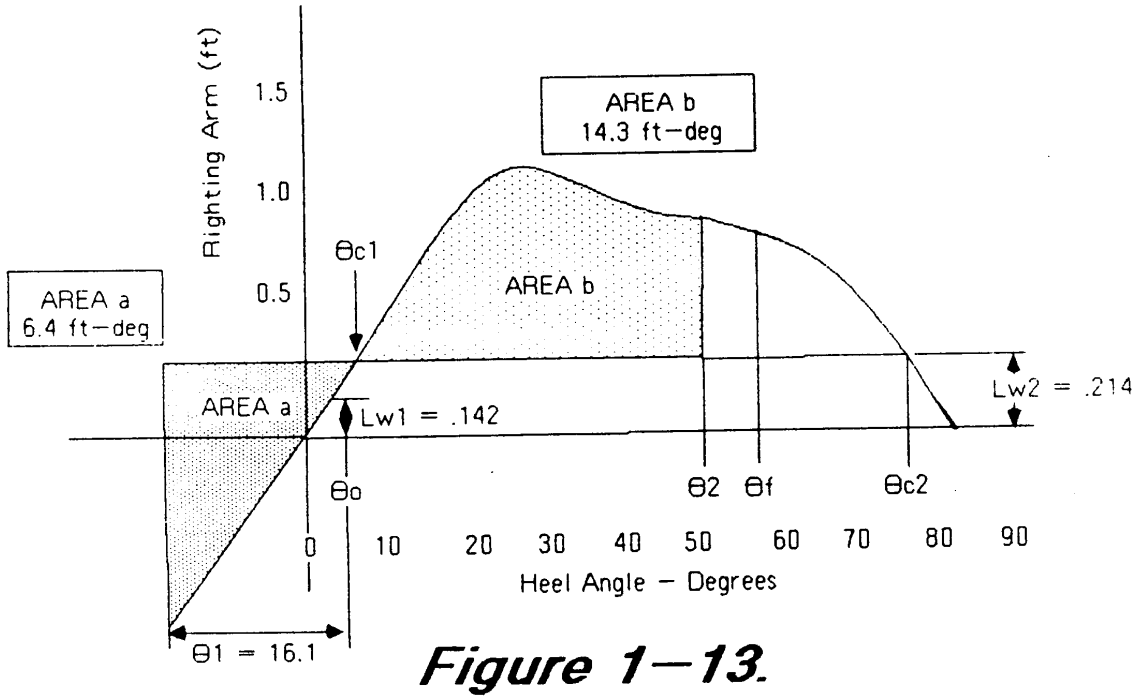


Figure 1−13.

Evaluation of F/V Diane L. against Severe Wind and Rolling Criteria

OPERATING INFORMATION FOR FISHING VESSEL DESIGNERS AND OPERATORS

A. Presentation of Stability Information to Fishermen

1. The fishing vessel operator needs stability information which he can quickly use to make an evaluation of the stability of his vessel. Thus, to be useful, stability information must be up-to-date, reflecting the current configuration and operation of the vessel (including the fishing rig in use), and it must be presented in a format with which the operator is comfortable Stability information which is based on the vessel as outfitted and equipped prior to modifications or which the operator cannot understand is useless.

2. In addition to those loading conditions suggested previously on page the coast Guard strongly recommends that naval architects discuss the most usual loading conditions with the operator so that these conditions can be evaluated and included in the stability information. After a period of operation using the loading conditions initially developed, a follow-up evaluation by the naval architect is also advised.

3. General Instructions

a. Regardless of how the stability of the vessel is evaluated, each vessel should have a set of general instructions for the safe operation of the vessel. These include but are not limited to the following:

(1) The stability of the vessel must be evaluated periodically by the operator throughout the voyage as fuel, water and stores are consumed. In addition, it should be evaluated when the levels in the fish hold are increased. Any other significant changes in the loading of the vessel are also cause for evaluating the stability.

(2) watertight and weathertight closures, such as main deck hatches and weather doors to the forecastle and machinery spaces shall be kept closed and fully secured at all times when underway, except when actually used for passage under safe conditions. These closures are shown in the attached diagram. (See Figure 1-9)

(3) No more than one centerline or P/S pair of the following tanks may be partially filled at any one time: fuel oil, lube oil, potable water, ballast/cargo water, fuel oil day tanks. Cross-connections between all port and starboard tanks pairs shall be kept closed at all times when underway.

(4) Bilges shall be kept pumped to minimum content at all times.

(5) The operator should make every effort to determine the cause of any list of the vessel before taking corrective action.

(6) No permanent ballast or other such weights shall be added, removed, altered, and/or relocated without first determining the effect on the stability of the vessel.

(7) No watertight bulkheads shall be removed or altered without first determining the effect on the intact and damage stability of the vessel.

(8) The watertight doors in the bulkheads at frames and shall be closed and properly dogged at all times when underway, except when actually used for passage under safe condition..

(9) Freeing ports and scuppers must be kept clear and open at all times.

(10) Beam seas should be avoided. A fishing vessel in beam seas has a tendency to ship water on deck more readily and is more subject to heavy rolling.

(11) Following seas should also be avoided. A fishing vessel in a following sea is more likely to become perched on a wave, in which case the stability of the vessel is decreased significantly. A fishing vessel in a following sea is also more subject swamping and loss of steering control.

(12) If the vessel encounters beam seas or following seas, course changes and/or speed changes to change the relative direction and speed of the waves are recommended.

b. Other instructions regarding ballasting, lifting, freeing a trawl caught on the bottom and any of the other areas discussed in the previous sections should be included in this section as appropriate. Instructions for lifting should include weather and loading conditions when a lift can safely be made, the maximum load, boom radius and boom angle. Instructions for freeing a trawl from the bottom should consider the cable strength, tending angle, winch capacity for hauling and braking, engine horsepower and righting energy of the vessel.

4. Recommended Formats

a. Pictorial Format

(1) Using this method, pre-calculated conditions which meet the stability criteria are shown in a pictorial presentation. A plan view and profile view are used together to show the vessel in acceptable loading conditions and also in those which are determined to be particularly unsafe. Those that are unsafe should be clearly marked as such. These conditions should be sequentially ordered (fuel burn sequence or fish hold loading sequence or a combination of both). A blank form is used by the operator to show the loaded condition of his vessel. He can then visually compare the loaded condition of his vessel, including the deck loads and equipment, with those in the loading booklet to make sure his vessel is in a safe loading condition.

(2) This method is simple and easy to use. It involves no calculation on the part of the operator since all loading conditions are pre-calculated It allow. the operator to readily see what he can do to put his vessel in a safe condition. The main disadvantage is that it is practical to show only a

limited number of loading conditions. Therefore, it is not possible to show every possible safe loading condition.

(3) An example showing this method is presented in Figures 1-14 through 1-20. Figures 1-14 through 1-18 show a sequence of consuming fuel and water and catching fish during a voyage. Figure 1-19 shows an arrival condition with approximately 10 percent consumables and 20 percent catch. Figure 1-20 shows a condition in which the vessel should not be loaded under any circumstances. This example is intended t6 show only how this method may be used, and does not include all possible loading conditions. Other conditions which should be covered are safe combinations of intermediate tank and fish hold levels, icing conditions and deck load conditions.

b. Tabular Format - This method is similar to the pictorial format except that the satisfactory loading conditions are presented in tabular form. This method is also very direct and easy to use but presents limitations in the number of loading conditions which can be shown. This method is shown below.

SAMPLE LOADING TABLE
F/V DIANE L

	LOADING CONDITION	FISH HOLD	#1 P/S F/O TKS	#2 P/S F/O TKS	FOREPEAK F/W TANK	#1 P/S F/W TANKS
1.	DEPART PORT	EMPTY	100 %	100 %	100 %	100 %
2.	ARRIVE FISHING GROUNDS	EMPTY	100 %	75 %	60 %	100 %
3.	AT FISHING GROUNDS	50 %	100 %	EMPTY	EMPTY	80 %
4.	DEPARTURE FROM FISHING GROUNDS	100 %	60 %	EMPTY	EMPTY	50 %
5.	ARRIVAL AT PORT	100 %	25 %	EMPTY	EMPTY	30 %
6.	ARRIVAL AT PORT 20 % CATCH	100 %	25 %	EMPTY	EMPTY	30 %

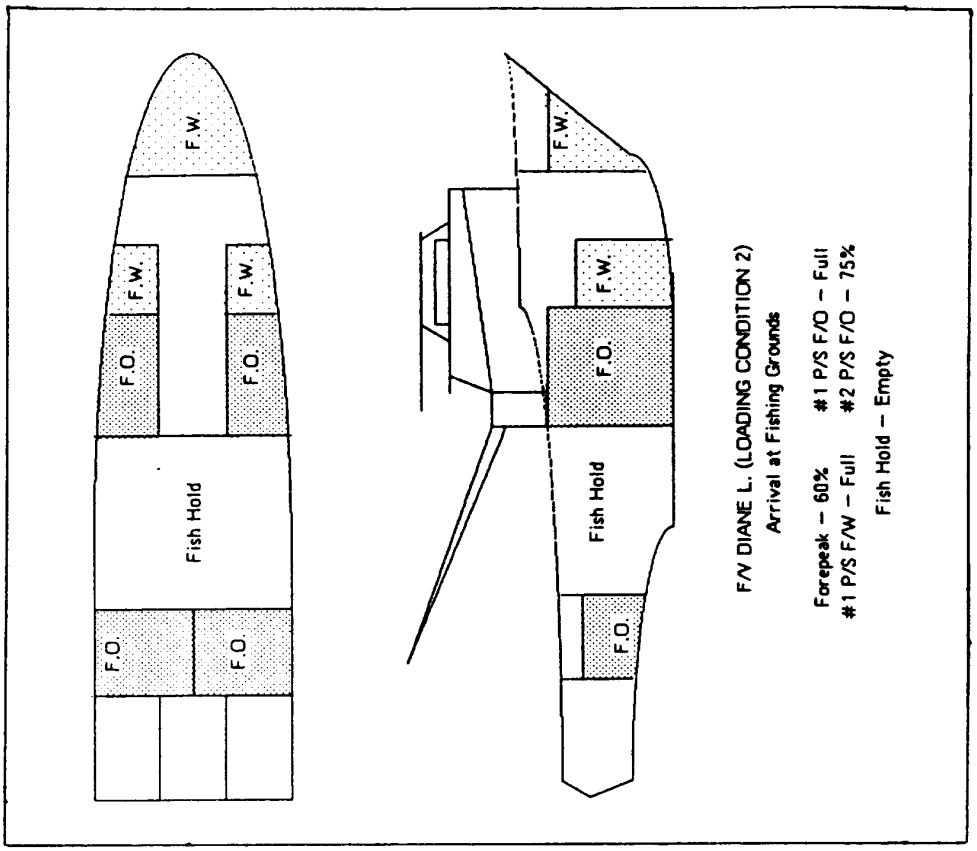


Figure 1–15.

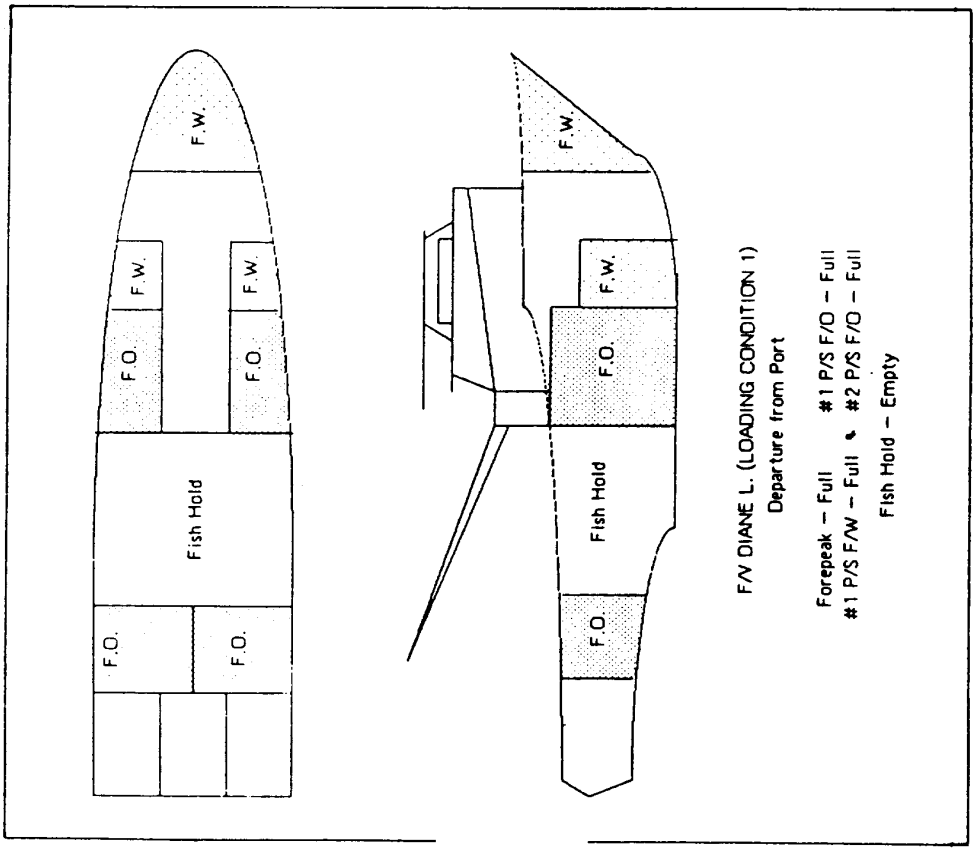


Figure 1–14.

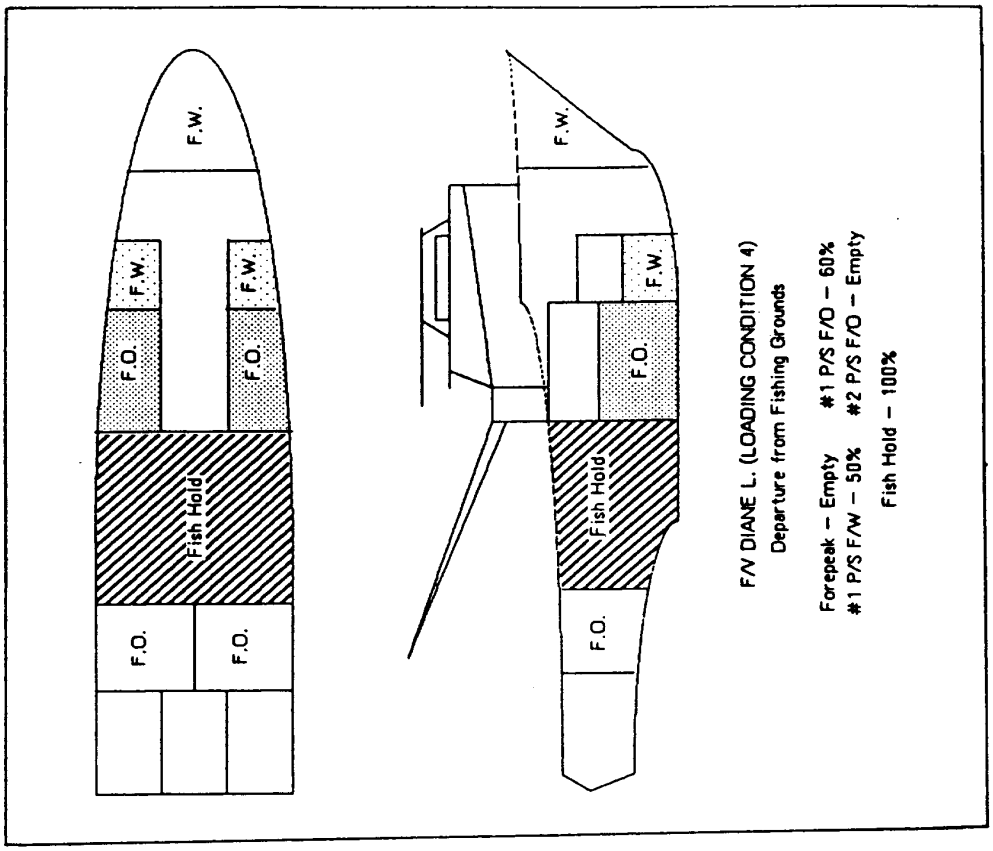


Figure 1–17.

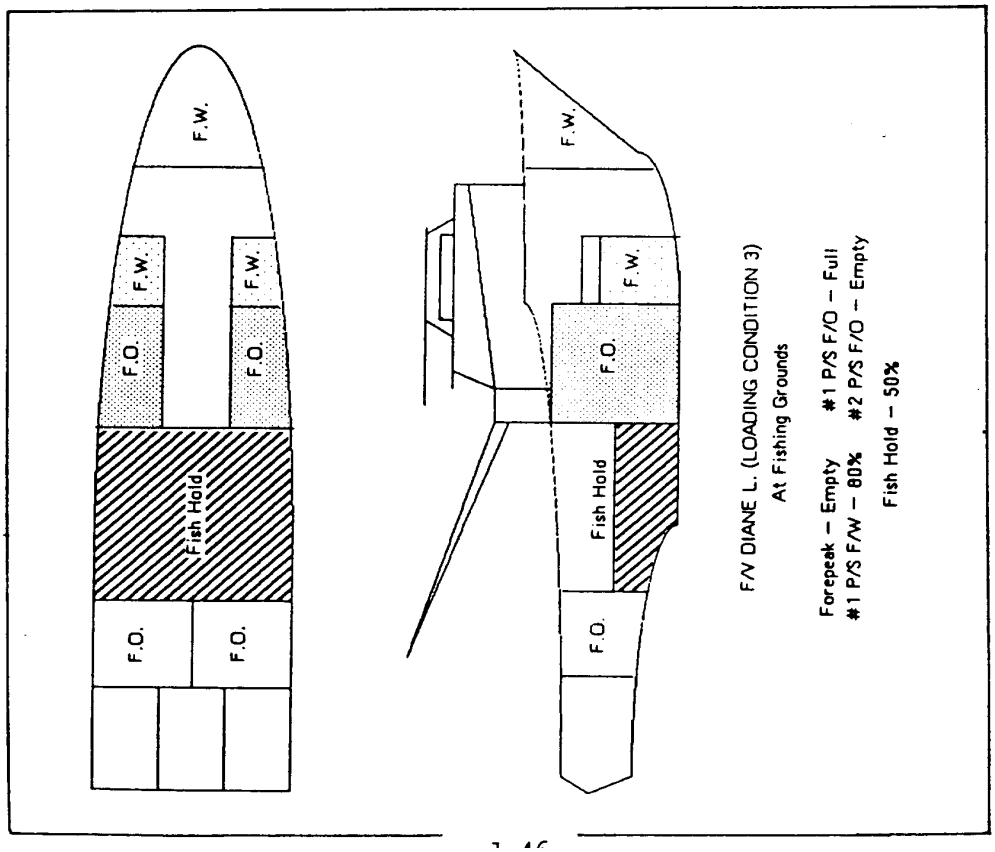


Figure 1–16.

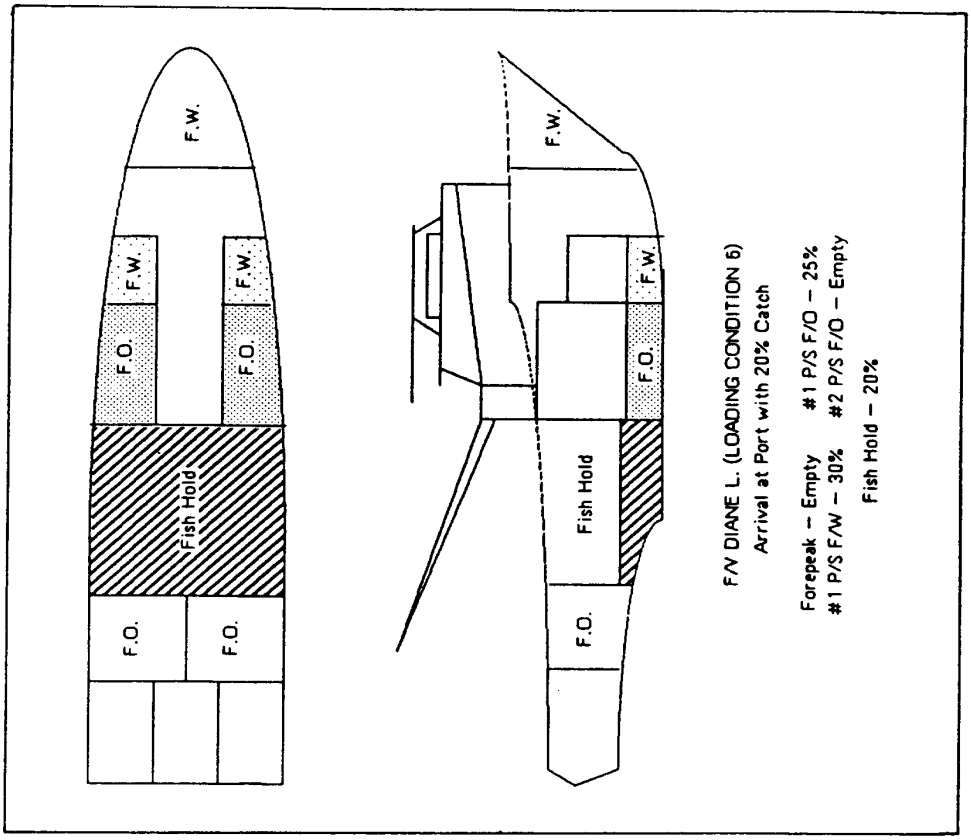


Figure 1–19.

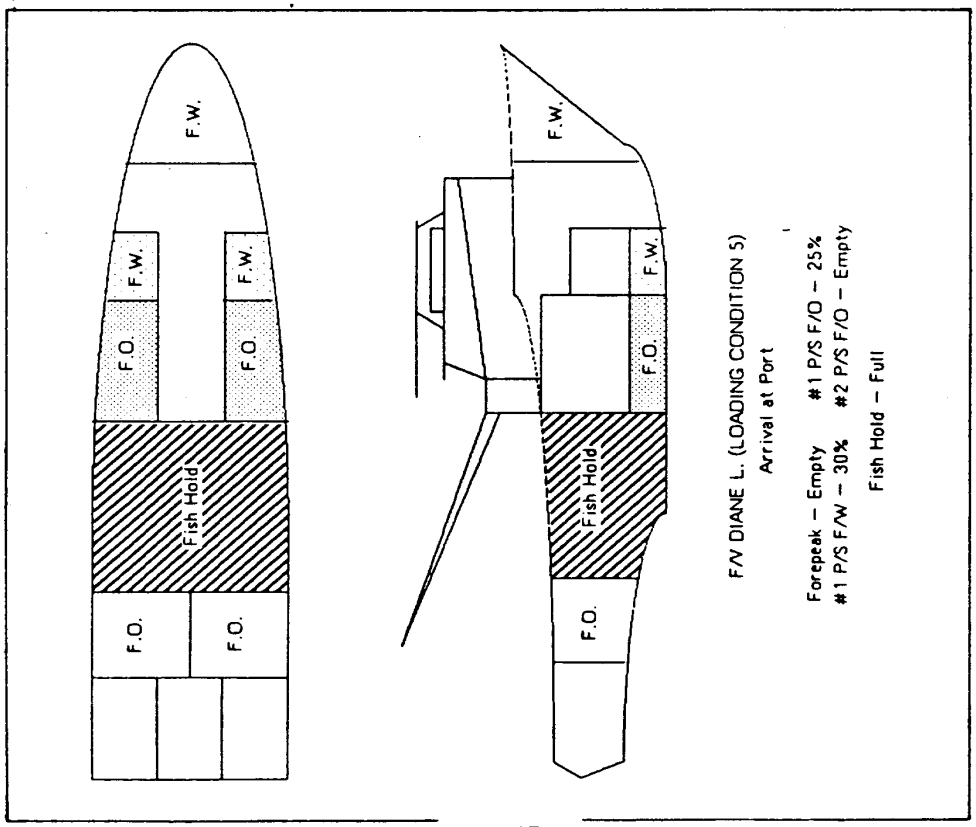


Figure 1–18.

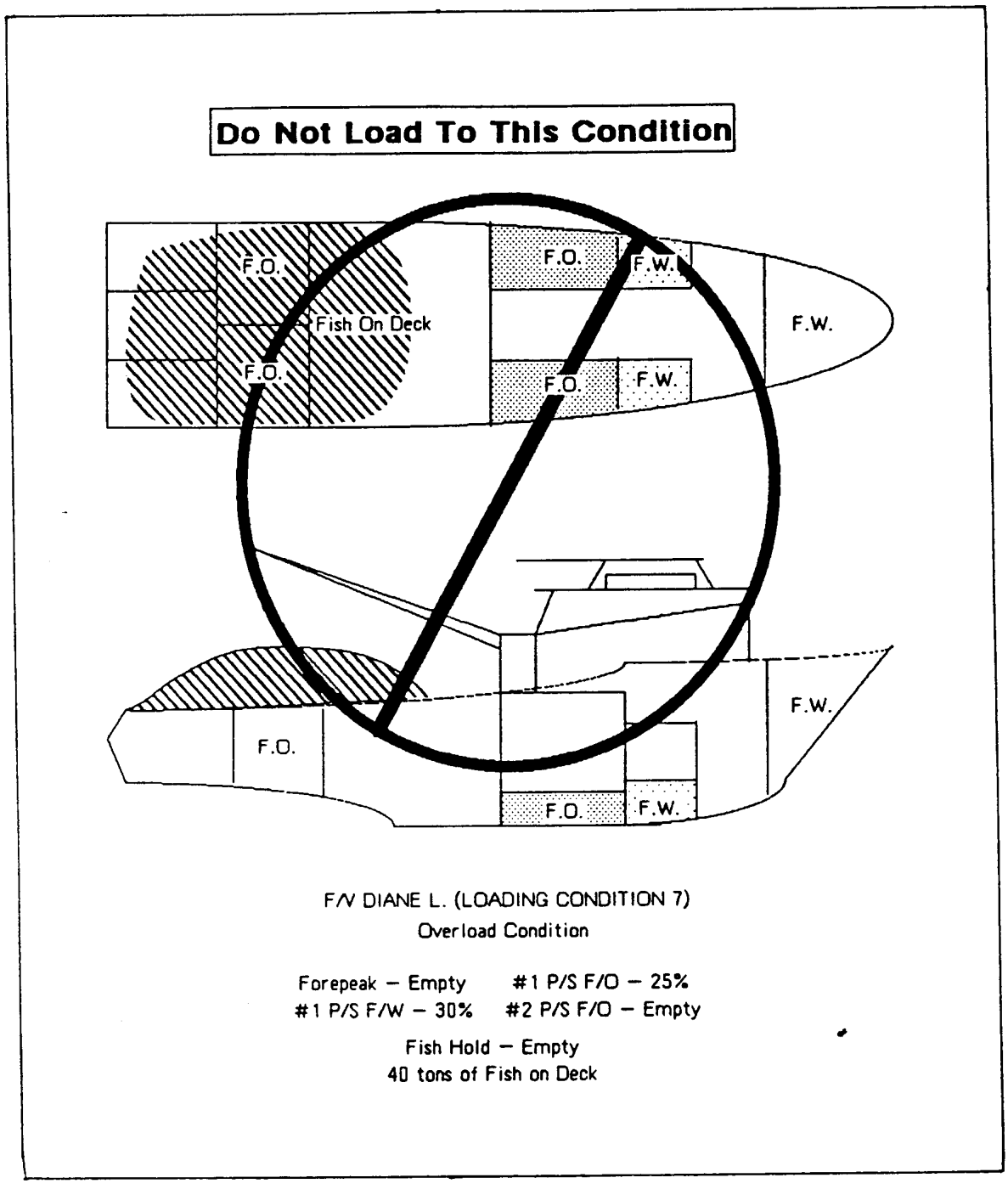


Figure 1–20.

c. Simplified Trim and Stability Book

(1) This format can be used for vessels whose righting arms do not change significantly with trim or that do not trim substantially over the range of operating conditions. It may also be used when the least righting arms generated when trim is considered are used. It is intended to provide

slightly more information to the operator and can be used when additional flexibility in loading the vessel is required. In this format, the operator is given simplified instructions to calculate displacement, vertical center of gravity (VCG) and longitudinal center of gravity (LCG) along with tank capacity tables. The operator is then directed to calculate these values for the vessel as actually loaded and compare these values to those shown on curves of allowable VCG versus displacement and LCG versus displacement (Figures 1-21 and 1-22). These curves are prepared with a standard free surface correction and the effects of lifting already accounted for and are marked with safe and unsafe operating regions. The designer may want to place limitations on trim at the bow and stern to improve handling or to maintain freeboard at the stern. In this case, a range of allowable LCG should be shown.

(2) This method presumes little knowledge of stability on the operator's part, only an ability to add, substract, divide and multiply. The operator does not need to know how to calculate draft, trim, metacentric height, free surface or righting energy. An example is presented on the following pages.

Figure 1—21.

Simplified Allowable VCG Diagram

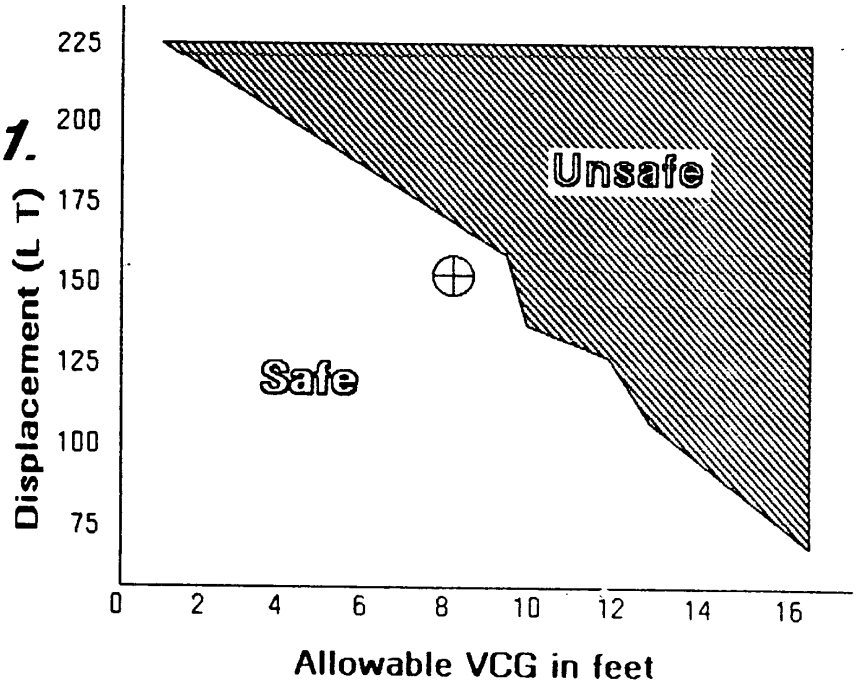
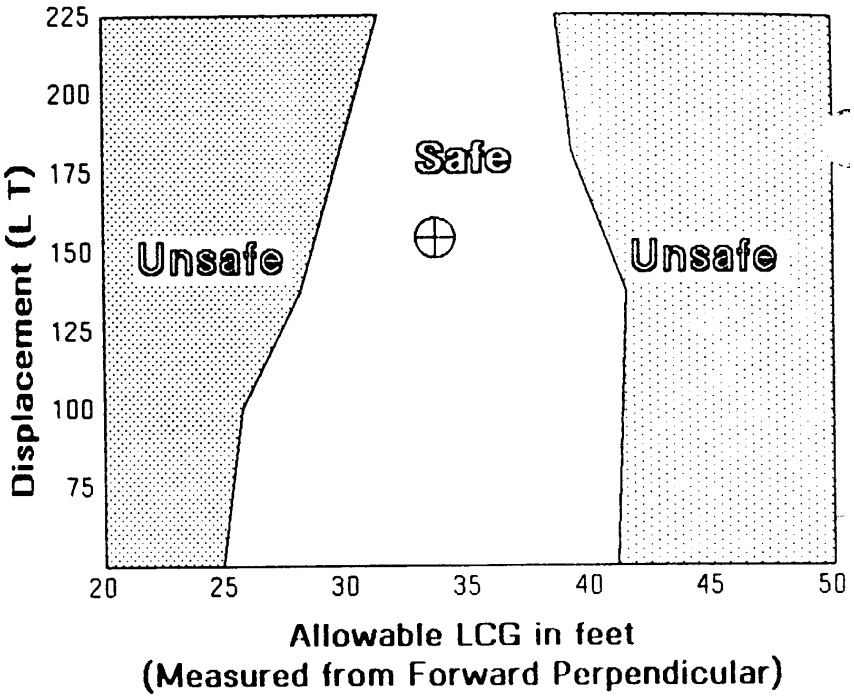


Figure 1–22.

Simplified Allowable LCG Diagram



F/V DIANE L
Sample Loading Condition

	Weight	VCG	Vertical Moment+	LCG *	Longitudinal Moment
Operational Ltship**	98.2	9.8	962.4	37.7	3702.1
#1 P/S FUEL OIL	25.0	5.5	137.5	26.5	662.5
#2 P/S FUEL OIL	5.0	5.0	25.0	57.3	286.5
FOREPEAK FRESH WATER	10.0	75.0	75.0	4.2	42.0
#2 P/S FRESH WATER	1.5	4.5	6.8	16.3	24.5
FISH HOLD	9.0	3.0	27.0	42.6	383.4
DECK LOAD	5.0	14.0	70.0	47.9	239.5
3 TOTAL	153.7	XXX	1303.7	XXX	5340.5

* To avoid confusion, the Coast Guard recommends that all LCG values be referenced to the forward perpendicular so that plus and minus values for LCG are eliminated.

** Operational lightship includes crew and effects and stores

1. TOTAL DISPLACEMENT = SUM OF ALL WEIGHTS - 153.7 TONS

2. VERTICAL MOMENT - WEIGHT x VCG

Example: Vertical Moment for the DECK LOAD - 5.0 TONS x 14.0 FT = 70.0 FT-TONS

3.

TOTA

L VERTICAL MOMENT - SUM OF ALL VERTICAL MOMENTS - 1300.7 FT-TONS

4. VERTICAL CENTER OF GRAVITY (VCG) =

$$\frac{TotalVerticalMoement}{TotalDisplacement} = \frac{1301.7FT-TONS}{153.7TONS} = 8.5FT$$

5. LONGITUDINAL MOMENT - WEIGHT x LCG

Example: Longitudinal moment for the DECK LOAD - 5.0 TONS x 47.9 FT = 239.5 FT-TONS

6. TOTAL LONGITUDINAL MOMENT - SUM OF ALL LONGITUDINAL MOMENTS = 5340.5 FT-TONS

7. LONG. CENTER OF GRAVITY (LCG) (AFT OF FWD PERPENDICULAR) =

$$\frac{TotalLongitudinalMoment}{TotalDisplacement} = \frac{5340.5FT-TONS}{153.7TONS} = 34.7FT$$

(3) The calculated VCG and LCG values are plotted on the curves of VCG versus Displacement and LCG versus Displacement.

(4) A further simplification of this method is to provide fish hold and tank tables for incremental stages of filling (e.g. 25%, 50%, 75%, and 100%) and include only the weights, vertical and longitudinal moments in the table used to evaluate the stability of the vessel. An example of this is shown below. The advantage of this simplification is that the operator need only look up the precalculated moments for each of the tanks and simply add them. Using this method, the free surface effect for each tank can be included in the moment values rather than having to account for it in the Allowable LCG and VCG curves.

Example: #1 Fuel Oil Tanks (Port and Starboard) Values listed are for both tanks

Sounding Level	Weight	Vertical Moment*	Longitudinal Moment*
25%	7.0	18.9	185.5
50%	14.0	51.8	371.0
75%	21.0	94.5	556.5
100%	28.0	162.4	742.0

* Note these values include an allowance for free surface of the tank

(5) Using tables like this for each of the compartments, including crab pots perhaps broken down by tiers or deck load broken down into tonnage increments, each of the loads on the vessel could be accounted for in terms

of moments and weights. All that would then be required would be to add the moments for the operational lightship plus all of the loads and then divide them by the sum of the weights to obtain LCG and VCG values. This further simplification allows calculation of these values with only three additions and two divisions. The only shortcomings of the technique are its inability to handle unusual loads and a slight loss in accuracy. These are far outweighed by the ease of use.

d. Simplified letter format - Another acceptable format is a simple letter prepared by the designer stating limitations on loading of catch based on specific amounts of fuel oil, water and ballast in designated tanks on board the vessel. Below is a sample of this format which has been used for a crab boat.

F/V CATHY G.- STABILITY INSTRUCTIONS

I. To comply with the intact and damage stability standards for fishing vessels recommended by the U.S. Coast Guard, the following limits on number of crab pots to be carried must be observed:

A. With both hold tanks empty of liquid, with any amount of diesel oil and fresh water aboard, in non-icing conditions, a maximum of 74 pots may be carried, of which 16 must be in the holds, and not more than 41 in the first layer on deck, and not more than 17 in the second layer on deck.

B. With both hold tanks empty of liquid, with any amount of diesel oil and fresh water aboard, in icing conditions, a maximum of 57 pots may be carried, of which 16 must be in the holds, and not more than 41 on deck, all in one layer.

C. With both hold tanks empty of liquid, with any amount of diesel oil and fresh water aboard, in non-icing conditions, with no pots in the holds, a maximum of 41 pots may be carried on deck, all in one layer.

D. With both hold tanks empty of liquid, with any amount of diesel oil and fresh water aboard, in icing conditions, with no pots in the holds, a maximum of 41 pots may be carried on deck, all in one layer.

E. With both hold tanks completely full and overflowing with salt water, with any amount of fresh water and diesel oil except transom diesel oil tanks limited to not more than 50% full, in non-icing conditions, a maximum of 52 pots may be carried, in not more than 2 layers on deck, with not more than 17 in the second layer.

F. With both hold tanks completely full and overflowing with salt water, with full fresh water and diesel oil except transom diesel oil tanks limited to not more than 50% full, in icing conditions, a maximum of 35 pots may be carried, in one layer on the deck.

G. With both hold tanks completely full and overflowing with salt water, with any amount of fresh water and diesel oil, including the transom diesel oil tanks more than half full, in non-icing conditions, a maximum of 27 pots may be carried, in one layer on the deck.*

H. With both hold tanks completely full and overflowing with salt water, with any amount of fresh water and diesel oil, aboard, including the transom diesel oil tanks more than half full in icing conditions, a maximum of 15 pots may be carried, in one layer on the deck.*

*Note that having the transom diesel oil tanks more than half full substantially reduces the stability, as evidenced by the number of pots allowed to be carried. Compare Conditions G and H with preceding Conditions E and F.

