RETURN BIDS TO:
RETOURNER LES SOUMISSIONS À:

Bid Receiving - PWGSC / Réception des soumissions - TPSGC
11 Laurier St. / 11, rue Laurier
Place du Portage , Phase III
Core 0B2 / Noyau 0B2
Gatineau, Québec K1A 0S5
Bid Fax: (819) 997-9776

SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Comments - Commentaires

Vendor/Firm Name and Address
Raison sociale et adresse du fournisseur/de l'entrepreneur

Issuing Office - Bureau de distribution
Ship Refits and Conversions / Radoubss et modifications de navires and / et
11 Laurier St. / 11, rue Laurier
6C2, Place du Portage
Gatineau, Québec K1A 0S5

Title - Sujet LEONARD J COWLEY VLE REFIT- 2015	
Solicitation No. - N° de l'invitation F7049-140286/A	**Amendment No. - N° modif.** 007
Client Reference No. - N° de référence du client F7049-140286	**Date** 2015-01-24
GETS Reference No. - N° de référence de SEAG PW-$$MD-021-24828	
File No. - N° de dossier 021md.F7049-140286	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à 02:00 PM** **on - le 2015-02-09**	**Time Zone** **Fuseau horaire** Eastern Standard Time EST
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☐ **Other-Autre:** ☐	
Address Enquiries to: - Adresser toutes questions à: Byron, Dan	**Buyer Id - Id de l'acheteur** 021md
Telephone No. - N° de téléphone (819) 956-0691 ( )	**FAX No. - N° de FAX** (819) 956-7725
Destination - of Goods, Services, and Construction: **Destination - des biens, services et construction:**	

Instructions: See Herein

Instructions: Voir aux présentes

Delivery Required - Livraison exigée	**Delivery Offered - Livraison proposée**
Vendor/Firm Name and Address **Raison sociale et adresse du fournisseur/de l'entrepreneur** **Telephone No. - N° de téléphone** **Facsimile No. - N° de télécopieur**	
Name and title of person authorized to sign on behalf of Vendor/Firm (type or print) **Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)** **Signature** **Date**	

Solicitation Amendment #7 is issued to:

1) Include the following question and answers into the solicitation.

INCLUDE:

QUESTION NUMBER	QUESTION	ANSWER
8	H-02 3.2.17 this shelter for the duration of the refit and is it for on board the vessel or in the yard.	The shelter is for HD-06 Hull Underwater Hull Painting and HD-08 Hull Painting Above Ice Belt.
9	H-02, Para 17. – Services*:* Spec calls for “” Please expand on this requirement.	see answer provided above above
10	H-25, Para 3.1.2.4. – Galley Cold Rooms insulation*:* Generally, a cold room would be installed with a floor, but the spec notes that the floor is not required.Please explain why there is no requirement for a floor.	The floors are to be replaced this was noted in the Bidder's Conference in to delete (no) in sections 3.1.1.4. and 3.1.2.4 floor are required. The floor will be stainless steel 10cm thick c/w foamed place polyurethane cam locked panels to the walls.
11	H-29, Para 2.2.3 – Inclining Experiment : Please supply “ and Stability Book Production for CGC Vessels, Dated October 2014.	I have attached the english version request gone in for French it may not be available because it is a new release.
12	HD-10, Hull Repairs: Please supply copy of CT-043-EQ-EG-001 Welding Specification	I have attached English and French
13	H-17, Para 3.18 – Galley Flooring: Can we substitute a 6” tall base tile in place of a 5” base, to avoid having to cut each tile?	No it has to be 5 inches in height because that all the room that is available.
14	H-17, Para 3.2 – Galley Flooring:Is the grout to be normal floor grout or an epoxy grout which requires no sealer? To apply a sealer coat, there is a 28 day curing period for the grout.	Contractor to use TEC Power Grout 550 or equivalent. Attached is the product information.

15	H-12, Para 2.32 – Flooring and Sub Floors*:* Can you advise the original carpet tile manufacturer?	Sorry haven' got that information, for us it must be Lloyd' approved for this area.
15	H-16, Para 3.1.12 – Galley Equipment Replacement*:* Model number shown for the MKE Hot food table corresponds to a 33" – two well unit. The description in the spec calls for 71" length. Please advise which is required.	We would require it in 71" length
17	H-16, Para 3.1.12 – Galley Equipment Replacement*:* Model Number HFT designates painted steel base. HTFS designation signifies all stainless. Which would be preferred?	We would require stainless steel.
18	Where the bidder' conference will be held? In the last addenda, it' says to be determined.	St. John CCGS Base Southside Rd in Gilbert room at 1300hrs January 15, 2015.
19	When the ship is in drydock, do we need still need to provide 400A ?	Yes
20	HD-10 – 1.2.1.1 : Do you accept plate DNV grade EH36 instead of Lloyd' grade E?	Lloyd's can accept given the following, 1. Prior visual inspection by LR Surveyor to confirm marking and condition of plate. LR to mark plate as accepted. 2. Thickness measurement to be randomly verified in accordance with certificates. 3 Mill sheets review against LR rules and found satisfactory. All testing to extent required by LR rules to confirm. Steel mill is LR approved. 4. Certificate endorsed as accepted by LR Surveyor.

21	HD-10 : Do we need to replace the stiffener on the steel plate to be renew?	No
22	HD-06: In the French spec, it' says to redo the Inerta coating but item 3.1, they never specify the product in the coating sequence. Item 1.1.	The origanal coating that was put on this vessel was inerta. The repair we use for inerta is described in section 3.1 and the the coating sequence. We don't repair inerta by putting inerta back on.
23	H-09 ,2.1.1: " reserves the right to direct procurement" This makes it difficult for the bidder to establish prices and develop a bid.	The reason for this is to make sure the quality of equipment is Lloyd's approved or Origanal Equipment manufacture where required.
24	H-09, 3.3.7: States " contractor shall replace any hangers deemed by Lloyds" This is throughout the specification. Will the cost of these replacements be by PWGSC 1379 action?	Yes this will by PWGSC 1379 action.
25	H-09: Specification frequently calls up the supply of manuals. Must these be bi-lingual	No they must be in English if they are available in French we would like them provided but we don't want the contractor to do any translation.
26	H-12, 3.1.2: What does the " substitution" refer to?	It refers to what is stated must be supplied.
27	H-12, 3.1.11.7: Should the "" be ""	Yes this should be "and" not "add"
28	H-16, 5.3: Please confirm which piece of equipment requires training by the supplier' technical representative?	Contractor shall go over all 9 new items.
29	H-29: Will Canada accept an interim stability book at delivery with the complete document at a specified time afterwards? If the inclining is conducted at the completion of the work as it should be the vessel will have to sit idle for a month while the final book is developed and approved.	Yes Canada will accept.an interim stability book at delivery with the complete document at a specified time afterwards.
30	HD-10, 2.2.2: Is air testing acceptable?	Must be hydostatically tested.

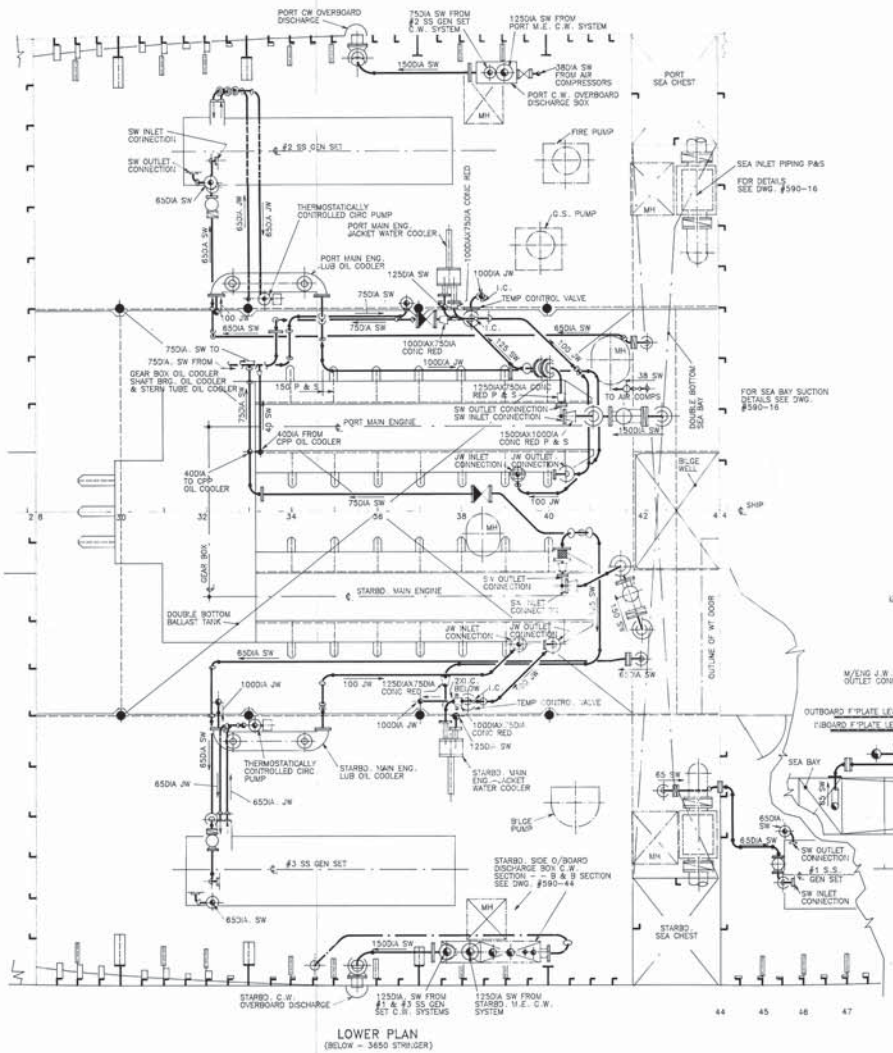
31	HD-13, 6.2.4: Tank is to be tested with vent caps off and at 6.2.6 tank is to be tested with vent caps on. Is the tank to be tested twice?	No. Sectiobn 6.2.6 to be deleted in its entiry.
32	HD-14, 4.2: We assume that the testing to 1.5 times working pressure refers to piping installed in the specification item?	Yes this is piping.
33	Is the tank to be hydrostatically tested?	Yes as per Lloyd's survey inspections.
34	HD-15, 3.1.3: Please indicate what is to be included in bid price.	Gas freeing a total of eight fuel tanks and bid per one for adjustment purposes by PWGSC 1379 action. Fuel Oil TK P & S: #1,2,3,4 as reference drawing 87536 Rev1
35	HD-16, 3.1.8: Will repairs to damaged internal plates be by 1379 action? Bidders cannot determine the extent of repairs required until tank is opened.	3.1.8 We are not looking at steel repairs it is coating repairs. The area for coating repairs for bidding purpose is 4.65 square meters.
36	E.05, 3.1.12, 3.2.8 and 313.9: require contractor to replace valves if required by Lloyds. In 3.4.9 the valves in the section if replaced will be done by 1379. Will this apply to all the valves requiring replacement in E.5?	Yes
37	ED-01, 1 Are all Rolls Royse expenses to be covered by the allowance and adjusted up or down by 1379?	Yes
38	ED-02, 3.1.23: Is contractor to include an allowance for Brown Broveri for overhaul of the turbo charger?	No. Turbo charger will be done by Wartsila
39	L-02: Can the supply of Woodward required components be included with the FSR allowance and adjusted by 1379?	No

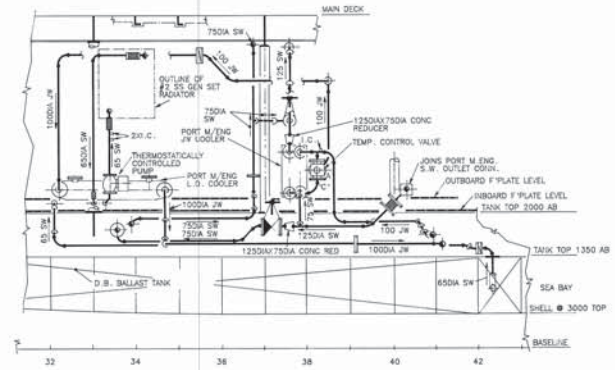
40	Is it possible to get the drawings for the Cowley piping systems in Auto CAD format?	Available drawings will be supplied 590-42-2 590-34 590-35 590-36 590-42-1 590-45-2 590-45-1 590-44-1 590-44-2
41	ED-09 Can you provide copy of drawings 590-43 Yes	Yes
42	HD-07 Can you provide copy of drawings 590-51	Yes
43	ED-05 Is there a pipe drawing for the R/O Unit Supply Pipe Replacement.	No
44	We have questions in regards with insurance requested in the ITT. We are looking to bring the ship at our dry-dock and the ship need to have a marine insurance which it' not requested in the spec. We understand that while the ship is in transit between the dry-dock and the outfitting quay, the insurance responsibility remain to Canada. The tugs insurance never cover the ship while on tow or in manoeuver in port. Can you confirm that your ship is still insured when the ship is under tow by you normal marine insurance? e questions in regards with insurance requested in the ITT.	The ship is under the care and custody of yard during the refit. It is the responsibility of the yard to provide any additional insurance that is needed. As per clause 7.11 in the solicitation, " contractor is responsible for deciding if additional insurance coverage is necessary to fulfil its obligation under the Contract and insure compliance with any applicable law. Any additional insurance coverage is at the Contractor' expense, and for its own benefit."

45	HD-15 Bilges keels, Is it possible to have the drawing 87536-1 Rev 1? We understand that no recoating is required inside the bilge keel after welding work.	drawing will be provided, and there is no paint to be applied after welding.
46	L-10, 1.3: Spec H-03 references Sea Trials confirm that this should be L-03?	This should be Fixed Smothering systems H-05. & L-03 Fire detection Systems
47	L-10, 3.1.1: Thirty Five Contact Devices are required.	Yes
48	L-10, 3.1.1: Four Engage Switches are required.	Yes
49	L-10, 3.1.1: Engage Switches will require 24 VDC power.	Engage Switches will require 24 VDC power. 24Vdc can be taken from LUA or LUB in main engine room as alarm is to be routed to these cabinets
50	L-10, 3.1.2: Fifteen Low Pressure Supervisory switches will be required	15 are required
51	L-10, 3.1.2.2: This function already exist on the Ship Fire Detection System Notifier Panel. Will this feature be removed from the Notifier Panel or Duplicated on the New Machinery Space System as well?	No
52	L-10, 3.1.3: We are not certified to install wiring to support Machinery Monitoring System. Is there a cash allowance for this?	Allowance of $10,000 for Trihedral rep included in 1.2
53	L-10, 3.1.4: Same as above. 3.1.3	Allowance of 10000 for Trihedral rep included in 1.2
54	L-10, 3.1.11: Blocked via switch or through Machinery Monitoring System?	If connected to Vts Trihedral system, can be done through HMI interface on screen in MCR
55	L-10, 3.1.13: Will an Auto-Cad Drawing be made accessible to the successful bidder for this scope?	yes
56	L-10, 5.1.1: Same comment as 3.1.13	will be made available in autocad

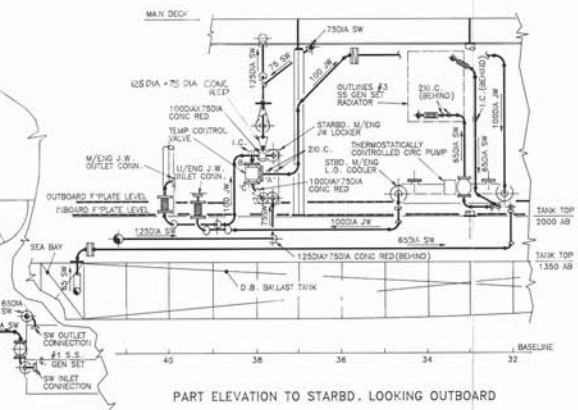
57	H-11, is the yard to supply and install the access hatch detailed in drawing 102-08-02 Helecopter Refueling System Access Hatch ?	Yes
58	H-11, Is the yard to supply install piping as per drawing 102-08-01 ?	Yes

End of Solicitation amendment #7





PART ELEVATION TO PORT LOOKING OUTBOARD



PART ELEVATION TO STARBD. LOOKING OUTBOARD

NOTES:-

-HIGH POINTS IN SYSTEM TO BE FITTED WITH VENT BOSSES & PLUGS
LOW " " DRAIN " "
INSTRUMENT CONNECTIONS TO BE FITTED AS REQUIRED

-FOR SMALL BORE PIPING UNDER, 50DIA. SEE DWG.#590-34 LATEST REV

-FOR SEA CHEST & SEA BAY PIPING DETAILS DWG#590-16 LATEST REV

-FOR OVERBOARD DISCH. ARRGT. SEE DWG.#590-44 LATEST REV.

-FRESH WATER LINES ARE MARKED J.W.
SEAWATER LINES ARE MARKED S.W.

-I.C. INDICATES INSTRUMENT CONNECTION

#18

REV.	DESCRIPTION		DATE
APPROVED	DATE	APPROVED	DATE
LLOYDS		OWNER	81/03/84
C.C.G.S.S.			

RivTow Industries Ltd.
West Coast Manly Shipyard Division

2050 E. KENT AVE. VANCOUVER, B.C. CANADA V5P 2T2 (604) 327-6311

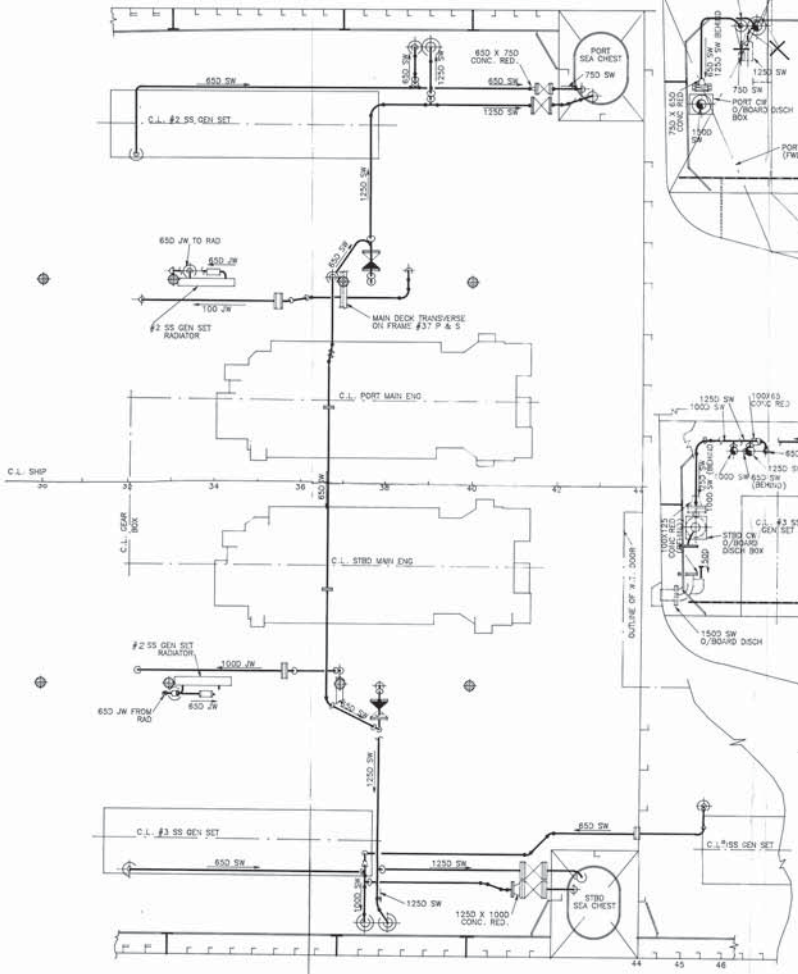
OWNER GOVERNMENT OF CANADA
DEPARTMENT OF FISHERIES AND OCEANS

VESSEL LEONARD J. COWLEY

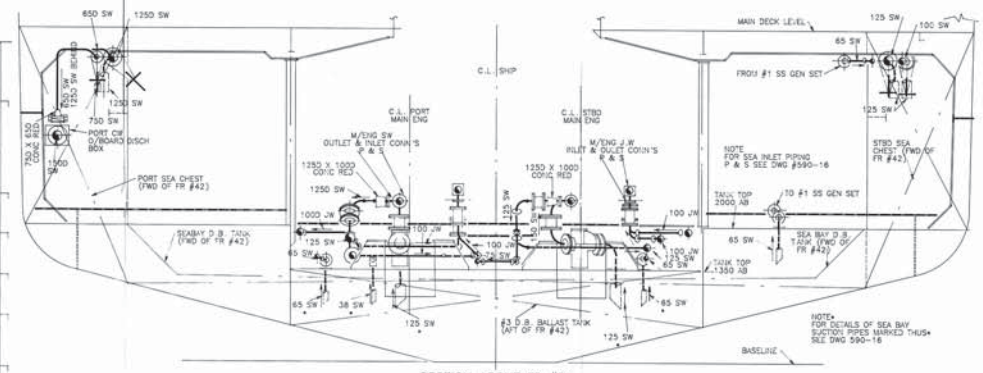
TITLE FRESH & SEA WATER COOLING PIPING (AS FITTED)

C & W	DATE	BY	SCALE: 1:25	REV.
DRAWN	JAN/84	D.MAINS	DRAWING NO. 590-43	0
CHECKED	"	BDH	SHEET 1 OF 2	
APPROVED	"	WC		

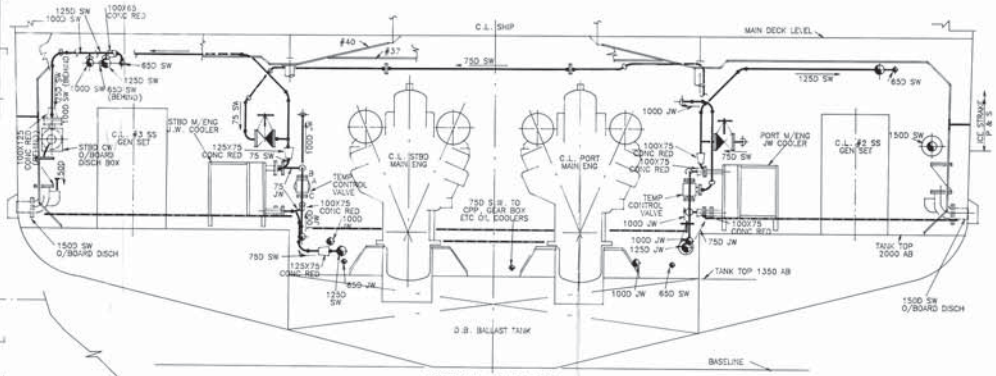
Box 1



UPPER PLAN
(BELOW MAIN DECK)



SECTION ABOUT FR #39
LOOKING FWD



SECTION AT FR #40
LOOKING AFT

FOR GENERAL NOTES
SEE SHEET #1 OF THIS DWG

REV.	DESCRIPTION			DATE
	APPROVED	DATE	APPROVED	DATE
	LLOYDS		OWNER	01/03/84
	C.C.G.S.S.			

RivTow Industries Ltd.
West Coast Manly Shipyard Division

2050 E. KENT AVE. VANCOUVER, B.C. CANADA V5P 2T2 (604) 327-6311

OWNER: GOVERNMENT OF CANADA
DEPARTMENT OF FISHERIES AND OCEANS

VESSEL: LEONARD J. COWLEY

TITLE: FRESH & SEA WATER COOLING PIPING (AS FITTED)

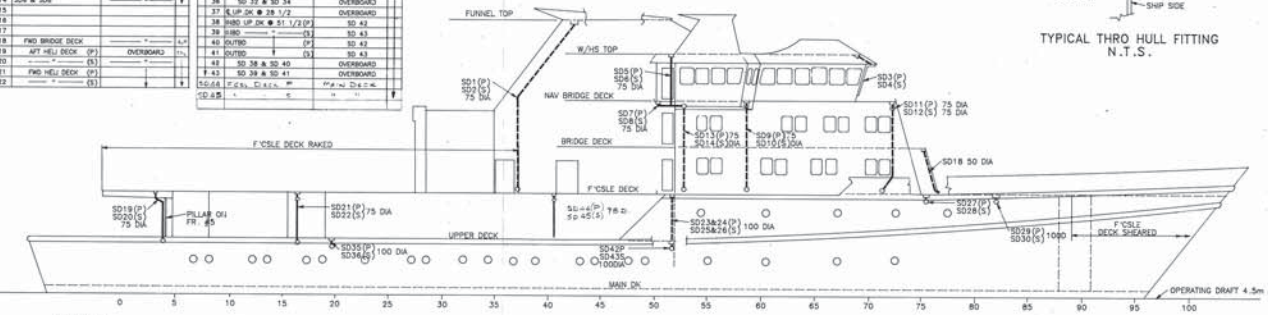
C & W	DATE	BY	SCALE: 1:25	REV.
DRAWN	JAN/84	D.MAINS	DRAWING NO. 590-43	0
CHECKED	"	BDH	SHEET 2 OF 2	
APPROVED	"	WC		

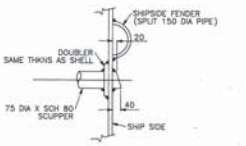
Box 1

LIST OF SCUPPERS

ID	DRAINS FROM	DRAINS TO	ø"
SD1	FUNNEL TOP (P)	F'CSLE DECK	4ø
2	——— " ——— (S)	"	
3	FWD W/HS TOP (P)	NAV BRIDGE DECK	
4	——— " ——— (S)	"	
5	AFT W/HS TOP (P)	SD13	
6	——— " ——— (S)	SD14	
7	AFT NAV BRIDGE DECK (P)	SD13	
8	——— " ——— (S)	SD14	
9	MID (P)	F'CSLE DECK	
10	" (S)	"	
11	FWD (P)	F'CSLE DECK	
12	" (S)	"	
13	SD5 & SD7	F'CSLE DECK	
14	SD6 & SD8	"	
15			
16			
17			
18	FWD BRIDGE DECK	"	4ø
19	AFT HELI DECK (P)	OVERBOARD	3½
20	" (S)	"	
21	FWD HELI DECK (P)	"	
† 22	——— " ——— (S)	"	