B. The Effects of Modifications on Fishing Vessel Stability

1. Nearly all of the fishing vessel casualties investigated by the Coast Guard involve vessels in which one or more modifications have been made. Typically, the changes have not been documented nor has the stability of the vessel been re-evaluated in order to provide updated stability information to the operator. In most cases, the modifications consist of adding deck equipment, such as winches, A-frames or other fishing gear, adding or modifying deckhouses or changing out engines. Where modifications have been made, they have generally increased the displacement of the vessel, resulting in a decrease in reserve buoyancy. In many cases, these changes have also substantially increased the VCG of the vessel. Both of these actions adversely affect the stability of the vessel.

2. So that operators and naval architects alike will recognize the extent of stability analysis needed following modifications, the Coast Guard offers the following recommendation:

a. If the cumulative total of weights added plus weights removed is less than one per cent of the original lightship weight, no inclining experiment or deadweight survey is required. A weight summation may be used to adjust the stability information to the operator.

b. If the cumulative total of weights added plus weights removed is between one and ten per cent of the original lightship weight, then a corrected lightship weight, VCG and LCG should be calculated based on the weight summation and then verified by a deadweight survey. If the results of the deadweight survey show a change in the lightship displacement of more than 10 % or a change in the LCG of more than 1% of the LBP, then an inclining experiment should be conducted.

c. If the cumulative total of weights added plus weights removed is greater than ten per cent of the original lightship weight, a new inclining is recommended.

d. As an example, assume a fishing vessel whose lightship displacement is 100 tons. During a conversion, 8 tons are added and 12 tons are removed. Because the total of weights added and removed, 20 tons, is greater than ten per cent of the lightship weight, a new inclining and stability analysis should be completed.

3. Operators should be aware that weight summation calculations are only as good as the weight, VCG and LCG estimates. The Coast Guard's experience has been that many of these estimates are not accurate enough because some items are overlooked or weights, VCG and LCG values are incorrect. Thus, the operator should keep a record of the weights added and removed. The record should include the estimated weight, the distance from a known longitudinal reference point such as a bulkhead or the end of a deck house and the distance above a known vertical reference point, such as the main deck. When the

record book shows that the sum of the weights added and removed exceeds one per cent of the original lightship weight, a new stability analysis should be conducted.

4. The Coast Guard also recommends that surveyors take photographs at each survey so that changes to the vessel can be readily detected and the need for a new stability analysis thoroughly evaluated. Likewise, the Coast Guard recommends that designers maintain plans and calculations which indicate the vessel's configuration and the equipment on board at the time of the most recent inclining experiment and stability analysis.

5. Vessels also have a tendency to "grow" in displacement over a period of a few years. This may be due to new equipment brought aboard the vessel, additional stores and spare parts not accounted for, or piecemeal modifications. Although few of these changes have a major effect by themselves, they do have a cumulative effect. As a check, operators should record the actual draft or freeboard readings for a particular loading condition (i.e. departure condition) at least every six months to ensure that the vessel has not added unaccounted weights. If the these readings have changed by more than two inches from the original readings, then the operator should ask for a new stability evaluation. Painted lines, such as waterlines or boot toppings, should not be used since these may change when the vessel is repainted.

C. Assessing the Combined Effects of Environmental Factors on Ice Accumulation

1. The effects of icing on stability were previously discussed. What is presented here are some basic graphs which can be used to provide operators with a means of estimating the likelihood of ice accumulation on their vessels. Generally, any time the air temperature is below 28^0 F, icing can occur. There are increased chances for icing on smaller vessels, on vessels which take more water and spray on deck, and on vessels with larger deckhouses and topside equipment. Vessels whose displacement is much less than 150 tons can expect heavier icing than that indicated.

2. When an operator is in or expecting a serious icing event, the guidelines below should be followed:

   a. All deck equipment should be covered and secured or moved below.

   b. Derricks, booms, and like items should be stowed in the lowered position.

   c. Watertight doors, manholes, and hatch covers should be battened down.

   d. Ice removal equipment should be readied for use; ice removal should be a frequent, almost continuous, operation.

   e. Freeing ports, lifesaving equipment, and rigging should be kept clear.

   f. Lifelines should be rigged and crew working on deck should wear safety harnesses.

   g. A regular radio watch with shore and other vessels should be established and maintained throughout an icing event.

3. Figures 1-23 and 1-24 were adapted from the Cold Regions Research and Engineering Laboratory (CRREL) Report 77-17. Figure 1-25 is a grouping of the latest icing nomographs developed by the National Oceanic and Atmospheric Administration (NOAA) from actual icing reports from fishing, Coast Guard, and towing vessels operating in Alaskan waters. These reports were of icing events that lasted anywhere from I to 26 hours but averaged about 3 to 6 hours. The icing rates predicted by these nomographs are over three times those predicted by earlier reports.

   a. Sea spray is the major source of water for ice on vessels. Figure 1-23 shows the amount of spraying related to the ship's heading to the waves. This graph is entered with the vessel's speed and the angle difference between the vessel's course and the waves. The frequency of spraying can be read from the vertical axis. This graph shows the importance that speed and heading can have on sea spray and thus ice buildup. A slight reduction in speed or change in course provides a greater reduction in spraying, thus a reduction in icing.

   b. Figure 1-24 shows the combined effects of wind speed and air temperature. This graph shows how changes in wind speed and air temperature can affect expected icing. Entering the graph with the existing or the forecast air temperature and relative wind speed, the point determined will show the operator what to expect for icing. For example, if the air temperature is expected to be 20^0 F and the wind offshore at 25 knots, a return trip to port at 10 knots will mean a relative wind of 35 knots and heavy icing can be expected.

   c. Figure 1-25 shows icing rates expected for different wind speeds, water and air temperatures. These nomographs give an idea of how much ice may accumulate for various environmental conditions. Used in conjunction with a stability evaluation which shows reduced catch based on amounts of ice accumulation, these graphs could provide valuable information to an operator on how to safely maximize the catch in a given set of environmental conditions.

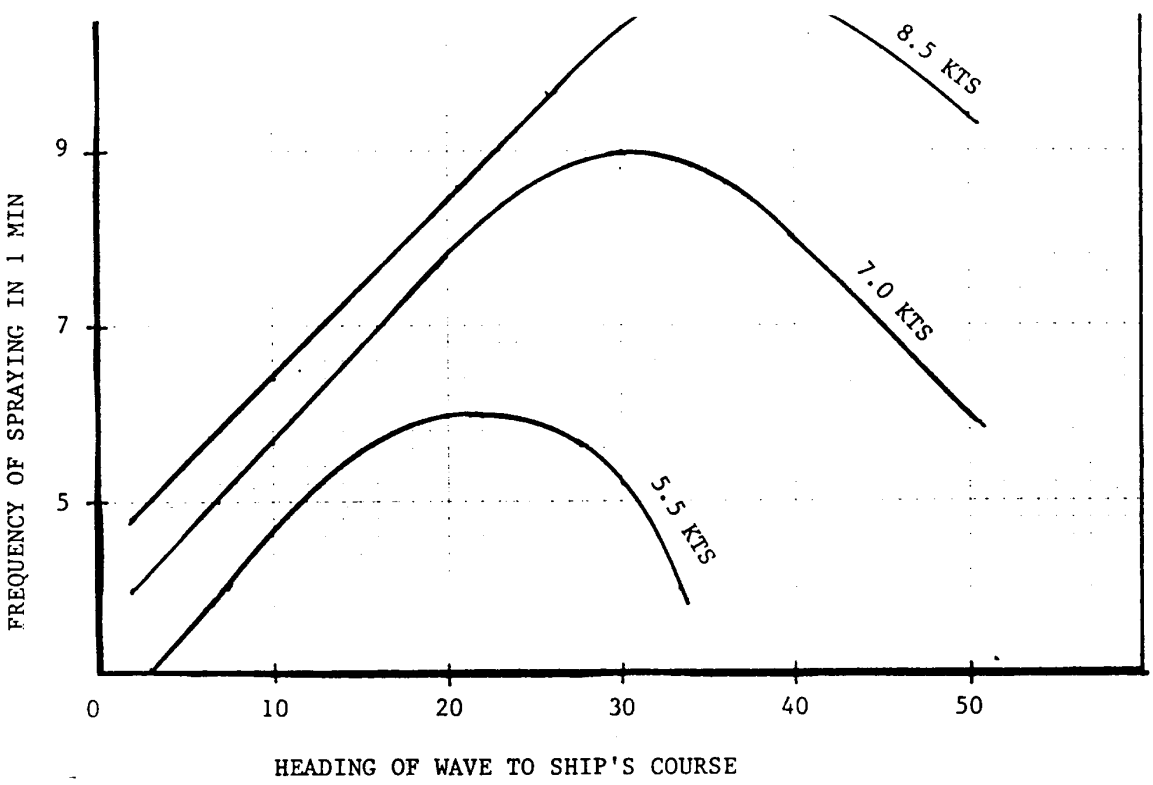


Figure 1-23 AMOUNT OF SPRAYING VERSUS HEADING OF SHIP TO WAVE

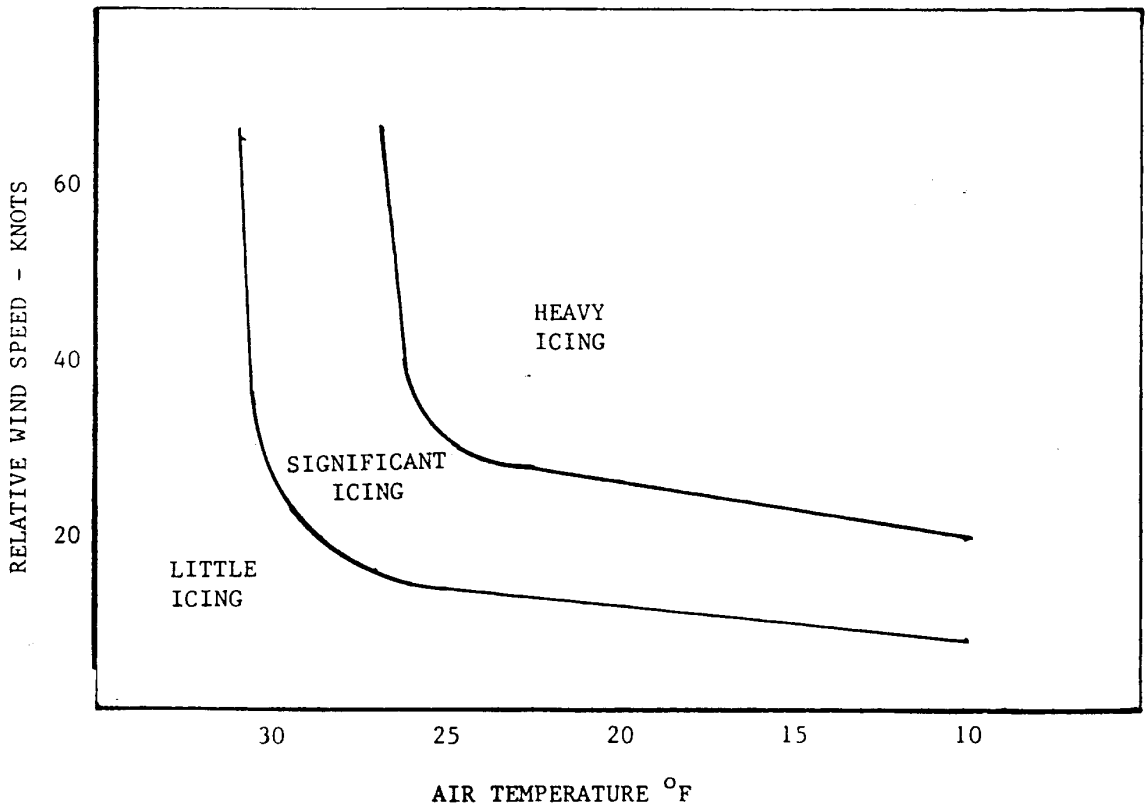
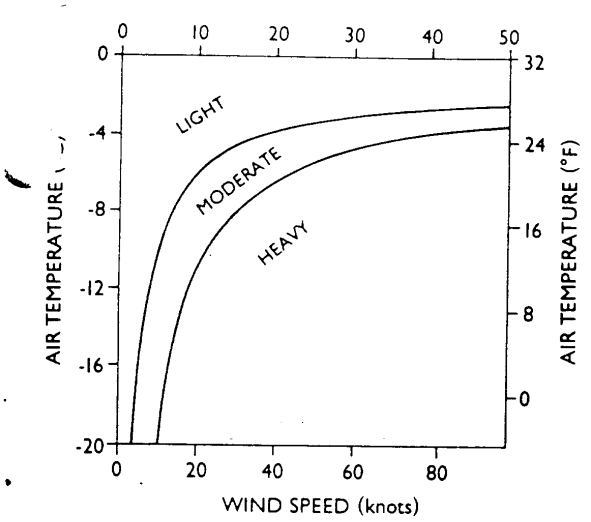
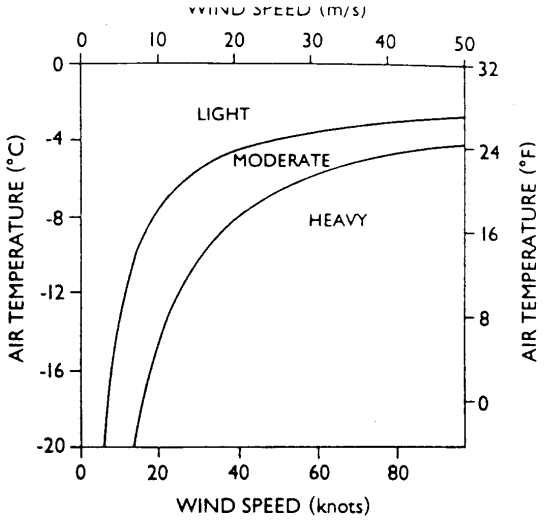


Figure 1-24 WIND SPEED VERSUS TEMPERATURE



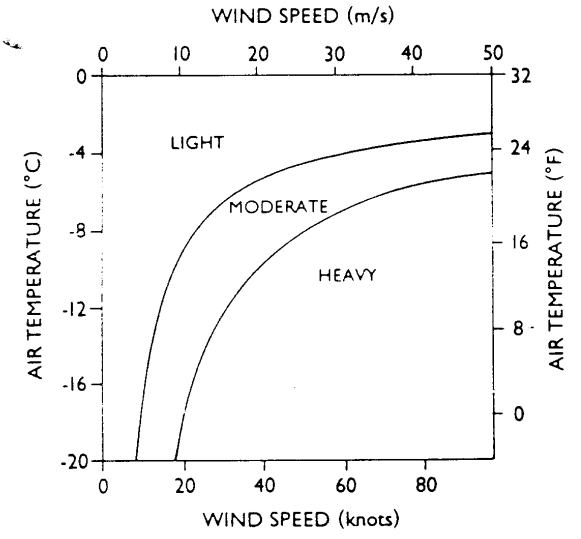
Icing conditions for vessels heading into or abeam of the wind for water temperatures of +1°C (34°F)

Light Icing - Less than 0.7cm/hr (0.3in/hr)
Moderate Icing - 0.7cm/hr (0.3in/hr) to 2.0 cm/hr (o.8in/hr)
Heavy Icing - Greater than 2.0cm/hr (0.8in/hr)



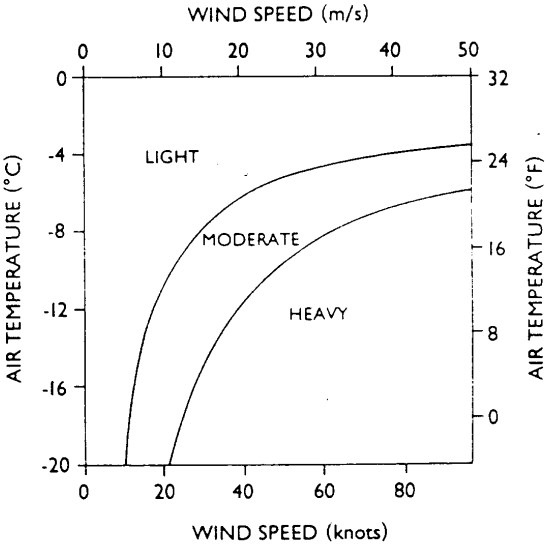
Icing conditions for vessels heading into or abeam of the wind for water temperatures of +3°C (37°F)

Light Icing - Less than 0.7cm/hr (0.3in/hr)
Moderate Icing - 0.7cm/hr (0.3in/hr) to 2.0 cm/hr (0.8in/h
Heavy Icing - Greater than 2.0cm/hr (0.8in/hr)



Icing conditions for vessels heading into or abeam of the wind for water temperatures of +5°C (41°F)

.ight Icing - Less than 0.7cm/hr (0.3in/hr)
Moderate Icing - 0.7cm/hr (0.3in/hr) to 2.0 cm/hr (0.8in/hr)
Heavy Icing - Greater than 2.0cm/hr (0.8in/hr)



Icing conditions for vessels heading into or abeam of the wind for water temperatures of +7°C (45°F)

Light Icing - Less than 0.7cm/hr (0.3in/hr)
Moderate Icing - 0.7cm/hr (0.3in/hr) to 2.0 cm/hr (0.8in/h
Heavy Icing - Greater than 2.0cm/hr (0.8in/hr)

Figure 1-25 EXPECTED ICING RATES 1-57

CHAPTER 2 - RADIO AND SHIPBOARD NAVIGATION EQUIPMENT

RECOMMENDED MINIMUM EQUIPMENT Below is a breakdown of recommended minimum radio and shipboard navigation equipment to be carried on board uninspected commercial fishing vessels by area of operation (distance offshore).

A. Operating up to 20 miles offshore:

1. Radio;
    a. VHF/FM Radiotelephone;
    b. Class C Emergency Position Indicating Radio Beacon (EPIRB);
2. RADAR;
3. Magnetic Compass;
4. Electronic Depth Sounder; and
5. Charts and Nautical Publications for the area of operation.

B. Operating more than 20 miles offshore:

1. Radio;
    a. Single Side Band Radiotelephone (SSB/MF (HF if more than 100 miles offshore));
    b. VHF/FM Radiotelephone;
    c. Class A or B EPIRB (Class A preferred);
2. RADAR;
3. Magnetic Compass;
4. Electronic Depth Sounder;
5. LORAN C; and
6. Charts and Nautical Publications for the area of operation

STANDARDS FOR RADIO EQUIPMENT

A. FCC Requirements

1. FCC regulations are contained in 47 CFR Part 80.

2. A power driven fishing vessel of 300 gross tons and upward while navigating upon the navigable waters of the U. S. is required by the "Vessel Bridge-to-Bridge Radiotelephone Act" to have a radiotelephone capable of operating from its navigational bridge. The radiotelephone must be capable of transmitting and receiving on the frequency or frequencies within the 156-162 MHz band (33 CFR 26.03).

3. Radio installations shall conform with all applicable FCC rules and regulations. Installations should be performed by or under the direction of an FCC licensed marine electronics technician.

4. A vessel equipped with any radio transmitting device (VHF/SSB, RADAR, or EPIRB) must have a current FCC Ship Station License. A license is not transferable from one vessel or person to another.

5. Electronic devices such as radiotelephone and RADAR require FCC design approval and licensing. The manufacturer’s literature should state FCC approval.

6. Check out, adjustments and repair of FCC regulated equipment require the services of a licensed electronic technician. In addition, for RADAR the technician's license must have an FCC RADAR endorsement.

7. Proper voice communication procedures should be used at all times. Further information can be found in the FCC[1]s "Study Guide and Reference Material for the Marine Radio Operator Permit", FO Bulletin No.33, available from FCC field and Washington, DC offices.

8. For additional information and license applications, contact the FCC local field office. The "Marine Radiotelephone Users Handbook", published by the Radio Technical Commission for Marine Service (RTCM)(P.0. Box 19087, Washington, DC 20036) in cooperation with the FCC is another good source of information.

B. Radio Frequencies

1. VHF Radiotelephone should be capable of receiving and transmitting on channels 6 (Intership Safety), 13 (Navigational-Bridge-to-Bridge) or channel 67 if on the lower Mississippi River, 16 (Distress, Safety and Calling), 20 (Coast Guard Liaison and Broadcast), and at least one additional frequency. Channel 67 is the Bridge-to-Bridge channel on the lower Mississippi River.

2. VHF Radiotelephone must be capable of readily reducing power to one watt, or less, when channel 13 or 67 is selected. Manual override to full power is permitted. After 21 January 1997, the reducing of power shall be automatic. (See FCC Regulation 47 CFR 80.80)

3. SSB should be capable of receiving and transmitting in the 2-17 MHz band including 2638 KHz (Intership Safety), 2182 KHz (Distress),.4125 and 6215.5 KHz (Distress), and 2670 KHz (Coast Guard Liaison and Broadcast).

4. 47 CFR 80.309 requires that all vessels subject to the Vessel Bridge-to-Bridge Radiotelephone Act keep a listening watch on the designated navigational frequency. The listening watch must be maintained by the master or a person designated who may perform

other duties provided such other duties do not interfere with the listening watch. 47 CFR 80.310 requires that voluntarily equipped vessels maintain a watch on 156.8 MHz (Channel 16) whenever the radio is operating and is not being used to communicate. "Vessel Bridge-to-Bridge Radiotelephone Act," where applicable, strictly governs the use of channel 13.

5. Radio checks may not be conducted with the Coast Guard on 2182 kHz or channel 16. Conduct radio checks with another vessel or station on a working frequency.

6. The Coast Guard broadcasts marine safety information, including notices to mariners, weather warnings and forecasts, and distress notices, for receipt in printed form on NAVTEX receivers on the frequency 518 kHz. Marine safety information is also broadcast on the VHF Radiotelephone channel 2A and the SSB radiotelephone frequency 2670 kHz. For more information concerning these and other safety broadcasts on other frequencies see "Radio Navigational Aids", Publication 117A (Atlantic and Mediterranean Area) and 117B (Pacific and Indian Ocean Areas) of the Defense Mapping Agency Hydrographic/Topographic Center, Washington, DC.

C. Antenna

1. All parts of the antenna system should be designed and installed to withstand stresses likely to be imposed on the system, such as strong wind, heavy seas and icing conditions.

2. A qualified technician should select the proper antenna, establish its best location on the vessel and its electrical connection to the radiotelephone.

3. The antenna, antenna mount and connections should be located so they will not be used as handholds.

4. Where a long wire antenna is used, interlocking type strain insulators should be installed at the ends of the antenna or that portion of the rigging used as an antenna. Where the antenna is not an integral part of the rigging, then strain relief should be provided.

D. Power Supply

1. Equipment should be protected from excessive currents, voltages, transients, and accidental reversal of the power supply polarity.

2. A separate circuit fused at the main distribution panel should be provided for each radio installation.

3. Batteries should be chargeable and tested weekly.

4. Batteries and cable connections should be easily accessible and protected from corrosion.

E. Operational Controls

1. Radio and/or a remote control unit should be mounted in a position accessible to the helmsman for emergencies.

2. Illumination should be provided to enable identification of controls and facilitate reading of indicators at all times. Means should be provided for dimming the output of any light source if it could interfere with navigation.

F. Emergency Power A reserve source of electrical energy (i.e. batteries), independent of the propelling power of the fishing vessel and of the fishing vessel's main electrical installation should be provided and, where practicable, be situated in the upper part of the vessel. This energy source should be capable of immediate operation and be capable of supplying energy continuously for a period of at least six hours. Additional information is contained in chapter 7.

G. Interference Electrical interference or mechanical noise produced by the radio or any other equipment should not mar the effective reception of radio signals, nor should there be interference from induction caused by fans, motors, mains and other electrical sources, or from noise caused by the working machinery.

H. Position Reporting

1. The Master should inform the owner or other responsible person of his departure from port, the proposed area of fishing and approximate duration of the voyage. A float plan, similar to one recommended in the NPFVOA/USCG Vessel Safety Manual, should be completed and left ashore prior to departure. The Master should notify the same person of his return to port. Whenever possible, position reports should be sent at not more than 24 hour intervals so the last known position -can be fixed with reasonable accuracy in the event of any mishap.

2. Voice privacy devices are available on the open market for persons who want their positions to remain private.

3 In case of radio failure, the captain should verbally pass his position to a nearby vessel (with radio facilities) so that it may be reported.

4. As required by the "Maritime Safety Act of 1984" (PL 98-498), an owner or other responsible person having reason to believe (because of the lack of communication with or non-appearance of a vessel or any other incident) that the vessel may have been lost or imperiled shall notify the Coast Guard and use all available means to determine the status of the vessel. The person notifying the Coast Guard should provide the:

   a. Name and identification number of the vessel; and

   b. Names of individual on board.

5. The Act a180 states the owner or other responsible person shall also submit written confirmation to the Coast Guard within 24 hours after verbal notification.

6. Notification required by the Act should be made to the cognizant Rescue Coordination Center (RCC) or local Search and Rescue (SAR) authority.

I. Distress Communications

1. A card of instructions summarizing the radio distress procedures should be displayed in full view of the radio operating station. A sample "Distress Communication Form" and information to include in a MAYDAY message is provided in the NPFVOAIUSCG Vessel Safety Manual.

2. All vessels are required to monitor the calling and distress frequencies. You may be the vessel in the best position to assist a distressed vessel or relay important information to rescue units. Marine weather warnings are transmitted on Channel 16 and the broadcast notice to mariners on Channel 2 Simplex.

J. General

1. Radio equipment should be capable of continuous operation under the conditions of various sea states, ship's motion, vibration, humidity, and temperature likely to be experienced.

2. Manufacturers should provide installation and maintenance instructions. Where applicable, these instructions must meet FCC requirements. Information should also be available to operate and maintain the equipment including step-by-step instructions for all operating modes and options as necessary.

3. Distress channels should be readily identifiable day and night.

4. Radio and components should be firmly secured in their operating positions. Speakers, wiring or other components designed to be mounted on open decks or cabin tops should be secured so they will not be dislodged or damaged by deck wash or breaking seas.

5. More information concerning radiotelephone equipment can be found in the "Marine Telephone Users Handbook". This book can be purchased from Radio Technical Commission for Maritime Services (RTCM), P.O. Box 19087, Washington, DC 20036.

STANDARDS FOR RADAR

A. Transmitter-Receiver

1. Radar emissions may contain harmful radiations; therefore, extended exposure should be avoided.

2. All radar equipment shall be Type Accepted by FCC and installed in accordance with FCC requirements.

3. Each installation must have a FCC station license.

4. The indicator should be mounted in a position accessible to the operator.

5. Controls should be accessible and readable by day and night.

6. More information on RADAR installation can be found in the following publications:

a. "Standards and Recommended Practices for Small Craft", published by the American Boat and Yacht Council Inc., P.O. Box 806, Amityville, NY 11701.

b. "Performance Standards for Navigational Equipment" (Sales Number 979 82.07.E ISBN 92-801-1137-x), published by the International Maritime Organization, London. Copy can be obtained by writing to IMO Sales, New York Nautical Instrument and Services Corp., 140 W. Broadway, New York, NY 10017.

c. "Standards for Navigating Appliances and Equipment 1983", TP 3668, published by Transport Canada (Canadian Coast Guard), Ottawa, Ontario, K1A 0N7.

B. Scanner

1. If practical, the radar scanner (antenna) should be elevated to provide 360 degree radar vision. It should be located to avoid injury to personnel or fouling of rigging. Safe access to the scanner for service should be provided.

2. The scanner should be well above eye level of operating personnel.

STANDARDS FOR MAGNETIC COMPASS

A. Compass Interference

1. Steel fittings with doors or drawers opening towards the compass should be arranged so a safe distance is maintained.

2. If electronic equipment is installed or the ship's wiring modified within a 3 foot range of the compass, the compass should be re-checked for deviation and re-compensated if necessary. In some cases it may be necessary to make different deviation tables for use when electronic equipment is operating or switched off.

3. A compass deviation table should be on board.

4. Deviation tables should be kept up to date, particularly after alterations to the vessel that might affect the compass deviation (i.e. alteration to electrical wiring and equipment or the installation of new electronic equipment).

B. Adjustment of Compass

1. Adjustable magnetic compass should be provided.

2. The magnetic compass should normally be adjusted when:

a. The compass is first installed;

b. The vessel undergoes structural repairs or alterations that are liable to affect its permanent and induced magnetism;

c. Any alteration or addition of electrical or magnetic equipment in the vicinity of the compass that may affect its performance;

d. At least every three years; or

e. It becomes unreliable.

C. General

1. The compass should operate satisfactorily and remain usable under the operational and environmental conditions likely to be experienced.

2. The magnetic compass equipment should be installed, if practicable and reasonable, on the ship's centerline and so it is easily accessible for correction and maintenance.

3. Securing devices for the compass and compensators should be made of non-magnetic materials.

4. If illumination is provided by the vessel's main electrical supply, emergency illumination should be available. Primary and emergency illumination (if installed) should be provided so the card may be read at all times.

5. Illumination and facilities for dimming should be provided to enable reading of the compass card at all times.

6. With the exception of the illumination, no electrical power supply should be necessary to operate the magnetic compass.

STANDARDS FOR ELECTRONIC DEPTH SOUNDER

A. Transducer Location

1. The location and installation of the transducer is perhaps the greatest single contributing factor towards the effectiveness of a depth sounding system. Each type of hull presents different problems for an echo sounder installation depending on its width, length, hull material and construction. Consider the following when deciding on a location:

a. Locate away from the effects of the propeller, sea-chests and overboard discharge.

b. A position near but off the center line should be chosen to minimize the effects of roll and pitch.

c. The ideal position is where the effect of surface, engine and propeller noise is minimal. Few positions are suitable in every respect and optimum positions vary from one design of a vessel to another. The principal source of aeration is the bow wave created by a moving vessel. This wave rises some way up the stem, curls over, and then is forced down beneath the vessel, taking a quantity of air with it.

The bubble stream produced varies in form and intensity according to the speed, draft, shape of bow and hull, and the trim of the vessel as well as sea state. To avoid aeration a position at the forepeak may seem desirable; however, it is unlikely to be satisfactory in a vessel with a light draft forward or large trim by the stern, especially in bad weather conditions. Also the hull form in the bow section is restrictive and makes fitting difficult. Ensure that the receiving transducer is not too far aft to be affected by noise or aeration from the propeller; tests may be necessary to confirm this.

d. When separate transmitting and receiving transducers are fitted, they should be sufficiently separated to prevent interaction but close enough to ensure accurate sounding in shallow water. Positions either side of the keel are sometimes satisfactory.

e. Install transducers according to manufacturer's instructions.

f. If a windowed transducer must be used, the window should be acoustically thin, preferably of glass reinforced plastic so that the range of the equipment will not be diminished.

g. Keep the length of transducer cable run to a minimum. Protect it to prevent mechanical damage.

B. Interference Some echo sounder equipment (i.e., spark recorders) may radiate interference. Separate them as far as operationally practicable from radio receiving aerials, including unscreened feed cables and unscreened parts of sensitive equipment i.e. radio receivers.

C. General

1. The equipment should be capable of continuous operation under the conditions of sea state, vibration, humidity and change of temperature likely to be experienced in the vessel in which it is installed.

2. Transceiver-receiver should be designed for reliable operation and should be durable. The power output and receiver sensitivity should permit soundings at the equipment's maximum range.

3. Provide information so personnel can operate the equipment efficiently.

4. Provide adequate illumination to enable identification of controls and facilitate reading of record and scales at all times. Provide facilities for dimming.

5. The display should be in the wheelhouse. It should be positioned to provide suitable access, viewing and servicing and where the effect of any necessary lighting does not interfere with the keeping of a proper lookout.

6. Internal access should be available to the transducer for maintenance. Put the transducer and junction boxes in a dry space.

7. Echo-sounding apparatus should be frequently tested and well maintained.

8. Depth indicator (flashing light, meter, digital or cathode ray tube) should be durable and free of loose or fragile parts.

9. Equipment should be protected from excessive currents and voltages, transient and accidental reversal of power supply polarity.

10. If provision is made for operating the equipment from more than one source of electrical energy, arrangements for rapidly changing from one source of supply to the other should be provided.

STANDARDS FOR LORAN C RECEIVERS

A. General

1. LORAN C receivers should meet the following standards/specifications:

   a. RTCM Minimum Performance Standards (MPS); and

   b. RTCM MPS Automatic Coordinated Conversion Systems if the LORAN C receiver contains an automatic Loran C time difference to latitude/longitude coordinate converter.

2. The LORAN C receiver should be labeled or otherwise identified to show it meets the RTCM standards/specifications.

3. Install the receiver, antenna, and transmission line according to the manufacturer's instructions. Keep the lead-in from this antenna (which may pick up noise) as short as possible.

4. Scheduled LORAN C off-air periods are announced by selected Coast Guard radio stations during their Local Notice to Mariners broadcasts. For more information contact the Chief, Aids to Navigation Branch at the nearest Coast Guard District Office.

5. LORAN C USERS HANDBOOK (GPO Stock No. 050-012-00171-5) published by the Coast Guard, is available for a nominal fee from the Superintendent of Documents, Order Section, U.S. Government Printing Office, Washington, DC 20402.

CHARTS AND NAUTICAL PUBLICATIONS

A. General

1. As appropriate for the intended voyage, vessels should carry at least one up-to-date copy of:

   a. Charts;

   b. Coast Pilots;

   c. Light List;

   d. Notice to Mariners;

e. Tide Tables;

f. Current Tables; and

g. International and Inland Navigational Rules (COLREGs).

2. In the interest of safety, charts should be the latest editions available and of as large scale as practicable. The latest additional information from Notice to Mariners and Local Notice to Mariners, (and in particular that referring to buoys, extinguished lights and other navigational hazards), should be kept up to date on the charts.

3. Charts should show: all navigational marks which may be used when navigating; all known hazards affecting those waters; and any information concerning traffic separation schemes, two-way routes, inshore traffic zones, ferry routes and routes applicable to those waters and areas which are to be avoided.

4. Charts issued specifically for use with electronic position-finding aids (i.e., LORAN C) should be carried.

5. Vessel should have harbor scale charts for the port from which they normally operate and other ports which they regularly visit.

STEERING

A. General

1. Keep steering gear in good working condition by frequent checks and performing preventative maintenance.

2. Test steering gear before getting underway.

3. When the automatic pilot is used in areas of high traffic density, conditions of restricted visibility, and other hazardous navigational situations, the master or operator should ensure that:

a. It is possible to immediately establish manual control of the ship's steering;

b. A competent person is ready at all times to take over steering control; and

c. The change-over from automatic to manual steering and vice versa is made by or under the supervision of a qualified person.

4. Additional information is contained in chapter 6.

NAVIGATION SAFETY

A. Rules of the Road

1. The Navigational Rules of the Road apply to all vessels. The "International Rules" apply on the high seas and the "Inland Rules" upon the inland waters and Great Lakes. Every vessel operator is required to know and follow the navigational rules. Violators of these rules are liable to a civil penalty of not more than $5,000 for each violation.

2. The operator of each self-propelled vessel of 39.4 feet (12 meters) or more in length operating on the U.S. inland waters and U.S. vessels operating on the Great Lakes shall carry on board and maintain for ready reference a copy of the Inland Navigation Rules.

3. All navigation and special purpose lights and sound signals shall conform with applicable International Rules for the Prevention of Collision at Sea.

4. Recommendations on the use of radar information as an aid to avoiding collision at sea are contained in Rule 7 of the Navigation rules.

5. Navigational lights should be electrically wired so that only the appropriate navigational lights can be switched on.

6. Positioning details for navigational lights (international rules) are contained in Tables 2-1 (power driven vessels) and 2-2 (vessels engaged in fishing). Table 2-3 contains sound signaling device requirements. To use the Tables do the following:

    a. In Table 2-1, use the "Vessel Length" column on the far left to determine the positioning and lighting requirements to the right.

    b. In Table 2-2, determine the type of fishing activity (far left column) and size of vessel (next column to the right) to determine the positioning and lighting requirements to the right.

    c. Table 2-3 is self explanatory.

7. The Coast Guard publishes the Navigational Rules, International-Inland (COMDTINST Ml6672.2) which is available for a nominal fee from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

TABLE 2-1

POWER-DRIVEN FISHING VESSELS, UNDERWAY, NOT ENGAGED IN FISHING
INTERNATIONAL LIGHTS REQUIRED (Note 1)
(See Rules 21, 22, and ANNEX I of the Navigation Rules)

VESSEL LENGTH	RED-GREEN SIDE LIGHTS(2)	WHITE STERN LIGHT(3)	MASTHEAD(4)-WHITE, FORWARD	MASTHEAD(4)-WHITE, AFTER
Minimum Distance of Visibility in Miles →	3	3	6	6
164 feet (50 meters) or more	YES(5) Shall be placed above the hull at a height not greater then 3/4 of that of the forward masthead light. They shall not be so low as to be interfered with by deck lights. The sidelights shall not be placed in front of the forward masthead lights.	YES(3)	YES(7) Height above the hull(6) not less than 19.7 feet (6 meters). If breadth of vessel exceeds 19.7 feet (6 meters), then at a height above the hull not less than such breadth. However, in any case the light need not be placed at a greater height above the hull than 39.4 feet (12 meters)	YES(7,8) Shall be at least 14.8 feet (4.5 meters) vertically higher than the forward one. Also shall not be less than 1/2 the length of the vessel aft of the forward one. This horizontal distance aft need not be greater than 328.1 feet (100 meters)
65.6 feet (20 meters) or more but less than 164 feet (50 meters)	They shall be placed at or near the side of the vessel. 2	YES(3) 2	5	NOT REQUIRED 5 Not required on vessels
39.4 feet (12 meters) or more but less than 65.6 feet (20 meters)	YES The above positioning applies unless a combined lantern is carried in which case 2	YES(3) 2	YES(7) Shall be placed at a height above the gunwale of not less than 8.2 feet (2.5 meters) 3	on vessels of less 3 than 164 feet (50 meters) in length. If carried
Less than 39.4 feet (12 meters)	the lantern shall be placed not less than 3.3 feet (1 meter) below the masthead light. 1	YES(3) May in lieu of a stern light and a masthead light exhibit an all-round(9) light of 2 miles visibility. 2	YES(7) Shall be carried at least 3.3 feet (1 meter) higher than the side lights. May in lieu of a masthead light and stern light exhibit an all-round light of 2 miles visibility. Such all-round light shall be not less than 8.2 feet (2.5 meters) above the gunwale. 2	must be positioned as 2 indicated above.

NOTES:

(1) Navigation lights should be of a type approved by the Commandant of the Coast Guard, meet the technical details in the applicable navigation rules, and meet UL 1104.