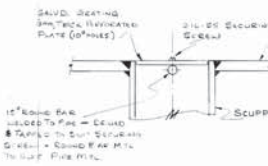
ID	DRAINS FROM	DRAINS TO	ø"
SD23	SBD F&E DK●81 1/2(P)	F'CSLE DECK	3½
24	INBD " (P)	"	
25	INBD " (S)		
26	OUTBD " (S)		
27	F'CSLE DK ● 75 1/2 (P)	OVERBOARD	
28	——— " ——— (S)	"	
29	F'CSLE DK ● 87 1/2 (P)		
30	——— " ——— (S)		
31	INBD UP.DK ● 19 1/2(P)	SD 35	
32	INBD UP.DK ● 19 1/2(S)	SD 36	
33	OUTBD ——— " ——— (P)	SD 35	
34	OUTBD " (S)	SD 36	
35	SD 31 & SD 33	OVERBOARD	
36	SD 32 & SD 34	OVERBOARD	
37	UP.DK ● 28 1/2	OVERBOARD	
38	INBD UP.DK ● 51 1/2(P)	SD 42	
39	INBD ——— " ——— (S)	SD 43	
40	OUTBD " (P)	SD 42	
41	OUTBD " (S)	SD 43	
42	SD 38 & SD 40	OVERBOARD	
† 43	SD 39 & SD 41	OVERBOARD	
SD44	F'CSL DECK "	MAIN DECK	
SD45	" "	" "	



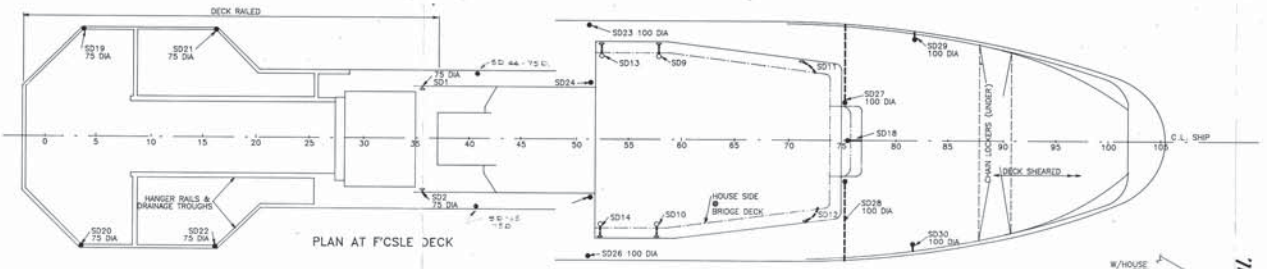


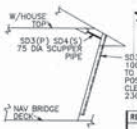
TYPICAL THRO HULL FITTING
N.T.S.

NOTE:
- SCUPPERS & PIPING ARE POSITIONED IN SUCH A MANNER AS TO CLEAR INTERFERENCES WHILE EFFICIENTLY PROVIDING DRAINAGE TO AREAS WHERE WATER MAY COLLECT
- SCUPPER PIPES ARE OF MARINE GRADE SCH 40 ALUM. OR SCH 80 BLACK STEEL - SEE LIST OF SCUPPERS
- ALL DECK SCUPPERS FITTED WITH REMOVEABLE GRATINGS OF NON FERROUS MATERIALS (SEE DETAIL)
- THE REMAINING REQUIREMENTS OF LLOYDS RULES, CSI RULES AND VESSEL SPECIFICATION, AS ARE APPLICABLE SHALL BE COMPLIED WITH



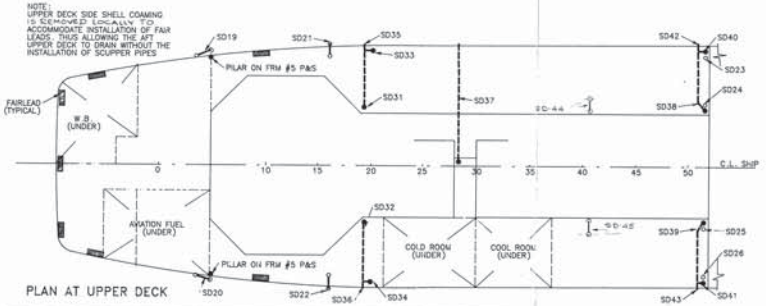
DETAIL OF REMOVABLE SCUPPER GRATING

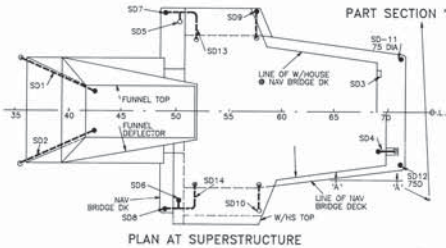




PART SECTION 'A-A'

NOTE:
UPPER DECK SIDE SHELL COAMING IS REMOVED LOCALLY TO ACCOMMODATE INSTALLATION OF FAIR LEADS, THUS ALLOWING THE AFT UPPER DECK TO DRAIN WITHOUT THE INSTALLATION OF SCUPPER PIPES





RECEIVED
NOV 12 1985
SHIP BRANCH

SHIP BRANCH
DFO OTTAWA
MAY 22 1985
EXAMINED
BY

REV.	DESCRIPTION		DATE
APPROVED	DATE	APPROVED	DATE
LLOYDS		OWNER	
C.C.G.S.S.			

RivTow Industries Ltd.
West Coast Manly Shipyard Division
2050 E. KENT AVE. VANCOUVER, B.C. CANADA V5P 2T2 (604) 327-6311

OWNER: GOVERNMENT OF CANADA
DEPARTMENT OF FISHERIES AND OCEANS

VESSEL: LEONARD J. COWLEY 'AS FITTED'

TITLE: EXTERIOR SCUPPERS & DRAINS

C & W	DATE	BY	SCALE: 1:100	REV.
DRAWN	AUG/84	D.MAINS	DRAWING NO. 590-51	0
CHECKED				
APPROVED				

(BOX 1)

Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Coast Guard | Garde côtière canadienne

CT-043-EQ-EG-001-E

Welding Specification

Canadian Coast Guard

Welding Specification

Canada

Published under the Authority of:
Integrated Technical Services Directorate
Fisheries and Oceans Canada
Canadian Coast Guard
Ottawa, Ontario
K1A 0E6

CT-043-eq-eg-001-E

Welding Specification EKME#3049715

Disponible en français :**Norme de soudage des métaux ferreux**

FIRST EDITION – - MARCH 2014

Document Control

Record of Amendments

#	Date	Description	Initials

Approvals

Office of Primary Interest (OPI)	Tracey Clarke	Approved: Date:	
Manager, Engineering and Maintenance Hull/ Mechanical/ Electrical	Anne Marie Sekerka	Approved: Date:	
Director, Marine Engineering Services (ITS)	Gary Ivany	Approved: Date:	
Director General, Integrated Technical Services	Michel Cecire	Approved: Date:	

Contents

List of Tables

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Document Management

1. Authority

This document is issued by the Director General, Integrated Technical Services under delegation from the Deputy Minister, Fisheries and Oceans and the Commissioner of the Canadian Coast Guard.

2. Responsibility

A) The Director, Marine Engineering is responsible for:

i) creating and promulgating of the document; and

ii) identifying an Office of Primary Interest (OPI) who is responsible for the coordination and the content of the document.

B) The OPI is responsible for:

i) verifying the validity and accuracy of the content;

ii) ensuring the availability of this information;

iii) updating as needed;

iv) ensuring the periodical revision; and

v) following up all requests, comments and/or suggestions received to the originator.

3. Inquiries and/or Revision Requests

All inquiries regarding this document, including suggestions for revision and requests for interpretation shall be addressed to:

Position Title:	Manager, Engineering and Maintenance: Hull/ Mechanical/ Electrical
Address:	Fisheries and Oceans – Canadian Coast Guard 200 Kent Street, Ottawa, Ontario K1A 0E6

All requests should:

i) be clear and concise; and

ii) reference the specific Chapter, Section, Figure or Table.

Foreword

This Specification has been prepared by Marine Engineering, Integrated Technical Services (ITS), Canadian Coast Guard, Fisheries and Oceans Canada, Ottawa.

The purpose of this Specification is stated in Chapter 1.0, Scope.

When, this Specification is used other than as stated in the Scope, it shall remain the responsibility of the user to judge its suitability for their particular purpose.

CHAPTER 1 SCOPE

This Specification establishes the requirements of Marine Engineering, Integrated Technical Services, Canadian Coast Guard, Fisheries and Oceans Canada, Ottawa.

This Specification shall be followed whenever required by contract.

This Specification details the requirements for welding and non-destructive inspection of welds for structural steel, aluminum and stainless steel and the wide variety of other materials used for installation of pressure piping, pressure vessels and pressure containment systems and, shipboard equipment.

This Specification is intended as an Owner's requirement. In addition to this Specification, the Contractor shall meet all regulations and rules required by Transport Canada Marine Safety and Security and, the governing Classification Society as applicable.

When the above mentioned rules exceed the requirements specified herein, the more stringent requirement shall take precedence.

CHAPTER 2 DEFINITIONS & ABBREVIATIONS

The following definitions and abbreviations apply in this Specification:

Approved (approval)	means reviewed and accepted by the Delegated Representative of the Director, Marine Engineering, unless otherwise specified.
Contractor	means the company to which a contract has been awarded by the Owner.
CWB	means the Canadian Welding Bureau.
Delegated Representative	means the individual that has been assigned the authority to represent the Director, Marine Engineering regarding matters related to the requirements of this Specification, as applied to a specific contract.
Engineer (in the referenced standards)	means the Delegated Representative.
Examination, Inspection, Testing	means the act of looking at something closely, by either destructive or non-destructive methods, in order to learn more about it, to determine acceptance or rejection to a defined criterion, to locate problems.
Owner	means, in the context of this Specification as applied to a given contract, Marine Engineering, Integrated Technical Services (ITS), Canadian Coast Guard, Fisheries and Oceans Canada, Ottawa.
Pressure Piping	means any piping used to convey a fluid at a pressure above atmospheric pressure, unless otherwise stated.
Provincial Pressure Vessel Authority	means the organizations legislated by the Provinces of Canada to provide oversight for welding pressure piping, pressure vessels and pressure containment systems.
Structure (s) or Structural	means primary hull structure and secondary structure.
Structure, Primary Hull	means that part of the vessel hull structure which makes up the primary hull girder, including structure to resist ice loadings. It consists of strength decks, platforms and shell plating and their supporting framing, tank top, vertical keel, longitudinal and main transverse bulkheads. In addition to the primary hull girder, water, oil and gas tight bulkheads shall be considered part of the primary hull structure.
Structure, Secondary	means all of the vessel structure which is not included in the definition for primary hull structure.
Sub-Contractor	means the company to which a contract has been awarded by the Contractor.

CHAPTER 3 APPLICABLE DOCUMENTS

The Contractor or Sub-Contractor performing welding or inspection of welds shall be familiar with the applicable Codes, Standards, Rules and Publications referred to within this Specification (See Annex "A").

Use of the above-mentioned references shall be the latest edition approved by the organization issuing the publication specified at the time of contract award.

Except as noted in Chapter 1, when the requirements of other publications are in conflict with the requirements specified herein, the Delegated Representative shall be requested to establish precedence.

CHAPTER 4 ADMINISTRATION

This Specification shall be administered by the Director, Marine Engineering, Integrated Technical Services, Canadian Coast Guard, Fisheries and Oceans Canada, Ottawa.

For the purpose of administration, the Director, Marine Engineering shall delegate representatives that shall be responsible for measuring the Contractor's performance and ability to meet the requirements specified herein.

The Contractor shall allow the Delegated Representatives access to the facilities, files and records relative to the requirements of this Specification for the duration of the contract and warranty period.

The documentation that is to be made available to the Delegated Representatives shall include, but not necessarily be limited to, personnel qualification records, welding specifications and weld procedure data sheets, certification records, visual and non-destructive inspection results, quality control and quality assurance manuals and reports, and other associated documents.

CHAPTER 5 WELDING STRUCTURES

5.1 CONTRACTOR REQUIREMENTS

5.1.1 Steel Structures

All welding contractors shall be certified by the CWB to CSA Standard W47.1 Division 1 or 2 for new construction and work packages other than new construction.

5.1.2 Aluminum Structures

All welding contractors shall be certified by the CWB to CSA Standard W47.2 Division 1 or 2 for new construction and work packages other than new construction.

5.1.3 Welding Procedures

All welding procedure specifications and/or welding procedure data sheets shall be reviewed and approved by the CWB prior to use.

5.1.4 Welding Personnel

All welding personnel shall be approved by the CWB prior to their commencing any welding work

5.1.5 Performance and Qualification Testing

All performance and procedure qualification testing shall be fully witnessed and documented by the CWB.

5.1.6 Limitations Prior to Commencing Welding Work

All Contractors shall submit their welding personnel qualification records and approved welding procedures to the Delegated Representative prior to commencing any welding work.

All welding procedures, including welding procedure specifications and welding procedure data sheets, shall include an indication of acceptance by the Contractor (by signature, seal or other appropriate means) and a stamp of acceptance by the CWB.

5.1.7 Governing Standards for Welding

For structural steels $\geq$ 3 mm in thickness, welding shall meet the requirements of CSA Standards W47.1 and W59, except as modified by this Specification.

For structural aluminum $\geq$ 3 mm in thickness, welding shall meet the requirements of CSA Standards W47.2 and W59.2, except as modified by this Specification.

5.2 WELD DESIGN AND SYMBOLS

5.2.1 Weld Design

Weld design shall be to the Rules of a Classification Society that is an approved Recognized Organization by Transport Canada Marine Safety and Security. Unless otherwise approved by the Delegated Representative, the following conditions shall be met:

- all groove welds in butt joints shall be full penetration; and,
- all corner joints shall be full penetration groove welds combined with single continuous fillet weld

A weld design schedule shall be submitted to the Delegated Representative in drawing form for review prior to commencing any welding work.

5.2.2 Symbols for Welding

Design drawings shall include weld requirement symbols and construction drawings shall include welding symbols following the requirements of CSA Standards W59 and W59.2. For fillet welds, the drawings shall indicate if the weld dimension shown in the symbol is throat size or leg length.

5.3 WELDING CONSUMABLES

5.3.1 Introduction

This Section provides contractors a means of quickly finding the information required to match welding consumables to the various grades of steel and aluminum materials used for shipbuilding and repair. For steel, cross reference is made between CSA welding consumable and shipbuilding material designations. This Section also guides the contractor in the selection of corrosion resistant welding consumables for ships built of atmospheric corrosion resistant steels and for welds located in the external shell envelope of ice transiting ships. For welding processes other than those listed herein, consult the governing standards referenced in Chapter 5.1, Section 5.1.7 of this specification.

5.3.2 Steel

5.3.2.1 Electrode and Consumable Selection

Electrodes and consumables for all welding processes shall be selected on the basis of retained hydrogen, mechanical properties (UTS, YS, elongation and toughness) and resistance to corrosion in sea water.

Generally, the requirements of Tables 5.1- 5.5 inclusive shall apply involving the use of steels having a yield stress below 360 MPa (N/mm²) and charpy-v-notch toughness requirements at test temperatures above -45°C.

For other materials or conditions, welding electrodes and consumables shall be selected in accordance with the requirements of the following Sections of this Specification:

- Section 5.3.2.8 for higher strength notch tough steels;
- Section 5.3.2.9 for atmospheric corrosion resistant steels;
- Section 5.3.2.10 for Shell Butts & Seams – Ice Transiting Steel Ships

Welding electrodes and consumables for welding steel shall be certified by the CWB to the requirements of CSA Standard W48 or the applicable AWS A5 series of standards.

When two different grades of material of the same tensile strength properties are being joined by welding and corrosion resistance is not a consideration, electrodes and consumables for the lower grade is generally acceptable. Similarly, when joining materials with differing tensile strength properties, electrodes and consumables are to be suitable for the tensile strength of the component on which the weld size (e.g. fillet weld) has been determined.

Care shall be taken not to overmatch weld metal mechanical properties.

5.3.2.2 Storage and Handling

Storage and handling of welding consumables, electrodes and fluxes shall be in accordance with the requirements of CSA Standard W59.

5.3.2.3 Low or Controlled Hydrogen Electrode Requirements

In addition to other factors that must be considered for matching weld metal deposits to various grades of base materials, welding processes and their respective welding electrodes and consumables produce varying amounts of hydrogen gas which may be retained in the deposited weld metal. Although the amount of retained hydrogen may be reduced by increasing preheat temperatures, low and controlled hydrogen electrodes and consumables shall be required in accordance with Table 5.1.

Table 5.1 Selection of Low or Controlled Hydrogen Electrodes

Mandatory Use of Low and Controlled Hydrogen Electrodes		Other than Low Hydrogen Electrodes (1)	
Material Grade	**Material Thickness**	**Material Grade**	**Material Thickness**
Gr. A Gr. E Gr. AH 32, 34 36 Gr. DH 32, 34, 36 Gr. EH 32, 34,36 Gr. FH 32, 36,40 Gr. FH 42 - 69	(t) ≥ 19 mm All Thicknesses	Gr. A	(t) ≤ 19 mm
Where (t) is the thickest member		**Where (t) is the thickest member**	

Note: (1) Independent of the material grade specified, when the carbon equivalent (CE) of the material exceeds 0.40 where the carbon equivalent is calculated from the ladle analysis as follows:

$$CE = \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Basic or controlled hydrogen electrodes are required.

When the grades of base metals requiring low or controlled hydrogen electrodes and consumables are produced using thermo-mechanical controlled rolling practice, the Contractor may apply to the Delegated Representative for exemption from mandatory requirements listed in Table 5.1. Exemption will only be granted after due consideration of susceptibility to hydrogen assisted or induced cold cracking.

5.3.2.4 Shielded Metal Arc Welding (SMAW)

Welding electrodes for shielded metal arc welding normal and higher strength shipbuilding grade steels shall be selected following the requirements of Table 5.2.

Table 5.2 Selection of Welding Electrodes for Shielded Metal Arc Welding

Material Grade	CSA W48 Electrode
Grade A	E4300, 10, 11, 13, 27 (2) E4914, 24 (2) E4918, 28,48 (1)
Grade E	E4918-1 (1)
GradesAH32, 34, 36 DH32, 34, 36	E4918, 28, 48 (1)
Grades EH32, 34, 36	E4918-1 (1)
Grades EH40 FH-XX XX-40-69	See Section 5.3.2.8 herein.

NOTES: (1) As required in Table 5.1; (2) Restricted use as detailed in Table 5.1;

5.3.2.5 Submerged Arc Welding (SAW)

Wire electrode-flux combinations for submerged arc welding normal and higher strength shipbuilding grade steels shall be selected following the requirements of Table 5.3.

Table 5.3 Selection of Wire Electrodes and Flux for Submerged Arc Welding

Base Material	CSA W48	
Grade	Flux (1)	Electrodes
Grade A	F43A1-XXXX F49A1-XXXX	XXXX-EL12 XXXX-EM12K
Grades E	F49A4-XXXX F49A5-XXXX	XXXX-EM12K XXXX-EM13K
Grades AH32, 34, 36 DH32, 34, 36	F49A1-XXXX F49A2-XXXX	XXXX-EM12K XXXX-EM13K
Grades EH32, 34, 36	F49A4-XXXX F49A5-XXXX	XXXX-EM12K XXXX-EM13K
Grades EH40 FH-XX XX-40-69	See Section 5.3.2.8 herein.	See Section 5.3.2.8 herein.

Note: (1) Neutral flux only for shell plate groove welds.

5.3.2.6 Flux Cored and Metal Cored Arc Welding (FCAW & MCAW)

Wire electrodes for flux cored arc welding and metal cored arc welding normal and higher strength shipbuilding grade steels shall be selected following the requirements of Table 5.4. Shielding gas type shall be in accordance with approved weld procedure data sheets for the wire electrode selected.

Table 5.4 Selection of Wire Electrodes for Flux Cored and Metal Cored Arc Welding

Base Materials	Wire Electrode					
Grade	CSA W48					
Grade A	E49X **See Note #2**	- T	-1 (M) -5 (M) -6 (M) -8 -9 (M) -12	E490X **See Note #2**	-T	-G (1) -GS (1) -4 (1) -7 (1) -10 (1) -11(1)
	E49X **See Note #2**	- C	(M) -3 (M) -6 (M)	E49X **See Note #2**	-C	-G (1)
Grades AH 32, 36 DH 32, 36	E49X **See Note #3**	- T	-1 (M) -5 (M) -6	E49X **See Note #3**	-T	-8 -9 (M) -12 (M)
	E49X **See Note #3**	- C	-3 (M) -6 (M)	E49X **See Note #3**	-C	-G1
Grades E EH 32, 36	E49X-T-X(X)-J, E49X-C-X(X)-J **See Notes #3 & 4** E49X-T-X(X)-J, E49X-C-X(X)-J **See Notes #3 & 4** E55X-T-X(X)-J, E55X-C-X(X)-J **See Notes #3 & 4**					
Grades EH40 FH-XX XX-40-69	No pre-approved consumables. See Section 5.3.2.8 herein. Qualification Tests are required using the shielding gas type planned for production.					

1. Submit for approval;
2. H16 designation for the thicknesses required by Table 5.1.
3. H16 designation for all thicknesses.
4. Must carry "J" designation, average impact energy of 27 j @ -40 C.

5.3.2.7 Gas Metal Arc Welding (GMAW)

Wire electrodes for gas metal arc welding normal and higher strength shipbuilding grade steels shall be selected following the requirements of Table 5.5. Shielding gas type shall be in accordance with the approved weld procedure data sheets for the wire electrode selected.

Table 5.5 Selection of Wire Electrodes for Gas Metal Arc Welding

Base Materials	Wire Electrodes
Marine Grade	**CSA W48:06 CAN/ISO 14341:06**
Grade A t ≤ 19 mm……. t > 19 mm……	 ISO 14341-B-G-49A-X-X-XX ISO 14341-B-G-49A-2-X-XX ISO 14341-B-G-49A-3-X-XX
Grade E	ISO 14341-B-G-49A-4-X-XX ISO 14341-B-G-49A-5-X-XX ISO 14341-B-G-49A-6-X-XX
Grades AH 32, 36 & DH 32, 36 EH 32, 36	ISO 14341-B-G-49A-2-X-XX ISO 14341-B-G-49A-3-X-XX ISO 14341-B-G-49A-4-X-XX ISO 14341-B-G-49A-5-X-XX ISO 14341-B-G-49A-6-X-XX ISO 14341-B-G-55A-4-X-XX ISO 14341-B-G-55A-5-X-XX ISO 14341-B-G-55A-6-X-XX
Grades EH40 FH-XX XX-40-69	No pre-approved consumables. See Section 5.3.2.8 herein. Qualification Tests are required using the shielding gas type planned for production.

Wire electrodes approved by the yield strength and average impact values of 47 J, the “A” suffix method, shall be submitted to the Delegated Representative for review and acceptance. Weld procedure qualification testing is required.

5.3.2.8 Electrodes for Higher Strength Notch Tough Steels

Welding electrodes and consumables for joining normal and high strength shipbuilding grade steels that have been manufactured using the thermo-mechanical controlled rolling practice method shall be approved by a series of weld procedure qualification tests.

Welding electrodes and consumables for joining shipbuilding steel grades FH-XX and XX-40 through XX-69 inclusive shall also be approved by a series of weld procedure qualification tests.

As a minimum, welding electrodes and consumables shall match the base metal strength (UTS, YS and elongation) and notch toughness properties at the base metal test temperature.

To qualify welding electrodes and consumables, a series of weld procedure qualification tests shall be performed in each position of welding using joint configurations typical of that intended for production. For each of the test conditions, two welds shall be made; one test each at the minimum and maximum anticipated heat inputs (kj/mm) planned for production welding.

Assemblages, type of tests and specimens shall be in accordance with CSA Standard W47.1. Each procedure qualification test shall be supplemented with 15 charpy-v-notch specimens; 5 specimens with the "v" notch located at the centre of the joint, 5 specimens with the "v" notch intersecting the line of fusion and 5 specimens with the "v" notch located 5 mm from the fusion line (HAZ). Charpy-v-notch specimens shall be tested in accordance with the requirements of CSA Standard W47.1 at test temperatures equivalent to that of the base metal classification (ie. E & EH @ -40°C, FH @ -60°C, etc.).

The minimum acceptance requirements for each test method shall be those requirements of the test specification under which the base metal was qualified.

5.3.2.9 Electrodes for Atmospheric Corrosion Resistant Steels

Welding electrodes and consumables for joining atmospheric corrosion resistant steels such as CSA Standard G40.21 grades 350A, 350AT, 400A and 400AT including ASTM grades A242 and A588 steels shall be carefully selected to match the copper and nickel content of the base plate and the ultimate and yield strength, elongation and toughness properties. Close attention shall be paid to matching all of the chemical elements that prevent corrosion in sea water.

Butts and seams in the shell, weather decks and all welds in uncoated ballast tanks shall be performed with welding electrodes and consumables that are proven to be resistant to weld zone (weld deposit and HAZ) corrosion in accordance with the requirements of Section 5.3.2.10 herein. These requirements also apply to weld repair of scars in shell plating caused by removal of temporary attachments. There are no pre-approved corrosion resistant weld metal deposits for welding atmospheric corrosion resistant steels. For welds in other locations of primary and secondary structure, electrodes and consumables may be selected and matched in accordance with the requirements of CSA Standard W59.

5.3.2.10 Shell Butts & Seams – Ice Transiting Steel Ships

The finishing layers of shell butts and seams located on the sea water side of ice-transiting ships shall be performed with welding electrodes and consumables that are proven to be resistant to weld zone (weld deposit and HAZ) corrosion in accordance with the requirements of this Section.

For shielded metal arc welding, E5518-C3 is approved for use without testing. There are no other pre-approved corrosion resistant consumables for any welding process.

Once the Contractor has matched a welding electrode and consumable to the minimum base plate mechanical property requirements of this Specification; coupons shall be prepared, welded and tested for corrosion resistance in sea water by conducting anodic dissolution tests as outlined in Annex “B” of this Specification. Two weld coupons shall be made for each weld metal/base metal combination; one test each at the anticipated minimum and maximum heat inputs (kj/mm) planned for production welding. Welding bead sequence for these tests must employ a stringer temper bead technique as illustrated in Annex B of this Specification. No weaving is permitted.

The target acceptance criterion sought is near equivalent loss of the base plate, heat affected zone and weld metal deposit. Since this may not always be accomplished for all grades of base metal, slight loss of weld metal is desired over any loss in the heat affected zone. Anodic dissolution test results shall be tabulated and submitted to the Delegated Representative for approval.

For finishing layers of welds located on the external shell plating of ice transiting ships, a temper bead approach shall be employed similar to what is illustrated in Figure 5.1.

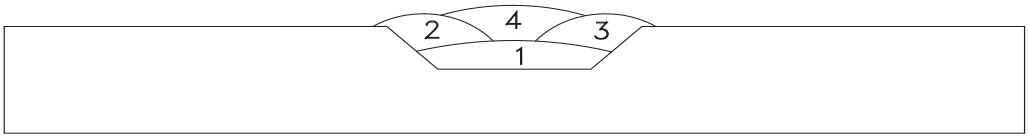


Figure 5.1 Temper Bead Approach for Finishing Layers in Shell Plating

The first layer of corrosion resistance weld metal shall be deposited 5 mm below the plate surface.