(2) Sidelights means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 65.5 feet (20 meters) in length the sidelights may be combined in one lantern carried on the fore and aft centerline of the vessel. (Rule 21, Navigation Rules-International)

(3) Sternlight means a white light placed as nearly as practible at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel. (Rule 21, Navigation Rules-International)

(4) Masthead light means a white light placed over the fore and aft centerline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel. (Rule 21, Navigation Rules-International)

(5) The sidelights shall be fitted with inboard screens painted matt black, and meeting the requirements of Section 9, Annex I of the Navigational Rules. (Annex I, Navigation Rules-International)

(6) The term height above the hull means height above the uppermost continuous deck. This height shall be measured from the position vertically beneath the location of the lights. (Annex I, Navigation Rules-International)

(7) In all circumstances the masthead light or lights shall be so placed as to be above and clear of all other lights and obstructions. (Annex I, Navigation Rules-International)

(8) The vertical separation of masthead lights shall be such that in all normal conditions of trim the after light will be seen over and separate from the forward light at a distance of 3280.8 feet (1,000 meters). (Annex I, Navigation Rules-International)

(9) All-round light means a light showing an unbroken light over an arc of the horizon of 360 degrees. (Rule 21, Navigation Rules-International)

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TABLE 2-2

ENGAGED IN FISHING-INTERNATIONAL LIGHTS
(See Rule 26 and Annexes I and II of the Navigation Rules) (Note 1)

FISHING ACTIVITY	VESSEL LENGTH	WHITE-MASTHEAD LIGHT	GREEN ALL-ROUND LIGHT	RED ALL-ROUND LIGHT	WHITE ALL-ROUND LIGHT	RED-GREEN SIDELIGHTS	WHITE STERN LIGHT	DAY SHAPE	ADDITIONAL SIGNALS AUTHORIZED	OPTIONAL MANEUVERING LIGHTS
Minimum Distance of Visibility in Miles →		YES [6]	YES [3]	NO	YES [3]	YES [3]	YES [3]	YES	YES [1]	[5]
TRAWLING (2, 3, 5, 6, 7)	164 Feet (50 meters) or more	Position abaft of and higher than all-round green light.	Position not less than 6.5 feet (2 meters) above the all-round white light.(7)		Position below all-round green light. Shall be spaced not less than 6.5 feet (2 meters) apart from green all-round light. White all-round light shall be placed at a height of not less than 13.1 feet (4 meters) above the hull. Also, this light shall be at a height above the sidelights not less than twice the distance between the two vertical lights. On a vessel less than 65.6 feet (20 meters) the white all-round light shall be placed at a height of not less than 6.6 feet (2 meters) above the hull.(7)	Required only when making way through the water. See Table 1 for positioning details.	Required only when making way through the water.	Two cones with apexes together in a verticle line one above the other.(7)	Shooting nets: Two white lights in vertical line. Hauling nets: One white light over one red light in a vertical line. Fouled net: Two red lights in vertical line. Pair Trawling: Search light toward and forward of other vessel of pair. Shooting, Hauling, or Fouled net use signals as above. (5, 6, 7)	All-round white light synchronized with the whistle and complying with the provisions of Annex I of the Navigation Rules. (Rule 34)
	39.4 feet (12 meters) or more but less than 164 feet (50 meters)	NO [5] Not required but if carried must be positioned as indicated above. If vessel is less than 65.6 feet (20 meters) the distance of visibility is reduced to 3 miles.	YES [2] As above, except on a vessel of less than 65.6 feet (20 meters) position not less than 3.3 feet (1 meter) above the all-round white light.	NO	[2]	YES [2] As above.	YES [2] As above.	YES [2] As above except that a vessel less than 65.6 feet (20 meters) in length may instead of two cones exhibit a basket.(7)		
FISHING (Other than Trawling) (2, 4, 5, 6, 7)	164 feet (50 meters) or more	NO	NO	YES [3] Position not less than 6.5 feet (2 meters) above the all-round white light.(7)	YES [3] Position below all-round red light. Shall be spaced not less than 6.5 feet (2 meters) apart from red all-round light. White all-round light shall be placed at a height of not less than 13.1 feet (4 meters) above the hull. Also, this light shall be at a height above the side lights not less than twice the distance between the two vertical lights. When there is outlying gear extending more than 492.1 feet (150 meters) horizontally from the vessel, a second all-round white light in the direction of gear shall be displayed. The light shall be placed at a horizontal distance of not less than 6.6 feet (2 meters) and not more than 19.7 feet (6 meters) away from the two all-round red & white lights. This light shall be placed not higher than the all-round white light and not lower than the side lights. (7)	YES [3] As above.	YES [3] As above.	YES [3] Same as above for vessels of same length. Also, when there is outlying gear extending more than 492.1 feet (150 meters) horizontally from the vessel, a cone, apex upward in the direction of the gear.(7)	YES [1] For Purse Seiners Hampered by Fishing Gear: Two yellow lights in vertical line flashing alternately every second.(5, 6, 7)	
	39.4 feet (12 meters) or more but less than 164 feet (50 meters)	NO	NO	YES [2] As above, except on a vessel of less than 65.6 feet (20 meters) position not less than 3.3 feet (1 meter) above the all-round white light.(7)	YES [2] As above. Except on a vessel of less than 65.6 feet (20 meters) the white all-round light (the one below the all-round red) shall be placed at a height not less than 6.6 feet (2 meters) above the hull.(7)	YES [2] As above.	YES [2] As above.	YES [2] As above, except that a vessel less 65.6 feet (20 meters) in length may instead of the cones, exhibit a basket.(7)		

NOTES: (1) General Definitions [Rule 3(d)]: The term "vessel engaged in fishing" means any vessel fishing with nets, lines, trawls, or other fishing apparatus which restricts maneuverability, but does not include a vessel fishing with trolling lines or other fishing apparatus which do not restrict maneuverability.

(2) Lights and Shapes Definitions (Rule 21) (Partial list)

a. Sidelights means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 65.5 feet (20 meters) in length the sidelights may be combined in one lantern carried on the fore and aft centerline of the vessel. (Rule 21, Navigation Rules-International)

b. Sternlight means a white light placed as nearly as practible at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel. (Rule 21, Navigation Rules-International)

c. Masthead light means a white light placed over the fore and aft centerline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel. (Rule 21, Navigation Rules-International)

d. All-round light means a light showing an unbroken light over an arc of the horizon of 360 degrees. (Rule 21, Navigation Rules-International)

(4) Fishing vessels other than trawling.[Rule 26(c) and Annex I)

(5) Fishing in Close Proximity to Other Vessels Engaged in Fishing [Rule 26(d)]: A vessel engaged in fishing in close proximity to other vessels engaged in fishing may exhibit the additional signals described in Annex II of the Navigation Rules.

(6) Additional Optional Signals for Fishing Vessels Fishing in Close Proximity (Annex II of the Navigation Rules):

General - The lights mentioned herein shall, if exhibited in pursuance of Rule 26(d), be placed where they can best be seen. They shall be at least 0.9 meter apart but at a lower level than lights prescribed in Rule 26(b)(i) and (c)(i). The lights shall be visible all around the horizon at a distance of at least 1 mile but at a lesser distance than the lights prescribed by these rules for fishing vessels.

(7) Fishing Vessels Not Engaged in Fishing [Rule 26(e)]: A vessel when not engaged in fishing shall NOT exhibit the lights or shapes prescribed in Rule 26, but only those prescribed for a vessel of her length.

TABLE 2-3

SOUND SIGNALING DEVICE REQUIREMENTS
(See Notes 1,2)

VESSEL LENGTH	WHISTLE	BELL	GONG
Less than 39.9 feet (12 meters)	Not specifically required; however, if a whistle or bell is not carried, some other means of making an "efficient sound signal" must be carried.		
39.4 feet (12 meters) to 328.1 feet (100 meters)	YES	YES	NO
328.1 feet (100 meters) or more	YES	YES	YES

Notes: (1) The technical details for sound signaling devices are found in ANNEX III of the Navigation Rules (COMDTINST M16672.2A).

(2) Apply to Navigation Rules 32, 33, 34, 35, 36, and 37

SOLAS 74 Chapter V, (Safety of Navigation) of SOLAS 74 and the Protocol of 1978 relating to SOLAS 74 apply to all ships. Chapter V "applies to all ships on all voyages, except ships of war and ships solely navigating the Great Lakes of North America and their connecting and tributary waters as far east as the lower exit of the St. Lambert Lock at Montreal in the Province of Quebec, Canada." Requirements are contained below. For the purpose of this section, "constructed" means a stage of construction where the keel is laid; or construction identifiable with a specific ship begins; or assembly of that ship has commenced comprising at least 50 tons or 1% of the estimated mass of all structural material, whichever is less.

A. Ships of Less Than 150 Gross Tons Steering Compass and means for taking bearings.

B. Ships of 150 Gross Tons and Upward shall be fitted with:

1. A standard magnetic compass.

2. A steering magnetic compass, unless heading information provided by the standard compass required under (A) is made available and is clearly readable by the helmsman at the main steering position.
3. Adequate means of communication between the standard compass position and the normal navigation control position to the satisfaction of the Administration.

4 Means for taking bearings as nearly as practicable over an arc of the horizon of 360 degrees.

5. Each magnetic compass referred to above shall be properly adjusted and its table or curve of residual deviation shall be available at all times

6. A spare magnetic compass, interchangeable with the standard compass, shall be carried, unless the steering compass mentioned in subparagraph (2) or a gyro compass is fitted.

C. Ships of 500 Gross Tons and Upward constructed on or after 1 September 1984 shall be fitted with:

1. Gyro compass. The master gyro compass or a gyro repeater shall be clearly readable by the helmsman at the main steering position.

2. Radar (at least a 9 inch display) installation. Facilities for plotting radar readings shall be provided on the navigating bridge.

3. Indicators showing the rudder angle, the rate of revolution of each propeller, and if fitted with variable pitch propellers or lateral thrust propellers, the pitch and operational mode of such propellers. All these indicators shall be readable from the conning position.

D. Ships of 1,600 Gross Tons and Upward shall be fitted with:

1. A gyro repeater or gyro repeaters suitably placed for taking bearings as nearly as practicable over an arc of the horizon of 360 degrees.

2. In ships constructed before 1 September 1984:

   a. A radar (at least a 12 inch display) installation. Facilities for plotting radar readings shall also be provided on the navigating bridge a

   b. Indicators showing the rudder angle, the rate of revolution of each propeller and in addition, if fitted with variable pitch propellers or lateral thrust propellers, the pitch and operational mode of such propellers. All these indicators shall be readable from the conning position.

3. In ships constructed on or after 1 September 1984 the plotting facilities shall be at least as effective as a reflection plotter.

E When Engaged on an International Voyage

1. All ships of over 150 gross tons shall have on board an efficient daylight signaling lamp which shall not be solely dependent upon the ship’s main source of electrical power.

2. Ships of 1,600 gross tons and upwards constructed before 1 September 1984 shall be fitted with a gyro compass complying with the following:

   (1) The master gyro compass or a gyro repeater shall be clearly readable by the helmsman at the main steering position.

   (2) The gyro repeater or gyro repeaters shall be provided and shall be suitably placed for taking bearings as nearly as practicable over an arc of the horizon of 360 degrees.

3. Ships of 1,600 gross tons and upwards constructed before 25 May 1980 and ships of 500 gross tons and upwards constructed on or after 25 May 1980 shall be fitted with an echo-sounding device.

4. Ships of 500 gross tons and upwards constructed on or after 1 September 1984 shall be fitted with a device to indicate speed and distance.

5. Ships of 1,600 gross tons and upwards shall be fitted with a radio direction-finding apparatus complying with these provisions:

   a. It shall be efficient and capable of receiving signals with the minimum of receiver noise and of taking bearings from which the true bearing and direction may be determined.

   b. It shall be capable of receiving signals on the radiotelegraph frequencies assigned by the Radio Regulations for the purpose of distress and direction-finding and for maritime radio beacons.

   c. In the absence of interference it shall have a sensitivity sufficient to permit accurate bearings being taken on a signal having a field strength as low as 50 microvolts per meter.

   d. As far as is practicable, it shall be located so that as little interference as possible from mechanical or other noise will be caused to the efficient determination of bearings.

   e. As far as is practicable, its antenna system shall be erected so that the efficient determination of bearings will be hindered as little as possible by the close proximity of other antennae, derrick, wire halyards or other large metal objects.

   f. An efficient two-way means of calling and voice communication shall be provided between the direction-finder and the bridge.

   g. It shall be calibrated on first installation. The calibration shall be verified by check bearings or by a further calibration whenever any changes are made in the position of any antennae or of any structures on deck which might affect its accuracy. The calibration particulars shall be checked annually or as near thereto as possible. A record shall be kept of the calibrations and their accuracy.

6. Ships of 1,600 gross tons and upwards constructed on or after 25 May 1980 shall be fitted with radio equipment for homing on the radiotelephone distress frequency, complying with the provisions below:

   a. It shall be capable of taking direction-finding bearings on that frequency without ambiguity of sense within an arc of 30 degrees on either side of the bow.

   b. When installing and testing the equipment referred to in this paragraph due regard should be given to the relevant recommendation of the International Radio Consultative Committee (CCIR).

F. All Ships

1. In areas of high traffic density, in conditions of restricted visibility and in all other hazardous navigational situations where the automatic pilot is used:

   a. It shall be possible to establish human control of the ship's steering immediately;

   b It shall be possible for the officer of the watch to have available without delay the services of a qualified helmsman who shall be ready at all times to take over steering control;

   c. The change-over from automatic to manual steering and vice versa shall be made by or under the supervision of a responsible officer; and

   d. The manual steering shall be tested after prolonged use of the automatic pilot, and before entering areas where navigation demands special caution.

2. All ships shall carry adequate and up-to-date charts, sailing directions, lists of lights, notice to mariners, tide tables and all other nautical publications necessary for the intended voyage.

3. All ships which are required to carry a radiotelegraph or a radiotelephone installation shall carry the International Code of Signals.

G. General

1. All reasonable steps shall be taken to maintain the gyro compass, gyro repeater etc., in efficient working order.

2. All equipment shall be of a type accepted by the Federal Communications Commission.

CHAPTER 3 - FIRE SAFETY MEASURES

FIRE SAFETY

A. Introduction

1. The purpose of this Chapter. is to provide recommended fire safety measures to naval architects, marine surveyors, the fishing community, and others involved in the design and operation of uninspected fishing vessels.

2. Coast Guard statistics continue to indicate a disproportionate number of fishing vessel casualties in relation to the number of vessels in service. On the average ten per cent of all fishing vessel casualties and twenty per cent of the vessels declared a total loss are caused by fire.

3. A review of the casualty files maintained by the Coast Guard indicates that the majority of fires occur on board vessels less than 100 feet in length and start in unattended machinery spaces. These fires are often detected too late, either when the machinery stops or when smoke billows from the machinery space. Initial fire fighting efforts often entail using portable fire extinguishers and occasionally a fixed CO_2 or halon system, but this is usually inadequate because the fire has had time to build and there is not enough fire extinguishing agent to put out the fire. The vessel is abandoned and the fire soon engulfs the accommodation area and pilot house either through openings such as doors, vents, cable and pipe penetrations, etc., or by transmission of heat to combustibles located on the other side of the deck or bulkhead. Several causes of machinery space fires include broken fuel or lube oil lines that spray fuel on hot engine parts, faulty electrical systems (e.g., frayed cables, burned electric motors, etc.), uninsulated exhausts penetrating decks made of combustible materials, rags and other combustibles in the vicinity of hot motors or engines, and self ignition of oil soaked rags.

Other common areas where a fire is likely to start are in the accommodation spaces (often from careless smoking), and in galleys from cooking oil that is allowed to become too hot or from combustible materials in close vicinity of hot stoves.

4. Minimum regulatory requirements for fire fighting equipment are contained in Title 46, Code of Federal Regulations (CFR) Subchapter C. The Coast Guard believes that compliance with the additional recommended fire safety measures found in this Chapter on the part of the fishing industry will have a significant effect in reducing casualties.

5. Many fishing vessel fires could be eliminated by proper stowage of oily rags, oil free bilges, sound electrical systems, insulated engine exhausts, and care when smoking or cooking. Damage can be minimized through early detection, minimized use of combustible materials in the vessel’s construction, tight compartmentation to isolate the fire, and adequate fixed fire extinguishing systems and portable fire extinguishers.

6. Design features should be used during construction of new vessels or renovation of existing vessels to minimize the consequences of ship-board fires. This involves built-in fire endurance for bulkheads and decks to provide barriers to contain a fire, and also allow escape of personnel and time for putting the fire out.

B. Basic Fire Safety

1. Basic Fire Safety is general and points out the need for good housekeeping practices, fire detectors, fire extinguishing equipment, and training.

2. It is a fact of life that fires do and will continue to occur on vessels whether they are tied up to the pier or underway. A program to prevent a fire and to minimize the damage to a vessel after a fire occurs should be the goal of all fishing vessel owners, operators, and crew members.

3. Many aspects of fire prevention measures are basic common sense, but their importance cannot be overstressed. The below conditions should be met at all times.

   a. Bilges should be kept dry and oil free.

   b. Used rags should be stowed in a covered metal container.

   c. Fuel and lubricating oil lines should be free of kinks; hoses should be replaced if cracked, brittle or otherwise damaged; connections should be tight; and pipes should be arranged to prevent rubbing against structural members of the vessel.

   d. Electrical outlets should not be overloaded. All loose, frayed, or worn electrical cables should be replaced. Fuses and circuit breakers should be properly sized, electric motors should not be overloaded, and short circuits should be properly repaired.

   e. Paints, thinners, solvents, and other combustible or flammable liquids should be properly stored in a designated locker or storeroom that has good ventilation and which is protected with sufficient fire extinguishing equipment.

   f. Smoking should be prohibited in bed and in areas where combustible materials or flammable liquids or vapors are present. Cigarette butts and matches should be properly disposed of in ashtrays.

   g. Noncombustible materials should be used for bulkheads, decks, and other structures, in accommodations, service areas, and control spaces. Fire resistant materials should be used for all curtains and carpets.

   h. Noncombustible materials should also be used for furniture in accommodations, service areas, and control spaces. Where this is not practicable hardwood furniture may be used provided it is not overstuffed or does not have thick foam padding. This is intended to minimize the fuel available for a fire.

   i. Cardboard boxes, plywood, and other combustible materials should not be stored in machinery spaces, galleys, and other spaces where a source of heat is present.

   j. Heaters, stoves, etc., should be turned off when left unattended. Galley hoods and filters should be cleaned regularly.

4. Fires are usually much easier to put out if discovered when they first start. Fire and smoke detectors are very important on vessels; especially in machinery spaces, galleys, and

accommodations. An Underwriters Laboratory, Inc. (UL) approved house type smoke detector is usually adequate for accommodations and galleys. Machinery spaces, because of the noise level and the high fire risk involved, should have a fire or smoke detecting system with an audible and a visual alarm located in the pilot house and on deck if necessary.

5. Small fires may often be put out with a proper size and type of portable fire extinguisher. If this is unsuccessful or the fire is large when discovered, it is best to isolate the fire; that is, close the doors, notify the skipper, begin further fire fighting efforts, secure ventilation fans and openings, deenergize the electrical circuits for the space; remove combustible materials from the other side of the bulkhead and decks, etc.

6. It is very important to limit combustible materials on board the vessel to reduce the amount of fuel available for a fire. Some construction materials such as insulating foams and plastics produce extremely toxic products when burning. These should not be used or at least reduced in quantity wherever possible.

7. Machinery spaces, especially' unattended engine rooms, should have a fixed fire extinguishing system. A properly designed fixed fire extinguishing system is very effective in putting out a fire; provided doors are closed, fans are shut down, and there are no openings in the bulkheads and decks. To prevent a reflash after a fixed fire extinguishing system is discharged; the space should not be entered until the space has cooled down. For further information on the use of fire fighting equipment consult manufacturers instructions or maritime fire fighting handbooks.

8. All fishermen should be trained in the use of fire fighting equipment and systems aboard a vessel. This may be accomplished through a formal training program organized by fishing associations on their own or through local, state or federal firefighting training facilities and informal training on the vessel. Each crew member should know where all fire and lifesaving equipment is stored and how to use it. Fishermen should also have preassigned duties in the event of a fire or other emergency condition. This should be in the form of a station bill. Crew members should know their duties at all times and under all conditions.

9. An additional source of fire safety information and guidance is: National Fire Protection Association (.NFPA), Batterymarch Park, Quincy, MA 02269.

FIRE SAFETY MEASURES FOR ALL FISHING VESSELS

A. Introduction This Section applies to existing and new fishing vessels and contains detailed recommendations for fire detection, fire extinguishing equipment, means of escape, heating and cooking appliances, and good housekeeping design standards. In addition, for existing vessels, considerations are provided for structural fire protection, and ventilation and fire main systems which recognize the costs of major modifications in these areas.

B. Definitions

1. "Noncombustible material" is a material which neither burns nor gives off flammable vapors in sufficient quantity for self-ignition when heated to 1350^0F or above.

2. "Fire resistant material" is a term applied to materials such as wood, FRP, fabrics, paddings and floor coverings. It is a considerably lower degree of fire protection than noncombustible, yet maintaining a degree of protection higher than that of non-fire resistant materials of similar construction. The intent of recommending fire resistant materials is to provide a construction method with a lower probability of ignition, slower flame spread, and a reduction in smoke.

3. "'A' Class divisions" are those divisions formed by bulkheads and decks made of steel or equivalent material construction, suitably stiffened and made intact with the main structure of the vessel; such as shell, structural bulkheads, and decks. They are built so that if subjected to the standard fire test, they would be capable of preventing the passage of flame and smoke for one hour.

4. "'B' Class divisions" are those divisions formed by bulkheads and decks made of noncombustible materials and made intact from deck to deck and to shell or other boundaries. They are built so that if subjected to the standard fire test, they would be capable of preventing the passage of flame for one half hour.

5. "Steel or equivalent material" means steel or any noncombustible material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test (e.g., aluminum alloy with appropriate insulation).

6. "Accommodations" are those spaces used as halls, dining rooms, lounges, corridors, lobbies, cabins, offices, hospitals, pantries without cooking appliances, etc.

7. "Service areas" are those spaces used as galleys, pantries with cooking appliances, lockers and storerooms, workshops, etc., and trunks to such spaces.

8. "Control spaces" are those spaces in which the ship's radio, main navigation equipment, or emergency source of power is located.

9. "Machinery spaces" are those spaces containing propulsion machinery, boilers, fuel oil units, steam and internal combustion engines, generators, steering gear, major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilating and air conditioning machinery, etc., and trunks to such spaces.

C. Automatic Fire Detection and Fire Alarm Systems

1. Each unattended main machinery space should have a smoke or fire detection system that initiates an audiovisual alarm in the wheelhouse and in other spaces where it can be noticed when the vessel is underway or in port. This smoke or fire detection system should be fed automatically from an emergency source of power or batteries.

2. Smoke or fire detection systems should be installed to indicate the presence and location of fire or smoke in galleys, accommodations, and other high risk spaces.

3. Smoke or fire detection equipment should meet either the requirements found in 46 CFR 161.002 or NVIC 7-80 "Use of Fire Detection Systems Which are Not Approved Under 46

CFR 161.002". Equipment that is listed and labeled by a nationally recognized testing laboratory such as Underwriters Laboratory, Inc. (UL) can be used.

D. Fixed Fire Extinguishing Systems

1. Machinery spaces containing oil fired boilers, fuel oil units, or internal combustion engines should have a fixed fire extinguishing system. The medium should be carbon dioxide or Halon 1301.

2. Cargo spaces with a high fire risk should be protected by a fixed carbon dioxide fire extinguishing system.

3. All fixed fire extinguishing systems should be designed to 46 CFR 95.15, NVIC 6-72, "Guide to Fixed Firefighting Equipment Aboard Merchant Vessels", and Change 1 to NVIC 6-72, and use fittings, materials, and equipment suitable for marine use. NFPA 12 (C02 Extinguishing Systems) and NFPA l2A (Halon 1301 Extinguishing Systems) are also a good source of information as long as they are applied in conjunction with the above guidelines.

E. Portable Fire Extinguishers

1. Minimum requirements for fire extinguishing equipment on uninspected vessels are found in 46 CFR 25.30. The following tables provide minimum recommendations for fire extinguishing equipment on uninspected fishing vessels which in some cases exceed the regulatory requirements for the type and quantity of fire extinguishers. All portable fire extinguishers should be suitable for marine use.

TABLE 3-1 PORTABLE AND SEMIPORTABLE EXTINGUISHER TYPES

Classification		Foam	Halon	CO_2	Dry Chem
Type	Size	gallons	pounds	pounds	pounds
A	II	2 1/2			
B	I	1 1/4	2 1/2	4	2
B	II	2 1/2	10	15	10
B	III	12		35	20
B	V			100	50
C	I		2 1/2	4	2
C	II		10	15	10

Extinguishers are broken up into various "Types" to indicate what type of fire they are best suited to extinguish. They are as follow:

Type A - Those extinguishers used to put out fires in ordinary combustible materials (such as wood, bedding, clothing, canvas, rope and paper). Class A fires leave hot embers or ashes. Materials of this type must be cooled throughout to make certain the fire does not start up again.

Type B - Those extinguishers used to put out fires in flammable liquids (such as gasoline, oil, grease, paint, etc.). These materials burn at the surface where the vapors are given off.

The burning liquid should be smothered or blanketed with foam, $C0_2$, halon 1301, dry chemical or water fog.

Type C - Those extinguishers used to put out fires in electrical equipment. Here the use of a nonconducting extinguishing agent is of first importance. In most electrical fires it will be necessary to cut the power to that equipment before any progress can be made. $C0_2$ and halon 1301 are nonconductors and will not damage electrical equipment. Dry chemical can also be used.

TABLE 3-2 RECOMMENDED PLACEMENT

Space	Class.	Quantity and location
Wheelhouse/steering station.....	B-II	1 - in the vicinity of exit **
Passageways	A-II	1 - in each main corridor
Radio room.....	C-I	1 - in vicinity of exit
Galleys.....	B-II	1 - outside galley near exit
Combustible liquid storeroom....	B-II	1 - outside space near exit
Accessible storerooms.....	A-II	1 - for each 1,200 ft^2 or fraction thereof near exits
Propulsion machinery space with.. fixed CO_2 or Halon 1301 system	B-II	1 - in vicinity of exit
Propulsion machinery space without fixed CO_2 or Halon 1301 system	B-II*	1 - for each 1000 BHP but not less 2 nor more than 6

* On motor vessels of over 300 gross tons either one B-Ill semiportable fire extinguishing system or a fixed fire extinguishing system must be fitted in the machinery space (See 46 CFR 25.30-20(b)(2)(ii)).

** Foam is not recommended in this application.

F. Means of Escape

1. Stairways, ladders, and corridors serving accommodations and other spaces where the crew is normally employed, other than machinery spaces, should be arranged to provide a ready means of escape to the open deck where the survival craft are located. The following should be considered for the means of escape.

   a. There should be at least two widely separated means of escape for each accommodation area. Below the weather deck the means of escape should be a stairway and the second escape could be a trunk or a stairway. Above the weather deck the means of escape should be stairways or doors to an open deck, or a combination of them. Where it is not practical to fit stairways or doors, one of the means of escape could be through adequately sized and easily accessed (provide ladders or steps) portholes or hatches protected where necessary against ice accumulation, blockage by stores, ships gear, etc.

b. A corridor or part of a corridor from which there is only one route of escape should not exceed 8 feet in length.

c. The width and the continuity of the means of escape should be based upon the size of the vessel and the number of persons using it.

2. Two widely separated means of escape should be provided from every machinery space. Stairs and vertical ladders used as means of escape should be made of steel.

G. Heaters and Cooking Appliances

1. All heating and cooking appliances should be suitable (preferably UL or FM listed) for the desired use.

2. Electric radiators should be built and secured to reduce the risk of fire. No element should be exposed such that clothing, curtains, etc., can be scorched or set on fire by the heating element.

3. Open fires should not be used for heating. Heating stoves and other similar appliances should be firmly secured and insulated from beneath and around, and also in way of their uptakes. Uptakes of stoves should be arranged to minimize the possibility of becoming blocked by soot and should have an easy means for cleaning. Dampers for limiting drafts in uptakes should, when in the closed position, leave an adequate open area to prevent a buildup of combustion gases in the uptake. Spaces where stoves are installed should be provided with ventilators to provide an adequate supply of air for combustion of the stove. These ventilators should not have a means of closing.

4. Kerosene heaters should not be used for heating unless designed and approved for marine use.

5. Open flame gas appliances, except cooking stoves and water heaters, should not be used. Spaces where open flame stoves and water heaters are installed should have adequate ventilation to remove fumes and possible gas leakage to a safe place. This should be done through an exhaust type ventilation system with the inlets placed low (or high in the space dependent on the fuel used) in the space. All pipes that convey gas from a container to a stove or water heater should be made of steel or equivalent material. Automatic shutoff devices should be fitted to operate on loss of pressure in the gas main pipe or a flame failure.

6. Gasoline appliances should not be used on any vessel.

7. For further information on the installation of liquefied petroleum gas (LPG) or compressed natural gas (CNG) systems, galley stoves, and heating systems see NFPA-302 (Fire Protection Standard for Pleasure and Commercial Motor Craft) or American Boat and Yacht Council, Inc. (ABYC) Projects' A-l, A-3, A-7, and A-22. Also NFPA 54 (National Fuel Gas Code) can provide additional guidance but where this code conflicts with NFPA 302 or ABYC, due to marine constraints, the latter take precedent.

H. Storage of Gas Cylinders and Other Dangerous Materials

1. Gas cylinders should be properly secured and should meet U.S. Department of Transportation (DOT) standards for construction, testing, and marking.

2. Spaces that contain highly flammable liquids, (e.g., volatile paints, paraffin, etc.) should have direct access only from open decks.

3. Electrical wiring and equipment should not be installed in spaces with highly flammable liquids or liquefied gases unless the equipment is explosionproof, intrinsically safe, or purged and pressurized. Sources of heat should be kept clear of these spaces and "No Smoking" and "No Open Lights" notices should be prominently displayed at the entrance to the space.

4. NFPA 30 (Flammable and Combustible Liquid Code) can provide additional guidance on the use, storage and protection of these materials.

5. Additional information is contained in chapters 4 and 6.

I. Fireman's Outfit Fishing vessels having provisions for a fire fighting -party should have a sufficient number of fireman's outfits on board the vessel. A fireman's outfit should contain the following equipment: Self-contained breathing apparatus with lifeline attached, flashlight, rigid helmet, boots and gloves, protective clothing, and fire axe. It is important when a fireman's outfit is provided that personnel be properly trained in its use. NFPA standards 1971, 72, 73 & 81 provide guidance on requirements for the types of acceptable outfit equipment and their construction. These standards can provide some good recommended guidelines for choosing fireman's outfits.

J. Foam Insulation Polyurethane and other organic foam materials are often used on vessels because of their excellent insulating properties and light weight. When organic foams are exposed to fire or heat, they may ignite and burn with rapid flame spread, high temperature, toxic gases, and a large amount of smoke. Thus, insulation fitted in refrigerated compartments and fishholds should be noncombustible unless the exposed surfaces are protected by close fitted cladding. For further information consult NVIC 8-80, "Fire Hazard of Polyurethane and Other Organic Foams When used as a core material in sandwich construction of hulls, the selected foam should be fire retardant or at least protected by a skin of fire retardant FRP.

K. Periodic Inspection and Testing

1. Portable fire extinguishers should be examined at least monthly to ensure the following:

   a. Proper location;

   b. Absence of corrosion or mechanical damage;

   c. A full charge;

   d. A clear nozzle; and

   e. Good condition of the hose.

2. All portable and semiportable fire extinguishers should be checked annually by a qualified fire extinguishing service facility or qualified vessel personnel. This should include examining them for excessive corrosion and by testing in the below manner.

   a. Foam - Discharge. Clean hose and inside of extinguisher thoroughly. Recharge.

   b. Carbon dioxide - Weigh cylinders. Recharge if weight loss exceeds 10 percent of the weight of charge. Inspect hose and nozzle to be sure they are clear. Semiportable $C0_2$ cylinders should be tested and marked; and all flexible connections and discharge hoses should be tested and renewed in accordance with 46 CFR 147.04-1.

   c. Dry chemical (cartridge operated type) - Examine pressure cartridge and replace if end is punctured or if the cartridge is otherwise determined to have leaked or to be in an unsuitable condition. Inspect hose and nozzle to be sure they are clear. Insert charged cartridge. Be sure dry chemical is free flowing (not caked) and chamber contains a full charge.

   d. Dry chemical (stored pressure type) - See that the pressure gage is in the operable range. If not recharge the extinguisher.

   e. Halon 1301 - Weigh cylinders. Recharge if weight loss exceeds 5% or if a pressure drop of more than 10% is noted. Cylinders, hose and connections should be tested as per NFPA 10.

   f. Additional guidance for portable and semiportable extinguishers use, maintenance and testing can be found in NFPA 10 (Standard for Portable Fire Extinguishers).

3. Fixed CO_2 and Halon 1301 extinguishing systems should be tested annually by a qualified fire extinguishing service facility. CO2 systems should be tested by weighing the cylinders and recharging if weight loss exceeds 10 percent of the weight of the charge. Halon 1301 systems should be tested by weighing each cylinder and replacing or recharging if weight loss exceeds five percent; and checking the pressure of each cylinder and recharging or replacing the cylinder if a pressure drop (adjusted for temperature) of more than ten percent is recorded. In addition, alarms, release mechanisms, and automatic shutdowns should be checked, and cylinders should be tested and marked and all flexible connections should be renewed or subjected to a pressure test in accordance with 46 CFR 147.04-1 (It should be noted that Halon 1301 should only be tested to a pressure that is 1 1/2 times that of the system pressure. See NFPA 12A (Halon 1301 Fire Extinguishing Systems) for further guidance).

4. The fire main system should be operated at least every six months and the pressure checked at the outlets having the greatest pressure drop between the fire pumps and the nozzles. All fire hose should be subjected to a test pressure equivalent to the maximum pressure to which it may be subjected, but not less than 100 psig. On small vessels (65 feet in length and less) where 3/4-inch hose of good commercial grade together with a commercial garden hose nozzle is used, the fire hose should be tested to the available fire pump pressure.

5. All fire detection systems, fire nozzles, applicators, etc., should be inspected monthly or as necessary by the crew to determine that they are in a good and operable condition.

L. Miscellaneous

1. Primary deck coverings in accommodations, service areas, and control spaces should be made of a material which will not readily ignite or give rise to toxic or explosive hazards at elevated temperatures.

2. Exposed interior surface finishes should be of a type to restrict the spread of flames and should not be capable of producing excessive quantities of smoke.

3. Materials that will melt or deform at temperatures below 1700^0F (aluminum, plastics, etc.) should not be used for overboard scuppers, sanitary discharges, and other through hull fittings below the working deck unless adequately protected with insulation.

4. Skylights to spaces containing main propulsion machinery and auxiliary internal combustion type machinery should be operable from outside the space. Windows in skylights should be nonopening, wire reinforced, and have permanently attached external shutters made of steel or equivalent material.

5. Insulating materials in accommodations, service areas, control spaces, and machinery spaces should be noncombustible (Mineral wool, etc.). Machinery space insulation should have a barrier impervious to oil or oil vapors applied to its surface.

6. Internal combustion engines of 3350 HP and over should be fitted with crankcase oil mist detectors or engine bearing temperature detectors.

7. All fuel pumps should be fitted with remote stopping controls located outside the space.

8. Pipes that convey oil, other combustible liquids, gases, or compressed air should be made of steel or other equivalent material.

9. Drip trays should be fitted to prevent oil from leaking into bilges.

10. All waste receptacles other than those used in fish processing should be made of noncombustible materials with no openings in the side or bottom and have a tight fitting and self-closing cover of the same material.

11 All vessels should have at least one readily accessible fire axe.

12. All vessels should have at least one gasoline or diesel powered portable fire pump for emergency backup of the main fire pump. The fire pump is usually in the main machinery space or which if in another space is supplied with power from the main machinery space or if the vessel does not have affixed fire pump a portable will provide a source of firefighting water.

13. Batteries should be installed in accordance with guidance in NFPA 302.

14. Sources of approved or listed materials and equipment are the Coast Guard Equipment List (COMDTINST Ml6714), and UL Building Materials Directory and Fire Protection Equipment Directory.

STRUCTURAL FIRE PROTECTION, VENTILATION SYSTEMS AND FIRE MAIN SYSTEMS

A. Existing Vessels

1. The recommendations for structural fire protection, and ventilation and fire main systems found in paragraph B below should be considered for existing vessels; however, where this is not practicable an existing vessel should meet at least the following:
   a. Penetrations in accommodations, galleys, and machinery space bulkheads and decks for the passage of cables, pipes, etc., should be made tight with materials which will prevent the spread of fire;

   b. Maintain all doors, hatches, skylights, etc. in good working order to ensure tight closure and easy exit from a space;

   c. Combustible furnishings should be kept to a minimum;

   d. Ventilation fans should have a remote means of stoppage from outside the space served; and

   e. Sufficient hose should be available to the deck water washdown valve to reach all areas of the vessel.

B. New Fishing Vessels

1. This section has recommendations for structural fire protection, ventilation systems, and fire mains for new fishing vessels 79 feet (24 meters) in length and less, and new fishing vessels greater than 79 feet (24 meters) in length. These recommendations are based on the requirements for small passenger vessels inspected under 46 CFR Subchapter T, large inspected vessels. The requirements of the Torremolinos Convention (which are used as necessary to spell out the intent of the regulations), and sound marine practice.

2. General - Containment of a fire within the space of origin is a very important aspect of fire safety and is accomplished by specifying the fire endurance of bulkheads and decks and minimizing the amount of combustible materials in a space. Steel or equivalent material used for the construction of the hull, superstructure, structural bulkheads, decks, and deckhouses provides a much better fire integrity than wood or fiberglass reinforced plastic (FEP) and should be used for construction whenever possible. Vessels over 180 feet (55 meters) in length should always be built with steel or equivalent materials. The following recommendations for structural fire protection, ventilation systems, and fire mains are derived from the Torremolinos International Convention for the Safety of Fishing Vessels, 1977, Voluntary Guidelines for the Design, Construction, and Equipment of Small Fishing Vessels, 1980, and portions of Title 46, Code of Federal Regulations.

C. New Fishing Vessels 79 Feet (24 Meters) in Length and Less

1. Vessels with the hull, superstructure, structural bulkheads, decks, and deckhouses constructed of noncombustible materials should meet the following:

    a. The decks and bulkheads that separate machinery spaces from control spaces, other machinery spaces, accommodations, and service areas should be constructed to a minimum "B" class division standard. Doors and other openings in these decks and bulkheads should be kept to a minimum; however, where installed, they should be built to provide the same protection in resisting fire as the deck or bulkhead in which they are fitted.

    b. Corridor bulkheads serving the accommodations, service areas, and control spaces should extend from deck to deck. These bulkheads and decks should be built to a minimum "B" class division standard. Doors and other openings in these decks and bulkheads should be kept to a minimum; however, where installed, they should be built to provide the same protection in resisting fire as the surrounding structure.

    c. Interior stairways serving machinery spaces, accommodations, service areas, or control spaces should be made of steel or other equivalent material.

2. Vessels with the hull, superstructure, structural bulkheads, decks, and deckhouses constructed of wood or FRP should meet the following:

    a. To meet the requirements of A- and B-Class construction the divisions must be constructed of noncombustible materials. However, vessels using combustible construction can meet the intent of these divisions by providing noncombustible insulation and cladding. They also can try to use noncombustible construction in joiner work, inside the hull and in the deckhouse as much as possible.

    b. The internal surfaces of the overhead, boundary bulkheads, sideshell down to the light waterline, and casings of machinery spaces, enclosures to stairways, bulkheads and decks enclosing control spaces, and corridors serving accommodations should be insulated to provide a minimum equivalent to a "B" Class division standard.

    c. The number of openings in the bulkheads and decks should be kept to a minimum and have closing devices which provide the same protection in reacting fire as the surrounding structure.

    d. Special attention should be given to adequately insulating and properly positioning exhaust pipes, ducts, and equipment which could otherwise present a fire risk. NFPA 37 (Stationary Combustion Engines and Gas Turbines) and NFPA 302 provide guidance on exhaust system construction and installation in combustible divisions.

    e. Vessels having FRP construction should be built with fire retardant resins within accommodations, service areas, and machinery spaces. Fire retardant resins are used to reduce the fire risk of the material.

f. Vessels having wood construction should be built with wood (plywood) that is treated to increase its resistance to fire within the accommodations, service areas and machinery spaces.

3. Ventilation systems should meet the following:

a. There should be a means to stop ventilation fans and to close main openings to ventilation systems from outside the space served.

b. Ventilation systems serving machinery spaces should be independent of systems for other spaces. The ventilation ducts for main machinery spaces should not pass through accommodations, service areas, or control spaces unless they have an automatic/manual operable steel fire damper installed and the duct is steel at the machinery space division for a length of 36 inches, preferably divided 18 inches on either side of this division. NVIC 6-80 provides additional guidance on penetrations of fire protection divisions.

c. Ventilation ducts for accommodations, service areas, or control spaces should not pass through main machinery spaces unless the ducts are made of steel and arranged to preserve the integrity of the fire division.

d. Storerooms that contain appreciable quantities of highly flammable products should have a separate ventilation system. Ventilation should be arranged at high and low levels and the inlets and outlets of ventilators should be positioned in safe areas, capable of being closed from outside the compartment, and fitted with spark arresters.

4. Every vessel should have a fire main system designed and outfitted to the provisions found in Subparts 181.10 and 181.15 of 46 CFR Subchapter T (Small Passenger Vessels (Under 100 gross tons)).

D. <u>New Fishing Vessels Greater Than 79 Feet (24 Meters) in Length</u>

1. Vessels with the hull, superstructure, structural bulkheads, decks, and deckhouses constructed of noncombustible materials should be built to the provisions of Title 46, Code of Federal Regulations, Part 92.07 - Structural Fire Protection and NVIC 6-80, "Guide to Structural Fire Protection Aboard Merchant Vessels".

2. Vessels with the hull, superstructure, structural bulkheads, decks, and deckhouses constructed of combustible materials should meet the following:

a. To meet the requirements of A- and B-Class construction the divisions must be constructed of noncombustible materials. However, vessels using combustible construction can meet the intent of these divisions by providing noncombustible insulation and cladding. They also can try to use noncombustible construction in joiner work, inside the hull and in the deckhouse as much as possible.

b. The decks and bulkheads separating machinery spaces from accommodations, service areas, or control spaces should be built to a minimum equivalent of the "A" Class division standard.

c. Decks and bulkheads separating control spaces from accommodations and service areas should be built to a minimum equivalent of the "B'. Class division standard.

d. Bulkheads of corridors that serve accommodations, service areas, and control spaces should be built to a minimum equivalent of the "B'. Class division standard. The bulkhead should extend from deck to deck unless a continuous ceiling of the same Class as the bulkhead is fitted on both sides of the bulkhead, in which case the bulkhead could end at the continuous ceiling.

e. Boundary bulkheads and decks of spaces containing any emergency source of power, galleys, combustible liquid or highly flammable material storerooms, accommodations, service areas, or control spaces should be built to a minimum equivalent of the "A" Class division standard.

f. Interior stairways serving accommodations, service areas, or control spaces should be built with steel or other equivalent material. These stairways should be within enclosures constructed of "B" Class divisions. However, if a stairway penetrates only one deck it could be endorsed at one level, otherwise it should be enclosed at each level.

g. All doors should be built to provide the same level of fire resistance as the divisions in which they are fitted. Doors to machinery spaces should be self-closing.

h. Penetrations for electrical cables, trunks, ventilation ducts, etc., that pass through bulkheads and decks should be arranged to ensure the fire integrity of the division is not impaired.

i. Air spaces enclosed behind ceilings, panellings or linings in accommodations, service areas, and control spaces should be divided by close fitting draft stops not more than 23 feet apart. A draft stop is a division installed between ceilings or linings and the vessel's structure to prevent the horizontal and vertical spread of fire in hidden and concealed spaces.

j. Vessels having FRP construction should be built with fire retardant resins within accommodations, service areas and machinery spaces. Fire retardant resins are used to reduce the fire risk of the material.

k. Vessels having wood construction should be built with wood (plywood) that is treated to increase its resistance to fire within the accommodations, service areas and machinery spaces.

3. Ventilation Systems - Ventilation systems should be designed and arranged to meet the provisions of Title 46, Code of Federal Regulations Parts 92.15-5 thru 92.15-15.

4. Fire Main System - Fire pumps, hydrants, and nozzles should be provided for all vessels. The arrangement and details of the firemain system should meet the provisions of Title 46, Code of Federal Regulations Parts 95.10-5 thru 95.10-15.

CHAPTER 4 - LIFESAVING EQUIPMENT AND PROTECTION OF THE CREW

WEARABLE PERSONAL FLOTATION DEVICES

A. Federal Regulations (46 CFR 25.25)

1. Vessel under 40 feet - There must be one wearable personal flotation device (PFD) for each person on board.

    a. Each PED must be either Type I, II or III, except that vessels carrying passengers for hire must carry TYPE I PFDs.

    b. Certain Type V PFDs may be substituted for Type I, II, or III PFDs, if the intended use statement on the label specifies that the Type V is an approved substitute for the particular service in which the vessel is employed. At present, only certain anti-exposure coveralls have been approved to be substitutes for Type II or Type III PFDs.

    c. Coast Guard approved exposure suits may be substituted for Type I, II, or III PFDs, if the vessel does not carry passengers for hire.

2. Vessel 40 feet and over - There must be one wearable personal flotation device (PFD) for each person on board.

    a. Each PFD must be a Type I.

    b. Although none are approved at present, Type V PFDs may be approved that could be substituted for Type I PFDs, if the intended use statement on the label specifies that the Type V is an approved substitute for the particular service in which the vessel is employed.

    c. Coast Guard approved exposure suits may be substituted for Type I PFDs, if the vessel does not carry passengers for hire.

3. All vessels - Each wearable PFD must be:

    a. Coast Guard approved;

    b. Readily available;

    c. In serviceable condition;

    d. Of suitable size for the intended wearer;

    e. Equipped with Coast Guard approved retroreflective material, a minimum of 31 square inches on both front and back and on any reversible side located around the shoulder area so it will not be submerged when in water (see 46 CFR 25.25-15); and

f. If in ocean, coastwise, or Great Lakes service, equipped with a Coast Guard approved personal flotation device light. The light must have an up-to-date power supply (unexpired battery) and be securely attached to the shoulder area of each PFD. Note that approved lights are available in a wide selection of quality and performance. Strobe lights are the most expensive approved lights available, but they are also the most effective.

B. Recommendations

1. Each PFD comes with an information pamphlet. This pamphlet should be retained on board so it can be read and understood by the crew.

2. Appropriate PFDs should be provided and worn by everyone working on an open deck, especially in bad weather or at night. There are a number of Type V PFDs (see following discussion) designed specifically as devices intended to be worn while working. Work vests provide flotation, yet allow the freedom of movement necessary to complete most tasks. Some PFDs are made up as deck suits or coats, and provide protection from cold air and cold water, in addition to flotation.

C. Discussion of PFD Types There are five types of Coast Guard approved PFDs. Some PFDs have the characteristics of more than one type.

1. TYPE I - A Type I PFD is designed to turn an unconscious person in the water from a face-down position to vertical or slightly backward position with the face out of the water. The TYPE I is the best performing of all PFD types, and therefore provides the greatest protection to the wearer. The TYPE I is recommended for all waters, but especially for offshore and ocean operations when there is a probability of delay in rescue. TYPE I PFDs are available in two sizes - ADULT and CHILD.

2. TYPE II - A Type II PFD is intended to keep its wearer in a vertical or slightly backward position in the water. It will turn many persons from a face-down position to a position with the face out of the water, but it should not be relied upon to do this for everyone. The Type II PFD is suited for operations closer to shore. Type II PFDs are available in three sizes - ADULT, MEDIUM CHILD, and SMALL CHILD.

3. TYPE III - A Type III PFD is designed to keep a conscious person in a vertical or backward position in the water. It will not normally turn a person from a face-down position to a position with the face out of the water. The Type III is suitable for use in close inshore operations, in relatively calm waters where there are other boats around. Type III PFDs are available in a variety of sizes.

4. TYPE IV - The Type IV PFD is a device designed to be thrown to a person in the water. See the following section on "RING LIFE BUOYS."

5. TYPE V - A Type V PFD is a device designed for specific and restricted use. The specific approved use of a Type V will be described on its label. Some Type V PFDs are also approved as Type III devices$_1$ such as some "float coats" and "work vests."

RING LIFE BUOYS (46 CFR 25.25)

A. Federal Regulations

1. Vessel 26 feet and over - At least one ring life buoy (Type IV PFD) is required on board in addition to the wearable PFDs required.

   a. The ring life buoy must be Coast Guard approved with an approval number beginning with "160.050/-". Older cork ring life buoys with approval numbers beginning with "160.009/-" may continue to be used if they are in good and serviceable condition.

   b. The ring life buoys may be of the 20, 24, or 30 inch diameter sizes.

   c. Ring life buoys must be stowed so that they are immediately available, and must be kept in serviceable condition.

2. Vessel under 26 feet, No requirements for ring life buoys.

B. Recommendations

1. Each vessel should have a ring life buoy near each working area on an open deck. On vessels where the work is physically separated from the operations area, buoys should be provided in both areas.

2. Each ring life buoy should be equipped with Coast Guard approved retroreflective material.

3. At least one ring buoy should have a waterlight and another ring buoy should have 60 feet of 3/8 inch buoyant line attached.

EXPOSURE SUITS

A. Federal Regulations (46 CFR 25.25) Exposure suits may be substituted for required Type I, II or III PFDs on vessels not carrying passengers for hire. Exposure suits substituted for PFDs must be:

1. Coast Guard approved with an approval number beginning "160.071/--;"

2. Equipped with Coast Guard approved retroreflective material (provided by the manufacturer on Coast Guard approved suits); and

3. If in ocean, coastwise, or Great Lakes service, equipped with a Coast Guard approved personal flotation device light. The light must have an up-to-date power supply (unexpired battery) and be securely attached to the shoulder area of the suit.

B. Recommendations

1. Coast Guard approved exposure suits are recommended for each member of the crew on vessels operating on all U.S. coastal waters, except for Hawaii, the Gulf of Mexico, and the Caribbean Sea. Even in these waters, exposure suits should be considered if the vessel will operate far offshore in winter, where prompt rescue may not be available. Exposure

suits come in a variety of sizes 80 the operator should ensure each person on board has a suit that fits.

2. Exposure suits should be stored in a very accessible, dry place, such as the wheel house. Every crewmember should know the location of all survival equipment, especially the exposure suits. Donning instructions should be posted in a place where crewmen will notice it.

3. Exposure suits should be carefully checked and maintenance performed at least once a year, preferably more often. A recommended maintenance check list follows.

   a. Check all zippers for smooth operation. And corroded, broken or malfunctioning zippers should be replaced.

   b. Lubricate the watertight zipper on the front of the suit with paraffin, and make sure that the zipper is open (down) when the suit is repacked.

   c. Check the stitching and gluing on all of the seams on the suit as well as the seams on the storage bag.

   d. Inflate the external floatation bladder to insure that it will hold air. Pay particular attention to the joints and connection point of the inflation tube. Contact the manufacturer for instructions if repair is required.

   e. Write the date that you inspected the suit on the outside of the storage bag.

C. Exposure Suit Performance

1. The Coast Guard approved exposure suit is a one-piece, insulated, dry suit that reduces the crippling effects of "cold shock" and immersion hypothermia. The term "survival suit" is often used to describe an exposure suit, but there are also devices such as "work suits" or "anti-exposure coveralls" which are approved as Type V PFDs that are sometimes called "survival suits". These other devices do not provide the same protection as an exposure suit. Make sure what you buy is an approved exposure suit.

2. Exposure suits are tested by placing people wearing them in ice water (320 F) for 6 hours and measuring body temperature drop. The insulation of the suits is quite effective.

3. Exposure suits do not provide indefinite protection from hypothermia, but they reduce the rate of body cooling and survival is possible for many hours or even days depending upon water temperature.

4. Exposure suits are leak tested to prove that the wearer will remain dry. This adds to the effectiveness of the insulation, but the suit will still keep a wearer warm and afloat even with some water inside. A trickle of water through a small leak can cause discomfort, but constant flushing of water in and out of the suit, through an open zipper or a large tear, will render it ineffective.

5. Exposure suits are NOT flameproof. They are tested to make sure that after a two second exposure to flame and six seconds of being allowed to burn before being extinguished, the

suit is still serviceable. In that length of time it is assumed the wearer will have been able to extinguish any flames.

6. Present designs of exposure suits will NOT turn an unconscious wearer face up in the water. The assumption is that the wearer is more likely to remain conscious if warm. The suit will allow the wearer to turn face-up easily, and float nearly horizontal. The flotation bladder or pillow supports the head further out of the water to reduce fatigue.

7. Exposure suits are not appropriate for routine wear while working on deck. Although the suits are tested to ensure that a wearer can do simple things like walk on a wet deck, climb a ladder, and even pick up a pencil and write, all activities are slower and more difficult in the suit. The suit is for wear when ABANDONING SHIP or when encountering dangerous situations such as crossing a bar where there is a chance of being thrown into the water or vessel capsizing. For routine wear, you may want to invest in a Type V work suit.

D. Exposure Suit Maintenance

1. The suit comes in a storage bag and should be kept in that same bag. The bag itself is tested to provide significant protection to the suit, and is clearly marked.

2. The zipper of the suit needs to be waxed periodically to lubricate it. If no wax came with the suit, or if it is used up, buy paraffin (the type used for home canning, from a supermarket) or beeswax (from a sewing or fabric store). Rub the wax over the zipper teeth, then open and close the zipper several times to spread it around. Store the suit with the zipper OPEN.

3. Do take the suit out and try it on, in the water if possible, as soon as you get it and periodically after that. This is a good way to check its condition, and the more familiar you are with it the more likely you are to survive if you ever need it. Treat it with reasonable care.

4. After use, hang or spread the suit out to dry thoroughly. When the outside is dry, turn it inside out to dry again. Water usually does get inside somehow, and it will cause mildew and odor if you skip this step.

5. Leaks or rips can render the suit ineffective. If they cannot be repaired using a kit packed with the suit, or by the manufacturer, the suit must be replaced.

6. If the fabric covering the exterior of the suit is worn through, exposing the foam underneath, it's time to replace the suit.

7. Two manufacturers voluntarily recalled early suits because of problems with the inflation tube for the auxiliary buoyancy unit. We still find these suits in use today on some uninspected vessels who didn't get the word. If your suit manufactured in 1981 or before does not have a clamp around the tube at each joint, contact the manufacturer. You may have one of the problem suits. The manufacturers involved are still making free repairs to those early suits. (See the section on recalls on page 19 of this NVIC)

8. Mark the suit with the vessel's name in large letters using a waterproof marker or stencil. Avoid using paint which may become brittle. Marking the suit permanently may help

prevent theft and will help rescuers who may find a suit afloat to identify the vessel it came from.

EMERGENCY POSITION INDICATING RADIO BEACONS (EPIRB)

A. Recommendations

1. All fishing vessels operating in the ocean more than 20 miles offshore should carry either a Class A or B EPIRB.

2. All fishing vessels operating up to 20 miles of shore, on the Great Lakes, and on other large inland waters should carry a Class C EPIRB.

B. EPIRB Classes There are three types or classes of EPIRBs.

1. Class A and B EPIRBs - These transmit a swept tone signal on the civil aviation distress frequency, 121.5 MHz, and the military distress frequency, 243.0 MHz.

a. They are required to operate at least 48 hours in freezing water, and will operate much longer in warmer water, up to seven days in water of 70 degrees F.

b. Their signal is transmitted "line of sight", and will not follow the curvature of the earth, and can be interrupted by waves, hills and the like.

c. Reception range to an aircraft under ideal conditions is about 200 miles at about 40,000 feet, and decreases as the height of the receiving antenna decreases.

d. They are intended for use on vessels operating 20 or more miles offshore.

e. They can be detected and located by SARSAT satellite which will relay their position to the appropriate Rescue Coordination Center (RCC).

f. Class A EPIRBs are designed to float off the sinking vessel and automatically activate.

g. Class B EPIRBs are not required to float and must be manually activated.

2. CLASS C EPIRBs - These transmit a brief alerting signal on VHF-FM channel 16 and then alternately a homing signal on channel 15.

a. The channel 16 alerting signal is long enough to recognize as an EPIRB for anyone monitoring channel 16. The channel 15 homing signal is long enough to get a directional fix. The silent period conserves battery power.

b. Their range is about 20 miles depending on the height of the receiving antenna.

c. Their signals can be received by other vessels, Coast Guard stations and search and rescue units.

d. These EPIRBs must be manually activated and transmit for 24 hours and then automatically shut off. They can also be manually reactivated for additional transmissions.

C. About EPIRBs

1. EPIRBs are vital in distress situations where radio communications have not been or can not be established. Using the EPIRB is a simple, effective way to bring the Coast Guard to your aid during disasters at sea. Waiting until a vessel is reported "overdue" usually results in long, fruitless, frustrating and expensive searches. The number of "saves" and the marked reduction in search time clearly indicates the value of EPIRBs.

2. No emergency rescue/survival equipment is foolproof, and EPIRBs are no exception. Activating an EPIRB may not result in an immediate rescue. Much of survival and rescue depends on good judgment and using good quality and well-maintained equipment. Accidental activation must be avoided to assure availability of rescue forces and a fully charged battery for real distresses.

3. Just as visual distress signals must be seen, EPIRBs must be heard. There have been many rescues involving the use of EPIRBs. Commercial and private aircraft are not required to monitor Class "A" and "B" EPIRBs. Many do if they have a spare receiver, but around busy airports they generally monitor traffic control and/or company channels. Normally U.S. military and Coast Guard aircraft monitor the EPIRB frequencies. Larger Coast Guard cutters also monitor, but their receiving range is limited by antenna height.

4. Distress frequencies used in Class "A" and "B" EPIRBs are a180 monitored by satellite (SARSAT or COSPAS/SARSAT) which greatly enhances the chances of rescue by providing an accurate location of the distress. The extreme altitude of the satellite also provides a broad area of coverage but due to its track path on the earth, it could be hours before the satellite receives the distress signal and relays information to search and rescue authorities. Class "C" EPIRBs will not be picked up by SARSAT; they operate alternately on channels 15 and 16 in the FM marine band and are intended for use within 20 miles of the coast.

5. Recommendations on operating EPIRBs:

a. EPIRBs should be turned on and left on when used. A continuous transmission provides the best means for alerting, determining position, and homing.

b. The lanyard attached to the EPIRE should be securely fastened to the raft or the individual in the water.

c. EPIRBs operate best when floating with the top out of the water and the antenna vertical.

d. In rough conditions, it is recommended that the EPIRB be operated inside the life raft, even though this may reduce the range of the signal. Hold it upright, clear of the raft and do not touch the antenna. CAUTION: EPIRBs with water-activated switches must be kept in the water.

e. When rescue units are near, use your visual distress signals, (found in Rule 37 and Annex IV of the Navigation Rules) so your position can be pinpointed.

6. To test a Class "A" (automatic) or Class "B" (manual) EPIRB you will need the EPIRB, a small FM broadcast receiver (small commercial radio), a bucket with enough water to activate the water activated switch if the EPIRB is so equipped, and a watch:

a. Operate the battery test switch. Turn on the FM radio and tune it to 99.5 MHz. - Check the time. The full-power test can be made only during the International Distress Frequency test period (00 to OS the first five minutes of any hour).

b. Before placing the EPIRB in the water, visually examine the sealing gasket. If the gasket is missing, torn or lose, do not conduct the emersion test because the EPIRB could fail.

c. When the time is right, dunk the bottom of the class "A™ (automatic) EPIRB into the water. For a class "B" (manual) EPIRB just turn it on. Watch the indicator lamp and listen to the radio. NOTE: You cannot hear the EPIRB operating unless the radio is tuned to 99.5 MHz.

d. If the EPIRB is operating properly, the indicator lamp will light and you will hear the EPIRB signal - an oscillating tone -on the radio. Pull the EPIRB out of the water - turn it off as soon as you hear the signal. This full power test must not last longer than one second or three audio sweeps.

e. If you do not hear the signal on the radio, the EPIRB needs service. Perform this test each month and log the results.

VISUAL DISTRESS SIGNALS

A. Recommendations

1. Visual distress signals are recommended for all vessels, and are required equipment for all inspected commercial vessels (46 CFR 75.90, 94.90, 180.35) and most recreational boats (33 CFR 175.110). Visual distress signal ARE NOT required equipment for uninspected commercial fishing vessels. The prudent fisherman should however, carry visual distress signals on board the vessel and any life raft. Signals should be effective, safe and reliable.

2. As a minimum, vessels should carry both day and night visual distress signals that meet the minimum requirements for recreational boats. Any one of the below categories will meet both the day and night recommendation.

a. Three hand-held red flare distress signals, with Coast Guard approval numbers beginning 160.021/-.

b. Three parachute red flare distress signals, with Coast Guard approval numbers beginning 160.024/-. A 37 mm flare pistol with Coast Guard approval number beginning 160.028/- is necessary to launch these signals.

c. Three hand-held, rocket-propelled parachute red flare distress signals, with Coast Guard approval numbers beginning 160.036/-.

d. Three red aerial pyrotechnic flares, with Coast Guard approval numbers beginning 160.066/-. These devices may be either meteor or parachute-assisted type. Some of these signals may require use in combination with a launching device with an approval number beginning 160.028/-.

3. Any combination of both a day and night signal listed below will also meet the visual distress signal recommendation.

a. Day signal

(1) Three floating orange smoke distress signals, with Coast Guard approval numbers beginning 160.022/-.

(2) Three hand-held orange smoke distress signals, with Coast Guard approval numbers beginning 160.037/-.

(3) Three floating orange smoke distress signals, with Coast Guard approval numbers beginning 160.057/-.

(4) An orange flag with black ball-and-square distress symbol certified to meet 46 CFR 160.072.

b. Night signal - An automatic electric "S-O-S" distress light certified to meet 46 CFR 161.013.

4. Vessels operating on ocean or coastwise routes should carry more signals and be of higher performing types.

a. Vessels operating up to 20 miles offshore should carry at least 6 hand-held flares, aerial flares, or parachute flares. The signals should be selected from those with Coast Guard approval numbers beginning with 160.021/-, 160.024/-, 160.036/-, or 160.066/-, provided the device has a minimum 25-second burn time.

b. Vessels operating more than 20 miles offshore should carry at least 12 parachute flares. The signals should be selected from those with Coast Guard approval numbers beginning with 160.024/-, or 160.036/-.

5. Inflatable liferafts should also have pyrotechnic distress signals in their emergency packs. Liferaft servicing facilities can equip rafts with a package of signals suitable for the type of service in which the vessel is engaged.

B. Types of Visual Distress Signals

1. Coast Guard approved visual distress signals are recommended because they must meet minimum performance and quality control requirements. Railroad or highway type flares should be avoided because their signals are not nearly as bright as approved marine flares, and they may eject a large amount of hot slag as they burn.

2. Flare pistols should be inspected regularly and projectiles should be replaced

C. Stowage Visual distress signals, as well as all types of emergency equipment, should be stored where they are readily available for use in an emergency. Flare guns and projectiles should be stored in a cool dry place and labeled. Flares should be kept in their original plastic wrappers.

D. Signaling Mirrors Signaling mirrors or "heliographs" can be useful over long distances in bright sunlight. Coast Guard approved signaling mirrors are available with approval numbers beginning 160.020/-. These mirrors come in airtight packages to protect them from oxidation, and include an aiming circle and instructions.

INFLATABLE LIFERAFTS

A. Recommendations

1. Each vessel should have one or more inflatable liferafts of a combined capacity large enough to accommodate every person on board the vessel. An inflatable liferaft is vital to the safety of the personnel.

2. The Coast Guard recommends inflatable liferafts with water ballast systems to minimize the chances of capsizing in wind and waves. (See discussion in "Selection of Liferafts" section, below.)

3. The crew should be familiar with the instructions for launching the raft (usually on a label on the raft container). Arrangements should also be made to have crewmembers visit the facility where their raft is serviced.

B. Servicing

1. For satisfactory performance in an emergency, an inflatable liferaft should be inspected, tested, and overhauled yearly. This precaution will ensure that the CO_2 cylinder remains fully charged and that the raft is able to pass a working pressure leakage test. The annual servicing by specialists ashore will also include the renewal and replacement of such things as light cells, pyrotechnic signals, water and provisions, etc.

2. Servicing should be done ONLY by a servicing facility AUTHORIZED BY THE MANUFACTURER OF THE LIFERAFT. While much emphasis has been placed on liferaft design in recent years, even the best liferaft is useless if it does not inflate, or fails when it does inflate.

a. If a liferaft has not been recently serviced by someone who has been trained by the manufacturer to inspect, test, and repack the liferaft correctly, it may not inflate properly.

b. If a liferaft has not been recently serviced by a facility that has the manufacturer's servicing manuals with all current updates and servicing bulletins, it may not inflate properly.

c. If a liferaft is not repaired with parts and materials that the manufacturer intends for use with the liferaft, it may not inflate properly, or may fail when it does inflate.

d. The names of the servicing facilities for the make of raft are readily available from the manufacturer or listed in the instructions included with the raft when purchased. A servicing facility that is authorized by the manufacturer will have a recent letter of authorization on the manufacturer's letterhead and signed by a company official. In addition, if the manufacturer makes Coast Guard approved liferafts, the servicing facility will have a copy of a letter from the Coast Guard to the manufacturer stating that the facility is approved by the Coast Guard to service that brand of liferafts. Before you turn your liferaft over to a servicing facility, ask to see these letters. A legitimate servicing facility will be happy to show them to you. When servicing is complete, a legitimate servicing facility will give you a manufacturer's servicing certificate.

e. One manufacturer has notified the Coast Guard of an additional precaution that they have taken to protect liferaft owners from "pirate" servicing stations. The manufacturer issues inspection stickers to its authorized facilities. These inspection stickers bear the registered trademark of the manufacturer, and have names of months printed along the left edge and years along the bottom edge. These are punched out to indicate the date that the servicing of the raft expires.

f. If at all possible, ask the servicing facility to allow members of the crew to visit the facility while the raft is being serviced. This will probably be the only chance they have to see the raft and become familiar with it. This familiarization could be very important if the raft has to be used in an emergency. Many servicing facilities will be happy to have crew members in to see the raft and to show off their facility.

C. Selection of Liferafts

1. The Coast Guard approves inflatable liferafts for use on “inspected” (i.e. cargo, tank, and passenger) vessels, but manufacturers offer approved rafts to any purchaser. Coast Guard approval provides the purchaser some assurance that the liferaft is built to pass a series of rigorous tests, that it is made of high quality materials, and that it will operate reliably if it is properly serviced.

2. Liferafts not approved by the Coast Guard are also available; these are eligible for use aboard "uninspected" vessels such as commercial fishing vessels and yachts. The quality varies widely. Some are of excellent quality and construction, while others are not. Purchasers should carefully consider the details of the raft they intend to purchase. The Coast Guard recommends that rafts have a canopy to protect the occupants from wind and seas and an inflatable floor to insulate occupants from cold water temperature.

3. On January 11, 1985, the Coast Guard published a Notice of Proposed Rule Making intended to improve the stability of inflatable liferafts in high winds and heavy seas. The proposed rules would require Coast Guard approved rafts to be equipped with water ballast systems underneath the raft to reduce the probability that the raft will capsize. The proposed rules do not require any particular design, but they do include a number of

performance tests that a raft would have to complete in order to be Coast Guard approved. The proposal states, "... it is evident that a large water volume can improve the stability of liferafts." The Coast Guard can not endorse any particular designs, but it is evident that rafts with large water volumes in their ballast appendages will perform better than rafts of a similar design but with less water volume. The raft must, of course, be constructed substantially enough that the forces imposed by the water ballast do not damage or destroy the raft.

4. One important consideration in selecting a raft is its survival equipment. Coast Guard approved rafts come with either an "ocean service" or "limited service" equipment pack. This will be clearly indicated on the raft container.

    a. Rafts of both of the above categories have such things as canopy lights, paddles and distress signals.

    b. Ocean service equipment packs also contain emergency drinking water and food, a first aid kit, fishing tackle, and some other items. Ocean service rafts should be used on all vessels operating in the ocean.

    c. The Coast Guard recommends that liferafts also be equipped with an EPIRB. Additional information concerning EPIRBs is contained on chapter 2.

5. Rafts not approved by the Coast Guard may be provided with a complete equipment pack or with little or no survival equipment packed inside. The owner should specify what items will be in the equipment pack. The following items are recommended:

    a. Boarding ladder or ramp;

    b. Heaving line;

    c. Survival instructions;

    d. Safety knife;

    e. Interior and exterior canopy lights;

    f. Paddles;

    g. Painter;

    h. Manual inflation pump;

    i. Sea anchor;

    j. Bailer;

    k. Flashlight;

    1. Repair kit;

R. Distress signals;

n. Sponge;

o. EPIRB;

p. First aid kit (for vessels in ocean service);

q. Signaling mirror (for vessels in ocean service);
r. Emergency drinking water (for vessels in ocean service); and

s. Provisions (for vessels in ocean service).

D. Installation

1. Once aboard the vessel, the raft should be installed in a carefully selected location.

a. The raft should be accessible to the crew but so located as to permit the raft to float free if the vessel should sink.

b. The location should be clear of deckhouse overhangs or rigging that could foul a raft's upward floatation. At the same time, a raft should not be installed on a lower deck subject to boarding seas that could damage the container and its contents.

c. Do not install the rafts near exhaust stacks, as heat and gases will deteriorate the rubber gaskets on the container. This will allow corrosive salt spray to enter the raft container and most probably damage the raft stored inside.

d. Life rafts should display operating instructions on their containers or nearby and printed in a language understood by the users. All crewmen should receive instructions in their use.

2. The Coast Guard does not recommend the common practice of lashing rafts to the tops of deckhouses. Frequently, life rafts lashed in this manner have gone down with the vessel. Sharp knives are not always handy in an emergency. There are other storage methods that will allow either a rapid manual launching or permit it to float free in the event of a rapid sinking or capsizing.

a. The two fold purpose of hydraulic (hydrostatic) releases is to permit either manual or automatic release at a predetermined depth. The raft should be installed on a foundation or bed shaped to fit the bottom of the raft's storage container, and secured by a band or wire with a turnbuckle at one end and a release at the other. The turubuckle is used to put the right tension on the release mechanism. The maintenance of a hydrostatic release calls for its inspection and testing at the same time the raft undergoes annual servicing. (See Figure 4-1)

b. Racks designed to allow rafts to float free without the aid of a hydrostatic release exist primarily on larger vessels. Borne manufacturers have racks available for their rafts, but the same thing is possible by an arrangement of four to six pipe uprights that surround the raft container. The pipes are loose fitting and pinned at

the bottom, so they can be easily removed for manual launching of the raft, if necessary. There must be adequate clearance between the pipes and the raft so the raft will not jam as it floats off the vessel. (See Figure 4-2)

3. Whether you use a hydraulic release or a float-free rack, attachment of the raft's painter to the vessel is necessary by means of the weak link supplied with the raft. The painter, when completely pulled out of the container, will automatically activate the inflation mechanism. As the raft continues to pull on the painter, it will break the weak link and allow the raft to float to the surface.
4. For a complete discussion on care and installation of hydraulic releases see NVIC 4-86, "Hydraulic Release Units for Liferafts, Life Floats, and Buoyant Apparatus, and Alternate Float-Free Arrangements."

RETROREFLECTIVE MATERIAL

A. Regulations (46 CFR 25.25)

1. Each wearable PFD must have retroreflective material (see section on wearable PFDs).

2. If the PFDs do not have retroreflective material, it is a simple task to add it.

a. Coast Guard approved material and adhesive primer can be obtained from most marine supply stores. It usually comes in 4" by 4" squares. Four squares are needed for each Type II or Type III PFD, two for the front side and two for the back side. The number of squares needed for Type I's depends on the number of reversible sides. Standard Type I PFDs need eight squares. 'Horse-collar' Type I's need six. See NVIC 4-80 for more information on location of the retroreflective material.

b. Put the material in a place that is dry and free of dirt and grease. Mark off the area of each piece of tape. Apply the adhesive primer to the marked area, allow to dry. Peel the backing off the retroreflective material, and carefully apply it to the PFD.

c. Even though the retroreflective material has a self-stick backing, do not skip application of the primer. The material will easily peel off if the primer is not used.

B. Recommendations Retroreflective material is recommended for all other lifesaving equipment. See NVIC 4-80 for suggested arrangement.

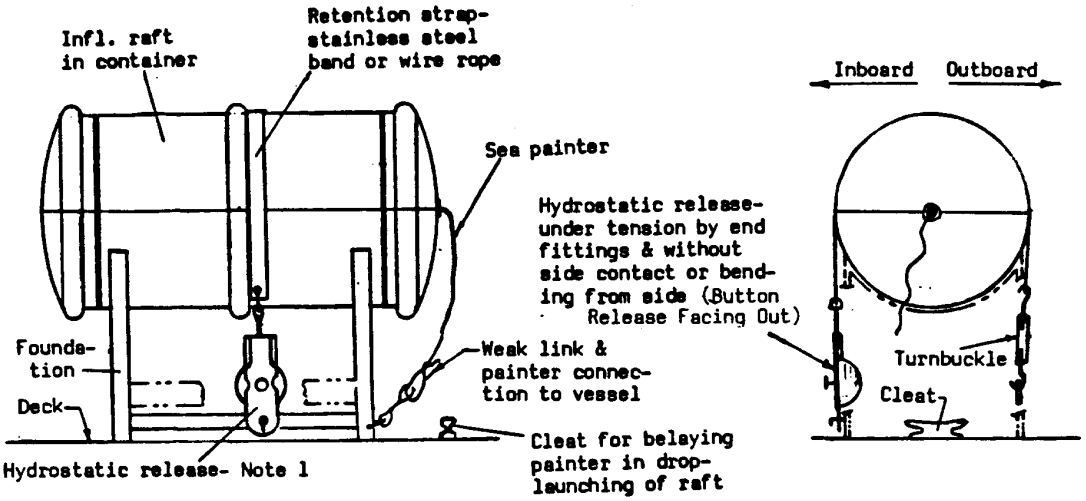
RECALLS AND OTHER CORRECTIVE MEASURES FOR LIFESAVING EQUIPMENT Lifesaving devices, like other manufactured products, are sometimes defective or are unsuitable for various reasons. Despite quality control at the factory and production testing by the Coast Guard, defective products occasionally escape detection and may be sold for shipboard use. Some of these defects can be corrected simply on the vessel; others may require recall of the product by the manufacturer. In spite of the efforts of the manufacturer to notify purchasers of recalled items, these notifications are often not fully successful. Navigation Vessel Inspection Circular 4-85 of 29 May 1985 contains information on current manufacturers' recalls of lifesaving equipment, and information on corrections that should be made to other items of lifesaving equipment. Because of the time lag involved in revising NVIC 4-85, persons seeking information concerning approval or recall status of an approved equipment item should contact the local

Coast Guard Marine Inspection Office, Marine Safety Office, or Commandant (G-MVI-3) at (202) 267-1444 for current information.

EMERGENCY PROCEDURES AND DRILLS

A. Station Bill and Abandon Ship Procedures

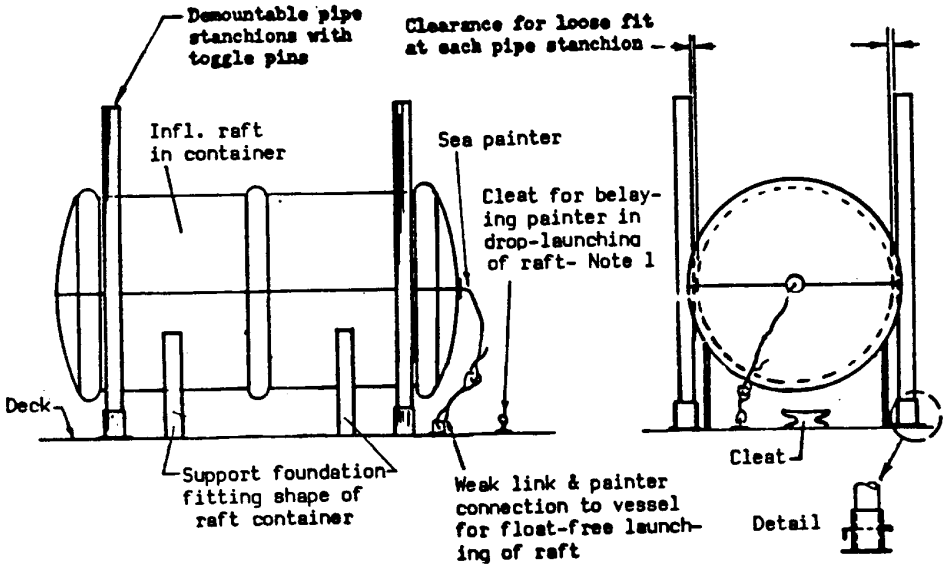
1. Military and inspected commercial vessels prepare a station bill identifying special duties to be performed by personnel in case of an emergency. Fishing vessels should have a similar document which should be drawn up prior to the vessel leaving port. Special duties to be performed in an emergency should be allotted to each member of the crew. The station bill or similar document should include the information below.