5.3.3 Aluminum

5.3.3.1 Electrode and Consumable Selection

Welding electrodes, rods and consumables shall be matched to the base metal in accordance with the requirements of CSA Standard W59.2. All welding electrodes, rods and consumables shall be certified by the CWB to the requirements of AWS A5.10.

5.3.3.2 Storage and Handling

Storage and handling of welding electrodes, rods and consumables shall be in accordance with the requirements of CSA Standard W59.2.

5.4 WORKMANSHIP

5.4.1 Environment

The work being welded shall be adequately protected against the direct effects of wind, rain and snow throughout the welding operation.

Welding steel at ambient temperatures below -18°C requires approval in accordance with CSA Standard W59. Aluminum welding shall not be carried out when the work surfaces are damp or wet or at ambient temperatures below 0°C.

Welding with processes that utilize externally supplied shielding gas shall not be performed in a draught or wind unless the weld zone is protected from loss of shielding gas as required by CSA Standards W59 and W59.2 for steel and aluminum, respectively.

5.4.2 Preheat and Interpass Temperatures

Preheating and interpass temperatures for welding steel and aluminum shall follow the requirements of CSA Standards W59 and W59.2, respectively.

5.4.3 Plate Forming

5.4.3.1 General

Heat line bending by the application of oxy-fuel gas torches for creating curvatures in steel plates is permitted for certain shipbuilding grade steels, providing the requirements of this Section are met.

Heat line bending of aluminum requires special consideration and approval. Annex “C” of this Specification offers guidance notes on hot and cold forming practices for aluminum.

5.4.3.2 Personnel

Personnel performing heat line bending shall be trained and qualified prior to forming plates for production or repair of distortion. A list of qualified personnel shall be submitted to the Delegated Representative prior to any heat line bending operations.

5.4.3.3 Materials

Heat line bending is permitted on shipbuilding grade materials "A"-"EH36" providing the material has not been produced by the thermo-mechanical controlled rolling practice method. All other grades of steel including "FH-XX" and "XX-40 through XX-69" inclusive, shall require special consideration and approval by the Delegated Representative. Heat line bending is not permitted on quench and tempered steels.

5.4.3.4 Procedures

For those pre-approved shipbuilding grades of steel listed in Section 5.4.3.3 herein, forming is not to be performed between 205° C and 425° C. If the forming temperature exceeds 650° C for as-rolled, controlled rolled or normalized steels, mechanical tests are to be made to assure that these temperatures have not adversely affected the mechanical properties of the steel. Water quenching should not occur at temperatures above 550° C.

For applications where toughness is of particular concern, when the steel is formed below 650° C beyond 3% strain on the outer fibre, charpy-v-notch impact tests shall be performed to the satisfaction of the Delegated Representative to demonstrate impact properties meet material specification minimum requirements. The percent strain on the outer fibre shall be calculated by; 65 times the plate thickness divided by the outer radius.

For those materials not pre-approved, heat line bending procedures shall be submitted to the Delegated Representative for consideration. The submission shall contain results of metallurgical, physical and corrosion tests.

5.4.3.5 Controls

During plate forming, controls shall be in place to check maximum plate and water or air quenching temperatures. On material grades having notch toughness properties, direct supervision and monitoring is required.

5.4.4 Weld Size and Dimensions

The size and length of welds shall not be less than, nor shall they be substantially in excess of, those specified by the design requirement.

For tee joints in the skewed condition, the deposited leg length of fillet welds shall be adjusted based on the fitted angle and gap as required by CSA Standards W59 and W59.2 for steel and aluminum, respectively. Gaps shall not exceed 5 mm and the dihedral angle shall not exceed 135°.

5.4.5 Adjacent Weld Spacing

The minimum dimension between adjacent groove welds that do not appear on approved drawings or form part of an insert located in shell plating shall be 300 mm minimum.

The minimum dimension between a groove weld in a table member and a fillet weld to the same table member that do not appear on approved drawings shall be 30 mm minimum.

The minimum dimension between fillet welds attaching an abutting member to a table member and a groove weld in the same abutting member that do not appear on approved drawings shall be 300 mm minimum.

5.4.6 Inserts and Doublers

Where a local increase in plate thickness is required, insert plates shall be used instead of doubler plates.

When an insert is to be located within the shell envelope the minimum dimension shall be 1000 mm x 1000 mm. When an insert is to be located in other locations the minimum dimension shall be 300 mm x 300 mm. Welds should be connected to existing butts and seams whenever possible. The minimum corner radius used for all insert plates independent of location shall be 5 (t), 75 mm minimum.

For shell and weather deck plating, the rolling direction of an insert plate shall be fitted to match the rolling direction of the surrounding base plates.

Welding sequences shall be carefully developed in order that shrinkage stress is balanced and restraint cracking does not occur.

5.4.7 Edge Preparation and Fitted Tolerances

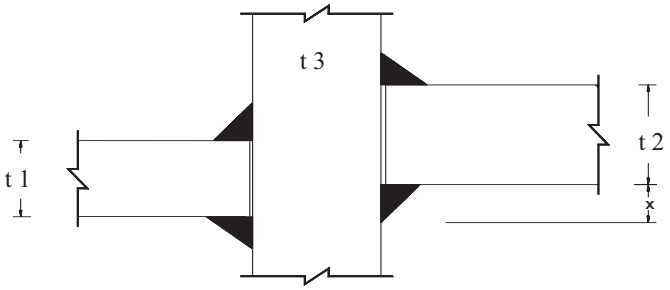
The edge preparation is to be accurate and uniform and the parts to be welded are to be fitted in accordance with the approved joint detail.

Means are to be provided for maintaining the parts to be welded in correct position and alignment during the welding operation.

The occasional misalignment of joints fitted for welding shall not exceed the dimensional tolerances detailed in CSA Standards W59 and W59.2 for steel and aluminum, respectively, and this Specification.

5.4.8 Intercostals

The occasional misalignment of intercostals for steel structures shall not exceed the limitations illustrated in Figure 5.2.



(X) = misalignment measured on the heel line Where t 3 is less than t 1, then t 3 should be substituted for t 1.		
For Strength Members:	- When (X) ≤ $t^1/3$	Increase Fillet Leg Size Equal to Offset
	- When (X) > $t^1/3$	Release and Re-Align
For Other Members:	- When (X) ≤ $t^1/2$	Increase Fillet Leg Size Equal to Offset
	- When (X) > $t^1/2$	Release and Re-Align

Figure 5.2 Intercostals

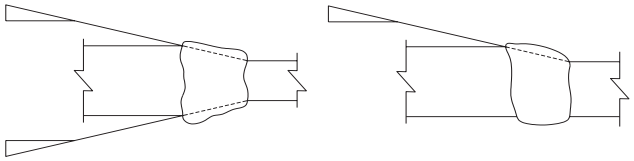
Misalignment of intercostals is not permitted in aluminum structures.

5.4.9 Dissimilar Plate Thickness

Plates of different thicknesses that are groove welded require a transition as follows:

- Exterior Shell Plating of Ice Transiting Steel Ships, 1 in 4
- Other, 1 in 3

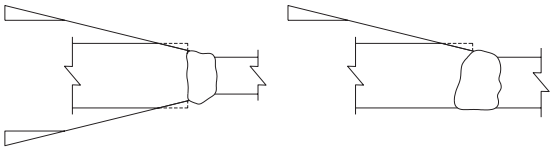
When the difference in thickness is less than or equal to 5 mm and 3 mm for steel and aluminum, respectively, the transition may be created by welding as illustrated in Figure 5.3.



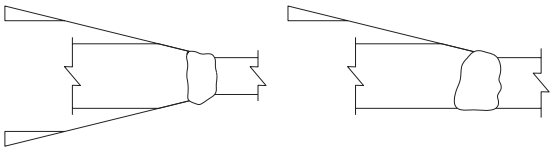
TRANSITION BY SLOPING WELD SURFACE

Figure 5.3 Sloping Weld

When the difference in thickness exceeds 5 mm and 3 mm for steel and aluminum, respectively, the transition may be achieved by chamfering or a combination of chamfering and welding as illustrated in Figure 5.4.



TRANSITION BY SLOPING WELD SURFACE AND CHAMFERING AFTER WELDING



TRANSITION BY CHAMFERING THICKER PART PRIOR TO WELDING

Figure 5.4 Chamfering

5.4.10 Flush Tolerance

Surfaces of welds required to be flush shall meet the requirements of CSA Standards W59 and W59.2 for steel and aluminum, respectively. In addition, for aluminum the weld shall be finished so as not to reduce the cross section below the base metal's mill tolerance set by the material's compliance standard.

5.4.11 Smooth Tolerance

Surfaces of groove welds required to be smooth shall be finished so as to ensure that the weld reinforcement does not exceed 1.5 mm. There shall be no valleys or grooves between individual weld beads and weld toes shall blend smoothly into the base metal without undercut or overlap.

5.4.12 Preparation of Welds for the Application of Coatings or Paints

Completed welds shall be prepared to the requirements of the coating and/or paint manufacturer prior to the materials being applied.

5.4.13 Distortion and Residual Stress

5.4.13.1 General

Welding of structures, sub-assemblies and parts shall progress symmetrically to minimize distortion. Members should remain unrestrained during welding to minimize stresses. Welds shall be deposited in a sequence that shall balance the heat applied throughout the welding process. Welds shall progress from points where the parts are relatively fixed in position towards points where they have relatively greater freedom of movement.

It should be noted, plain carbon steels are more forgiving than aluminum. The thermal expansion coefficient of aluminum is about twice that of steel. The total amount of thermal expansion varies inversely with the speed of welding. As a result, fixtures should be designed so that plate alignment will accommodate twice the dimensional change normally expected for welding a similar steel component.

Unlike steel, restrictions apply to correcting distortions in aluminum caused by welding. In addition, as-deposited weld metal elongation properties are 5 - 7% on average rendering weld deposits more prone to cracking under restraint.

Weld sizes shall be kept to a minimum. Excessive weld cross sections and over welding shall be avoided. Joints anticipated to cause significant shrinkage shall be welded first.

5.4.13.2 Submission of Welding Sequence

All Contractors shall submit a welding sequence to the Delegated Representative prior to performing any welding work.

Welding sequences shall be developed for the method of construction (block or frame and plate) and for insert plates.

For block construction, a sequence for assembling blocks and erecting and welding blocks to each other at the berth is required.

For frame and plate construction, a sequence for welding shell butts and seams, frames and bulkheads to shell plating, tank top to inner bottom framing and "A" frames and stern tubes and other critical components is required.

5.4.13.3 Restrained Joints

When welding joints that are restrained and/or where significant shrinkage is anticipated, welding shall be carried out continuously or to a point that shall ensure freedom from cracking after the joint has cooled below the interpass temperature. Root passes shall be of adequate size to withstand shrinkage stress. Block welding or cascade welding techniques should be used wherever practicable.

5.4.13.4 Jigs and Fixtures

Jigs, fixtures, clamping and strong backs shall be used in such a manner as to avoid restraint during welding. Strong backs welded on one side of the joint and wedged on the other are preferred. When removing strong backs, care shall be taken not to scar the material to which they are welded. Repair of scars to base plates shall be in accordance with approved procedures.

5.4.13.5 Progression

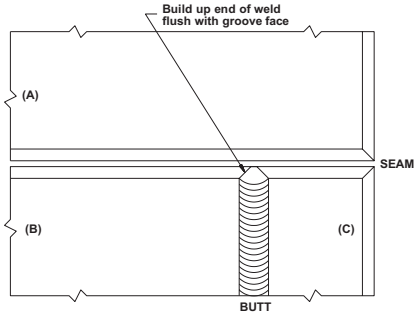
Frames, stiffeners or intercostals should be welded to each other before they are welded to the plating. When joining sub-assemblies to each other, joints connecting plating should be welded prior to welding the butt joints of the sub-assembly framing.

Welding should be started in the centre of the ship and progress outward, forward and aft. Sub-assemblies should be welded in the same manner starting in the centre, progressing outward.

Transverse butts in plating should be welded prior to longitudinal seams.

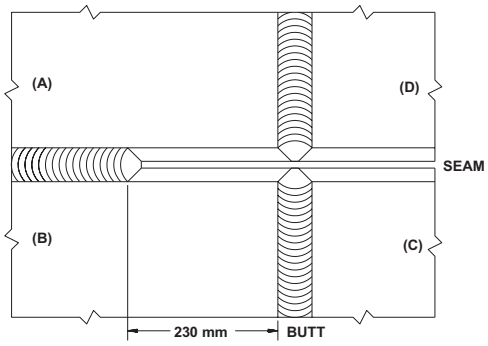
5.4.13.6 Intersections and Release Distance

Care shall be taken when welding intersecting butts and seams. The techniques illustrated in Figure 5.5 and Figure 5.6 shall be followed.



1. Weld the butt between (B) and (C) and then the weld seam between (A) and (B).

Figure 5.5 Staggered Butt Weld



1) Weld seam between (A) and (B) to within 230 mm of butt.
2) Weld butt between (B) and (C).
3) Weld butt between (A) and (D).
4) Complete welding seam to within 230 mm of next butt.

Figure 5.6 Aligned Butt Weld

Stiffeners fillet welded to plating that traverse butts or seams shall be released and remain unwelded for a distance of at least 230 mm in each direction until the butts or seams they traverse have been fully welded. For plates $\geq$ 19 mm in thickness, the release distance shall be increased to 300 mm minimum.