Notes

1- A pelican or other slip hook connecting the HRU to the retention strap would be an acceptable addition to the above arrangement.

FIGURE 4-1 TYPICAL INFLATABLE RAFT INSTALLATION WITH HYDROSTATIC RELEASE



Notes

1- Drop-launching of the raft requires a bypassing of the weak link so that the vessel will keep a strong hold on the raft as it floats alongside for the embarkation of personnel. A few feet of painter pulled out of the raft container and made fast to the cleat will bypass the weak link.

FIGURE 4-2 INFL. RAFT INSTALLED ON RACK DESIGNED TO ALLOW RAFT TO FLOAT FREE

a. Duties assigned in an emergency to different members of the crew in connection with:

(1) Closing of any watertight doors, valves, etc.;

(2) Equipping of survival craft;

(3) Launching of the survival craft;

(4) General preparation of other life-saving appliances;

(5) Manning of fire parties assigned to deal with fires; and

(6) Special duties in respect to the operation of fire-fighting equipment and installations.

b. The station bill should include the signals for summoning the crew to their survival craft and fire stations.

2. The last chapter of the NPFVOA/USCG Vessel Safety Manual contains a sample station bill which can be adjusted or modified to a level more in keeping with the size of the vessel and crew and the type of fishing activity.

3. A list of emergency signals should be posted in several parts of the vessel, in particular, the wheelhouse and crew accommodations.

B. Practice Drills

1. Abandon ship and fire drills or similar form of instruction or orientation should take place within 24 hours of leaving port and whenever 25 per cent of the crew has been replaced since the last drill. In cases where a vessel makes frequent trips and less than 25 percent of the crew has been replaced since the last drill then drills or a similar form of instruction or orientation can take place at intervals of not more than one month.

2. When holding drills, the lifesaving, firefighting and other safety equipment should be examined to ensure they are complete and working satisfactorily.

3. Drills should be arranged to ensure that crews thoroughly understand and receive practice in the duties they have to perform including instructions in the handling and operation of liferafts carried on board.

4 Fire drills should be realistic and deal with an assumed outbreak of fire in some specified part of the vessel. The appropriate signal should be given, hoses should be laid out and tested, the fire extinguishers unshipped, and occasionally one of the extinguishers should be discharged. Crewmen should be trained to close ports, doors, ventilating shafts and other openings which should be shut, and should be exercised and instructed in the use of breathing apparatus and other fire fighting appliances carried on board.

C. Training in Emergency Procedures

1. Vessel owners and operators should ensure that crews are adequately trained in their duties in the event of emergencies. Such training should include, as appropriate, the following items:

a. Understanding the different signals listed in the station bill;

b. The meaning of and action to be taken on hearing the emergency signal;

c. The preparation and lowering of the liferaft into the water and getting it away from the vessel;

d. Knowledge of the equipment carried in the liferaft and how to use such equipment;

e. Methods of launching and inflating liferafts and precautions to be taken before, during and after launching;

f. Boarding liferafts;

g. Righting an inverted raft;

h. Knowledge of how to use the sea anchor;

i. Understanding the reason for .•topping up™ buoyancy tubes and for inflating the floor;

j. Understanding how to survive in a liferaft;

k. The dangers of hypothermia and how to minimize its effects;

1. The use of life preservers and exposure suits;

m. The use of fire hoses with different nozzles if applicable;

n. The use of fire extinguishers;

o. The use of the EPIRB;

p. The use of the shipboard radio equipment and distress frequencies; and

q. The location of all the above listed emergency equipment.

HAZARDS ASSOCIATED WITH CONFINED SPACES

A. Introduction

1. The term 'confined space' refers to any space which has limited openings for entry and exit and poor natural ventilation. Such spaces may lack sufficient oxygen to support life or may contain dangerous air contaminants. Some examples of confined spaces are: cargo holds, tanks, machinery spaces, cofferdams, double bottoms, fish holds and lacerates.

2. All confined spaces are assumed to be immediately dangerous to life and health unless proven otherwise. Asphyxiation (or death by suffocation) in fish holds has claimed the

lives of at least 32 fisherman in the past 15 years. Deaths and injuries can be prevented by making everyone aware of the danger posed by confined spaces, and taking precautions as outlined below.

a. TEST the space with appropriate instruments, if available, before entering.

b. VENTILATE before entering and while remaining in the space.

c. RETEST and CONTINUE VENTILATING until the space is safe.

OR

d. WEAR A Self Contained Breathing Apparatus (SCM) while in a confined space which has not been proven to be safe, and

e. HAVE A RESCUE PLAN ready in case someone collapses in the space.

4. Although adequate ventilation will usually make a space safe to enter, it is advisable to test the atmosphere in the space before entering without an SCBA.

B. Equipment - Vessel owners may wish to consider outfitting their vessels with some of the equipment listed below. The amount and type of equipment selected may vary depending upon the crew size, size of the vessel, type of fishing activity, length of the trip, size of fish holds or tanks, and climate.

1. Portable Blowers (preferably explosion proof).

2. Positive pressure-demand Self contained breathing apparatus (SCM). (Other types of respirators do not supply oxygen and supply less effective protection from toxic gases. Their use is not recommended in spaces which may be oxygen deficient).

3. Oxygen meter.

4. Combustible gas indicator.

5. A meter or calorimetric detector tube kit for each toxic gas that can be expected to be found on board.

6. Rescue harness, lifeline and rigging designed to hoist an unconscious person from a space.

C. Description of Hazards

1. Lack of Oxygen - Normal fresh air contains about 20.9% oxygen by volume. Oxygen is consumed by internal combustion engines, by persons breathing in the space, and by chemical reactions such as the formation of rust or the action of bacteria as they decompose organic material (such as fish products). Oxygen can also be displaced by other gases which may be either heavier or lighter than air. These gases can be particularly dangerous because they can exist in invisible pockets within a space. There are many devices available on the market which allow you to measure the amount of oxygen in a space. Any space which contains less than 19.5% oxygen should not be entered without a

self-contained breathing apparatus. Oxygen content of less than 20.9% indicates the existence of another gas which is displacing the oxygen. It is preferable to continue ventilation of any confined space until the oxygen content is approximately 20.9%.

2. Combustible gases and vapors - METHANE (also called swamp gas) and in some cases HYDROGEN SULFIDE are formed by the decomposition of fish products (or other organic materials) by bacteria. HYDROGEN is formed in lead-acid batteries as they are charged. Among the dangers that these gases pose is the ability to form explosive mixtures in air. The introduction of a flame or spark into such a space can be disastrous. There are combustible gas meters available to measure spaces for the existence of explosive gases. These meters usually have direct readout expressed in terms of percent of the lower explosive limit (LEL). The lower explosive limit is that percent by volume of a particular gas that will form an explosive mixture when mixed with air. Any space which contains greater than 10% of the LEL should not be entered without further ventilation and testing.

3. Toxic Gases and Vapors

   a. Toxic substances are those materials which can produce disease, acute discomfort, bodily injury or death. Airborne toxins are classified as either acute (fast acting) or chronic (long term). In substances possessing both acute and chronic effects, acute effects usually occur in response to higher dosages than chronic effects. An example of an acute effect is death caused by respiratory failure from exposure to .1% (1000 parts per million [ppm]) hydrogen sulfide. Asbestos is a chronic toxin because cumulative exposure has been linked to respiratory diseases years after the exposure has stopped.

   b. Concentrations of toxic gases are normally expressed in parts per million by volume (ppm). The maximum recommended concentration of toxic materials to which a worker may be exposed can be expressed in several ways.

      (1) Eight hour time weighted average (TWA) is the maximum average concentration to which the average worker can be exposed 8 hours/day 5 days/week. It is also called the threshold limit value (TLV).

      (2) The TLV-C is a ceiling value that should not to be exceeded.

      (3) The short term exposure limit (STEL) is the acceptable excursion limit concentration above the TLV which may be exceeded for a specified period of time.

   c. These values are published annually by the American Conference of Governmental Industrial Hygienists. It is entitled "TLVs Threshold Limit Values for Chemical Substances in Work Air Adopted by ACGIH for (current year)." Copies may be obtained by writing to: ACGIH, 6500 Glenway Ave., Bldg. D-5, Cincinnati, OH, 45211.

   d. In depth evaluation of the hazards of toxic substances is an exceedingly complex subject and should only be done by a trained industrial hygienist.

   e. The toxic gases that follow can be expected to be found on fishing vessels.

(1) NITROGEN DIOXIDE is a brown non-flammable gas with a pungent odor. It is present in the exhaust of internal combustion engines. It causes severe irritation to the skin and eyes. It reacts with moisture to form nitric acid. It is extremely toxic and acts principally on the respiratory tract.

(2) SULFUR DIOXIDE is a colorless, non-flammable gas with a strong suffocating odor. Small amounts of this gas are present in the exhaust of internal combustion engines. The use of excess sodium bisulfite to prevent blackspot on shrimp has been linked to the formation of this gas. Sulfur dioxide reacts with moisture to form sulfuric acid. Exposure causes irritation of the eyes and lungs with severe choking.

(3) HYDROGEN SULFIDE is a very toxic, colorless, flammable, poisonous gas with a characteristic rotten-egg odor. Concentrations as low as .1% (l000 ppm) can be lethal. In large concentrations, the gas quickly desensitizes the nostrils and cannot be smelled. It is found in many mineral waters and is also formed by the rotting of fish products and other organic materials. It acts as a poison by inhibiting the ability of the body's cells to absorb oxygen. Exposure to this gas in high concentrations can cause immediate coma, convulsions, and death from respiratory failure. Symptoms of sub-lethal dosages include headache, dizziness, excitement, nausea, and diarrhea.

(4) CARBON MONOXIDE is a colorless, odorless and tasteless flammable gas which is formed from the incomplete combustion of carbon. Gasoline or diesel engines are common sources of this gas. It binds with the hemoglobin in the blood and interferes with the ability of the blood to carry oxygen to the body's cells. Symptoms of exposure include headache, dizziness, drowsiness, nausea, vomiting, collapse, coma and death.

(5) AMMONIA is a pungent colorless gas which is very soluble in water. It is sometimes formed during the decay of fish products. Ammonia is also used in some refrigeration systems. It is irritating to the eyes, nose and moist skin. Other symptoms of exposure include headache, burning in the throat, loss of ability to smell, nausea, vomiting, swelling in the throat, respiratory arrest and death.

f. The gases listed below have no toxic properties but they act by displacing oxygen.

(1) CARBON DIOXIDE is an colorless, odorless gas which is produced by normal breathing and the decay or combustion of organic matter. It is a major problem in the fishing industry because it begins to form shortly after the fish die. Dry ice is frozen carbon dioxide and can also be a source of this gas in fish holds. Fire extinguishers employing carbon dioxide are another potential source. It acts as a simple asphyxiate, that is, it displaces oxygen causing death by oxygen deficiency. Since carbon dioxide is heavier than air, it will form in pockets at the bottom of the tank or fish hold.

(2) METHANE is a colorless, odorless flammable gas. Methane acts as a simple asphyxiant in addition to being highly flammable. Methane is lighter than air and will rise to the top of a compartment.

(3) FREON is widely used as a refrigerant and aerosol propellant. It can also act as a simple asphyxiant. When exposed to extremely high heat, it decomposes into highly poisonous phosgene gas and related compounds. Freon is heavier than air and will sink to the bottom of a compartment.

D Entry Procedures

1. All vessel personnel should be properly trained in;

   a. The dangers posed by confined spaces;

   b. Safe entry procedures for these spaces; and

   c. Emergency rescue procedures.

2. No one should enter a confined space until they have obtained the permission of the vessel's master.

3. Fish holds should be cleaned as soon as possible after off-loading. Attempt to use clean seawater. Do not use water known to contain a large percentage of sewage or waste.

4. Any equipment in a confined space that could injure personnel if accidentally energized should be shut off at the electrical power supply. A tag should be placed on the power supply warning personnel not to re-energize the equipment.

5. Internal combustion engines should only be used in a confined space when there is adequate ventilation. Exhaust from these engines should always be vented out of the vessel.

6. Exhaust piping should be inspected frequently for leaks.

7. Ventilate spaces using blowers or other method of forced ventilation. Blowers should be explosion proof. The length of time needed to exchange the air in a space depends upon a number of factors including the size of the space and capacity of the blower.

8. If equipment is available measure the atmosphere to ensure that there is sufficient oxygen available (at least 19.5%). If the space is oxygen deficient then forced ventilation should be continued until the space has adequate oxygen. If emergency entry into an oxygen deficient space is necessary then an SCBA should be worn.

9. If equipment is available measure the atmosphere for the presence of combustible gases. If combustible gases in the space exceed 10% LEL, then continue forced ventilation and retest.

10. If equipment is available measure the atmosphere for those toxic gases listed under "Description of Hazards" above. If the concentration of toxic gases exceeds the published TLV, then personnel should not enter the space until concentrations of have been reduced to below the established TLV. Personnel who enter a confined space where the concentration of any toxic gas exceeds the TLV should wear proper respiratory equipment and be properly trained in the use of this equipment.

11. Continue to apply forced ventilation while personnel are in the confined space.

12. The person entering the space should wear a harness with a lifeline attached.

13. A self-contained breathing apparatus should be worn when entering any space which has not been ventilated and tested. Additionally, there should be at least one person stationed at the entrance to the space equipped with SCBAs and rigging to hoist the person from the space in case emergency rescue is necessary. This person should be in continuous visual or verbal contact with the persons in the space.

14. One half of the accidents happen because of atmospheric changes that occur after initial testing; therefore if equipment is available the atmosphere should continually be retested as the work progresses. Disturbing a pool of sludge or chipping rust can change the atmosphere by reintroducing hazardous gases into the space.

15. Entry into a confined space to effect rescue should be done only after donning a Self Contained Breathing Apparatus (SCBA).

16. Training and drilling in rescue procedures should be carried out frequently.

17. Personnel should be familiar with the operation of SCBAs, gas testing meters, and other rescue equipment which may be on board. Even the best confined-space entry program is useless unless personnel understand how to comply with it.

18. Additional specialized training i5 recommended for persons charged to use and maintain atmospheric monitoring devices and SCBAs if carried on board.

19. A respiratory protection program should be considered. Program content may vary depending upon the type of equipment carried. Items to consider are listed below.

    a. The proper type of respiratory equipment should be selected and maintained in proper working condition. (A positive pressure-demand type SCBA is the only respirator approved for entry into unknown atmospheres).

    b. The user should be instructed and trained in the proper use of respirators and their limitations.

    c. Where practicable, the respirators should be assigned to individual crewmen for their exclusive use.

    d. SCBAs should be regularly cleaned and disinfected. Those issued for the exclusive use of one crewmen should be cleaned after each day's use, or more often if

necessary. Those used by more than one crewmen should be thoroughly cleaned and disinfected after each use.

e. SCEAs should be stored in a convenient, clean, and sanitary location.

f. SCEAs used routinely should be inspected during cleaning. Worn or deteriorated parts should be replaced. SCBAs designated for emergency use should be thoroughly inspected at least once a month and after each use.

g. Appropriate surveillance of work area conditions and degree of personnel exposure and stress should be maintained.

h. There should be regular inspection and evaluation to determine the continued effectiveness of the program.

i. Crewmen should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician should determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

j. SCEA bottles should only be refilled with air suitable for human respiration.

k. SCM bottles must be periodically requalified in accordance with DOT regulations (usually hydrostatically tested every five years).

E. Atmospheric Monitoring Devices

1. There are many devices available on the market. These devices incorporate various scientific principles to detect the gas of interest. It is beyond the scope of this NVIC to outline the principles, calibration techniques and required maintenance for each available meter. This information is best obtained from the manufacturer of each device. In general, a specific meter will be needed to measure oxygen, one for combustible gases and one for each type of toxic gas that you expect to encounter. Some manufacturers have combined two or three of these capabilities into one instrument. When choosing a meter consider:

a. The accuracy of the meter;

b. Capability of both remote and diffusion sampling;

c. Ease of maintenance and calibration;

d. Ease of operation with minimal margin for human error;

e. Sensor life including its sensitivity to contamination; and

f. Explosion proof. (Devices certified "intrinsically safe" by Underwriters Laboratories, Factory Mutual or other recognized testing facilities are recommended).

2. Meters should be calibrated in accordance with manufacturers' instructions before each use.

3. Calorimetric detector tubes are an easy and simple method to measure toxic gases. A gas sample is drawn through a detector tube which contains a specific chemical. If the toxin is present, a color stain will be produced. The length of this stain can be correlated to the concentration of that toxin.

4. There are two main techniques for sampling the atmosphere of confined spaces. Remote samples should be taken first. This is accomplished by inserting a probe into the atmosphere through an opening and drawing a sample through a length of tubing with either a pump or hand aspirator. Several readings should be taken at various heights and locations within the space. This will aid in detecting those gases which are lighter or heavier than air. Test first for combustible gases, then for oxygen then for toxic substances. While in the spaces, meters Should be operated in the diffusion mode. Samples reach the meter in this case through normal air movements.

F. Respiratory Equipment - Various types of respiratory devices are available. The only device recommended for entry into known hazardous atmospheres which may be deficient in oxygen is the Self-Contained Breathing Apparatus (SCBA) (Pressure-demand type). All respirators must be approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration (NIOSH/MSHA). Chemical cartridge masks or gas masks do not supply oxygen. The pressure demand type maintains a slight positive pressure inside the wearers mask to prevent hazardous gases from leaking in. SCBAs should be cleaned after each use, and maintained in accordance with manufacturers' instructions. A current listing of approved respirators can be obtained from: Publications Department, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, 4676 Columbia Parkway, Cincinnati, OH 45226.

G Additional References:

"Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment Adopted by the ACGIH", ACGIH, 6500 Glenway Ave., Bldg D-7, Cincinnati, OH, 45211, (513) 661-7881

"American National Standard; Practices for Respiratory Protection", ANSI Z88.2-1980, American National Standards Institute, Inc., 1430 Broadway, New York, N. Y., 10018

"Compressed Air for Human Respiration, Pamphlet G-7", Compressed Gas Association, Crystal Gateway Number 1, Suite 501, 1235 Jefferson Davis Highway, Arlington, VA., 22202

"Working in Confined Spaces; Criteria for a Recommended Standard", Publication NO. 80-106, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH., 45226

SAFETY IN MACHINERY SPACES AND WHEN OPERATING MECHANICAL AND OTHER EQUIPMENT

A. Main Propulsion and Auxiliary Machinery

1. All machinery such as engines, electrical motors, gearing, chain and belt drives, friction clutches and shafting which by reason of their situation can cause injury to personnel

should be securely fenced or protected as far as practicable without impeding the safe operation of the vessel. All hot exhaust pipes within reach of personnel should be properly insulated or otherwise protected to prevent accidents or burns.

2. If safety devices or insulation have to be removed, they should be replaced as soon as possible, and in any case before the machinery or system is put into operation.

3. Parts of machinery not securely fenced or guarded should not be lubricated, adjusted or repaired while in motion. If such operations must be carried out while the machinery is running, they should be done only by competent persons. Before machinery is started or turned over, care should be taken to ensure that nobody is working on, or in the way of, moving parts. Always check that the stern is clear before moving the rudder or turning the propeller when in port.

4. Persons servicing machinery should wear clothing as close-fitting as possible and head gear to cover long hair. Rings on fingers should not be worn.

5. When machinery is stopped for servicing or repair, measures should be taken to prevent inadvertent restarting or turning. Fuses should be removed or circuit breakers secured from electrical circuits; water or air valves should be secured in the closed position; other machinery should be locked to prevent movement. Propulsion and -steering gear should be effectively prevented from moving when repairs are carried out at sea. Any secured valves, controls, circuit breakers etc. should be tagged by the person conducting repairs stating that the equipment is not to be operated or exercised until permission is received by the person performing the repairs.

6. Before work is attempted on a valve or any other piece of equipment which operates under pressure, it should be determined that pressure has been relieved. In doubtful cases, securing nuts should be eased off slightly before the joint is broken.

7. Spare machinery or heavy pieces of equipment should be secured to prevent movement in heavy seas.

8. Engine room floor plates, ladders to and from the engine room, handrails etc., should be kept free from grease and oil.

9. Railings on gratings in the engine room should consist of a handrail and guard rail where practicable; toe boards should be affixed to the edge of all gratings.

10. All machinery platforms should have handrails, hand-holds, or guardrails as appropriate.
11. All floor plates should be properly fitted and secured in place and have a non-slip surface.

12. Engine room ladders should be fitted with non-Blip treads, and guardrails on exposed sides, as appropriate and should be wall maintained.

B. Winches and Hoists

1. All moving parts of winches which may present a hazard should be securely guarded or fenced. In addition, protection should be provided around winch foundations to prevent a

person from being caught or dragged under. Sheaves should also be guarded where practicable.

2. A winch or windlass should only be operated by a competent person.

3. All equipment used in hoisting should be tested and examined at periodic intervals.

4. Blocks and sheaves should be properly lubricated at regular intervals. All shackles used aloft should be a locking type or should be fixed so they cannot come loose by themselves.

5. Wires should be secured to winch barrels at least by clamps, shackles or other equally strong method.

6. Winch operators should not leave winches unattended with power on or with a load suspended.

7. The winch operator should make sure that all persons are standing clear of the danger zone before applying any load.

8. Loads being hoisted or lowered should not pass or remain suspended over persons.

9. Scarves, loose clothing and long hair are liable to be caught in a winch and should not be worn.

10. Frayed wire is a danger and should be properly replaced.

11. Wire rope should be examined before use to ensure that it is in sound condition and free from knots, kinks, reverse bends and broken strands.

12. Wire rope should not be used unless it has ample strength to meet the greatest load that may be imposed upon it during the work to be performed.

13. The controls of winches should have clear weather resistant operating instructions attached or adjacent to them.

14. Winch controls should be placed 80 winch operators have ample room for unimpeded operation and have as unobstructed a view as possible of the working area. Controls should also be placed so the operator cannot be positioned in way of rotating winch heads, drums, warps, or other items in motion. Where practicable, control handles should be arranged to return to the stop position when released and be provided with a suitable locking device to prevent accidental movements or displacement or unauthorized use.

15. Where a winch is provided with remote controls, these should be arranged to prevent simultaneous operation with local controls. The operator should have a clear view of the winch and adjacent area from either position. An emergency cut-out should be provided at the winch and in the pilothouse.

16. Winches should be provided with means to prevent overhoisting and to prevent the accidental release of a load if power supply fails.

17. Winches should be equipped with brakes capable of effectively arresting and holding the safe working load. Brakes should be proof-tested with static load before installation, suitably in excess of the maximum safe working load. Brakes should be provided with a locking device. Brakes should be provided with simple and easily accessible means of adjustment. Every winch drum which could be uncoupled from the drive should be furnished with a separate brake independent of the brake connected with the drive.

C. Refrigeration Plants and Compressed Air Systems

1. Whenever any gas which may be harmful to persons is used in a refrigeration system, vessel owners should consider having a supplied air or self contained breathing apparatus conveniently near the refrigeration plant but not in a position likely to become inaccessible in the event of a gas leak. The number of breathing apparatus may depend on a number of factors such as crew size and the size of the refrigeration system.

2. No flame-producing devices, or hot surfaces which may cause explosions, should be permitted in spaces in which refrigeration machinery or equipment using flammable gases is installed.

3. Additional information is contained in chapter 6.

D. Gas Cylinders and Installations

1. Cooking and domestic appliances using heavy gases (e.g. propane) should be used only in well-ventilated spaces. Care should be taken to avoid dangerous accumulation of gas.

2. The contents of cylinders for compressed, liquefied and dissolved gases should be clearly marked on the cylinder. Extreme care should be taken to ensure that the correct gas and appropriate fittings are used.

3. Cylinders containing flammable or other dangerous gases should be stowed on open deck, and all valves, pressure regulators and pipes leading from the cylinders should be protected against damage. Cylinders also should be protected against excessive variations of temperature) direct rays of the sun, accumulation of snow, and continuous dampness.

4. Cylinders should always be properly secured.

5. Oils or grease should not be used on oxygen cylinders or fittings.

6. Compressed oxygen should never be used in lieu of compressed air for the starting or turning over of engines or machinery.

7. Additional information is contained in chapters 3 and 6.

E. Electrical Installations

1. Only competent persons should be permitted to install, maintain or remove electrical equipment or circuits. Unauthorized installation of any electrical equipment is dangerous and should not be permitted.

2. Until proven otherwise, electrical circuits should be treated as though they are live.

3. All portable electrical equipment should be regularly checked with special attention to the condition of power cables and their connections.

4. All non-conducting metal parts of electrical equipment should be grounded or otherwise suitably protected such as by double insulation or by an isolating transformer. Ground faults should not be allowed to persist, but should be remedied as soon as possible.

5. All possible precautions should be taken to prevent steam, water or dirt from accidentally contacting switchboards, generators, motors and other electrical equipment.

6. Smoking or generating of sparks should be prohibited near electrical storage batteries.

7. Battery storage areas should be well ventilated, and under no circumstances should they be fitted in an accommodation space.

8. Additional information is contained in chapter 7.

F. Hand Tools

1. Handles of hand knives should have guards or finger grips to prevent the hand from sliding onto the blade.

2. Open-bladed knives, fish-hooks, gaffs and similar sharp implements should be sheathed or otherwise put safely away when not in use.

3. Tools or small parts of equipment should never be left lying on staging, gratings, etc., in the engine room, aloft or on deck. They should be placed in a box, bucket or bag, or lashed to prevent them from accidentally falling and injuring persons passing or standing below.

4. Tools and other equipment should be lowered from above by use of a gantline.

5. It is dangerous to use a wrench on moving machinery. Tools or other gear should be removed before restarting a machine which has been serviced.

G. Hot Work

1. Soldering, welding and similar hot work should not be undertaken on tanks and other containers holding flammables or on empty tanks and containers or in spaces which have held flammables or acids.

2. A fire watch should always be kept when cutting, burning or welding is being done. Fire extinguishers should be available for immediate use in case of an emergency.

SAFETY ON DECK

A. Gangways, Stairways, Ladders, Railings, Guards and Lifelines

1. Gangways, stairways, ladders and passageways should be kept clean and dry to prevent falls due to slippery conditions. Stairways and ladders should have non-skid treads.

2. Gangways and ladders should be secured 80 they do not come loose or collapse. They should not be located within the swinging radius of derricks or expose personnel to other hazards.

3. Frequently accidents occur through not using the proper means of getting on or off the vessel. Never jump from the vessel to shore or from the shore to the vessel. When a vessel does not lie close against a dock, and platforms are used, they should be hooked over the bulwark. When vessels are berthed alongside each other, suitable steps should be provided to give safe passage between vessels. There should also be a lifebuoy with a suitable line readily available by the gangway. A net under the gangway may also be useful in some circumstances.

4. When the shipboard end of a ladder or gangway rests upon the bulwark, firmly fixed steps should lead from the top of the bulwark to the deck, and be provided with a handhold such as a rail or stanchion. Care should be taken that the arrangement permits easy and comfortable access from ladder or gangway to steps, or vice versa.

5. Gangways should be not less than 22 inches in width and of sufficient strength. Railings or ropes should be provided at each side to a height of 36 inches with footstops and intermediate rails or ropes not more than 18 inches apart.

6. Portable ladders should stand on a firm base and be secured by effective lashing.

7. A ladder should not be used if it has a missing or defective rung or is attached by nails or other unsafe means.

8. Precautions should be taken when ladders are used. Loads should not be carried on them, and ladders should never be used where stairways or gangways are provided for boarding or leaving the vessel or for crossing from one vessel to another.

9. The use of portable ladders at sea should be avoided. If it is necessary to use them, they should be firmly secured. Non-slip bases should be used or the ladder held at its lower end by another person. The legs at each end should be placed on flat, solid -surfaces and lashed in place.

10. If rope ladders are used, they should be provided with two cross battens to prevent twisting. They should not be made of steel wire rope or be used if any rungs are missing, cracked or rotten, the rope is in poor condition or has broken strands, or the ladders are not long enough to reach the water-level or dock.

11. Rope ladders should be fully extended and should not be secured to the bulwark by the rungs. Only one person at a time should be permitted on a rope ladder. Persons going up or down a rope ladder should take care to hold the ropes and not the rungs.

12. Portable handrails should be in place when the vessel is underway and secured so they do not accidentally come loose.

13. Adequate lifelines should be rigged to assist men walking on the open deck in rough weather. A PFD or exposure suit should also be worn.

14. Fishermen required to work aloft or outboard of the bulwark rails or down the ramp of a stern trawler should be secured by a safety belt. A PFD should also be worn.

15. Stern trawlers should be provided with suitable protection such as doors, gates or nets at the top of the stern ramp at the same height as the adjacent bulwark or guard rail. When such a protection is not in position, a chain or other means of protection should be provided across the ramp.

16. Bulwarks, rails, chains, and wire rope should be fitted around all exposed parts of the working deck and superstructure decks if they are working platforms. Chains and ropes where fitted should be kept taut.

B. Deck Lighting

1. During hours of darkness sufficient lighting should be provided at gangways, and all other locations on deck where personnel must work or pass, so that obstructions are readily visible. A hand lantern should be used if necessary.

2. Lighting should be placed so that it does not interfere with the keeping of a proper lookout or prescribed navigational lights.

3. Additional information is contained in chapter 7.

C. Ropes and Lines

1. Wire rope should be handled with care, and gloves used as a protection against injury from projecting strands.

2. Care should be taken to see that all ropes in use are in good condition and have a strength appropriate to their application.

3. Wire ropes should be periodically lubricated and frequently examined for abrasions and broken, deteriorated or displaced fibers or strands and other defects.

4. Ropes should not be exposed to excessive heat or harmful chemicals. When not in use they should be coiled and stored under well-ventilated conditions away from direct sunlight.

5. All blocks should be of sufficient strength and large enough for the rope. The diameter of the sheaves should be suited to the ropes.

6. A wire rope should not be passed over an undersized diameter pulley, sheave or winch barrel.

7. A wire rope around a thimble of suitable size to form an eye should be well spliced or secured by means of U-clamps so that the U-bolt fits over the short end of the wire.

8. During the handling of mooring lines or other wires or ropes, care should be taken not to stand in the bights. Hawsers should be coiled down in their correct places and wires wound on their reels to reduce the likelihood of bights forming.

9. Sheaves should be guarded where practicable.

10. Blocks should be inspected for wear and damage and lubricated at regular intervals.

SANITATION

A. General

1. Toilet, washing and shower facilities, lockers and other personal service spaces should be maintained clean and sanitary and protected against insects, rats, mice and vermin.

2. Galley and food storage areas are particularly prone to infestation by insects, rats, mice and vermin. These areas always should be kept clean and food should not be left out and exposed to the air. Dishes and utensils should be washed properly and a suitable disinfectant used when washing dishes.

3. Soil pipes should not pass overhead in the mess rooms, sleeping rooms, dry provision store rooms or galleys, except where it is impracticable to place then elsewhere.

4. No soil pipe or waste pipe should pass through drinking water tanks or other fresh water tanks.

PROTECTIVE CLOTHING

A. Protective Clothing and Equipment

1. Work clothes should fit as closely to the body as possible; there should be no loose strings or cuffs on trousers.

2. Footwear should be in good condition and appropriate for the work being performed.

3. Waterproof safety boots should be worn in certain working conditions such as on deck while handling heavy objects.

4. During rain or bad weather and in darkness, protective clothing having a highly visible color should be worn. A PFD should also be worn.

5. Aprons should not be worn near revolving or reciprocating machine parts or electric motors.

6. Safety belts and harnesses should be tested periodically and checked before being used.

7. Gloves sufficiently reinforced to provide adequate protection against cuts should be worn when cutting or gutting fish. In selecting work gloves, consideration should be given to the hazards the wearer may encounter and to the need for free movement of the fingers. Gloves should fit snugly at the wrists.

8. The attention of fishermen should be drawn to the harmful effects of high noise levels in the engine room and to the various methods to minimize them. Protective earplugs or other suitable equipment should be worn in the presence of high and medium speed diesel engines.

9. Eye injuries are often caused by fragments of metal or paint, and are generally serious. Goggles should be worn for protection when performing such work as chipping rust or paint, working on electrical storage batteries, sanding, grinding and spray painting etc.

GENERAL SAFETY PRECAUTIONS

A. Marine Sanitation Devices

1. Use of Chemicals - These devices use chemicals and produce gases as a byproduct. Some of these chemicals and gases present a potential hazard. The manuals for all marine sanitation devices employing chemical treatment list the type of chemical to be used by brand name and state the amount to be used. The vast majority use chlorine bleach in one form or another. Bleach when mixed with certain cleansers (Ammonia) will form a poisonous gas (chlorine gas) that may cause death. Do not experiment with your chemical treatment tank. The safest method of treating the black water is described in the manual supplied by the manufacturer and should be followed to the letter.

2. Personal Protection

a. In all cases when working in these tanks, wear rubber boots, overalls, rubber gloves, and hair covering. No one working on these tanks should be allowed free movement about the vessel until their protective clothing has been removed and placed in plastic bags. The used clothing should be either discarded or washed immediately.

b. Methane and Hydrogen Sulfide are gases which are a product of the decay of matter. The hazards associated with these two gases cannot be overstated. Methane is a highly explosive gas. Before entering large holding or treatment tanks or even spaces containing these tanks make sure the space has been

adequately ventilated and that the tanks are safe for workers (see the section on toxic gases). Use explosion-proof lights. Do not allow smoking.

B. Dangerous Work

1. In heavy weather, fishermen should not work alone on deck without the watch in the wheelhouse being aware of their presence.

2. All exposed weather deck hatches should have hatch locking devices. In spaces where personnel are located, the locking devices should be able to be opened from the inside.

3. A draw-bucket should not be used when a vessel is under way as there is a danger that the person may be pulled overboard.

4. It is hazardous to work in the vicinity of radio antennae or radar scanners due to danger from both radiation and the rotation of scanners. Permission should be obtained from the person in charge of the bridge before such work is undertaken and the circuit fuses should be removed to make the equipment inoperable; A MAN ALOFT notice should be placed on the equipment.

C. Galley

1. In rough weather, pots and kettles should be removed from the stove or should only be partially filled. The stove should be fitted with sufficient rails or equivalent restraining devices.

3. Towels or similar items should not be left hanging above the stove.

4. Every galley range, exhaust hood, filter and exhaust duct should be kept free of accumulated grease and other waste products.

5. Galley floors should be constructed of, or covered with, non-slip material.

6. Dangerous parts of slicing machines should be securely fenced with permanent guards.

D. Painting - Protective gloves or barrier creams should be worn when painting. Persons painting in closed spaces should wear a respiratory mask (filter type) and safety goggles. Spaces should also be ventilated.

E. Heaters

1. Electric heaters should be built and secured to reduce the risk of fire. No element should be exposed such that clothing, curtains, etc., can be scorched or set on fire by the heating element.

2. Open fires should not be used for heating. Heating stoves and other similar appliances should be firmly secured and insulated from beneath and around, and also in way of their uptakes. Uptakes of stoves should be arranged to minimize the possibility of becoming

blocked by soot and should have an easy means for cleaning. Dampers for limiting drafts in uptakes should, when in the closed position, leave an adequate open area to prevent a buildup of combustion gases in the uptake. Spaces where stoves are installed should be provided with ventilators to provide an adequate supply of air for combustion of the stove. These ventilators should not have a means of closing.

3. Open flame gas appliances, except cooking stoves and water heaters, should not be used. Spaces where open flame stoves and water heaters are installed should have adequate ventilation to remove fumes and possible gas leakage to a safe place. This should be done through an exhaust type ventilation system with the inlets placed low in the space. All pipes that convey gas from a container to a stove or water heater should be made of steel or equivalent material. Automatic shutoff devices should be fitted to operate on loss of pressure in the gas main pipe or a flame failure.

4. Gasoline appliances should not be used on any vessel.

5. For further information on the installation of liquefied petroleum gas (LPG) or compressed natural gas (CNG) systems, galley stoves, and heating systems see NFPA-302 or American Boat and Yacht Council, Inc. (ABYC) Projects' A-l, A-3, A-7, and A-22.

F. First Aid

1. At least one crewman should be trained in giving cardiopulmonary resuscitation and maintain a valid certificate.

2. At least one crewman should be trained in giving first aid.

3. A first aid kit should be carried and placed in a weatherproof container with individual sealed packages for each type of item. Contents should be checked before getting underway for each trip to ensure that all expended items have been replaced. Kits can be obtained from a number of sources and contents may vary depending on crew size and operation of the vessel.

4. Contents of unopened or intact sterile disposable packages should remain sterile until opened. However, to be assured that the contents have not deteriorated, they should be replaced at least every five years or on the expiration date. One of the first aid trained crewmen should be assigned the responsibility of maintaining the kit. The kit should have a paper seal on it so it can be easily determined if it has been opened and needs to be restocked.

5. Vessel owners should consider carrying a copy of the U.S. Public Health Service book "Ships Medicine Chest and Medical Aid at Sea" (DHHS Publication No. [PHS] 84-2024 revised 1984). It can be ordered by writing to: Department 39, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Request the latest edition. Among other things, this book contains a recommended list of the minimum number of items to carry in a first aid kit for fishing vessels which normally do not carry more than 15 persons, and are never more than a few days from home port, or a few hours from a port of call. The book also describes in non-technical language, the diseases and medical emergencies most commonly encountered while at sea and "first aid" and "follow-up" care required until the patient can be evaluated and treated by a physician.

6. The North Pacific Fishing Vessel Owners' Association's "Vessel Safety Manual" also contains a chapter on medical emergencies at sea and lists recommended supplies for a first aid kit.

CHAPTER 5 - HULL DESIGN AND CONSTRUCTION, ARRANGEMENTS, MAINTENANCE AND REPAIR

INTRODUCTION

These recommendations are intended to serve as a guide for the design and construction, arrangements, maintenance, and repair of the hull and equipment on fishing vessels. These guidelines apply to all fishing vessels, and are drawn in large part from the 1977 Torremolinos Fishing Vessel Convention. Recommendations in this chapter cover features commonly found on fishing vessels and are based on accepted good practice. They are drawn from international conventions, Coast Guard regulations, professional society standards, classification society rules, and published guidelines for fishing vessels listed on pages 5-20 thru 5-23 at the end of this chapter.

ARRANGEMENTS

A. General

1. Hinged covers of hatchways, manholes and other openings should be latched to protect against accidental closing. Heavy covers on escape hatches should be equipped with counterweights.

2. Accommodations, recreation spaces, and the pilot house should be separated from sources of noise and odors. Machinery should not be located next to such spaces unless noise reduction procedures are taken. Vents from machinery spaces and tanks should not lead into manned spaces.

3. Dimensions of access hatches should not be less than 24 by 20 inches.

4. Railings should be provided to prevent personnel from falling through deck openings. Skylights and hatches should have coamings or guards.

5. Handholds should be provided above the level of the deck over escape openings.

B. Bulwarks, Rails and Guards

1. Bulwarks should have rails to provide a handhold in rough seas. Storm rails should be fitted on the outside of superstructures and deckhouses. Guard rails, gangways, lifelines, or underdeck passages should be provided for the crew to get between quarters, machinery spaces, and other working spaces.

2. Bulwarks and exterior rails should be at least 39.5 inches high. Clearance between the lowest course of a rail and the deck should be less than 9 inches, with other courses spaced not more than 15 inches apart. Stanchions should be spaced not more than 5 feet apart. Stanchions and rails should not have sharp edges or corners and should be of substantial (rigid) construction.

3. Stern trawlers should have doors, gates, or other protective arrangements at the top of the stern ramp as high as adjacent bulwarks. A chain or other device should be fitted across the ramp when the doors are open.

C. Deck Coatings Effective coating of decks and working areas should consist of a two part system. A non-skid paint or grating system should be provided for personnel working and walking areas to insure good footing. Abrasion resistant coatings should cover other areas where nets and lines are worked to better protect the deck. Peel and stick mats or sand sprinkled in the last coat of paint are appropriate for light use areas. Specially developed aggregates of aluminum oxide, or even sand blast grit, can be applied with epoxy or urethane paints in heavy use areas. Rubber, fiberglass, or rubber coated fiberglass gratings are also effective for heavy use walking and working areas. Paint manufacturers recommend carefully prepared and applied inorganic zinc and anti-corrosive undercoats to these areas because of the extra loads imposed on the paint films.

D. Means of Escape The galley, messing areas, machinery space, accommodations, work areas, and other normally manned spaces should have at least two means of escape. These should be as remote from each other as possible in order to minimize the chance that both escapes could be blocked by the same incident, such as fire, fallen fishing gear, or ice. If possible, the means of escape should not be through watertight doors in the hull because they may not be usable in the event of flooding. The means of escape, whether they are doors, scuttles, or hatches, should be capable of being opened from the inside. They should not have locks or other devices which would prevent them from being opened quickly in an emergency.

E. Stairways and Ladders

1. Stairways and ladders should be provided for safe working at sea and in port. They should be of adequate size and strength with treads that are flat and specially prepared to minimize slipping. Stairways and ladders leading to holds, 'tweendecks, bunkers, or used for emergency escape should be permanently attached. Emergency escapes may be portable if stowed adjacent to the escape and can be secured in place without using tools or other mechanical aids.

2. Permanently attached vertical ladders should be at least 6 inches from the bulkhead. The rungs of steel vertical ladders should be of square bars with a sharp edge upwards. Where ladders are constructed with stringers, the rungs should pass through the stringers. Handholds should be provided if necessary.

3. Stairways more than 39.5 inches high should have handrails or hand grips on both sides.

F. Rudder and Propeller

1. A naval architect or marine engineer can give advice on the best combination of engine and propeller for a vessel. A kort nozzle may provide increased efficiency for trawling or dredging.

2. In order to prevent lines or wire ropes from jamming the propeller, a rope guard can be fitted around the gap between the end of the stern tube and the propeller boss. The guard, which is a metal ring that fits closely over the gap, should be maintained in good condition.

3. Rudder and propeller design should consider the necessary maintenance to be performed including removal of the propeller shaft and examination of the bearings.

4. Nuts used for attaching the rudder and propeller should be lockable or have a method of locking them in place.

G. Forepeak The forepeak should not be used for carrying fuel. Coast Guard pollution regulations (33 CFR 155.470) prohibit the carriage of oil forward of the collision bulkhead on some vessels over 300 gross tons, and they provide for grandfathering certain vessels depending on when they were constructed. The regulations should be consulted to determine whether a vessel is exempt from the prohibition of carrying fuel forward of the collision bulkhead.

H. Ice Operation

1. The hull may require additional strengthening for operation in ice.

2. Vessels should be equipped with de-icing arrangements and tools such as axes and wooden clubs to remove ice from rails, bulwarks, and structures in order to maintain adequate stability. Wooden vessels should have appropriate ice protection sheathing. Classification societies have guidance in this regard.,.

I. Single Person Operation

1. Vessels which are operated with one person on watch should have a means to allow the operator to climb back on board after an accidental fall overboard. The operator should wear a lifeline designed so that a fall overboard causes the engine to stop.

2. Vessels operated by one person, with others aboard in a compartment other then the wheelhouse, should contain an efficient intercom (call) system.

J Noise and Vibration

1. Harmful noise and vibration should be minimized. Coast Guard Navigation and Vessel Inspection Circular (NVIC) 12-82, "Recommendations for the Control of Excessive Noise" contains useful guidelines on noise reduction measures. Where practical, maximum noise levels in a given area should not exceed 75dB(A).

2. Means for reducing noise levels include:

a. Resilient mounting of vibrating machinery, especially generators;

b. Noise barriers such as sound absorbing material around high noise spaces;

c. Flexible mountings for exhaust, ventilation, and other service lines;

d. Ensuring that all fit-ups are tight;

f. Seals around penetrations through spaces;

g. Silencers or attenuators on air intakes and exhausts;

h. Sound absorption treatment of accommodation spaces; and

i. Isolation of noisy spaces or manned spaces.

K. Chains and Anchors

1. The anchoring system should hold the vessel and stand up to wear and tear.

2. Vessels over 79 feet long should meet the standards in Section 22, ABS "Rules for Building and Classing Steel Vessels Under 61 Meters in Length." Vessels more than 200 feet long should meet the requirements in Section 28, ABS "Rules for Building and Classing Steel Vessels."

3. The following guidelines are for those vessels less than 79 feet long. The following formula may be used to calculate if one or two anchors should be carried on board.

$$E = L*(B+D)$$

L, B, and D are the length, breadth, and molded depth in feet

If the value of E is greater than 400, then two anchors should be carried. The Coast Guard encourages all fishing vessels to carry at least two anchors.

4. The holding power of an anchor depends on factors such as vessel type, bottom conditions, and weather and sea conditions. Anchor manufacturers can recommend anchor sizes.

5. The anchor rode (between the anchor and the deck shackles) should have a breaking strength of five times the anchor hold if made of line or wire rope, or two times the design load if made of chain. The rode should be at least 7 times the water depth.

6. The rode absorbs most of the loading due to waves and should be compliant. Chains and lines best serve this requirement. If a wire rope is chosen for the rode, a short length (10-12 feet) of chain should be used to attach the anchor to the rope. The short length of chain will help weigh the anchor.

7. A safe method of stowing the rode should be in place. Loose line on the deck should be avoided.

L. Winches, Tackle and Lifting Gear

1. A fishing gear system, including warping heads, winches, tackle, nets, etc., should provide safe and convenient operation. Wires and warps should be of adequate strength for the anticipated loads. Moving parts of winches and of warp and chain leads which may present a hazard should have adequate guards. Repairs to winches, tackle, and lifting gear should be to original standards of construction. Repairs should be tested using dead loads before the gear is placed back in service.

2. The diameter of blocks and fairing leads used with ropes should be at least 6 times the diameter of the rope. For wire ropes the diameter should be at least twelve times the diameter of the rope.

3. Winches should be designed such that the maximum effort necessary for operating handwheels, handles, crank handles, levers, etc., does not exceed 36 pounds and in the case of pedals, 72 pounds.

4. If a winch has local and remote controls, they should be arranged to prevent simultaneous operation. The operator should have a clear view of the winch and adjacent area. An emergency cut-off should be provided at the winch and in the pilothouse. Controls should have a means to prevent accidental movement or unauthorized use.

5. Winches should have a means of stopping and holding the safe working load. Brakes should be proof-tested with a dead load in excess of the maximum safe working load. Brakes should be easy to adjust. Every winch drum which could be uncoupled from the drive should have a separate brake.

6. Where manually operated "guiding on" gear is installed, the operating wheels should not have open spokes or protrusions that could injure the operator. Such gear should be able to be disengaged when the warps are playing out.

7. Winch barrels should have a means for fastening wire ends, such as clamps, shackles or other methods which should not kink the wires.

8. Regular periodic testing as shown in pages 5-23 thru 5-25 should be performed on the fishing gear system.

M. Fish Holds

1. The fish hold should be divided 80 that boxes may be secured at sea. Portable divisions can help subdivide the fish hold for better stability, but they must be of adequate strength.

2. The hold should be designed for easy cleaning so that water and fish waste drain freely from all points in the hold to the bilge suction point. Dampness can lead to structural deterioration as well as unsanitary conditions, so adequate drainage and ventilation are necessary. Ventilation is extremely important for personnel working in the holds. Hydrogen Sulfide (poisonous) and Carbon Dioxide gasses generated by decaying fish and Freon from leaking refrigeration lines can cause serious illness or death for workers in poorly ventilated holds.

3. The hold should be lined with a material which keeps the fish boxes away from the sides of the vessel. The lining may be of wood, metal (galvanized iron or aluminum) or fiberglass reinforced plastic. These materials require frequent inspection for deterioration, especially at the fastenings.

4. Insulation used in fish holds should be nonabsorbent and not susceptible to rot or fungus growth. On wooden vessels there should be some circulation of air between the insulation and the hull to inhibit rot and decay of the wood. Fiberglass insulation similar to that used in home construction allows for a small amount of air circulation.

5. Hatches to fish holds must be capable of being made watertight, and hatchcovers should be designed and constructed for easy closing, preferably by one person. Hatches

should be kept closed except when being loaded, to minimize the possibility of downflooding.

WATERTIGHT INTEGRITY

A. General The number of openings through which water can enter the vessel should be kept to a minimum. Openings should be kept as high up in the vessel and as close to the centerline as possible. All external openings should be capable of being made watertight or weathertight by closures such as covers, coamings, or doors. The number of openings in the side of. the vessel below the working deck should be kept to a minimum. Openings should be above the deepest operating waterline if possible. Closures on side openings should be watertight and as strong as the surrounding structure. A notice should be posted at closures stating that they should be closed at sea except when in use.

B. Hatches and Hatch Covers

1. All flush hatch covers in the deck should be watertight and easy to handle by one person. They should be as strong as the surrounding deck structure.

2. Raised hatch covers and doors should be weathertight. Hatch covers should be kept closed at sea. They should be marked to indicate the proper position of dogs or other fastening devices for closing.

3. Watertight hatch covers should not be made of wood except on wooden vessels. Wood weathertight covers are acceptable on all vessels, except for machinery space openings, where fire hazards, heat, and moisture make wood unsuitable.

C. Exterior Doors Access openings on the main deck to superstructures should have weathertight closures which can be secured from either side. Doors on the working deck should have a sill at least 12 inches high for vessels up to 40 feet long, and at least 23.5 inches high for vessels over 79 feet long. Sill height on vessels between 40 and 79 feet can be calculated by interpolation. Exterior door sills above the working deck should be 12 inches high.

D. Pilothouse The pilothouse should be weathertight. Windows should have deadlights or other suitable storm shutters and should be made of untinted tempered or safety glass. The door to the pilothouse should be capable of being secured weathertight from either side by one person. The door to the pilothouse should have a sill at least 15 inches high.

E. Portholes Portholes on or below the working deck should have inside hinged watertight deadlights. Portholes should be at least 19.5 inches above the deepest operating waterline.

F. Skylights Skylights should be above the working deck. They should be of substantial construction and be capable of being closed weathertight. In case the skylights are damaged, there should be a backup means for closing the opening such as wood or canvas covers.

G. Ventilators

1. Ventilators should be as strong as the surrounding structure and have weathertight closures for storm conditions.

2. Engine supply air should be available under all weather conditions from a high, protected part of the vessel, near the centerline, to limit downflooding when heeled or taking on water due to wave action.

H. Vents Exposed vents to tanks or other spaces below deck should be strong and located as close to the vessel's centerline as practical. Ball check valves, hinged closures, wooden plugs, canvas hoods, or other permanently attached means should be provided for closing vents in high seas. Fuel oil tanks must have a way of equalizing air pressure when the vessel is secured for storm conditions. Vents should be at least 30 inches high on working decks, and 18 inches high on superstructure decks.

I. Inlets and Discharges

1. Pipe discharges leading through the hull should have means for preventing water from passing inboard. Each discharge should have an automatic non-return valve with a readily accessible positive means of closing it. Discharges from unmanned spaces should have valves operable from a position on or above the working deck. Valves should have an indicator showing whether the valve is open or closed.

2. In manned machinery spaces, inlets and discharges essential for the operation of machinery should be controlled locally. Controls should be easily accessible and provided with means of indicating open or shut valves. Alarms should be placed to indicate leakage of water into the space.

J. Watertight Bulkheads

1. The vessel should have a watertight collision bulkhead between five and fifteen percent of the vessel's length aft from the bow. Doors, manholes, ventilation ducts or any other openings should not be fitted in the collision bulkhead below the working deck. Pipes piercing the collision bulkhead should be fitted with screw down valves easily operated from the working deck.

2. The main machinery space should also be bounded by watertight bulkheads which extend up to the working deck.

STRUCTURAL DESIGN

A. Design Guidelines The design and construction of a vessel should be sufficient to withstand the intended service. Classification societies have rules for building and maintaining vessel structures and machinery, and although they are not intended specifically for fishing vessels, they may be applied in most cases. Rules which may be useful for fishing vessels include:

1. American Bureau of Shipping (ABS) "Rules for Building and Classing Steel Vessels Under 61 Meters (200 Feet) in Length";

2. Lloyds Register of Shipping (LR) "Rules and Regulations for the Classification of Yachts and Small Craft";

3. Navigation and Vessel Inspection Circular (NVIC) 11-80, "Structural Plan Review Guidelines for Aluminum Small Passenger Vessels";

4. ABS "Rules for Reinforced Plastic Vessels"; and

5. American Boat and Yacht Council's (ABYC), "Safety Standards for Small Craft'..

B. Deck

1. The deck must be designed to carry all anticipated loads from equipment, gear, nets, and cargo. It should be reinforced to support heavy equipment such as winches and pot haulers, or to support equipment added to meet different fisheries needs on the same vessel. Decks may be reinforced by pads (doublers) under heavy loads to spread them over a larger area. Additional underdeck framing may also be necessary.

2. Equipment on the deck should be arranged so as not to impair visibility or access. Suitable storage should be provided for gear so that it is not lying loose during transit or is in the way of normal operations.

MAINTENANCE AND UPKEEP

A. Design for Maintenance The hull and equipment should be arranged for ease of regular maintenance. Care taken during the design and construction stages will reduce maintenance and repair costs. Design considerations related to maintenance include:

1. Deck drainage should be arranged to avoid water pockets;

2. The outer hull should be painted with anti-fouling and anti-corrosion coatings and protected with fenders and/or rub rails;

3. Moving parts should be arranged for ease of lubrication; and

4. The inner hull should be arranged for easy access behind linings. Most corrosion on steel and decay in wooden hulls starts at the fittings. Easy access will allow the inner hull to be inspected and maintained.

B. Maintenance Plan Maintenance should be performed regularly. A maintenance plan which identifies all items that need maintenance, the type of maintenance necessary, and the frequency should be prepared and followed. It should be prepared during construction or before the vessel is put in service. This plan can be divided into items which should be checked daily) weekly, monthly, semi-annually, or annually. As routine maintenance is performed, a work list of necessary repairs should be prepared. Pages 5-26 thru 5-28 at the end of this chapter contains sample maintenance checklists. They can be used as a starting point for a preventative maintenance program tailored for any vessel. The checklist should be modified as necessary based on experience in operating the vessel. Specific instructions for performing maintenance can be obtained from manufacturers' operating guides.

C. Outer Hull Maintenance

1. Steel and aluminum vessels should be hauled out or drydocked every two to three years. Wooden vessels should be hauled out every two and a half years if practicable. Vessels under constant use in harsh environments may require more frequent haulings, while

vessels used seasonally in fresh water, or in mild environments may go somewhat longer between haul outs. Each vessel should be placed in a drydock or on a slipway on blocks of sufficient height to enable the bottom to be examined throughly. Preparation for inspection, painting, or repairs can vary from high pressure water washing to sand sweeping to a complete white metal sand blast.

2. Many coatings are available for different applications. Coatings may perform differently depending on the weather conditions when they are applied. When using anti-fouling paints, the primer and paint must be compatible with each other. This usually can be assured by choosing the primer and paint from the same manufacturer. Special epoxy paints can be applied near the rudder and screw to protect against prop wash erosion.

D. Inner Hull Maintenance

1. Many places on the interior of vessels can be painted only during the initial fitting out. On steel vessels a good coating free from defects should be obtained during the initial fitting out.

2. Interior deck and structural members on wooden vessels should not be painted, but treated with a preservative, so that any damage will be readily apparent. Linings should be removable or have access panels so that preservatives may be sprayed behind them. A light colored oil resistant paint should be used in the engine compartment so that leaks are visible.

3. Paints used near intense heat should be heat resistant.

4. The lining and insulation in the fish hold should be maintained as free as possible from nicks and gouges which expose the planking and/or sheathing behind. This is especially necessary on wooden vessels to prevent the underlying planking from rotting. Gouges also provide a breeding place for bacteria which could cause the catch to spoil.

E. Propulsion System The propeller and rudder assembly should be checked at each drydocking for corrosion, fracture, bent blades or shafts, and misalignment. Bearings should be checked for excessive wear. The propeller should be polished to improve efficiency. Loose bolts and fittings should be repaired or replaced.

MATERIAL CONDITION OF HULL

A. General The material condition of a vessels hull affects its strength and integrity. Periodic inspection and maintenance is necessary to identify and correct deficiencies which affect the hull to the extent that the vessel could become unsafe. When a deficiency is found, it must be evaluated to decide if safety is compromised. The extent and degree of the damage will determine whether immediate repair is necessary. In general, when serious damage is discovered, the safest thing to do is "renew in kind." Brief information concerning deterioration, inspection, and repair is provided in the following sections. Additional details, including structural design standards, can be found in classification society. rules and guides, U.S. Coast Guard Navigation and Vessel Inspection Circulars (NVICs), Society of Naval Architects and Marine Engineers (SNAME), or American Welding Society (AWS) publications and a variety of books and magazines published by public and private marine-oriented organizations. See pages 20 thru 23 for purchase information on these and other references.

B. Deterioration The most common source of deterioration of metal hulls is corrosion. Corrosion results in widespread or localized wastage or pitting of the hull. Corrosion may be severe in vessels built with dissimilar metals and used in salt water. Various methods are used to inhibit corrosion; the simplest and most common methods are hull coatings and sacrificial anodes. Sacrificial anodes (zinc or aluminum for steel hulls, zinc for aluminum hulls) are often placed near the stern and rudder area to provide partial underwater hull protection. Caution should be taken when using impressed current, because corrosion can be accelerated if it is used improperly. Other suggestions to prevent corrosion include use of plastic insulators or bushings between dissimilar metals (such as with steel bolts or cast iron fittings on aluminum hulls) and by avoiding stray currents produced from electrical equipment. Power tools used on board should use the power supply from the boat. A shielded ground and not the hull should be used as an electrical return.

C. Inspection

1. Inspections should coincide with maintenance. Inspection begins with an overall look at the exterior of the hull. Any areas of distortion of the hull surface, evidence of local damage, local cracking, interior wetness, seam weeping, rust streaks, and other discoloration should be noted. Any of these defects may be an indication of trouble, requiring more detailed examination of the hull. After the exterior structure has been inspected, a visual inspection of the interior of the hull should be made with special attention given to framing and heavily loaded areas such as the bow and bottom impact areas, engine mountings, and cargo gear attachments, and connections of the frames to the shell. Construction details, such as joints, framing attachments, and fasteners should be inspected. Defects noted in the course of inspecting the shell and decks deserve special attention on interior inspections. This overall inspection is followed by a close observation of highly stressed areas such as in the vicinity of rigging attachments, hard spots, areas of support when the vessel is in storage, and bottom impact areas near the bow or transom.

2. Most common problems in vessel structures are caused by poor design details and arrangements which produce stress concentrations or hard spots. A stress concentration is created by holes or abrupt changes in the size or shape of a stressed member. Cuts in the deck for hatch openings are a source of stress concentrations and merit close inspection.

D. Repairs

1. When deficiencies are found, the following questions should be answered by a qualified person prior to making repairs:

a. What is the extent and degree of deterioration;

b. Is the defect progressive and, if so, how can its progress be stopped; and

c. How long will it be before the area in question is next inspected?

2. Consideration of these questions will help decide which repairs to make and which can be postponed. Repairs necessary to maintain the vessel in a safe condition should be done immediately.

3. Repairs to vessels should follow these guidelines:

a. Use material compatible to that being replaced;

b. Make repairs extensive enough to ensure that the hull is essentially as strong as original;

c. Use details and fastenings at least equivalent in strength and in quality to those replaced; and

d. Use good workmanship.

STEEL VESSELS

A. Deterioration Corrosion is the most common problem with steel vessels. It is aggravated by age, inadequate maintenance, working of the hull, chemical or corrosive action of the cargoes, electrolysis, local wear, and improper design. In many cases, it is impossible to determine the amount of deterioration without gaging. As a general rule, local wastage of up to 25% of the original thickness (assuming a wastage allowance was originally built in) can be tolerated before replacement is necessary. In some cases, wastage less than 25% may call for replacement of material where deterioration results in radical changes in section thicknesses or obvious weakening.

B. Inspection

1. The bottom and side plating, especially in splash zones, should be examined for excessive deterioration or damage at each drydocking. Riveting and welding should be examined along with the hull plating. Areas of high stress and mechanical abuse, such as deck plating, should be inspected for cracks and leaks. Excessive wastage in an area relative to the surrounding plates should be repaired immediately. Serious localized corrosion may also take place around overboard discharges and scupper openings. Structural members, including deck and shell plating, frames, beams and stiffeners should be inspected for corrosion, distortion, or buckling. Structural members with more than 25% overall wastage should be replaced. Severe localized pitting or corrosion may be indicative of a problem requiring expert advice.

2. Some deformation of the hull plating is common in the forward portions of the vessel and may not require repair. Severe buckling or set-in, however, should be repaired. Tanks which are an integral part of the hull structure should be examined internally and may be pressure tested by liquid to a pressure equivalent to the maximum load experienced in service. Leaks should be repaired immediately. Watertight and oiltight bulkheads forming the boundaries of main compartments should be examined throughout their vertical and transverse extent. Thoroughly ventilate all tanks and closed voids and follow proper tank entry precautions and procedures before entering. Additional information is contained in chapter 4.

C. Repairs

1. Welding

a. Most repairs to steel vessels involve welding. Welding should be done by qualified welders and to an acceptable standard. Useful guidelines for steel hull welding are

found in Section 30 of the ABS "Rules for Building and Classing Steel Vessels" and in the American Welding Society's "Guide for Steel Hull Welding."

b. Replacement steel must be similar to the original material. high strength steels are used, special care must be taken in matching strength levels, using special filler metals, controlling heat input, and using post weld heat treatment.

c. ABS publishes a list of "Approved Welding Electrodes for Wire-Flux and Wire-Gas Combinations." Filler metals should be selected from that list. Electrodes should be kept dry while in storage. Low hydrogen electrodes must be baked prior to use.

d. Other important considerations for welding include proper edge preparation, welding sequence, procedure, and inspection for defects. Improper techniques will result in repairs which may be detrimental to the safety of the vessel.

e. When welding at the dock, the welding machine electrodes, work leads and associated control equipment should be on the vessel to avoid stray currents and its corrosion effects. Power tools used on board should use the power supply from the vessel and the ground should be close to the repair work.

2. Cracks which can be repaired without steel replacement should be drilled just beyond the end of the crack to inhibit further crack propagation after repair. The crack should be prepared by grinding, carbon arc gouging, or other suitable means before welding. Full access to both sides of the crack should be obtained to weld from both sides. If a crack in a plate runs across framing, the framing should be released before welding up the crack, then re-attached.

3. If repair is necessary to the sheer strake, the upper edge of the strake should be fair and smooth and any attachments should be faired in with curved brackets. Welding should be done with low hydrogen electrodes or using a 1500 F preheat throughout the operation.

4. Welding of heavy deck fittings to the working deck should use the same techniques described above. Ends of deck fittings should be kept clear of deck butts and seams. Fittings should be properly spaced and trimmed of sharp corners to minimize local stress concentrations.

5. Insert Plates

a. Repairs involving less than a full plate should be made with inserts rather than doubler type patch plates. Patch plates should be used only for emergency repair, and then with caution. When less than complete plates are replaced, the cuts and new welding should, as far as practicable, lie in existing lines of welding. Inserts should cover at least one frame space.

b. The welding sequence should be chosen considering the restraint imposed by the structure surrounding insert plates to minimize locked in stresses. Care must be taken when welding on or near existing welds.

6. Welded doubler plates should not to be used as permanent repair measures for the main hull girder. They can be used to provide local reinforcement, as strapping to increase hull girder strength and stiffness, or to restore watertight (not oiltight) integrity in non-strength areas. The corners of the doubler should be tapered and well rounded, and the plating to which it is attached should be in good condition to ensure efficient attachment.

7. Damaged or wasted sections of structural members (frames, beams, stiffeners) should be cropped out and replaced with new material. There should be sufficient material in the remaining portion of the member to permit sound attachment of the new material and sufficient room to permit a good weld. Otherwise, the entire member should be renewed.

8. Coast Guard NVIC 7-68, "Notes on Inspection and Repair of Steel Hulls," contains more detailed guidelines on repair to steel vessels.

ALUMINUM VESSELS

A. Deterioration

1. Aluminum hulls generally do not exhibit excessive corrosion under normal operating conditions. Areas where water collects and which are largely inaccessible should be treated with a heavy mastic coating or be constructed with special alloys designed to resist exfoliation. Exfoliation, characterized by swelling, flaking and an accumulation of a white aluminum hydroxide powder, can also occur near intersections of aluminum and steel plating. Aluminum alloys in contact with dissimilar metals, locally exposed by coating failures, or having prolonged contact with steel piers can corrode at an accelerated rate. Such conditions may occur between faying surfaces of aluminum and other metals, or when non-aluminum piping passes through aluminum bulkheads, decks, hull, etc. In such cases, aluminum should be isolated from the other metal by means of suitable non-water absorbing insulating tapes coatings or gaskets or by use of special pipe hangers or fittings. The use of sacrificial anodes are also a cost effective way to combat generalized corrosion of aluminum hulls in sea water. Aluminum in contact with wood, insulating materials or concrete should be protected against the corrosive effect of impurities in these materials by suitable coverings or coatings.

2. Mercury or copper-based anti-fouling systems are not recommended as they can cause severe corrosion of the aluminum. Instruments containing mercury, such as thermometers, barometers, or switches should not be carried because spilled mercury on aluminum can create a serious corrosion problem if not completely cleaned up.

3. Electrical shore ties should have a separate transformer for each aluminum vessel to prevent it from becoming an anode for another vessel.

B. Inspection Inspection of aluminum vessels is similar to that for steel. Aluminum is more susceptible to fatigue cracking than steel. Small cracks will likely occur at intersections of structural members and penetrations through decks and bulkheads. Fatigue cracks are formed easily in aluminum and will continue to grow if not corrected.

C. Repairs

1. Aluminum vessels should be repaired using many of the same principles as for steel hulls. Old material should be replaced with material of the same alloy and temper. It is likely that

most aluminum fishing vessel hulls are made of 5083, 5086 or 6061 alloy, but this should be confirmed by noting stenciled marks on the inside of plating or checking with the manufacturer of the vessel. Weld filler wire for repairs should be selected to match the alloy. Most welding on aluminum is done with inert gas welding processes (gas tungsten arc or gas metal arc). Shielded metal arc welding or use of flux-cored electrodes is not recommended as they may result in inferior welds, because the flux is corrosive to aluminum and is difficult to remove. Repair of cracks in aluminum structures requires special care because cracks in aluminum do not usually follow a straight line through the thickness of the material. Complete removal of the crack must be assured by examining both sides of the plate. Cracks probably cannot be stopped by drilling out the ends, or adding more material in the form 0£ doubler plates. Doublers may add additional stress concentrations while providing no resistance to further crack propagation. It is essential that cracks be welded from both sides; the first side is welded, the root ground to sound metal from the second side, and then the second side is welded. As with any repair weld, sharp notches at the weld toe or in the reinforcement must be ground to blend smoothly with surrounding metal. Where proper crack repair cannot be obtained, or where repaired cracks have re-cracked, it is advisable to cut that portion of the plating out and replace with an insert, not a doubler plate.

2. Proper welding sequence and procedures are extremely important in, welding aluminum due to high heat input and consequential expansion of the metal. The American Welding Society "Guide for Aluminum Hull Welding," ANSI/AWS D3.7-83 is a good reference for aluminum hull welding.

WOOD VESSELS

A. Deterioration Wooden hulls are affected mostly by decay and marine borers. This kind of deterioration can occur with surprising rapidity. Marine borers can attack any kind of wood regardless of the method of protection. Borers can enter the wood through hairline cracks or scrapes in the bottom paint. If borer attack is caught early, the holes can be burned clean and filled with a suitable compound. However, extensive damage can only be repaired by replacement of the wood. The best way to prevent borer attack is to keep the worm away from the wood. This is accomplished by sheathing or by toxic paints. The sheathing and bottom paint should be inspected often for nicks and scratches which render the sheathing and paint ineffective.

B. Inspection

1. A thorough internal inspection of wooden hulls should be conducted yearly to determine if hauling out is necessary. A severe problem on the outside will be apparent from the inside. Wooden vessels must be inspected for cracks, broken members, failures of fastenings and caulking, and damage due to collision or grounding. Distorted planking, cracked paint, pulled butts between planking, local damage, and unexplained wetness are telltale indications of potential problems.

2. In general, areas which are hard to maintain, have poor ventilation, or are subject to heavy stresses have the most damage. Particular attention should be paid to the stern and transom, regions under covering boards, the splash zone, and around hull fittings.

3. A wooden vessel is best inspected for leaks immediately after hauling out, and for decay and borers when completely dry. Decay can be detected by sounding with a hammer.

Sound wood will give a solid quick response when tapped with a hammer. Unsound wood will give a dead or dull sound. Rotted out timbers give a distinctive drum sound. Probing and boring should not be done as a matter of routine as it can help to start decay. It is important to remember that decay can progress rapidly. It is more economical to repair small decayed areas early rather than make major material replacement later due to neglected repairs.

4. Specific inspection items for wooden hulls are included below.

a. Fastenings which are loose, broken or wasted often result in sprung butts or in planks which are loose, or chatter when sounded with a hammer. Loose planking is best corrected by additional fastenings if there is sufficient room to obtain good holding power without weakening the planking. Often, the framing structure itself may be decayed and must be made sound before new fastenings can be installed. Rudder and propeller strut fastenings should be closely examined.

b. Caulking is subject to deterioration and should be checked often and replaced as necessary. Caulking should be applied evenly, without pushing it through the seams. Allowance must be made for expansion of the planking as it absorbs water.

c. Cracks or broken structure will most likely occur in areas of high stress or where the structure undergoes a sudden change in shape. The turn of the bilge is a prime location for damage. Wooden hulls are more prone than steel hulls to secondary damage remote from the site of collision or grounding. Damage may consist of pulled fastenings, sprung or cracked frames, and misalignment of the structure. Because of secondary damage, the entire hull should be inspected if serious damage is found.

C. Repairs

1. When it is necessary to replace planks in the structure, the supporting structure should be thoroughly inspected and restores to good condition as needed. Old fastening holes should be plugged to ensure that new fastenings will hold. Planks should be replaced in their entirety. Replacement planks should extend for at least six frames, and should not be less than five feet long. Butt joints should be staggered as much as possible (both horizontally and vertically in double skin boats) and should be mechanically fastened, never glued.

2. Portions of a plywood panel should not be replaced. A plywood patch may be used for temporary repairs for small damaged areas. In this case, the patch should be flush, have backing blocks, and be sealed with a suitable compound. All decayed material must be removed. Plywood is susceptible to decay, which can spread rapidly in all directions. Plywood replacement panels should be of marine grade plywood.

3. Fastenings should be equal in size and number to those in the rest of the planking. Ferrous fastenings should be galvanized. Brass or bronze fastenings, bolts or washers should not be used in conjunction with steel fasteners as they will cause excessive corrosion of the steel.

4. Damage (not decay) to a single frame or several scattered frames may be repaired by the use of sister frames. They should not be used on two adjacent frames. The sister frame should be at least as large as the original frame and as long as possible. It should be

fastened to the planking in the same manner as the original, with a preservative used on all faying surfaces. Decayed frames should not be "sistered" as the decay can rapidly spread to the sister frame. The only acceptable alternative is to replace the entire frame.

5. Fiberglass reinforced plastic (GRP) should only be used as a temporary repair in wooden structures. It does not provide the strength of wood, it develops cracks under stress allowing the entry of marine borers, it does not adhere to painted or preserved surfaces well, and it permits continued decay under the glass. Full GRP sheathing of an existing wooden hull to restore strength and watertightness is not recommended due to the possibility of covering over existing decay.

6. Additional details regarding repair methods, materials, preservatives, decay and marine borers is found in NVIC 1-63, "Notes on Inspection and Repair of Wooden Hulls."

FIBERGLASS REINFORCED PLASTIC (GRP) VESSELS

A. Deterioration

1. GRP will not corrode or decay, but is susceptible to progressive deterioration due to aging, built-in construction defects, or damage in service. Over time fiberglass surfaces will craze and check, which does not seriously degrade strength if repaired early. Fiberglass laminates can begin to break down and produce voids if water finds its way in. This can happen as a result of chips and surface cracks in the exterior gel coat.

2. Care is taken during GEP construction to control the laminating process, the temperature and humidity, and in the final inspection procedures; for this reason, most GRP boats are basically maintenance-free. Still, defects found during the service of a GRP vessel include the following:

   a. Voids or air bubbles created during construction by air entrapped in the resin, excessive heat produced during curing, or by failure to work out the air trapped under a ply of reinforcement during lamination;

   b. Delaminations in areas where the bond between adjacent plies in the laminate has failed, or was never achieves; and

   c. Surface flaws such as crazing (small cracks), pitting, alligator skin, blistering and peeling, caused by poor fabrication practice. These do not seriously affect the strength of the hull, but should be repaired to prevent further deterioration.

3. GRP decks and working areas can survive extended wearing under normal conditions but are susceptible to damage from impact loads. Many decks are made of GRP laid up over marine plywood. This provides a strong deck, but can cause problems if the GRP coating becomes damaged and water gets between the plywood layers, separating them and causing rapid deterioration.

B. Inspection

1. Inspection is required annually to detect and repair defects which were not found during construction or which have occurred due to abuse in service. GRP vessels should also be

hauled out about every two years for a complete hull inspection. Detrimental structural cracks in GRP will usually occur in areas of stress concentrations. Special attention should be given to areas which contain wood or other materials encased in laminates.

2. Determination of the quality of the laminate can be made by observing transmitted light and sounding the laminate. This inspection should be done prior to applying any gel coats. Under a strong light shining through the hull, a good laminate will appear uniformly translucent with only minor variations. When tapped with a coin or other hard object, a good laminate produces a clear, hard sound. A dull or muffled sound indicates the presence of substantial quantities of air bubbles, that delimitation has occurred, or that the resin has not properly cured. When tapping, attention should be given to the laminate in restricted areas such as sharp bends where it was difficult to work out entrapped air in constructing the laminate.

3. Construction details are very critical on GRP vessels and must be routinely inspected. The shell-to-deck connection is critical since failure of this joint may lead to failure of the structure as a whole even though the shell and deck laminates and framing are sound. Local damage due to impact should always be repaired as 800n as possible to prevent progressive failure.

4. Deterioration of sandwich construction is very difficult to determine until it is well advanced. Structural failures in sandwich panels are best detected by checking for flatness or fairness. Shear failure of the core usually takes place at the edge of a panel along the line of support and will appear as a small jog in the surface. Failure of the bond between the facings and core may be detected by tapping for differences in sound. In very severe cases the facing may actually be wrinkled. If the facings are very thin, a change in the color of the facing may be noticeable in the area where the bond has been broken.

5. Local failure due to impact, often caused by dropping a heavy object on the deck, will appear as a permanent dimple in the surface usually accompanied by a change in color of the facing such as that which results from facing-core delimitation. Most common core materials lack resilience under local impact loads and retain a permanent deformation.

C. Repairs

1. Damage is usually restricted to the immediate area of impact although inspection after damage should include the entire hull.

2. Minor Repairs

a. Repairs to surface damage consist of little more than filling voids and scratches with gel coat from a commercially available repair kit.

b. Minor damage to the laminate, where only one or two layers of reinforcing fiber are broken, will require an some additional steps. The damaged laminate should be carefully ground or sanded out, the edges tapered, and the gap layed up with a laminate similar to original, with cloth on the outside layer if the repair is external. Then the pure resin gel coat can be placed to match the surface and provide the finish.

3. Major Repairs

a. Repairs to holes or significantly cracked areas require a series of steps which are summarized here. More complete guidance should be obtained from an experienced repair facility or one of the many manuals and guides available from fiber and resin manufacturers. One of these is the Gibbs and Cox Fiberglass Marine Survey Manual, reference H.10.

b. Major repair steps are:

(1) Prepare a male or female mold or template to lay the repair up against.

(2) Cut out the damaged area, using edges beveled wider towards the side the repair is to be worked in a slope of at least 8 to 1 and preferably 16 to 1, rough the surrounding surfaces and clean thoroughly to provide a good working surface for the secondary bond.

(3) Coat the mold with mold release and attach.

(4) Build the repair, following the original lay up sequence or, if that is not known or available, use alternating layers of chopped strand mat and woven roving soaked in resin.

(5) Work air bubbles out of each layer as it is applied.

c. Some additional notes to consider are:

(1) Use an epoxy resin for a better secondary bond.

(2) Apply a good gel coat outside a cloth layer to help prevent water penetration.

(3) Saturate any wooden reinforcing members with resin for a quality bond.