5.4.14 Repair of Distortion

When distortion of plating between stiffeners exceeds the limits detailed in Table 6.10 of IACS No. 47, Shipbuilding and Repair Quality Standard as reproduced below, straightening shall be required.

Item	Standard	Limit	Item	Standard	Limit
Shell plate • Parallel part (side & bottom shell) • Fore and aft part	 4 mm 5 mm	 8 mm 8 mm	Forecastle & Poop deck • Bare part • Covered part	 4 mm 6 mm	 8 mm 9 mm
Tank top plate	4 mm	8 mm	Super structure deck • Bare part • Covered part	 4 mm 7 mm	 6 mm 9 mm
Bulkhead • Longl. Bulkhead • Trans. Bulkhead • Swash Bulkhead	 6 mm	 8 mm	House wall • Outside wall • Inside wall • Covered part	 4 mm 6 mm 7 mm	 6 mm 8 mm 9 mm
Strength deck • Parallel part • Covered part • Fore and aft part	 4 mm 6 mm 7 mm	 8 mm 9 mm 9 mm	Interior member (web of girder, etc.)	5 mm	7 mm
Second deck • Bare part • Covered part	 6 mm 7 mm	 8 mm 9 mm	Floor and girder in double bottom	5 mm	8 mm

Members distorted by welding shall be straightened by carefully following the procedures approved by the Delegated Representative following the methods and controls offered in CSA Standards W59 and W59.2 for steel and aluminum, respectively, and this Specification.

5.4.15 Temporary Welds and Lug Removal

5.4.15.1 Temporary Welds

Temporary welds shall not be located on a welded butt or seam
Temporary welds shall only be made using approved weld procedures.

5.4.15.2 Lug and Temporary Attachments

For the hull exterior, exposed bulkheads, decks, panels, superstructure, walkways, bulwarks, fairleads, bollards, and any other zone deemed necessary to avoid operational hazards and to provide a good cosmetic appearance to the vessel, all lugs, temporary fairing aids, studs, etc., shall be removed to render a flush and smooth surface.

5.4.15.3 Removal of Temporary Welds, Lugs and Attachments

Temporary welds shall be removed and the surface restored flush with the original surface.
Hammering or other mechanical means that will result in scars to base material shall be avoided.
Scars in plate surfaces shall be repaired by welding with approved procedures.
Welding electrodes and consumables for repairing scars in exterior shell plating shall be corrosion resistant in sea water and completed welds shall meet the acceptance criterion of this Specification.
Repair welds shall be ground flush or smooth as required by the Delegated Representative.

5.4.16 Arc Strikes

Arc strikes outside the area of welds should be avoided following the requirements of CSA Standards W59 and W59.2 for steel and aluminum, respectively, and of this Specification.

When an arc strike occurs in a location deemed critical by the Delegated Representative, the surface shall be lightly ground and inspected with the appropriate non-destructive inspection methods. Repair of arc strikes shall be to the satisfaction of the Delegated Representative.

5.5 WELD INSPECTION REQUIREMENTS

5.5.1 General

All non-destructive inspections required in this Specification shall be considered the minimum requirements of the Owner.

The method and location of inspections shall be determined by the Delegated Representative.

Inspection test results shall be returned to the Delegated Representative within the requested time frame.

No interpretation report or radiograph shall be destroyed or discarded.

The minimum number of locations ordered for examination at one time shall be a combination of any method cumulatively totalling 10, unless otherwise agreed to by the Delegated Representative.

Contractors desiring to use ultrasonic inspection in lieu of radiographic inspection to examine welds located in steel structures shall submit a detailed proposal to the Delegated Representative for consideration. At the discretion of the Delegated Representative, ultrasonic inspection may be accepted in lieu of radiographic inspection if the length of inspection is as required for ultrasonic inspection in Table 5.7 herein and the ultrasonic inspection procedures and techniques are proven accurate and repeatable by 30% spot radiography of the first fifteen locations examined by ultrasonic methods. Substitute inspection methods are not permitted for examining welds located in aluminum structures.

5.5.2 Monthly Facility Audits

In addition to the CWB biannual audits required to maintain certification to CSA Standards W47.1 and W47.2, the Owner shall retain the services of the CWB to perform monthly audits of the contractor's facilities and visual inspection results where welding is taking place. Audits shall measure the contractor's compliance with the requirements of this Specification.

5.5.3 Non Destructive Inspection Audits

The Owner reserves the right to retain the services of the National Non Destructive Testing Certification Body of Natural Resources Canada (NRCAN) or another organization acceptable to the Owner to perform audits of the radiographic film and interpretation reports. Audits shall measure the contractor's compliance with the requirements of this Specification.

5.5.4 Selection of Non Destructive Inspection Methods

The method of inspection shall be appropriate to depict discontinuities dependent on the material, joint and weld type, the orientation of potential discontinuities within the weld cross section and access to the part in need of inspection.
All welds shall be examined by visual inspection.
Full penetration welds shall be selectively sampled by radiographic and ultrasonic inspection methods.
Radiographic inspection shall be used for full penetration groove welds in butt joints.
Ultrasonic inspection shall be used for full penetration groove welds in tee and corner joints.
Fillet welds in steel structures shall be selectively sampled by liquid penetrant and magnetic particle inspection.
Fillet welds in aluminum structures shall be selectively sampled by liquid penetrant inspection.

5.5.5 Locations Subjected to Inspection

Welds subjected to non-destructive inspection shall include, but will not necessarily be limited to, the following locations:

Table 5.6 Locations Subjected to Inspection

• **Strength members:**	○ Flat and vertical keel; ○ Tank margin plates; ○ Sheer strake; ○ Bilge strake; ○ Deck stringer plates.
• **Shell plating:**	○ Intersection of butts and seams; ○ Transverse butts; ○ Longitudinal seams.
• **Other:**	○ Inserts and closure plates; ○ Cruciform welds; ○ Terminal welds.

The exact position of inspections shall be determined by the Delegated Representative.

5.5.6 Extent of Inspections

5.5.6.1 Visual Inspection

All welds shall be visually inspected their entire length.

5.5.6.2 NDE Methods – New Construction

For new construction, in addition to the requirements of Section 5.5.6.1 herein, the number of locations inspected by liquid penetrant, magnetic particle, radiographic and ultrasonic test methods shall be in accordance with the calculated requirements of Table 5.7 herein.

Table 5.7 Quantity of Inspections – New Construction

Inspection Method		Formula for Determining the Number Required
UT Inspections		= 0.50 x (L+B+D)
MT or PT Inspections		= 1.00 x (L+B+D)
RT Inspections		= 2.00 x (L+B+D)
Where:	PT	= Penetrant Inspections
	MT	= Magnetic Particle Inspections
	RT	= Radiographic Inspections
	UT	= Ultrasonic Inspections
	L	= Overall Length in meters
	B	= Greatest Moulded Breadth in meters
	D	= Moulded Depth at Side, in meters, measured at L/2

For example: A Lifeboat 15 meters in length having a breadth of 4.5 meters and a moulded depth of 2 meters will require:

Method	Number	Length of Inspection
UT Inspections	= 11	1000 mm – butts or seams 500 mm x 500 mm – intersecting butts and seams
MT or PT Inspections	= 22	1000 mm
RT Inspections	= 44	440 mm - butts or seams 300 mm x 300 mm – intersecting butts and seams

When access does not permit the use of 300 mm by 300 mm film size at intersecting butts and seams, a series of films shall be positioned to offer examination of 150 mm of weld in all directions.

5.5.6.3 NDE Methods - Other

For work packages other than new construction, in addition to the requirements of Section 5.5.6.1 herein, the number of locations inspected by liquid penetrant, magnetic particle, radiographic and ultrasonic test methods shall be in accordance with the requirements of Table 5.8 herein.

Table 5.8 Quantity of Inspections – Other

Item	Method	Number
Entire Plate Renewal – Butts & Seams (shell, decks, bulkheads, tanktop etc.)	RT	6 per plate
Entire Plate Renewal – Butts & Seams (secondary structure)	RT	2 per plate
Partial Plate Renewal – Butts & Seams (primary & secondary structure)	RT	See inserts herein
Insert – Butt & Groove Welds (shell, decks, bulkheads, tanktop etc.)	RT	4 per insert
Insert – Groove Welds (other primary structure)	RT	2 per insert
Insert – Groove Welds (secondary structure)	RT	1 per insert
Hull Penetration – Pipe or Plate to Shell Plate Opening (below waterline)	UT	Entire Weld Length
Pressure Pipe Girth Welds	RT	1 of each 5 welds Full Circumference

5.5.7 Surface Preparation Prior to Inspection

Prior to inspection by any method, the welds and adjacent areas shall be cleaned so as to be free from all rust, scale, primer, paint, weld spatter and other foreign matter to enable accurate interpretation of the area of interest (weld zone). Staging and lighting shall be provided to permit safe access for inspection.

For liquid penetrant, magnetic particle and radiographic inspections weld profiles and contours shall be sufficiently smooth to ensure that geometric conditions do not cause false indications.

For ultrasonic inspection, the contact surfaces shall be smooth to the extent that the finish does not interfere with the inspection. Tests performed on rough surfaces shall require special calibration procedures.

5.5.8 Delayed Inspection

When testing welds subject to high restraint and/or when the steel yield strength is greater than 360 MPa, tests shall be delayed at least 48 hours after weld completion.

5.5.9 Inspection Personnel Qualifications and Certificates

5.5.9.1 Visual Inspection

Individuals performing and interpreting visual inspection shall be currently certified by the CWB in accordance with CSA Standard W178.2, Certification of Welding Inspectors. The individual shall be Level 2 or Level 3 and shall maintain the following Code endorsement categories: Ships and Marine Structures; and Buildings and Industrial Structures. Level 1 personnel may only observe and/or assist Level 2 and Level 3 personnel perform the inspections.

5.5.9.2 Other Inspection Methods

Individuals performing and interpreting liquid penetrant, magnetic particle, radiographic and ultrasonic inspections shall be currently qualified by the National Non Destructive Testing Certification Body of Natural Resources Canada (NRCAN) to CAN/CGSB 48.9712 Level 2 or Level 3. Level 1 personnel may only observe and/or assist Level 2 and Level 3 personnel perform the inspections.

5.5.9.3 Certificates

For each inspection method, a copy of the examining individual's current year qualification certificate shall be attached to the initial interpretation or verification report supplied to the Delegated Representative. If a new validation year is entered or if a different individual is used, new qualification certificates shall be supplied with any subsequent interpretation report being submitted.

5.5.10 Steel Structures

5.5.10.1 Inspection Procedures

Inspection procedures and techniques are to be prepared by Level 3 personnel for each inspection method required by this Specification and submitted to the Delegated Representative prior to performing any inspections of completed work.Procedures for visual inspection shall follow the requirements of Clause 7 of CSA Standard W59 and ASME Section V.Procedures for liquid penetrant and magnetic particle inspections shall follow the requirements of Clause 7 of CSA Standard W59.Procedures for radiographic and ultrasonic inspections shall follow the requirements of Clauses 7 and 8 of CSA Standard W59.

5.5.10.2 Acceptance Criterion

The visual and liquid penetrant inspection acceptance criterion shall be in accordance with Clause 12.5.4.1 of CSA Standard W59.The magnetic particle inspection acceptance criterion shall be in accordance with Clause 12.5.4.1 or 12.5.4.3 of CSA Standard W59. The radiographic inspection acceptance criterion shall be in accordance with Clause 12.5.4.3 of CSA Standard W59. The ultrasonic inspection acceptance criterion shall be in accordance with Clause 12.5.4.4 of CSA Standard W59.

5.5.10.3 Radiographic Inspection

5.5.10.3.1 Source of Radiation

Radiographs shall be made by either x-ray or gamma ray as follows:

- x-ray shall be used for material less than 6 mm in thickness.
- the minimum material thickness inspected by gamma ray shall be 6 mm.
- the maximum material thickness inspected by gamma ray shall be 50 mm. Material thicknesses greater than 50 mm shall be examined by ultrasonic methods.
- for gamma ray applications, the source of radiation shall be Iridium 192.

5.5.10.3.2 Radiographic Film

The class of film is dependent on material thickness, source of radiation and required sensitivity. The following shall apply:

- for x-ray on material thickness less than 6 mm, class II film may be used providing the 2-2(t) hole is clearly visible on the radiograph. Otherwise, class I film shall be used;
- when the material thickness is greater than or equal to 6 mm and less than 12 mm, class I film and iridium 192 gamma radiation shall be used;
- when the material thickness is greater than or equal to 12 mm, class I or class II film and iridium 192 gamma radiation may be used.

5.5.10.3.3 Display of Information and IQI Essential Holes

The exposed radiograph shall show the outline of the “Hole Type” Image Quality Indicator (IQI), shims, IQI identification number, essential hole, radiograph identification number, location markers, the date it was taken, reference to the contract number or vessel identification and the radiographer's initials.

- When x-ray is used on materials thicknesses < 6 mm, the image of the 2-2(t) hole shall appear clearly on the radiograph.
- When iridium 192 gamma radiation is used on material thicknesses ≥ 6 mm but < 12 mm where class 1 film is required, the image of the 2-2(t) hole shall appear clearly on the radiograph.
- When iridium 192 gamma radiation is used on material thicknesses ≥ 12 mm but ≤ 30 mm, the image of the 2-4(t) hole shall appear clearly on the radiograph.
- When iridium 192 gamma radiation is used on material thicknesses greater than 30 mm, the image of the 2-2(t) hole shall appear clearly on the radiograph.