(4) Consult the builder for repairs to unidirectional fiber reinforced hull or framing members.

(5) Repairs to thin laminates may require reinforcing laminations over the repaired area to hold it in place.

LIST OF REFERENCES AND OTHER STANDARDS

A. Abbreviations

1. ABS American Bureau of Shipping 45 Eisenhover Drive, Paramus, NJ 07652

2. AWS American Welding Society 2501 N.W. 7th St., Miami, FL 33125

3. ABYC American Boating and Yachting P.O. Box 806, Amityvilie, NY11701

4. CFR Code of Federal Regulations Superintendent of Documents U.S. Government Printing Office, Washington, DC 20402

5. IMCO Inter-governmental Maritime Consultive organization (now IMO)

6. IMO International Maritime Organization 4 Albert Embankment, London SEl 75R, England

7. LR Lloyds Register of Shipping 17 Battery Place, New York, NY 10004

8. NVIC Navigation and Vessel Inspection Circular Commandant (G-MP-2)
United States Coast Guard
2100 Second St. S.W., Washington, DC 20593

or

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

9. SNAME Society of Naval Architects and Marine Engineers Publications Coordinator One World Trade Center, Suite 1369, New York, NY 1004822

10. USCG United States Coast Guard 2100 Second St. S.W., Washington, DC 20593

B. USCG Regulations

1. Oil Pollution Prevention Regulations for Vessels (33 CFR Part 155)

2. Load Lines (46 CFR Parts 42-46)

3. Cargo and Miscellaneous Vessels (46 CFR Parts 90-106)

4. Small Passenger Vessels (46 CFR Parts 175-187)

C. Navigation and Vessel Inspection Circulars (NVICB)

1. NVIC 1-63 Notes on Inspection and Repair of Wooden Hulls

2. NVIC 7-68 Notes on Inspection and Repair of Steel Hulls

3. NVIC 3-80 Acceptance of Gel Coats and Composite Laminate Coatings Which Meet 46 CFR 177.lO-5(a-l)

4. NVIC 11-80 Structural Plan Review Guidelines for Aluminum Small Passenger Vessels

5. NVIC 15-81 Guidelines for Conducting Stability Tests

6. NVIC 12-82 Recommendations On Control of Excessive Noise

D. American Bureau of Shipping Standards

1. Rules for Building and Classing Steel Vessels Under 61 Meters (200 feet) in Length

2. Rules for Building and Classing Reinforced Plastic Vessels
3. Rules for Building and Classing Steel Vessels

4. Approved Welding Electrodes for Wire-Flux and Wire-Gas Combinations with Appendix on Rules for Approval

5. Rules for Building and Classing Aluminum Vessels

6. Rules for Nondestructive Inspection of Hull Welds

E. American Welding Society Guides

1. Guide for Steel Hull Welding

2. Guide for Aluminum Hull Welding (ANSI/AWS D3.7-83)

F. Lloyds Register of Shipping Rules

1. Rules and Regulations for the Classification of Yachts and Small Craft

2. Provisional Rules for the Application of GRP to Fishing Craft

3. Rules and Regulations for the Construction and Classification of Steel Ships

4. Rules for the Hull Construction of Steel Ships Under 90 Meters (295 feet) in Length

G. International Maritime Organization Codes

1. International Conference on Safety of Fishing Vessels 1977, Final Act of the Conference, with attachments, including the Torremolinos International Convention for the Safety of Fishing Vessels, 1977

2. FAO/ILOIIMCO Voluntary Guidelines for the Design, Construction and Equipment of Small Fishing Vessels, 1980

H. Other References

1. American Boating and Yachting Council: Safety Standards for Small Craft (revised annually)

2. Bureau Veritas: Rules and Regulations for the Classification of Steel Vessels, Volume F, Fishing Vessels, 1250 Broadway, New York, NY 10001

3. Bureau Veritas: Rules and Regulations for the Construction and Classification of Wooden Fishing Vessels with Amendments (1970)

4. Canada: Regulations Respecting the Construction and Inspection of Fishing Vessels Not Exceeding Eighty Feet in Registered Length, Transport Canada, Place de Ville, Ottawa, Ontario, KIA 0N7

5. Det Norske Veritas, Rules for Classification of Steel Ships, Part 5, Chapter 6, Fishing Vessels, 111 Galway Place, Teaneck, NJ 07666

6. Det Norske Veritas, Rules for the Building and Classification of Wooden Vessels, 1970

7. Det Norske Veritas, Rules for the Construction and Certification of Vessels less than 15 meters

8. Edmunds, Arthur H.: Fiberglass Boat Survey Manual, John de Graf, Inc., Clinton Corners, NY, 1979

9. Germanischer Lloyd: Rules for the Classification and Construction of Seagoing Steel Ships (1982), 11 Broadway, New York, NY 10004

10. Gibbs & Cox, Inc. and Owens-Corning Fiberglass Corp.: Marine Survey Manual for Fiberglass Reinforced Plastics, 1962

11. Her Majesty's Stationery Office: The Fishing Vessels (Safety Provisions) Rules 1975. P.O. Box 569, London SEl 9NH, England

12. Her Majesty's Stationery Office: Survey of Fishing Vessels Instructions for the Guidance of Surveys 1975.

13. Holtyn, C. H.: Corrosion Protection Guidelines for Aluminum Hulls; Marine Technology, Vol. 22, No. 2, SNAME, April 1985, pp. 155-163

14. Pike, Dag: Fishing Boats and Their Equipment, 1979. Available from Fishing News Books, LTD, London, England, 1979. ISBN # 0 85238 0909

15. Roberts, John A.: Fiberglass Boats - Construction, Repair, and Maintenance, W.W. Norton & Co., New York, 1984

16. U. S. Coast Guard: Commandant's International Technical Series; Code of Safety for Fishermen and Fishing Vessels - Part B Safety and Health Requirements for the Construction and Equipment of Fishing Vessels. Report NO. USCG CITS-13-l-l. Available from NTIS, Springfield, VA, 22151

MAINTENANCE SCHEDULES

The following lists identify specific items or areas of the vessel which should be inspected, tested, or maintained on a regular schedule. Maintenance, repairs, or replacement should be made as necessary.

A. Daily:

1. Test electronics;

2. Test navigation lights, horn, windshield wipers;

3. Test alarms;

4. Check fluid levels such as fuel oil, engine coolant, lube oil, power steering fluid, battery electrolyte, marine gear lube oil;

5. Inspect engines externally including alternator belts and controls;

6. Check engines while running for proper operation and no leaks;

7. Check drip rate at propeller shaft packing gland;

8. Check operation of watertight closing devices;

9. Make sure bilges are dry and test bilge pumps;

10. Check operation of winches;

11. Secure equipment and watertight closures; and

12. Exercise steering system from full left to full right rudder.

B. Weekly:

1. Perform a visual and operational check of electronics systems including VHF-FM transceiver system, internal communications systems, depth sounder, radar, antennas;

2. Check operation of auxiliary generators;

3. Inspect galley and fish processing equipment;

4. Inspect starting system batteries;

5. Clean sea water strainers;

6. Inspect fuel oil filters;

7. Inspect fuel system for leaks;

8. Check and test batteries;

9. Verify proper operation of propulsion, auxiliary and steering Systems while underway;

10. Check hydraulic system for evidence of leaks;

ll. Drain and refill potable water supply;

12. Inspect condition of steering gear, especially bearings in rudder and stern tube;

13. Check operation of chain stoppers, brakes, clutches, controls of hoisting systems; and

14. Grease winches and lead blocks.

C. Monthly:

1. Test shipboard lights;

2. Inspect emergency equipment such as flares, potable water, food, life preservers, anchor and rode, communications equipment, life rafts, and fire extinguishers;

3. Lubricate windshield wipers;

4. Check alternator belt tension and pulley alignment;

5. Change engine and gearbox oil and filters;

6. Check for corrosion of machinery, equipment and compartments;

7. Check main engine expansion tank, salt water pump, and raw water tank;

8. Inspect galvanic anode system upon docking;

9. Inspect compartments for leaks;

10. Inspect lines, wire ropes and chains; and

11. Lubricate all moving and sliding parts on the vessel - especially the hoisting and steering systems.

D. Quarterly:

1. Inspect electrical distribution system;

2. Replace primary fuel filters;

3. Adjust alternator belt tension and connections and components;

4. Clean air filter units;

5. Visually check engines for leaks and change fuel oil filter and crankcase breather fitting;

6. Change water filter on diesel engines;

7. Check and lubricate steering system;

8. Check condition of non-skid coatings; and

9. Check winch hydraulics.

E. Semi-annual:

1. Visually inspect watertight bulkheads and fittings;

2. Replace fuel filter and strainer;

3. Change marine gear oil and clean filter;

4. Test main engine under full load; and

5. Examine exhaust system for leaks and fire hazards.

F. Annual:

1. Replace PCV valve;

2. Renew lube oil filter elements and change lube oil (or every 500 hours whichever is sooner);

3. Adjust and clean valves in fuel system and clean fuel injection pumps and injectors;

4. Replace main engine final fuel filter;

5. Inspect hull structure for cracks and corrosion;

6. Examine propulsion system for corrosion, fracture, bent blades or shafts, worn bearings, and loose fittings; and

7. Service lifesaving equipment and firefighting equipment.

SAMPLE ANNUAL PRE-SEASON INSPECTION LIST

A. Deck

1. Condition of non-skid coatings ..... ____
2. Winch heads and drums free from grooves..... ____
3. Broken of frayed stands in lines or wire ropes..... ____
4. Condition of blocks, shackles, pins ..... ____
5. Condition of guardrails, handrails, ladders..... ____
6. Condition of standing rigging - including shackles, hooks, lines, boom,..... ____ outriggers, poles, davits, stays
7. Condition of anchor and rode and winch ..... ____
8. Condition of mooring or tie-up equipment..... ____
9. Are all machinery belts guarded..... ____
10. Condition of running rigging..... ____

B. Hull

1. Condition of decking ..... _____
2. Condition of fish-hold..... _____
3. Condition of all hatches..... _____
4. Underwater inspection (if performed) satisfactory ..... _____
5. Sea-suction and discharge valves in good condition..... _____
6. Condition of propulsion system - especially screw and shaft..... _____
7. Condition of navigation lights..... _____

C. Watertight Integrity

1. Watertight (WT) doors..... _____
2. Hatches and closing appliances..... _____
3. WT closures for thru-hull openings..... _____
4. Engine room WT bulkheads ..... _____
5. WT bulkheads, doors and hatches..... _____
6. Hatch coamings ..... _____
7. Drainage of deck..... _____
8. Collision bulkhead..... _____
9. Portholes..... _____

D. Lifesaving Devices

1. Liferaft releasing gear properly adjusted..... _____
2. Liferaft serviced annually..... _____
3. Liferaft painter permanently secured..... _____
4. Crew knowledgeable on safety procedures ..... _____
5. Life-jackets Coast Guard approved..... _____
6. One life-jacket per person on board ..... _____
7. PFDs in good condition ..... _____
8. Ringbouys and associated lines in good condition..... _____
9. Distress or emergency flares in good condition..... _____
10. Emergency position indicating radio beacon in good condition..... _____
11. Emergency rations located near liferaft ..... _____

E. Engineroom

1. Foundations secure..... _____

2. Hydraulic valves in good condition ..... _____
3. Belts and chain drives guarded ..... _____
4. Electrical wiring in good condition..... _____
5. Ventilation adequate..... _____
6. Emergency shut-off of engine from outside of engineroom..... _____
7. Switchboard circuits identified..... _____
8. Tools secured..... _____
9. Metal receptacle with self-closing cover for oily rags ..... _____
10. Backfire flame control on gasoline engines..... _____
11. Fuel tank vent leading outside..... _____
12. Fuel tank fill pipe outside, on deck, so spilled fuel flows overboard ..... _____
13. Carburetor drip-pan ..... _____
14. N on-oily deck..... _____
15. Stuffing box in good condition..... _____
16. Steering gear, cables, etc. in good condition ..... _____
17. Exhaust system in good condition and provides from fire and fumes..... _____
18. Firefighting equipment handy ..... _____
19. Ventilators clean ..... _____
20. Adequate lighting ..... _____
21. Bilge pump in good condition ..... _____
22. Engine manifold cooling and exhaust lagging..... _____
23. Fuel supply piping in good condition ..... _____
24. Ballast piping in good condition..... _____
25. All other pumps and piping in good condition ..... _____

F. Electrical Equipment

1. Primary power and lighting systems in good condition ..... _____
2. Main engine and auxiliary generators in good condition ..... _____
3. Batteries in good condition ..... _____
4. Wiring insulation in good condition ..... _____
5. Motors, generators, alternators and controllers in good condition..... _____
6. Ignition wiring in good condition ..... _____
7. Navigation lights in good condition..... _____
8. Condition of radio, depth finding equipment, sonar, radar, loran, back-up ..... _____
   fuses and navigation compass

G. Gallery

1. Stove manufactured for marine use..... _____
2. Firefighting equipment nearby ..... _____
3. Cooking surface sectioned to prevent pots sliding in heavy seas..... _____
4. Lids of pots designed to prevent spilling of liquids ..... _____
5. Latches on all drawers and doors in good condition..... _____

H. Pilothouse

1. All electronic equipment in good condition.....
2. All electronic equipment protected against vibration, breakage and chafing..... _____
3. Up to date navigation charts on board..... _____
4. Smoke, flame and parachute flares on board .....

I. Forecastle
1. Sand bucket or tray for cigarettes ..... _____
2. Fire extinguisher handy ..... _____
3. Heating by other than flame type system ..... _____
4. Adequate lighting ..... _____
5. Condition of hooks on drawers and doors ..... _____

J. Firefighting Equipment
1. Minimum approved extinguishers aboard ..... _____
2. Extinguishers hung in easy-to-reach positions ..... _____
3. Extinguishers full by weight (C02) or by pressure (dry chemical) ..... _____

K. Alarms and Alarm Systems
1. Alarm signals within hearing range ..... _____
2. All alarms working especially those for engine oil temperature, engine ..... _____
water temperature, water in the bilge, fire and smoke, water in the voids, high pressure

L. Fishing Equipment and Gear
1. Location of winch controls ..... _____
2. Condition of towlines and links ..... _____
3. Condition of back deck lighting ..... _____
4. Condition of net reels ..... _____
5. Condition of hydraulics ..... _____
6. Knives handy ..... _____
7. Condition of main and lifting booms ..... _____
8. Condition of bulwarks and rails in the working area ..... _____
9. Condition of blocks and launchers ..... _____
10. Safety chain on lifting blocks for boom ..... _____
11. Condition of hydraulic systems for any fishing equipment ..... _____

M. Other
1. First-aid kit in good shape and easy to reach ..... _____
2. Crew familiar with all safety procedures including emergency evacuation, ... _____
survival techniques
3. Paint and solvents stowed in closed, well vented, approved safety containers ..... _____
4. Crew familiar with safety equipment and location ..... _____

CHAPTER 6 - MACHINERY INSTALLATIONS

INTRODUCTION

These recommendations are intended to serve as a guide for the installation, operation and maintenance of marine engineering systems and equipment on fishing vessels. They suggest good general practice to ensure the suitability and durability of equipment, and the safety of the vessel and its crew. Additional guidance can be found in the Modern Marine Engineer's Manual, Vol. 1, by A. Osborne and published by the Cornell Maritime Press, Inc.; the rules published by the various classification societies such as the American Bureau of Shipping; the Coast Guard Marine Engineering Regulations (46 CFR 50-64); and National Fire Protection Association (NFPA) standard 302, "Pleasure and Commercial Motor Craft." Various design and operating standards for marine systems and equipment are referenced in the Coast Guard Marine Engineering Regulations. These include the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code as well as numerous American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI) and Manufacturers' Standardization Society (MSS) Standard Practices for Pipe, Tubing and Pipe Fittings. These should be consulted when additional, detailed information is required.

MARINE SYSTEMS AND EQUIPMENT

A. General

1. Machinery, boilers, and pressure vessels should be of a design and construction adequate for the service for which they are intended and be installed and protected so as to minimize any danger to persons on board. Boilers, Pressure Vessels, and Hot Water Heaters that are built to ASME or Underwriters Laboratories (UL) standards are commercially available and are recommended.

2. All controls for operating the machinery, equipment measuring devices (e.g. pressure gages), pumping systems and arrangements, valves, cocks, air pipes, inlets, sounding pipes, switches, etc. should be permanently marked to clearly show their purpose. All handwheels should be marked to show the direction of closure, which generally should be clockwise.

3. Machinery spaces should be designed to provide safe and free access to all parts of the machinery which may require servicing at sea.

4. Steam fittings, steam pipes, exhaust pipes, and other hot surfaces within reach of personnel should be properly insulated or otherwise protected to prevent accidents or burns. Hot surfaces which could cause ignition should be protected from all possible contact with combustible liquid.

5. Railings on gratings in the machinery spaces should consist of a handrail and guard rail where practicable; toe boards should be attached to the edge of all gratings when appropriate.

6. Engines, electric motors, gearing, chain and belt-drivers, friction clutches and shafting which can cause injury to personnel should be provided with adequate guards or otherwise protected.

7. Floor plates should be properly fitted and secured in place and should have a non-slip surface where practicable.

8. Machinery space ladders should be steel, well maintained and fitted with non-slip treads. Adequate handrails should be provided.

9. On vessels not equipped with pilothouse controls, an efficient communication system should be provided between the principal steering station and the engineroom. Due account of the noise level in the engine room should be taken in selecting and locating the means of communication.

10. Machinery spaces which will be periodically unattended at sea should be provided with proper alarm, detection and machinery control systems.

11. Valves and cocks not forming part of a piping system should not be permitted in watertight bulkheads.

12. An adequate number of Spare parts, including Spare Fuses, Engine Belts, Filter Elements, Pump Impellers, etc. Should be available on board the Vessel.

13. Non-Metallic Flexible Hose used in Fuel, Lubricating or Hydraulic Oil Service should be wire Reinforced and have a Fire Resistant, Self-Extinguishing Outer Jacket.

14. PVC and other Non-metallic Pipe should not be used in Fuel Oil and Fire Fighting Systems.

B. <u>Boilers, Hot Water Heaters and Pressure Vessels</u>

1. Means should be provided to prevent overpressure in all boilers and other pressure vessels. Every boiler should be provided with not less than two safety valves except that only one safety valve may be fitted if, when considering the steam output or any other features of the boiler, the valve has adequate capacity to protect against overpressurizing the boiler. Each hot water heater and each unfired pressure vessel should be provided with at least one relief valve of adequate capacity to prevent overpressure.

2. Prior to installation, and at periodic intervals which should not exceed 3 years, every boiler or other pressure vessel and its mountings should be internally and externally inspected and subjected to a hydrostatic test at a pressure of 1 1/4 times its normal working pressure to ensure it is adequate in strength and design for the intended service, having regard to:

a. The design and the material of construction;

b. Its intended purpose; and

c. The working conditions under which it is intended to be used.

C. Boiler and Hot Water Heater Feed Systems

1. Every boiler, which could become dangerous by the failure of its feed water supply, should be provided with not less than two efficient and separate feed water systems so arranged that either of the systems may be opened for inspection or overhaul independently of the other. Means should be provided which will prevent overpressure in any part of the systems.

2. Valves, fittings and pipes in feed water systems should be designed and constructed to a pressure which exceeds the normal working pressure of the boiler. Valves, fittings or pipes should, prior to installation, be subjected to a hydrostatic test of at least 1.5 times their rated pressure.

3. Water level indicators, pressure gauges and other measuring devices should be so installed and illuminated as to be readily visible.

4. Where it is possible for oil to enter the feed water system of a boiler or a hot water heater, arrangements should be provided for extraction of the oil in the feed water.

5. Boiler feed systems should be maintained in an efficient condition and the feed pipes should be adequately supported.

6. Provision should be made to ensure that an adequate reserve of feed water is available.

D. Steam and Exhaust Pipe Systems

1. Steam piping systems should be designed and constructed to withstand the maximum working pressures to which they may be subjected, with an adequate factor of safety, having regard to:

a. The material of which they are constructed; and

b. The working conditions under which they will be used.

2. Each steam pipe or fitting should, prior to being put into service for the first time, be subjected to a hydrostatic test of 1.5 times its rated pressure. Each steam pipe or fitting should be maintained in an efficient condition.

3. Where fitted, main and auxiliary steam stop valves should be operable by one person, readily accessible and arranged to seat against boiler pressure.

4. Where more than one power boiler is fitted, the auxiliary steam piping should be 80 arranged that steam can be supplied from any power boiler.

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5. Steam pipes should not be led through dry cargo spaces. In vessels built of materials other than steel, steam piping should be insulated so that structural materials adjacent thereto are neither ignited nor rendered ineffective by heat.

6. Where positive shut-off valves are fitted in steam exhaust lines of machinery, and the exhaust lines are not designed for the maximum inlet pressure, relief valves of sufficient capacity should be fitted between the machinery exhaust and the shut-off valves.

7. Where a steam range may receive steam from any source at a higher pressure than it can withstand with an adequate factor of safety, an efficient reducing valve, relief valve and pressure gauge should be fitted.

8. Steam pipes should be adequately supported to avoid damage due to variation in temperature, vibration or the like.

9. Flanges in steam pipe systems should not be situated above or in the vicinity of switchboards or other electrical equipment. Where this is not practicable, provision should be made to prevent leakage onto the equipment.

E. Diesel Engine Exhaust Systems

1. Th e exhaust pipes should be water-jacketed or effectively insulated. Exhaust pipes of several engines should not be connected together, but should be run separately to the atmosphere unless arranged to prevent the return of gases to an idle engine.

2. Ex haust lines which are led overboard near the waterline should be protected against the possibility of water finding its way inboard. Boiler uptakes and engine-exhaust lines should not be connected.

F. Compressed Air Systems

1. Where machinery is required to be started, operated or controlled solely by compressed air, the vessel should be provided with an efficient air system, including an adequate number of air compressors and air receivers, arranged to ensure that an adequate supply of compressed air is available under all foreseeable service conditions.

2. Compressed air systems and their component parts, other than pneumatic control systems, which are subjected to air pressure, should be designed and constructed to a pressure equivalent to the maximum working pressure of the system. Prior to being put into service for the first time, compressed air pipes and fittings should be subjected to a hydrostatic test at least 1.5 times the system's maximum working pressure.

3. Adequate pressure relief devices should be provided to prevent overpressure in any part of a compressed air system including water jackets of casings of air compressors and coolers which might be subjected to overpressure due to leakage into them from air pressure parts. Relief Valves should be periodically tested and kept in proper operating condition.

4. Discharge pipes from starting air compressors should lead directly to the starting air receivers. Starting air pipes from the air receivers to main or auxiliary engines should be separate from the compressor discharge pipe system.

5. Where a compressed air pipeline may receive air from any source at a higher pressure than its design pressure, an efficient reducing valve, relief valve and pressure gauges should be fitted.

6. Provision should be made to drain condensation from air systems and to minimize the possibility of oil entry into any compressed air system.

7. Compressed air systems should be maintained in an efficient working condition.

G. Cooling Water Systems

1. Where cooling water systems are essential for the operation of main propulsion machinery, there should be at least two means of supplying water to these systems.

2. Sea inlets and discharges for cooling water systems should be fitted with a shutoff valve located as near the shell plating as practicable. Additionally, discharges should be equipped with automatic non-return valves The shutoff valve could be locally controlled if it is located in a manned machinery space. Valve controls should be readily accessible and should be provided with an indicator to show whether the valve is open or closed. In unmanned machinery spaces, all sea inlets and discharges should be remotely operable from an accessible location outside of the compartment in which they are located.

3. The sea water suctions of cooling systems for essential machinery should be provided with strainers which can be cleaned without interruption of the supply of water.

H. Hydraulic and Lubricating Oil Systems

1. Where oil for lubrication, cooling or operation of the main propulsion machinery and its auxiliaries is circulated under pressure, provision should be made for circulating oil in the event of failure of a pump.

2. Strainers capable of being readily dismantled for cleaning or replacement of the strainer element should be provided.

3. Pipes used to convey lubricating oil, cooling oil or hydraulic oil should be made of suitable material and should be properly installed$_1$ Pipes, joints and fittings should, before being put into service for the first time, be subjected to a hydrostatic test of at least 1.5 times their rated pressure (following this testing these systems should be thoroughly cleaned and blown dry - see General Machinery Maintenance section)

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ge glasses fitted to lubricating oil or hydraulic oil tanks should be of substantial construction, adequately protected and fitted with self-closing arrangements on the tank.

5. Nonmetallic flexible hoses in lubricating oil, cooling oil and hydraulic systems should be suitable for the intended service and limited, in general, to reasonable lengths where required for flexibility.

6. Adequate means should be provided for indicating failure of the lubricating oil system.

I. Fuel Oil Systems

1. Fuel oil used in boilers or machinery should have a flash point of not less than 60^0C / 140^0F (Closed Cup Test), except that, where the emergency source of electrical power is a generator driven by an internal combustion engine having an independent fuel supply and with efficient starting arrangements, the oil fuel provided shall have a flash point of not less than 43^0C / 105^0F.

2. Pumps forming part of the fuel oil system should be separate from the feed pumps, bilge pumps and ballast pumps and their systems and should be provided with a relief valve discharging back to the suction side of the pump.

3. Where a gravity fuel oil system is installed, filters should be provided which are capable of being cleaned without interrupting the supply of fuel oil.

4. Means should be provided under every fuel oil pump, filter, heater, etc. to prevent escaping oil from coming into contact with heated surfaces.

5. Fuel oil tanks which are not integral should be constructed of suitable material. These tanks should not be located directly above boilers, heated surfaces, stairways, ladders, or electrical installations.

6. Adequate means should be provided for sounding fuel oil tanks.

7. Piping subject to internal head pressure from fuel oil in a tank should be provided with positive shutoff valves located at the tank. The valve(s) should be arranged for local manual control at the valve and from a readily accessible and safe location outside of the compartment in which the valve(s) are located.

8. Nonmetallic flexible hoses in fuel oil systems should be suitable for the intended service and limited, in general, to reasonable lengths where required for flexibility.

9. Vent lines should be led from fuel oil tanks to weather and the outlet should be located so that there will be no danger of fire or explosion resulting from the venting of oil vapor from the pipe. Pipes should be fitted with flame screens of non-corrosive material.

10. Where fuel oil vent lines also serve as overflow lines, provision should be made to prevent the overflow running into or near any space where ignition may occur. Vent lines from fuel oil tanks and cross flooding lines attached to tanks should have a net cross-sectional area not less than 1.25 times that of fill lines.

11. Where steam is generated for main propulsion or essential auxiliary machinery by burning fuel oil under pressure, not less than two fuel oil units should be provided, each comprising a pressure pump, filters and a heater. The pump, filters and heater shall be of efficient design and substantial construction. Piping systems conveying oil that does not need to be heated for service should not have fuel oil heaters installed and should not be interconnected in such a manner that the oil can be heated in other fuel oil systems. Provision shall be made to prevent overpressure in any part of the fuel oil units.

12. Removable oil burners for boilers should be so constructed as to be removable only after the burner's fuel oil valve has been closed. To ensure the correct sequence for turning on and off fuel oil burners of boilers, fuel oil valves and air dampers should be so arranged that fuel oil inlet valves can be opened only after air inlet dampers have been opened, and that in turning off oil burners, air inlet dampers can be closed only after fuel oil inlet valves have been secured.

J Fuel Oil Installations (cooking ranges and heating appliances)

1. Where cooking ranges are supplied with fuel from an oil tank, the tank should be located outside the space containing the cooking range and the supply of oil to the burners should be capable of being controlled from outside that space. Means should be provided to shut off the fuel supply automatically at the cooking range or heating appliance in the event of fire or if the combustion air supply fails. Such means should require manual resetting in order to restore the fuel supply.

2. The oil tank supplying the cooking range should be provided with a vent line leading to weather, and in such a position that there will be no danger of fire or explosion resulting from the venting of oil vapor from the vent outlet. The outlet should be fitted with a flame screen of non-corrosive material.

3. Means should be provided for filling every such tank and for preventing overpressure. Every space in which a fuel oil tank or any part of a fuel oil installation is situated should be adequately ventilated. Reference should be made to "Recommended Fire Safety Measures for Uninspected Commercial Fishing Vessels," Section I, Part F for further guidance on portable heaters and cooking appliances.

K. Liquefied Petroleum Gas Installations (cooking ranges and heating appliances)

1. All gas-consuming appliances used for cooking and heating should be of a type tested and found satisfactory by a nationally recognized testing laboratory. Continuous-burning pilot flames should not be used on gas appliances when installed below deck.

2. Spaces where appliances consuming liquefied petroleum gas are used should be adequately ventilated. Mechanical ventilation systems fitted to any space in which gas cylinders or appliances are located should be of non-sparking design. The ventilation systems serving spaces containing gas cylinders or gas-consuming appliances should be separate from any other ventilation system. LPG cylinder compartments should be vented from the bottom and CNG cylinder compartments should be vented at the top.

3. An odorant should be added to the gas to enable gas leakage to be detected by smell, even when its concentration is lower than its lower flammable limit (LFL).

4. Printed instructions for proper installation, operation and maintenance of each gas-consuming appliance should be furnished by the manufacturer and should be available for use on the vessel.

L. Storage of Flammable Liquids, Toxic Liquids, Toxic Gases and Compressed Gases

1. When stored in compartments located on the weather deck, such compartments should have boundary bulkheads constructed from non-combustible materials. Where boundary bulkheads of such compartments are adjacent to other enclosed spaces, they should be gas tight, adequately insulated, and provided with ventilation arrangements which are separate from other ventilation systems. Ventilation should be arranged at high and low levels and the inlets and outlets of ventilators should be positioned in safe areas.

2. Where cylinders containing flammable or other dangerous compressed gases have to be carried below deck, separate stowage facilities should be provided for cylinders containing different types of compressed gas.

3. Additional information is contained in chapters 3 and 4.

M Bilge and Ballast Systems

1. Arrangements should be provided for draining any watertight compartment (other than small buoyancy compartments) under all service conditions. As an alternative, for the compartment forward of the collision bulkhead, a portable bilge pump or other equipment may be fitted, provided it is capable of effectively draining water from this compartment.

2. Bilge and ballast pumping Systems should be so arranged as to prevent water from the sea or water ballast spaces from passing into holds or machinery spaces, or from one watertight compartment to another.

3. Sea inlets and discharges for bilge and ballast systems should be fitted with a shutoff valve located as near the shell plating as practicable. Additionally, discharges should be equipped with automatic non-return valves The shutoff valve could be locally controlled if it is located in a manned machinery space. Valve controls should be readily accessible and should be provided with an indicator to show whether the valve is open or closed. In unmanned machinery spaces, all sea inlets and discharges should be remotely operable from an accessible location outside of the compartment in which they are located.

4. Individual bilge suction lines should be led to a central area or manifold. Each line should be provided with a stop valve at the central area or manifold and in addition should be provided with a check valve at some accessible point in the bilge line. A stop-check valve located at the central area or manifold will meet the recommendation for both a stop valve and a check valve.

5. A bilge line piercing a collision bulkhead should be fitted with a screw-down valve at the bulkhead with remote control from the weather deck with the appropriate indicator. If the valve is fitted on the after side of the bulkhead and is readily accessible under all service conditions, the remote control is not required.

6. Not less than two power-driven bilge pumps should be provided. Each pump should be driven by a separate prime mover, one of which may be the main propulsion engine. A ballast pump or other general service pump of sufficient capacity may be used as an independent bilge pump. One of the powered bilge pumps should have bilge suction capability from the compartment where the pump is located.

7. Bilge suctions should not be less than 1 inch diameter and should be fitted with suitable strainers having an open area not less than 3 times the area of the bilge pipe.

8. It should be noted here that fishing vessels are subject to the pollution prevention regulations of 33 CFR Parts 151 and 155. In most instances these regulations will require the installation of oily-water separating and monitoring equipment in bilge and fuel/ballast tank overboard discharge lines (see chapter 8).

N. Refrigeration Plants

1. Cold storerooms and spaces where evaporators are fitted should be provided with:

   a. Tight fitting doors operable from each side;

   b. An alarm which can be operated from within evaporator rooms and cold stores and audible in a normally occupied space. The alarm should be labeled so a person within the room knows what it is for;

   c. Means for indicating the location of the exit door, in the event of lights in the room being switched off or failing; and

   d. A venting system for the extraction of leaking refrigerant gases, provided that the associated controls should be operable from inside and outside the room;

2. Cold storerooms and spaces where evaporators are fitted should not have any permanently open vent which would permit the passage of refrigerants to other parts of the vessel.

3. When the refrigerant gas is either toxic or more dense than air, piping should be run so that leaking gas would not endanger personnel in their accommodation or working spaces. Refrigerating machinery utilizing toxic refrigerants should be located in an area separated from any adjacent crew accommodations by a gastight bulkhead. The space should be provided with a separate and self-contained ventilation system. Escape exits from such spaces should not lead directly into crew accommodations. Where toxic refrigerants are used, one of the exits should lead to the weather deck.

4. Portable means of detecting the concentration of any leakage of harmful gas should be provided.

5. Apparatus and pressure vessels of the refrigerating system should be provided with means for emergency drainage of refrigerants. Refrigerants should be drained off in suitable spaces so as to ensure the safety of the crew.

6. Each pressure vessel containing refrigerants, which may be isolated from the rest of the system, should be protected by a relief valve set to relieve at a pressure not exceeding the maximum allowable working pressure of the vessel. When a pressure vessel forms an integral part of a system having a relief valve, such vessel need not have an individual relief valve. The outlet of the relief piping should be located in the weather and directed to eliminate the possibility of discharge harmful to personnel.

7. Machinery compartments containing equipment for ammonia should be fitted with a sprinkler system providing an effective water spray and having a remote actuator.

8. Additional information is contained in chapter 4.

O. Automatic and Remote Control of Propulsion Machinery

1. To the greatest extent practicable, automatic or remote control systems should be designed and constructed 80 that a single failure will not prevent continued or restored operation of the vessel propulsion system.

2. Special attention should be paid to the strength, reliability, and location of any component that is not provided in duplicate or with a backup. This should include extra-strong construction, frequent inspection and maintenance, and the carriage of spare parts or components aboard the vessel.

3. All switches, valves, etc. for operating automatic or remote control systems should be clearly and permanently marked to show their purpose and operations.

4. A means to pass engine orders from the wheelhouse, to the engineroom (if applicable), should be provided.

5. An alternate means of control should be provided in the event of failure of any automatic or remote control system, component, or power source. Means to manually override the

failed automatic or remote control should be provided. The alternate control should be readily available, tested periodically, and instructions for its use should be posted.

6. Remote control should not overload or damage the propulsion machinery.

7. An automatic or remote control system should be at least as effective and safe as machinery under direct local manual control.

8. To the greatest extent practicable, failure of a remote propulsion control system should be alarmed in the wheelhouse. This item is particularly important for pneumatic, hydraulic, and electric control systems.

9. Unless propulsion control station throttle or pitch control settings are linked to ensure identical settings, control station transfer should not be possible until acknowledged by the station taking control. Emergency override from the engineroom is acceptable.

10. The wheelhouse should include:

a. Means to control and monitor speed and direction of propeller rotation, or propeller pitch if controllable pitch propellers are used;

b. A means, independent of the propulsion control, to shutdown the propulsion machinery in an emergency;

c. Instruments for monitoring the conditions, as applicable, listed in Table 6-1;

d. A means to charge the firemain, if provided; and

e. A means to start the main bilge pump.

11. The main machinery space, if provided, should include:

a. The controls and instruments listed in Table I for the wheelhouse;

b. Means to manually start the bilge pump(s);

c. Means to start the propulsion machinery;

d. Means to start, control, and shutdown electrical generators; and

e. Means to override remote or automatic control of main or auxiliary propulsion machinery.

P. Steering

1. All vessels should have two effective means of steering: a main steering gear and an auxiliary (emergency) steering gear. The steering gear, including the rudder and associated fittings, should be designed and constructed to steer the vessel at maximum speed, ahead or astern, as well as during maneuvers required by fishing operations.

2. The main steering gear should be capable of moving the rudder from hard-over (35^0) to hard-over in 30 seconds with the vessel at design service speed.

3. The auxiliary steering gear should be capable of moving the rudder from 15^0 on one side to $l5^0$ on the other side in no more than 60 seconds with the vessel at one half its design service speed ahead, or 7 knots, whichever is greater. A tiller, a block and tackle operating tillers or quadrants, chain falls, or winch operation of block and tackle may serve as an acceptable auxiliary steering gear, if this movement can be obtained. Such equipment should be readily available and used periodically, and instructions for its use should be posted. If use of this type of gear would expose the crew to extreme danger in heavy weather, a different type of auxiliary steering gear should be considered.

4. If the main steering gear is provided in duplicate, either one of the two may be considered the auxiliary steering gear.

5. On vessels less than 79 feet in length, an auxiliary steering gear is not necessary if:

   a. The vessel has twin screw propulsion;

   b. There are separate and independent controls in the wheelhouse for each screw; and

   c. The vessel can be reasonably maneuvered by the use of the screws.

6. As an alternative or a supplement to these guidelines on steering systems, fishing vessel designers and owners should consider the Coast Guard's standards for steering systems on offshore supply vessels of comparable gross tonnage, or the standards for cargo vessel steering systems, found in 46 CFR 58.25 and 111.93.

7. The wheelhouse should be arranged to permit the person steering to have the best possible all around vision.

8. Power driven steering systems should automatically resume operation, without reset, following electrical blackout.

9. Control of power-driven steering systems from the wheelhouse should include, as applicable:

   a. Control of equipment such as motors, pumps, and valves necessary to operate the main steering gear;

   b. A pilot light to indicate operation of each power unit; and

TABLE 6-1

Instrumentation

Description	Comments
Firemain Pressure	---
Low Propulsion Control Power	Electric, hydraulic or pneumatic; including clutch
Low starting power for generators and propulsion engines	Electric or pneumatic. Starting battery charging can be monitored as an alternative
Low lube oil pressure for propulsion engines, generators, and reduction gears	Automatic trips, preceded by alarms, are recommended
High cooling water temperature, propulsion engines and generators	---
Loss of alarm power	Alarm in wheelhouse
Low fuel level	---
Fire	Monitor unattended machinery spaces, alarm in wheelhouse. Monitor and alarm in berthing areas
High bilge level, spaces other than fish holds and tanks	Alarm in wheelhouse. Independent of any automatic bilge pumps, and set at a higher level.
Generator voltage, amperage, and frequency	Gauges, machinery space only
Automatic bilge pump operation	Indicator in wheelhouse
Shaft speed and direction	Direction need not be indicated in machinery space
Propeller pitch	---
Propulsion control failure	Alarm in wheelhouse

Notes: Monitoring should be done with alarms and gauges, or gauges only.
Alarms should be audible and visual.
Alarms should be of the self monitoring type; that is, an open circuit
should cause an alarm.
Switches should be provided to test visual alarms and indicators, and spare bulbs should be carried.

c. Visual and audible alarms to indicate loss of electric power to the controls or power units and overload of any electric motors.