5.5.10.3.4 Intensification Screens

Intensification screens shall not be used. If adequate contrast cannot be achieved with a single film when examining unequal thicknesses, a dual exposure technique shall be used.

5.5.11 Aluminum Structures

5.5.11.1 Inspection Procedures

Inspection procedures and techniques are to be prepared by Level 3 personnel for each inspection method required by this Specification and submitted to the Delegated Representative for approval prior to use.

Procedures for visual inspection shall follow the requirements of Clause 7 of CSA Standard W59.2 and ASME Section V.

Procedures for liquid penetrant, radiographic and ultrasonic inspections shall follow the requirements of Clause 7 of CSA Standard W59.2, and of this Specification.

5.5.11.2 Acceptance Criterion

The visual, liquid penetrant, radiographic and ultrasonic inspection acceptance criterion shall be in accordance with Clause 6 of CSA Standard W59.2, except as modified by this Specification.

If visual inspection reveals melt-through or suck-back, the affected weld metal or material shall be dressed by mechanical methods, repair welded if required and examined by liquid penetrant inspection its entire length.

5.5.11.3 Radiographic Inspection

5.5.11.3.1 Source of Radiation

Radiographs shall be made by x-ray. The maximum permissible kilovoltages shall be as shown in Table 5.9.

Table 5.9 Thickness vs. Maximum Kilovoltage

Thickness	Max Kilovolts
Up to 6 mm	80
6 mm to 13 mm	80 to 120
13 mm to 19 mm	120 to 130
19 mm to 25 mm	130 to 150
Greater than 25 mm	170 maximum

5.5.11.3.2 Radiographic Film

All radiographic film shall be class I only.

5.5.11.3.3 Display of Information and IQI Essential Holes

The exposed radiograph shall show the outline of the “Hole Type” Image Quality Indicator (IQI), shims, IQI identification number, essential hole, radiograph identification number, location markers, the date it was taken, reference to the contract number or vessel identification and the radiographer's initials.

For material thickness less than 5 mm the 2-1 (t) essential hole shall appear clearly on the radiograph. For material thickness 5 mm and over, the image of the 2-2 (t) essential hole shall appear clearly on the radiograph.

5.5.11.3.4 Intensification Screens

Intensification screens shall not be used. If adequate contrast cannot be achieved with a single film when examining unequal thicknesses, a dual exposure technique shall be used.

5.5.12 Double Loaded Film Requirement

All radiographic inspection shall be taken with a double loaded film technique so that two film negatives are obtained for each inspection. One film negative shall be sent to the Director, Marine Engineering and the other film negative shall remain at the work site in the possession of the onsite Delegated Representative. At contract completion, the film negatives stored at the work site shall be sent to the Director, Marine Engineering.

5.5.13 Radiographic Film Viewer

The Contractor shall have a professional radiographic film high intensity viewer capable of penetrating film densities of 1.5 to 4.5. The viewer shall be kept at the work site and available for use by the Contractor and Delegated Representatives for the entire duration of the contract and warranty period.

5.5.14 Inspection Reports

5.5.14.1 General

Inspection reports shall record the date of inspection, builder/Contractor's name, vessel type and hull number, Owner's name, inspection organizations name, inspection procedure number, interpretation report number, item, location, all discontinuities including single and accumulated indications, weld acceptance criteria, location of discontinuities and the name, qualification, level and signature of the individuals performing the inspection and interpretation.

Inspection reports shall reference material type, thickness, joint type and geometry.

When a portion of a weld is to be inspected by liquid penetrant, magnetic particle, radiographic or ultrasonic methods, the location shall be subjected to visual inspection in advance of the other inspection method. Interpretation reports are required for both inspection methods.

5.5.14.2 Visual Inspection

For block assembly new construction methods, a visual inspection verification report is required for each fabricated block and joining of blocks to each other.

For frame and plate new construction methods or work packages other than new construction, a verification report is required for each fabricated compartment (e.g. between two adjacent bulkheads/engine room compartment).

The verification report shall be a statement signed off by the Contractor’s qualified inspector which states that all welds have been inspected and that they conform to the requirements of this Specification.

Verification reports shall be presented to the Delegated Representative prior to the Owner’s scheduled audit date.

5.5.14.3 Radiographic Inspection

In addition to the requirements of Sections 5.5.14.1 and 5.5.14.2, radiographic interpretation reports shall reference IQI design and identification number, source of radiation, source to film distance, angle of incident radiation, film type and intensification screen design (if permitted) and, material type, thickness, joint type and geometry.

Each interpretation report shall contain a report number. The report number shall include the Contractor's hull number (i.e. #1-218, etc.) and/or ship’s name.

Each location listed on the report shall be identified with an Inspection number (i.e., location #50 port is Inspection #3).

For radiographs, each film and its duplicate shall be submitted in a paper protective folder. The identification to appear on each folder shall be Inspection #, Report # and Hull # as illustrated below.

Inspection #		Report #		Hull #
3	-	1	-	218

Each repaired location shall reference the original report of the rejected location, for example:

Location #50 - Port R1 - See 3-1-218

5.5.14.4 Inspection Arrangement Drawings

The Contractor shall prepare an adequate number of non-destructive inspection arrangement drawings and sketches that accurately document the location of the inspections.

The inspection method, weld identification number and abbreviations for each inspection shall be accurately recorded on a progressive basis (e.g. UT #75-R1, RT # 150 - adjacent - aft, etc). A legend detailing the identification symbols used by the Contractor shall appear on each arrangement drawing.

The Contractor shall supply updated arrangement drawings to the Delegated Representative on a regular basis throughout the contract period. Three copies of the final drawings shall be supplied to the Delegated Representative at contract completion.

5.5.15 Overlapping Inspection

When a discontinuity extends to either or both ends of a location being inspected, additional overlapping inspection shall be required. The overlapping inspection shall show a portion of the original end.

When an overlapping inspection displays unacceptable discontinuities at either or both ends, the entire weld length shall be considered unacceptable unless proven otherwise by the Contractor. Under this condition, welds shall be repaired to the extent required by the Delegated Representative.

All overlapping inspections shall be taken prior to repair of the originally rejected location. If repair has occurred prior to overlapping inspections and the entire weld length has not been repaired, the overlapping inspections shall be placed to overlap the start and finish of the repair.

The Contractor shall be responsible for all costs associated with performing overlapping inspections.

5.5.16 Rejected Weld or Part

When a portion of a weld contains discontinuities not meeting the acceptance criteria of this Specification, corrective action may be taken providing the Delegated Representative has reviewed the extent of unacceptable discontinuities and is in agreement with the repair procedure.

The repaired area shall be inspected by at least the same non-destructive inspection method used for the original inspection. Care shall be taken to ensure that the inspection of the repaired area is accurately located so that it measures the original location that was rejected.

For each failed location, one new location shall be examined. All new locations shall be selected by the Delegated Representative. Each new location shall be considered in addition to the requirements of this Section.

All costs associated with performing the additional inspections shall be at the Contractor's expense.

When an entire weld, base material, entire part or entire section contains unacceptable discontinuities as specified herein, no corrective action shall be taken until the repair procedure has been approved by the Delegated Representative and other interested parties.

CHAPTER 6 WELDING STRUCTURAL STAINLESS STEEL

6.1 SCOPE

The requirements of this Section shall apply to welding and inspection of all structural stainless steels.

6.2 DESIGN AND DRAWINGS

Weld design shall be to the Rules of a Classification Society that is an approved Recognized Organization by Transport Canada Marine Safety and Security.

Unless to the otherwise approved by the Delegated Representative, the following conditions shall be met:

- all groove welds in butt joints shall be full penetration; and,
- all corner joints shall be full penetration groove welds combined with a single continuous fillet weld.

A weld design schedule shall be submitted to the Delegated Representative in drawing form for review prior to commencing any welding work.

6.3 CERTIFICATION

Contractors undertaking the welding of stainless steel within the scope of this Specification shall be certified by the CWB to the requirements of CSA Standard W47.1 Division 1 or 2.

Welders, welding operators and welding procedures shall meet the requirements of CSA Standard W47.1, and of AWS D1.6 as permitted by CSA Standard W47.1.

6.4 WELDING ELECTRODES AND CONSUMABLES

Welding electrodes and consumables shall be selected following the requirements of AWS D1.6.

Welding electrodes and consumables for welding of stainless steel shall be certified by the CWB to the requirements of CSA Standard W48 or the applicable AWS A5 series of standards.

6.5 WORKMANSHIP

Welding shall meet the requirements of CSA Standard W47.1 and AWS D1.6, and of this Specification.

6.6 INSPECTION

6.6.1 General

All examination and inspection of structural stainless steel shall comply with the requirements of AWS D1.6

6.6.2 Personnel

All inspection personnel shall meet the requirements of Chapter 5.0, Section 5.5.9 of this Specification.

6.6.3 Inspections

All welds shall be visually examined along 100% of their length for correct size, profile and the presence of visible defects. Unacceptable conditions or defects shall be repaired to the satisfaction of the Delegated Representative.

Full penetration welds shall be selectively sampled. Radiographic inspection shall be used for full penetration groove welds in butt joints. Ultrasonic inspection shall be used for full penetration groove welds in tee and corner joints.

Fillet welds shall be selectively sampled by liquid penetrant and/or magnetic particle inspection.

All of the requirements of Section 5.5 of this Specification shall be met unless otherwise specified in this Chapter.

6.6.4 Acceptance Criterion

The visual inspection acceptance criterion shall be in accordance with Clauses 5.11 and 6.29.1 of AWS D1.6.

The liquid penetrant inspection acceptance criterion shall be in accordance with Clauses 6.7.6 and 6.29.4 of AWS D1.6.

The magnetic particle inspection acceptance criterion shall be in accordance with Clauses 6.7.7 and 6.29.2 of AWS D1.6.

The radiographic inspection acceptance criterion shall be in accordance with Clauses 6.9, 6.10 and 6.29.2 of AWS D1.6.

The ultrasonic inspection acceptance criterion shall be in accordance with Clause 6, Part “C” and Clause 6.29.3 of AWS D1.6.

CHAPTER 7 OTHER STRUCTURAL MATERIALS

7.1 SCOPE

The requirements of this Section shall apply to welding and inspection of all structural materials other than those included in the scope of CSA Standards W47.1, W59, W47.2 and W59.2 and AWS D1.6.

7.2 DESIGN AND DRAWINGS

Weld design shall be to the Rules of a Classification Society that is an approved Recognized Organization by Transport Canada Marine Safety and Security.

Unless otherwise approved by the Delegated Representative, the following conditions shall be met:

- all groove welds in butt joints shall be full penetration; and,
- all corner joints shall be full penetration groove welds combined with a single continuous fillet weld.

A weld design schedule shall be submitted to the Delegated Representative in drawing form for review prior to commencing any welding work.

7.3 CERTIFICATION

Welders, welding operators and welding procedures shall meet the requirements of ASME Section IX or other suitable standard(s) approved for use by the Designated Representative and the CWB.

All tests shall be fully witnessed and documented by the CWB.

7.4 WELDING ELECTRODES AND CONSUMABLES

Welding electrodes and consumables shall be selected following the requirements of ASME Section IX or other suitable standard(s) approved for use by the Designated Representative and the CWB.

Welding electrodes and consumables shall conform to the requirements of ASME Section IX and the applicable AWS A5 series of standards or other suitable standard(s) approved for use by the Designated Representative and the CWB.

7.5 WORKMANSHIP

Welding shall meet the requirements of CSA Standard W59, and of this Specification.

7.6 INSPECTION

7.6.1 Personnel

All inspection personnel shall meet the requirements of Chapter 5.0, Section 5.5.9 of this Specification.

7.6.2 Inspections

All welds shall be visually examined along 100% of their length for correct size, profile and the presence of visible defects. Unacceptable conditions or defects shall be repaired to the satisfaction of the Delegated Representative.

Full penetration welds shall be selectively sampled. Radiographic inspection shall be used for full penetration groove welds in butt joints. Ultrasonic inspection shall be used for full penetration groove welds in tee and corner joints.

Fillet welds shall be selectively sampled by liquid penetrant and/or magnetic particle inspection.

All of the requirements of Section 5.5 of this Specification shall be met unless otherwise specified in this Chapter.

7.6.3 Acceptance Criterion

The visual and liquid penetrant inspection acceptance criterion shall be in accordance with Clause 12.5.4.1 of CSA Standard W59.

The magnetic particle inspection acceptance criterion shall be in accordance with Clause 12.5.4.1 or 12.5.4.3 of CSA Standard W59.

The radiographic inspection acceptance criterion shall be in accordance with Clause 12.5.4.3 of CSA Standard W59.

The ultrasonic inspection acceptance criterion shall be in accordance with Clause 12.5.4.4 of CSA Standard W59.

CHAPTER 8 PRESSURE PIPE WELDING

8.1 SCOPE

The requirements of this Chapter shall apply to welding and inspection of all pressure piping in the absence of Classification Society oversight.

8.2 DESIGN AND DRAWINGS

Weld design for pressure piping shall be in accordance with ASME Code B31.1 - Power Piping. A weld design schedule for pressure piping shall be submitted to the Delegated Representative in drawing form for review prior to commencing any welding work.