10. To the greatest extent practical, the main and auxiliary steering gear should be designed and constructed so that a failure or damage to one of them will not prevent effective use of

the other. Isolation valves, disconnect switches, disconnect links, or completely separate systems may be necessary to do this.

11. A block and tackle, chain falls, restraining lines or other suitable means should be provided to center and steady the rudder(s) in an emergency. This is to permit towing of the vessel and transfer from the main to auxiliary steering gear.

12. Where a steering device other than a rudder is fitted, such as an outboard motor, an out drive, a Z drive, etc., its design, construction, and operation should be in general keeping with these guidelines.

13. A means to pass steering orders should be provided between the wheelhouse and any other location intended for control of the main or auxiliary steering gear.

14. Where the steering gear is power operated, a rudder angle indicator should be provided at the wheelhouse steering controls. The indicator should be independent and separate from any steering controls.

15. Strong and effective rudder stops should be provided to prevent jamming and damage to the rudder and its fittings. These stops may be structural or internal to the steering gear. Power operated steering gear should have a means, such as a limit switch, to stop the gear before it reaches the stops. Both the stops and the limiting device should be independent of the control system.

16. If the main steering gear consists of cables, chains, rods, and similar non-hydraulic means, buffers or springs should be provided to relieve the gear of shocks to the rudder.

17. Special attention should be paid to the strength, reliability, and location of any component that is common to the main and auxiliary steering gear. This attention should include extra-strong construction, frequent inspection and maintenance, and the carriage of spare parts or components aboard the vessel.

18. All switches, valves, etc. for operating the steering gear should be clearly and permanently marked to show their purpose and operation.

19. Where auxiliary steering equipment is provided, there should be:

    a. Readily available means for steering gear transfer; and

    b. Readily available tools, equipment, and instructions necessary to make the transfer.

20. Circuit breakers and fuses in steering systems should provide short circuit protection only. Fuses and circuit breakers that trip on overload (e.g. slow-blow and dual element fuses), should not be used.

GENERAL MACHINERY MAINTENANCE

A. Boilers, Hot Water Heaters and Pressure Vessels

1. As discussed previously all boilers, hot water heaters and pressure vessels should be visually examined for signs of distortion, cracks, serious corrosion etc. at least once every 3 years. The inspection technique described here are not all inclusive for every vessel but include those features common to most vessels and those of greatest importance.

2. If external or internal coverings, such as insulation, refractory protective linings, and corrosion-resistant linings, are in good condition and there is no reason to suspect an unsafe condition behind them, it is not necessary to remove them for inspection of the vessel. However, it may be advisable to remove small portions of the coverings to investigate their condition and effectiveness and the condition of the metal underneath them. Removal of insulation should be accomplished at the lowest point on the vessel as this is where condensation or leaking liquids will collect and cause rusting.

3. Examine the surfaces of shells and heads carefully for possible cracks, blisters, bulges, and other evidences of deterioration. Give particular attention to the skirt and to support attachment and knuckle regions of the heads. If evidence of distortion is found, it may be necessary to make a detailed check of the actual contour or principal dimensions and compare those contours and dimensions with the original design details. The insulation that is removed should include removal from the lowest point on the vessel as this is where condensation or leaking liquids will collect and cause rusting.

4. Examine welded joints for cracks or other defects. On riveted vessels, examine rivet head, butt strap, plate, and caulked edge conditions.

5. Examine the surfaces of all manways, nozzles, and other openings for distortion, cracks, and other defects, giving particular attention to all welding used for attaching such parts and their reinforcements. Normally, weep holes in reinforcing plates should remain open to provide visual evidence of leakage as well as to prevent pressure build-up in the cavity. Examine accessible flange faces for distortion and to determine the condition of gasket-seating surfaces. Periodically test the relief valve(s).

B. Piping Systems

1. All piping systems should be examined at regular intervals under full working pressure conditions, including thorough examinations during all drydocking periods. Where necessary a sufficient amount of lagging should be removed to give a good indication of the entire pipe line. If extensive corrosion is found the section of pipe affected should be removed, thoroughly examined externally and internally (as much as possible), and given a hydrostatic test of 1.5 times the working pressure.

2. During all drydocking periods all sea valves and sea chests should be opened, inspected, and repaired or renewed as necessary. Sea valves should be examined for evidence of leakage through the valve, stuffing box leakage or sticking valve stems. Leakage through the valve is generally caused by the disk and the seat not making a tight joint, and may result from scale, dirt, or waste, lodged on the seat in such a way that the disk can not be seated.

3. If the obstructing material can not be blown through, the valve will have. to be opened and cleaned out. Leakage through the valve can also be caused by scores in seat or disk caused by attempting to close the valve on scale or dirt, or by erosion. If the damage is slight the valve may be made tight by grinding; if more extensive, the valve will have to be resented and then ground. Stuffing-box leaks can be remedied by tightening up on the gland or repacking it if necessary. The gland should not be set up or packed so tightly that the stem sticks. Sticking valve stems can be corrected by loosening the gland and thereby relieving the packing pressure or by adjusting the positions of the nuts if the gland is misaligned. Paint or rust on valve stems should be removed by cleaning.

4. When not in use piping system should be kept thoroughly drained. Strainers, particularly those used in lubricating oil, hydraulic oil or fuel oil Systems, should be cleaned regularly. Every precaution should be taken to prevent the entry of water into lubricating oil, hydraulic oil and fuel oil Systems.

5. Whenever extensive repairs have been made to any piping system, the entire system should be thoroughly inspected and cleaned before being put back into service.

C. RefriReration Plants

1. At least once monthly the refrigeration system should be inspected. This should include an inspection for condenser cleanliness as well as a check of the refrigerator door gaskets (where fitted), coils and control contacts for their general condition. All soldered piping joints should be carefully examined.

2. A regular check should also be maintained of the refrigeration system while it is operating to assure its proper care and operation. It is good practice to check all temperatures and pressures throughout the system and of the oil level in the compressor crankcase. This will determine in due time the possible necessity of any corrective measures. Good judgment must always be used in the analysis of service troubles and specific corrections should be followed wherever possible. One of the best methods for determining when and what corrective measures are necessary for a plant which is not operating properly is by comparing the pressures and temperatures existing at various parts of the system with corresponding readings taken in the past when the plant is known to be operating properly and under similar heat load and circulating water temperature conditions.

D. Marine Engines

1. Trouble shooting marine engines is best carried out by following the trouble shooting guide contained in most manufacturer's operating manuals. Be sure that you always have a manufacturer's operating and maintenance manual for your engine. The manufacturer's instructions should be followed very closely unless your personal experience dictates otherwise. Every routine maintenance should include changing lubricating oil and fuel filters and cleaning sea strainers. Keep your fuel tanks clean, and a good corrosion preventative system in the fresh water and in the raw water systems. Battery water should be checked regularly.

2. Major overhauls of the engine and the drivetrain, including reduction gears, clutches, and couplings should be done in accordance with manufacturers' shop overhaul manuals. These

manuals are the best source of guidance on permissible operating hours between major overhauls.

CHAPTER 7 - ELECTRICAL INSTALLATIONS

INTRODUCTION

These recommendations are intended to serve as a guide for the design selection, installation and maintenance of electrical equipment and systems on all fishing vessels. They suggest good electrical practice to ensure the suitability and durability of equipment, and the safety of the vessel and its crew. Equipment and systems are continually undergoing design changes and improvements that might not be addressed in these recommendations. It should be ensured that such items, if used, provide safety and reliability levels comparable to those of these recommendations. Additional guidance on electrical equipment and installations, especially as appropriate for large vessels (e.g. greater than 150 feet (45m.)), can be found in the Coast Guard Electrical Engineering Regulations (46 CFR 110-113), the Institute of Electrical and Electronics Engineers Standard No. 45 "IEEE Recommended Practice for Electric Installations on Shipboard," and in rules published by classification societies such as the American Bureau of Shipping. Standards and Recommended Practices published by the American Boat and Yacht Council, Inc. can provide additional guidance specifically applicable to small vessels.

ELECTRICAL SYSTEMS AND EQUIPMENT

A. General

1. Electrical equipment should be accessible for operation and maintenance (inspection, adjustment, repair, and replacement). As far as practicable, electrical equipment should be located so that it is protected from dust, oil and fuel vapor, dripping or splashing liquids and bilge water.

2. Electrical equipment should be of rugged construction and suitable for marine use. Equipment should be designed, constructed, and installed to prevent any person from accidentally contacting energized parts. To provide for the safety of vessel personnel, electrical equipment such as switches, receptacles, outlet boxes, circuit breakers, motor controllers, air heaters, galley equipment, and lighting fixtures should bear the seal (label) of a nationally-recognized testing laboratory. It is highly recommended that all ignition-protected, explosion proof, and intrinsically safe equipment and systems bear this label.

3. Electrical equipment in the weather or in a location exposed to seas, splashing or similar moisture conditions should be waterproof or watertight. Enclosures and parts of equipment should be made of corrosion-resistant materials or should have a corrosion-resistant finish. Aluminum should not be used for current-carrying parts unless extra precautions are taken to minimize the problems of oxidation and cold flow (tendency to creep away from a stressed area when under pressure).

4. Electrical equipment and installations should be suitable for the roll, pitch, and vibration of the vessel underway. Contacts of relays and switches should remain in place under such conditions.

5. Electrical equipment should not be installed in lockers used to store paint, oil, turpentine, or other flammable liquid. If electrical equipment (such as lighting) Nulls be in these spaces, it should be explosion proof or intrinsically safe.

6. Spaces, compartments, or enclosures containing internal combustion engines should be adequately ventilated. Spaces, compartments or enclosures containing gasoline-fueled engines should have powered and natural ventilation. Power ventilators should have non-sparking fans and explosion proof motors. Electrical equipment within these locations should be kept to a minimum. Electrical equipment that must be in such a location should be ignition-protected, explosion proof, or intrinsically safe for use in gasoline atmospheres (Class I, Group D).

7. Electrical devices inside piping or tanks containing flammable or combustible liquids should be intrinsically safe.

8. Metallic enclosures for electrical equipment should be grounded. If the mounting of the enclosure does not provide a ground to a metal hull, the enclosure should be grounded through a grounding conductor. The equipment grounding conductor should be at least as large as the equipment power supply conductor.

9. Portable electrical equipment should be double-insulated, or should have exposed metal parts grounded through a conductor in the supply cord to a grounding pole on the receptacle.

10. Wooden masts should have a lightning ground conductor. Metallic masts should be grounded.

11. Vessels with non-metallic hulls (i.e. wood or fiberglass) should have a continuous grounding conductor run the length of the vessel. Metallic items such as engines, fuel tanks, and equipment enclosures should be connected to the grounding conductor.

12. Cable systems and electrical equipment should be installed in a manner to avoid or reduce interference with radio reception and compass indication.

B. Main Source of Electrical Power

1. Every vessel should have at least two sources of electrical power for vital loads. Where electrical power is the only means of maintaining the services necessary for the propulsion and safety of the vessel, there should be at least two generating sets. Safety related services include bilge pumping, fire fighting, engine and machinery space ventilation, lighting, steering, communication and alarm, automatic control equipment, navigation lights, and navigational equipment. For safety loads other than motors, a generator driven by the main engine and maintaining a storage battery in a fully charged condition is adequate, provided the electrical system automatically shifts to battery upon loss of the generator. At most, one generating set should be driven by the main engine. The power of these generating sets should be adequate for safety and propulsion loads with one generator stopped. Where a generator driven by the main engine is provided, it should be able to function regardless of the speed or direction of the Rain engine or shafting.

2. Where transformers are a necessary part of the electrical systems for propulsion and safety loads, they should be provided in duplicate.

3. On vessels 79 feet (24m.) in length or greater, if electrical power is normally supplied by operating only one generating set, there should be provisions (such as load

shedding) to ensure that sufficient power is provided for propulsion and steering loads. Should the operating generator fail, another generator should be capable of being started to assume propulsion and steering loads.

4. On vessels 79 feet in length or greater, if electrical power is simultaneously supplied by more than one generating set, there should be provisions to ensure that if one set fails, the remaining set(s) continue to power propulsion and steering loads.

Emergency Source of Electrical Power

1. In addition to the main source of electrical power, an emergency source should be provided to supply services necessary for the safety of the vessel and crew.

2. For vessels less than 79 feet in length not relying upon electrical power for propulsion or steering, only emergency lighting and battery powered navigational and communication systems need be considered. For vessels 39 feet (12m.) or less in length, the emergency lighting may consist of flashlights located in the wheelhouse and near the engine. For vessels greater than 39 feet and less than 79 feet in length, emergency lighting may consist of battery-operated relay-controlled lanterns with rechargeable batteries and an automatic battery charger that maintains the batteries in a fully charged condition.

3. Vessels 79 feet in length or greater should have an emergency source of electrical power located outside the machinery spaces. The emergency source should be either a generator or a storage battery or batteries capable of providing power for six hours to the following loads (where provided): communication equipment (internal and radio), fire detecting systems, signaling systems, navigation lights, emergency fire pump, and sufficient lights throughout the vessel to ensure illumination for vessel and machinery control, restoration of normal electrical power, and evacuation of the vessel. If a single source is provided, these loads should be connected to an emergency switchboard near the power source. The emergency switchboard should normally be supplied from the main source by a tie feeder circuit that is automatically disconnected at the emergency switchboard upon loss of the main power supply. Where individual storage battery installations are provided in lieu of a single source, they should be relay-controlled and should have an automatic battery charger that maintains the batteries in a fully charged condition.

4. Where the emergency source is a generator, it should have an independent fuel supply. If the generator is automatically started, the automatic starting system should not run-down the source of starting energy (hydraulic or air pressure or battery capacity). The capacity for at least three starts should be held in reserve.

5. Where the emergency source is a battery, it should be capable of maintaining battery voltage within 12% of its rating for 6 hours, without recharge.

D. Switchboards

1. Switchboards should be in as dry a location as possible. Piping, windows, and deadlights should not be over or in the vicinity of switchboards. Switchboards should have a drip shield or be otherwise installed to prevent liquid from dripping into them. All insulating material should be moisture resistant and fire-retardant.

2. Switchboards should have adequate working space to permit operation and maintenance. Switchboards should not have exposed live parts.

3. Non-conducting hand rails should be provided unless the switchboard installation provides nearby non-conducting structure that a crew member can hold while operating the controls in heavy weather. Non-conducting deck materials, mats or gratings should be provided in front of the switchboard. If there is a rear working area, it should also have non-conducting deck materials, mats or gratings.

4. Metal cases of switchboard equipment should be grounded.

5. All circuits and equipment should be clearly identified.

6. Switchboard wire should be of the flame-retardant type.

7. Switchboards should be adequately sized for the expected loads. Bus and bus connectors should be able to carry at least 75% of the total full load rated current of all equipment supplied.

8. It is recommended that vessels 150 feet (45m.) in length or greater, or vessels with electrical distribution systems having a total generating capacity of 50 KW or greater have a ground detection device. Such a device should continuously monitor the insulation levels to ground and should give an indication of abnormally low insulation values.

E. Overcurrent Protection

Note: Overcurrent devices are an essential part of the vessel's electrical system, and their proper use is essential to prevent personal injury and property loss. Overcurrent devices are used to protect from three types of failures: overloads, short circuits, and ground faults. An overload is a condition where equipment is operated in excess of its full load rating or a conductor is operated in excess of its current-carrying capacity (ampacity). If this condition persists for a sufficient length of time, damage to equipment or dangerous overheating could occur. A short circuit is a condition where a relatively low resistance path exists (accidentally in this case) between two electrical points and current flows essentially unlimited. This condition can be extremely dangerous and must be cleared immediately. A ground fault is an unintentional path of relatively low resistance between the "hot" or line side of a circuit and ground. This condition can cause current to flow through equipment enclosures and through the hull of metal vessels. Overcurrent devices are normally fuses, circuit breakers or overcurrent relays.

1. Each power source should be protected against overcurrent. Overcurrent devices for generators should be set at a value not exceeding 115% of the generator full load rating.

2. All circuits other than steering circuits should be protected against both overload and short circuit. Steering circuits should only have short circuit protection.

3. Conductors should be protected in accordance with their current-carrying capacities. If the allowable current-carrying capacity does not correspond to a standard device size, the next larger overcurrent device may be used provided it does not exceed 150% of the conductor current-carrying capacity.

4. Circuit breakers should simultaneously open all ungrounded conductors.

5. On circuits of 50 volts or greater, there should be a switch on the supply side of and adjacent to all fuses to de-energize the fuses for inspection and maintenance.

6. Overcurrent devices and switches should not be installed in permanently grounded conductors.

7. In general, lighting circuits (including crew convenience receptacles) should be protected by an overcurrent device rated 15 amperes or less.

8. Circuit breakers should be of the proper voltage rating, continuous current rating, and short circuit rating. They should be of the manually reset type and capable of repeatedly opening the circuit in which they are used without being damaged. They should indicate whether they are in the open or closed position.

9. Instruments, pilot lights, ground detector lights, potential transformers, and similar devices should be supplied by circuits protected by overcurrent devices.

10. Motors should be provided with protection against overload (running or overload protection). A protective device internal to the motor which is responsive to motor current or both motor current and temperature may be used. Overcurrent devices should be installed to protect the Rotor conductors and control apparatus against overcurrent due to short circuits or ground faults. These devices should be capable of carrying the starting current of the motor. Motor circuit overcurrent protection and motor running protection may be combined in a single device. (Additional guidance may be found in 46 CFR 183, the Electrical Installation Part of the Rules and Regulations for Small Passenger Vessels, and in the National Electrical Code).

F. Distribution Systems

1. If a grounded distribution system is provided, there should be only one connection to ground, regardless of the number of power sources. This ground connection should be at the switchboard and should be accessible for checking the insulation resistance of the generator to ground. The system grounding conductor should be adequately sized and should not be smaller than No. 8 AWG. For dc systems, the grounding conductor should be at least the size of the conductors supplying the system and should be connected to the negative bus.

2. A vessel's hull should not be used as a normal current-carrying conductor except for impressed current cathodic protection systems and locally grounded systems such as a battery system for engine starting that is a one-wire system with the ground wire connected to the engine.

3. Where an underwater copper plate is installed for electronics grounding, it should be located away from the propeller and should be connected to the vessel ground system.

G. Battery Installations

1. Batteries and battery installations should be capable of withstanding vessel roll, pitch and vibration, as well as exposure to a salt water atmosphere. Battery cells should not spill electrolyte if the battery is inclined at 30^0.

2. Batteries should not be located where they are exposed to seas or bilge water.

3. Batteries should be located in a well ventilated area to allow flammable gas generated by charging to be easily dissipated. Ventilation may be either natural or powered. Battery installations should be away from switches and other arcing devices. Vessels left unattended for extended periods with battery chargers connected should be given special attention to ensure that vapors are dissipated.

4. Battery installations should be provided with ample room for battery removal and terminal access. If the batteries are installed where items can fall on the terminals, insulated terminal covers should be provided.

5. Batteries should be secured against shiftiflg due to motion of the vessel, and should have a drip tray or be in a box made of a material that is corrosion-resistant to the electrolyte.

6. Battery connections should be made with permanent type connectors. Spring clamps or other temporary connectors should not be used.

7. Battery chargers should be of the type using an isolation transformer, and should have an ammeter in the charging circuit.

H. Cable Installations

1. All cable and wire should have copper conductors of the appropriate size and voltage rating for the circuit.

2. Each conductor should be at least No. 18 AWG. Conductors in power and lighting circuits should be No. 14 AWG or larger. Conductors should be sized so that voltage drop at load terminals is not more than l0%.

3. New installations should use stranded copper conductors.

4. New installations of circuits over 50 volts should use cable constructed in accordance with a standard for flame-retardant marine cable. Consideration should also be given to the use of marine cables that generate less smoke, less toxic gas, and less corrosive products under a fire condition.

5. Cable runs should be protected from the weather to the extent practicable. Wire and cable should be supported in such a manner as to avoid chafing or other damage. Cable should not be installed with sharp bends.

6. Cables in areas subject to mechanical abuse should be protected by metal coverings, angle irons, or other suitable means. Cables passing through fish storage areas should have a watertight jacket, watertight bulkhead and equipment fittings, and mechanical protection.

Cables installed in refrigerated compartments should be suitable for low temperature and high humidity. Cable should not be located in a tank unless the cable provides power to equipment in the tank. Such cable should be compatible with the fluid in the tank. Cable on hinged panels or where subjected to frequent movement should be extra-flexible.

7. Cable and wiring serving vital or emergency loads should be routed, as far as practicable, from high risk fire areas such as galleys, laundries, and machinery spaces. As far as practical, cables serving duplicated equipment should be separated so that a casualty that affects one cable does not affect the other.

8. All metallic cable armor should be electrically continuous and should be grounded.

9. Terminations and connections should be made in fire-retardant enclosures. Splices in conductors should be made in a manner that retains the original electrical, mechanical, flame retardant, and watertight properties of the cable. Termination, connections and splices should be made in a manner that is vibration resistant and should be accessible.

I. Shore Power

1. If provisions are made for connecting special precautions should be taken. vessel ground to the shore ground and reversing polarity.

shore power to the vessel, These include connecting the having a method to prevent

2. Plugs and receptacles should be rated for the proper voltage and current, corrosion-resistant and designed for outdoor service. They should a180 be of a polarized type.

3. Shore power Systems should have a polarity warning device to indicate when the polarity is not correct.

4. The vessel's electrical system should prevent the simultaneous use of onboard generators and shore power.

5. The grounding (green) wire should always be connected between the vessel ground and the shore ground. This topic has presented some controversy in the past. Disconnecting the grounding wire can help reduce the corrosion problem on metal-hull vessels, but can lead to a serious personnel hazard. The use of apparatus such as galvanic isolators or isolation transformers which can provide protection against corrosion without introducing a shock hazard should be considered.

6. On vessels with large electrical systems (typically 3-phase, 450 volts), consideration should be given to installing current-limiting fuses in the shore power feeders to limit the fault current available on the vessel.

7. Further information on shore power may be found in ABYC "Standards and Recommended Practices for Small Craft™.

J Miscellaneous Equipment and Systems

1. There should be sufficient receptacles throughout accommodation spaces for crew convenience items. Receptacles for circuits greater than 50 volts should have a grounding pole.

2. Lighting should be installed throughout the vessel. In large machinery spaces, lighting should be provided from at least two circuits 80 that failure of one circuit will not leave the area without light. Lighting fixtures should be installed to prevent temperature rises that could damage wiring and to prevent nearby material from becoming excessively hot.

3. Lighting fixtures in machinery spaces, fish holds, and in other areas subject to mechanical abuse, as well as portable lights (trouble lights), should have impact-resistant globes or guards.

4. It is the responsibility of the owner and operator to ensure compliance with the applicable navigation rules (1972 COLEEGS or Inland Rules), including the technical requirements for the navigation lights (color, intensity, and arc of visibility), and fixture placement. Navigation light fixtures should be used that have been designed for compliance with the applicable rules. For new installations, it is highly recommended that navigation light fixtures be used that have been approved by the Coast Guard for the appropriate rules and vessel length.

5. It is recommended that vessels 150 feet (45 m.) in length or greater have dual light sources for side, masthead, and stern lights, and a navigation light indicator panel that signals the failure of each of these navigation lights. Each light should be connected to a separate circuit in the panel having overcurrent protection and the panel should have a fused disconnect switch or circuit breaker.

6. Electric air heaters should have enclosed heating elements made of corrosion-resistant materials, and a thermal cut-out of the manually reset type in addition to the thermostat. Heaters should be mounted so that items cannot be hung on them. Portable heaters should have a bracket to hold them securely. The external temperature of a heater case should not be greater than 125^0C, and should not cause adjacent bulkheads and decks to get hotter than 55^0C.

7. Cooking appliances should be suitably mounted for vessel roll and pitch. Doors should have heavy duty hinges and locking devices to prevent accidental opening in heavy weather. Grills and similar cooking appliances should have a means to collect grease or fat and to prevent spillage on wiring or the deck. Ranges should have sea rails with adjustable barriers to resist accidental cook pot movement. Grab rails should be provided where necessary for crew safety.

8. Vessels should have a high intensity light with an on-off switch capable of being used for signaling, and powered from a rechargeable battery or other emergency power source.

ELECTRICAL EQUIPMENT MAINTENANCE

Introduction

An effective electrical maintenance program can increase the safety and dependability of the electrical system and can reduce costly electrical failures to a minimum. An electrical maintenance program can ensure that equipment is ready for service, and that personnel and the vessel are protected from

electrical hazards. Such a program includes knowledgeable personnel and regular inspection, testing, and servicing. Equally important is the application of sound judgment in evaluating inspection and test results, the correction of deficient conditions, and the keeping of complete, concise and accurate records.

Some of the primary factors for satisfactory operation of electrical equipment include the following:

- Circuits are correctly connected;
- Electrical contacts are clean, tight, and of low resistance;
- Moving parts function freely and in the way they are designed to operate; and
- Electrical equipment is in good condition; clean, dry, and insulation of high resistance.

A. Safety Considerations

1. Before performing any electrical maintenance, the following general electrical safety recommendations should be reviewed:

a. Before attempting any maintenance or repair work on electrical equipment, the equipment should be disconnected from the power source and measures taken to ensure that it is not inadvertently energized. If there is any doubt as to whether the equipment has been de-energized, it should be checked with a voltmeter or voltage tester. (Before each use of the voltmeter or voltage tester, it should be checked for proper operation on a known energized source).

b. Some electrical equipment may have more than one source of power. Other equipment, such as motors and generators, may have various accessories with separate sources of power. Check to ensure that all separate circuits and sources of power are de-energized prior to working on electrical equipment.

c. Some electrical and electronic equipment will have energy storage devices (capacitors or condensers) installed. These devices can produce a severe shock after the power has been disconnected. These devices can be discharged by connecting their terminals to ground and then to one another. Care should be taken since large capacitors can store a significant amount of energy and produce a sizable arc when shorted.

2. An exception to the rule for de-energizing the equipment may be made under unusual circumstances. In this case, special safety precautions are necessary. Every care should be taken to insulate the person performing the work from ground and from energized parts That person should observe the following additional safety precautions (as applicable):

a. Don’t work alone;

b. Provide ample illumination;

c. Do not wear a wrist watch, rings, chains, any metal article or loose clothing that might make accidental contact with live parts (Clothing and should should be as dry as possible);

d. Cover all grounded metal to which a worker might be exposed with insulating material;

e. Cover metal portions of hand tools with electrical insulating material to the maximum extent practicable;

f. Insofar as practicable, provide insulating barriers between the work and any other live parts;

g. Use only one hand to accomplish the work, if possible;

h. Wear rubber insulating gloves;

i. Use eye and face protection; and

j. Have someone standing by to turn off the power if necessary.

3. The importance of safety in performing electrical maintenance and repair cannot be over emphasized.

B. The Maintenance Program

1. The essential ingredients of an electrical preventative maintenance program are:

a. Responsible and knowledgeable personnel;

b. Survey and analysis of electrical equipment to determine maintenance requirements and priorities;

c. Programmed routine inspections and tests;

d. Analysis of inspection and test,

e. Performance of necessary work; and

f. Complete, concise records.

2. To develop an electrical maintenance program, the following four basic steps should be followed:

a. Compile a listing of all equipment and systems;

b. Determine what equipment and/or systems are most critical and most important;

c. Develop a system for keeping up with what needs to be done and when; and

d. Train people for the work that needs to be done, or contract for special services.

C. General Maintenance

1. Good housekeeping is an important factor in preventing failure of electrical equipment. Dust can block cooling passages and thus reduce capabilities of motors, transformers, circuit breakers, etc. by raising their operating temperatures above rated limits, decreasing operating efficiencies and increasing fire hazards. It is very important to keep electrical equipment clean and dry.

2. An important part of an electrical preventative maintenance program is electrical insulation testing. Electrical insulation deteriorates with time as it is exposed to heat, gases, fumes, vapors, liquids and various other agents. At some point it becomes ineffective and unsafe. Therefore, it should be tested periodically.

3. Electrical insulation resistance is normally tested with a high range resistance meter with a built in direct current generator. This test instrument is called a megohmmeter. Electrical insulation readings are affected by temperature and humidity. Readings at different times on the same day can give different results due to temperature changes. A rule of thumb is that for every 10^0C increase in temperature you halve the resistance and for a 10^0C decrease in temperature you double the resistance. For this reason the measure of insulation resistance that you get from a megohameter should be considered relative. It is important to keep records of insulation resistance readings and watch for a trend of lessening resistance. This is a warning of coming problems. There is another test method that is fairly independent of temperature and can give conclusive information without past records. This is the time-resistance method which is often referred to as absorption tests. In this test, resistance readings are taken at 30 seconds and 60 seconds. If the readings show a gradual increase the insulation is probably in good shape. If the readings are fairly constant, it indicates that there is a potential insulation problem. The instruction manual that comes with the megohmmeter should give information on how to conduct tests, however a few important points should be remembered.

a. Make sure that the item being tested is isolated from other equipment;

b. Follow safety procedures; and

c. Do not perform mgobmmeter tests on circuits that contain electronic device.. Many such device. are voltage sensitive and such tests will destroy them.

4. Switchboards should be inspected every six months. All connections should be checked and tightened as necessary. Switchboards should be cleaned to remove all dirt. Switchboard meters and instruments should be checked for calibration yearly.

5. Molded case circuit breakers should be inspected at least every 6 months. The housing should be clean and inspected for cracks. If cracks are found, the circuit breaker should be replaced immediately. A circuit breaker should always be replaced with one of the same size and type. Circuit breakers should also be inspected for loose connections and signs of overheating. Loose connections should be tightened. Each molded case circuit breaker should be mechanically exercised by manually tripping it off and on several times. This operation will keep the tripping mechanism free while the wiping action by the contacts

tends to avoid resistance build up and minimizes heating. Vital circuits should not be tested while underway.

6. Fuses should be replaced only with the same size and type, and should never be "jumpered".

7. Transformers should be inspected quarterly. Ventilation openings, casing, and the core (if accessible) should be cleaned using a vacuum cleaner or a blower. Connections should be inspected, cleaned, and tightened as necessary. Special attention should be given to ensure transformer connectors are suitable for use with copper conductors. These connections should be inspected carefully for tightness and for signs of corrosion. While terminals are disconnected, insulation resistance readings should be taken and recorded. Voltage, current, and temperature measurements should be taken and compared to the transformer ratings. High temperature, high current, and high or low voltage are indications of problems that must be corrected.

8. Electrical cables should be kept clean and should be inspected yearly for damage such as cracking, chaffing, jacket softening or oil absorption, and signs of overheating. Megohmmeter readings should be taken at 2 to 3 year intervals. Cables rated at less than 100 volts need not be tested. Cables subject to frequent flexing or located in areas subject to damage should be inspected more often.

9. Portable or spare electrical equipment should not be stowed in wet or damp locations.

10. Electrical equipment should be checked to ensure that air can circulate freely around it and no equipment has been stored against it.

11. Motors should be inspected, quarterly. Windings should be vacuumed or blown free of loose dirt with clean, dry air at no greater than 25 psig pressure. If the bearings are not of the sealed type, lubrication should be checked and added in accordance with the manufacturers recommendation. Care should be taken to not over lubricate, as oil may work its way into electrical windings. Motor connections should be checked to assure that they are tight and that there is no evidence of overheating of connections, fraying of insulation, or other insulation damage. Megohmmeter readings should be taken and recorded. These readings can be taken on the load side of the motor starter without disconnecting the motor. Voltage and current measurements should be taken and compared to the nameplate ratings.

12. Batteries should be inspected weekly to ensure that they are mounted securely, terminals are free of corrosion, fluid levels full, and there is no sign of leakage. The electrolyte should be tested with a hydrometer.

13. Porcelain electrical fixtures and fittings such as lampholders and fuseholders should be checked for signs of cracking.

14. Lamps in lighting fixtures should be checked to ensure they do not exceed the rated wattage of the fixture.

15. Switches and receptacles should be checked to ensure that connections are tight and faceplates are in place.

16. Portable cords should be checked for fraying, weakened end connections, and for insulation and should be placed out of traffic areas. When portable cables are used, the load end should be connected before the cable is connected to the power source.

17. All portable power tools should be inspected to ensure they have a 3 prong plug (if of the grounding type) or are double-insulated.

18. Portable appliances should be unplugged when not in use.

CHAPTER 8 - POLLUTION REQUIREMENTS

POLLUTION REQUIREMENTS

A. General

1. All U.S. flag fishing vessels are subject to the pollution prevention regulations contained in 33 CFR Parts 151, 155, 156 and 159. Failure to comply with these regulations can result in civil penalties being assessed against the boat owner and/or operator.

2. The basic purpose of Parts 151 and 155 is to implement the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). MARPOL 73/78 is an international treaty, to which the United States is a party, intended to reduce worldwide oil pollution in the ocean. For waters off the United States it applies to all oil pollution more than 3 miles off the coast. Within 12 miles, the Federal Water Pollution Control Act (FWPCA) also applies.

3. Part 151 contains the procedures that a vessel owner must follow in order to obtain certification that it complies with MARPOL 73/78. These procedures include the requirement for certain fishing vessels of 400 gross tons and above to undergo surveys and obtain an International Oil Pollution Prevention (IOPP) Certificate. In addition, Part 151 contains the oily-water discharge limits applicable to all fishing vessels, regardless of size, and the requirement that all fishing vessels of 400 gross tons and above maintain an Oil Record Book. Oil Record Books are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, stock number 7530-Ol-GF3-0660.

4. Subparts A and B of Part 155 give the design, equipment and operational requirements that vessels must meet with in order to comply with MRRPOL 73/78 and the FWPCA. These requirements vary depending on vessel size and include the following:

   a. Fuel oil and lubricating oil discharge containment for vessels of 100 gross tons and above;

   b. Bilge slop and fuel oil tank ballast discharge restrictions applicable to all vessels;

   c. Oily-water separating/filtering requirements for vessels of 400 gross tons and above; and

   d. Standard discharge connection requirements for oceangoing vessels of 400 gross tons and above.

5. Subpart C of Part 155 and Part 156 contains requirements applicable to oil transfer operations to, from and within a vessel. These requirements are generally applicable to fishing vessels with a capacity of more than 250 barrels (10,500 gallons) of oil.

6. Part 159 contains the requirements for the installation of marine sanitation devices with the intent to prevent the discharge of untreated or inadequately treated sewage into U.S. waters. This part also contains the requirements for the design, testing and certification of marine sanitation devices by the Coast Guard.

B. IOPP Certificate and Required Surveys

1. An IOPP Certificate is documentary evidence, issued by the Coast Guard, that a vessel complies with MRRPOL 73/78. All fishing vessels of 400 gross tons and above which engage in voyages to ports or places under the jurisdiction of other countries that are party to MRRPOL 73/78 are required to have an IOPP Certificate and its corresponding Form A supplement. A fishing vessel requiring an IOPP Certificate must undergo an initial and certain periodic surveys. Specific guidance on the requirements and procedures for obtaining an IQPP Certificate is contained in NVIC 7-83.

2. A fishing vessel of 400 gross tons and above that is not required to have an IOPP Certificate does not have to undergo the surveys required in Part 151. However, it is still required to meet the applicable regulations in Part 155. The owner/operator of one of these vessels may request a survey and a completed Form A supplement. This will provide the vessel with documentary evidence that it has been found to comply with the regulations and, further, will expedite the issuance of an IOPP Certificate should the need suddenly arise for the vessel to have one.

C. Bilge Monitor/Separator Requirements All fishing vessels of 400 gross tons and above are required to have oily water separating equipment for the processing of bilge slops. This equipment comes in two categories, 100 parts per million (ppm) or 15 ppm. Under Part 151 and MARPOL 73/78, all vessels are restricted from discharging oily-water mixtures exceeding 100 ppm when outside of 12 miles from the nearest land and mixtures exceeding 15 ppm when within 3 to 12 miles from the nearest land. Under the FWPCA, an oily-water mixture which would cause a sheen cannot be discharged within 3 miles from shore. Therefore, owners/operators should carefully consider the area of operation of their vessels when choosing the type equipment to install. It would be of little value to install 100 ppm equipment on a vessel which primarily operates within 12 miles of land.

D. Fuel Carried in Fish Holds

1. It is not uncommon for fishing vessels, especially tuna seiners, to load fuel in the fish holds to increase the range and duration of fishing operations. This practice raises a number of safety and pollution prevention issues. In many cases this is done "over the top" by discharging directly from a hose into an open hold. For vessels having a capacity of over 250 barrels, this is a violation of 33 CFR 156.120(g) which requires the oil transfer line be attached to a fixed connection on the vessel. In many instances the vessels do not have a fixed connection to attach the hose to. Guidance concerning this practice can be found in COMDTINST Ml6000.7, Section 31.E.3.c, which includes alternative procedures the Coast Guard may accept under 33 CFR 156.107. These include the following:

a. Hose which meets the requirements of 33 CFR 154.500 or portable piping which meets 46 CFR Part 56;

b. Connections which meet the requirements of 33 CFR 156.130;

c. A closure such as a manhole cover, Butterworth plate, flange or deepwell pump stack, which forms a vapor-tight seal over the opening of the tank top through which the cargo is transferred. This closure should be bolted or dogged in place, and the hose drop line should be connected to it;

d. A metallic drop line which meets the requirements of 46 CFR 153.282;

e. A drip pan of at least 1/2 barrel capacity under each connection on the weather deck or ashore; and

f. A shutoff valve at or near the point of entry into the tank.

2. Suitable venting should be provided for the fish holds. The vents should have a cross sectional area equal to the cross sectional area of the hose or pipe being used to fill the hold with fuel. Vents terminating in enclosed areas, such as a wet deck, present a hazardous situation because of the possibility of accumulation of vapors and the presence of non-explosion proof electrical equipment located in the area. Arrangements to avoid the hazardous accumulation of fuel vapors should be provided. For example, a portable hose could be run from the vent in the hatch cover to a location outside the enclosed area.

3. For vessels of 400 gross tons and above, permanent piping from the fish holds must be provided in order that the oily wastes which accumulate when the hold is washed may be processed through the oil-water separator required by 33 CFR Part 155 or retained on board in a slop tank for subsequent discharge to a waste reception facility.