8.3 WELDING ELECTRODES AND CONSUMABLES

All welding electrodes and consumables shall comply with ASME IX and ASME B31.1. Electrodes and consumables not covered by ASME Section IX may be used provided a weld procedure qualification test is successfully completed prior to performing any work. Tests shall reflect the requirements of ASME Section IX.

8.4 PERSONNEL QUALIFICATIONS

Qualification of welders and welding operators shall comply with the requirements of ASME Section IX and ASME B31.1. Testing and approval shall be administered by the local Provincial Pressure Vessel Authority. Personnel qualification records shall be forwarded to the Delegated Representative prior to welding.

8.5 QUALIFICATION OF WELD PROCEDURES

Welding procedures shall be qualified in accordance with ASME Section IX and ASME B31.1. Testing and approval shall be administered by the local Provincial Pressure Vessel Authority. Weld procedure qualification records shall be forwarded to the Delegated Representative prior to welding.

8.6 WORKMANSHIP

All workmanship shall be in accordance with the requirements of ASME B31.1.

8.7 INSPECTION

8.7.1 General

All examination and inspection of pressure piping, pressure vessels and pressure containment systems shall comply with the requirements of ASME B31.1.

8.7.2 Personnel

All inspection personnel shall meet the requirements of Chapter 5.0, Section 5.5.9 of this Specification.

8.7.3 Inspections

All welds in pressure piping and pressure containment systems shall be visually examined along 100% of their length for correct size, profile and the presence of visible defects. Unacceptable conditions or defects shall be repaired to the satisfaction of the Delegated Representative.

Full penetration groove welds shall be sampled by spot radiography at a frequency of one in every five welds produced by each welder. Welders shall be assigned a unique identification number that shall be stamped on each full penetration connection welded. If a radiograph reveals gross defects, one additional joint shall be inspected by radiography. If the new radiograph reveals gross defects, the remaining three welds shall be radiographed

Repair of defects shall be performed following procedures accepted by the Delegated Representative. Second repair attempts shall not be permitted without due consideration of the conditions and agreed to by the Delegated Representative.

8.7.4 Acceptance Criterion

For all inspection methods, welds shall be evaluated in accordance with the acceptance standards of ASME B31.1.

ANNEX A REFERENCED CODES, PUBLICATIONS AND STANDARDS

A.1 LIST OF CODES, PUBLICATIONS AND STANDARDS

ASME	B31.1	Power Piping
	Section V	Boiler and Pressure Vessel Code, Non-destructive Examination
	Section IX	Boiler and Pressure Vessel Code, Welding and Brazing Qualifications
AWS	A5 Series	Specifications for Filler Metals and Consumables
	A5.10	Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods
	D1.6	Structural Welding Code – Stainless Steel
CAN/CGSB	48.9712	Qualification and Certification of Non-Destructive Testing Personnel
CAN/ISO	14341:XX	Welding consumables – Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels - Classification
CSA	G40.21	Structural Quality Steel
	W47.1	Certification of Companies for Fusion Welding of Steel
	W47.2	Certification of Companies for Fusion Welding of Aluminum
	W48	Filler Metals and Allied Materials for Metal Arc Welding
	W59	Welded Steel Construction (Metal Arc Welding)
	W59.2	Welded Aluminum Construction
	W178.2	Certification of Welding Inspectors

ANNEX B TESTS FOR RATING CORROSION RESISTANCE OF CARBON STEEL WELD METALS IN SEA WATER

B.1 SCOPE

When required by Section 5.3.2 of this Specification, weld metals shall be tested for corrosion resistance in sea water following the procedures detailed herein.

This Annex specifies the requirements for welding and testing plate assemblages. Organizations performing machining, mechanical testing of welds and corrosion tests shall be approved by the Delegated Representative in advance of any tests. Welding of test assemblies shall be fully witnessed and documented by the CWB.

B.2 TEST ASSEMBLY

Test assemblies shall be made in accordance with the requirements of Figure B1 herein.

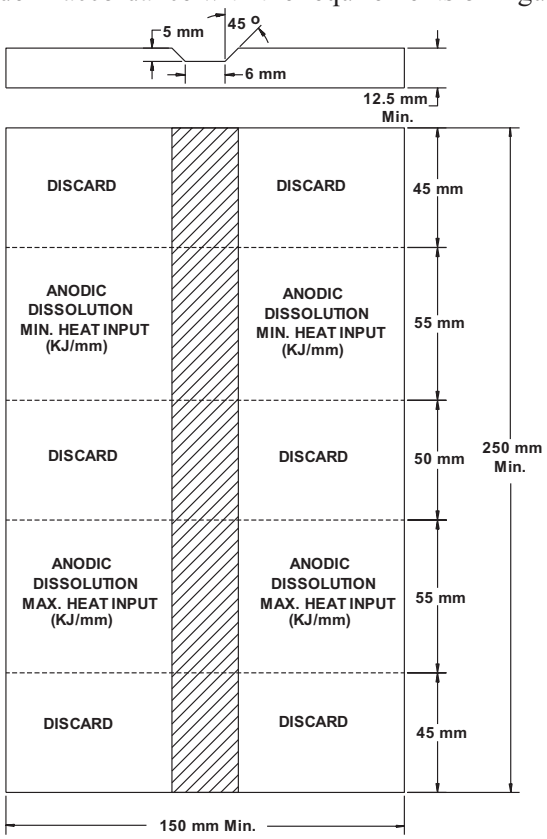


Figure B1 Anodic Dissolution Test Plate Assembly

Welds shall be deposited following a stringer temper bead sequence at the lowest and highest heat input (kj/mm) planned for production as illustrated in Fig. B2 herein. The centre 50 mm discard portion of the test assembly shall be used as a transition between low and high heat input welds (stop/starts).

For automatic welding using the submerged arc welding process, two test assemblies may be used; one for high heat input and the other for low heat input welds. Bead and layer sequences shall be adjusted to offer split layer finish to the weld.

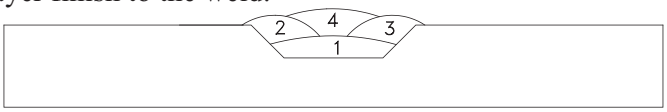


Figure B2 Bead Sequence

B.3 ANODIC DISSOLUTION TESTING

Specimens removed from the test assemblages detailed in Section B2.0 of this Annex shall be prepared by machining as illustrated in Figure B3 herein.

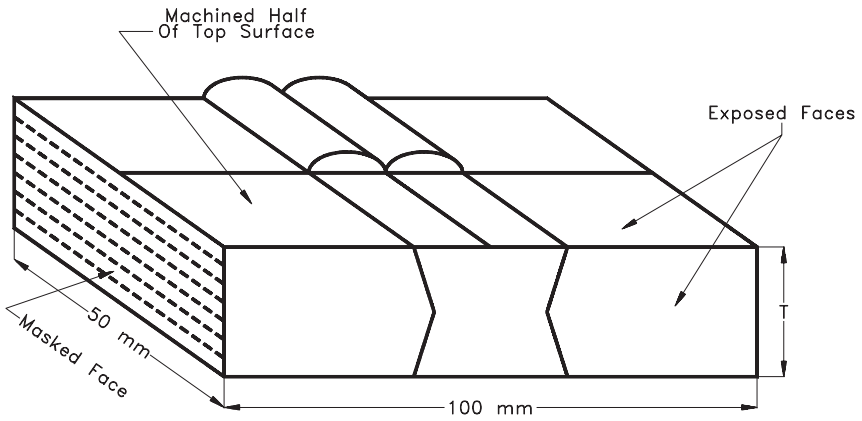


Figure B3 Anodic Dissolution Test Specimen

Each of the specimens shall be corroded at room temperature at a nominal current density of 0.88 mA/cm² for a period of 15 days. The test solution shall be 3.5% NaCl. Intermixing of the anolyte and catholyte shall be prevented by placing a membrane over the opening to the cathode compartment. The test system shall be as illustrated in Figure B4 herein.

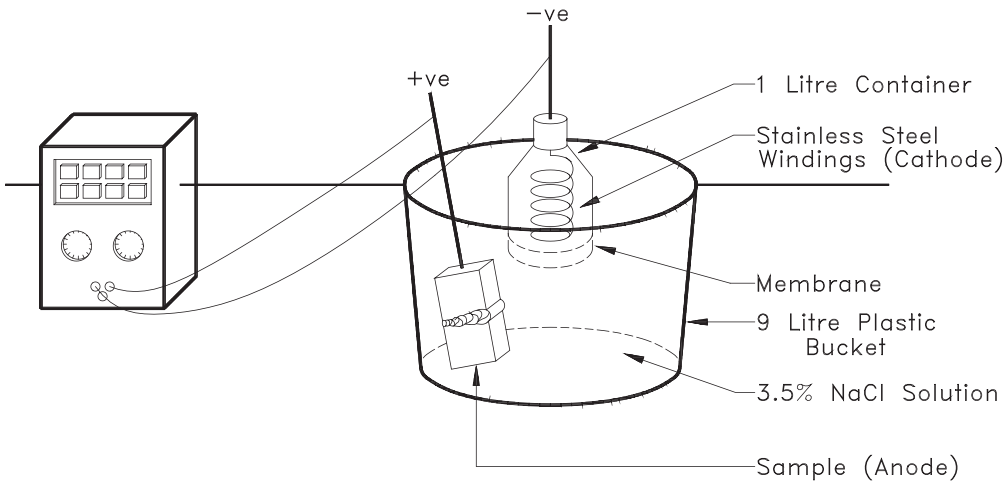


Figure B4 Anodic Dissolution Test System

Anolyte and catholyte pH shall be monitored daily to ensure the membrane is not leaking. Anolyte pH should be in the range of 6 to 8.5 units and anode potentials should be in the range of -600 to -560 mV vs. SCE which are potentials typical of unprotected steel in sea water. When the potential is > -600 mV vs. SCE, daily stirring shall occur to avoid pH stratification of the anolyte.

B.4 REPORTING TEST RESULTS

Mechanical test results, base plate and weld metal chemistries shall be recorded on weld procedure qualification record forms.

Corrosion test results shall be accurately documented and supported by colour photographs and black and white macro examination photo records at 5X magnification.

Corrosion loss shall be quantified by taking a series of profile measurements across the weld zone using a profilometer system having resolution in the "Z" direction of ± 0.0125 mm. The depth of attack shall be well documented for each area of interest in the weld zone; unaffected base plate, heat affected zone and weld metal.

Three copies of the test result reports shall be provided to the Delegated Representative for review and approval of the optimum corrosion resistant weld metal.

ANNEX C FORMING AND THERMAL REQUIREMENTS - ALUMINUM

C.1 HOT FORMING

All hot forming procedures shall be approved by the Delegated Representative in advance of hot forming operations.

The majority of aluminum sections can be formed cold. For severe forming, heat may be used. Maximum holding times for the forming of aluminum alloys at various temperatures are given in Table C1.

Hot forming of 5000 series aluminum alloys is generally conducted at temperatures between 260°C and 425°C. Appropriate temperature control methods are to be used in all hot forming and stress relieving operations. In hot forming or stress relieving, exposure of the 5000 Series alloys to the 65°C to 200°C temperature range is to be minimized by the use of appropriate cooling techniques.

Table C1 Maximum Heat Exposure Time at Temperature Preparatory to Forming Aluminum Alloys

Holding Temperature (Note 1) 0°C	6061-T4, T5 6061-T5, 6063-T5, 356.0-T4, (Note 2)	5454 (Note 3)	5083, 5086, 5154, 5254, 5456
430	NR(4)	50 Hours	50 Hours
260	NR(4)	50 Hours	50 Hours
230	5 Minutes	50 Hours	50 Hours
220	15 Minutes	50 Hours	50 Hours
205	30 Minutes	50 Hours	50 Hours
190	1-2 Hours	50 Hours	NR(4)
175	8-10 Hours	50 Hours	NR(4)
120-165	50 Hours	50 Hours	NR(4)

NOTES:

1. *Equal formability may be obtained with shorter periods of heating at correspondingly higher temperatures. Time at temperature for clad alloys should be kept at a minimum to prevent diffusion of the cladding into the core alloy. Heating should be as rapid as possible, particularly for temperatures 205°C and above. Excessive time to approach the desired temperatures can have deleterious effects similar to those resulting from excess time at temperature.*
2. *Losses in strength for these alloys in the T6 temper will not exceed about 5% when heated at the temperature and for the periods shown. Strength of the T4 temper alloys will increase.*
3. *These alloys will be annealed at 345°C and above.*
4. *NR = Not Recommended*

C.2 COLD FORMING

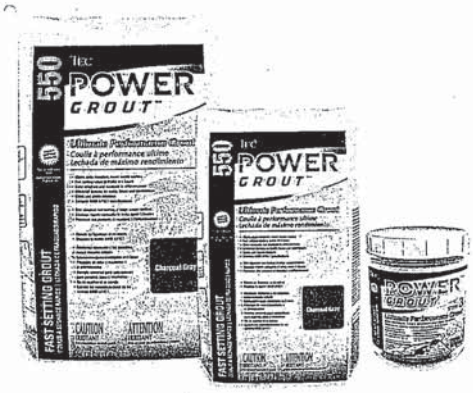
Cold forming of 5000 series aluminum alloys is to be conducted at temperatures below 50°C, except for the 5454 alloy, where the maximum temperature may be 150°C. When the extent of cold forming is such that base plate properties are changed beyond acceptable limits, appropriate re-heat or stress relief treatments are to be used to re-establish acceptable properties.

Advanced Performance Grout

Power Grout™ Ultimate Performance Grout
TA-550

TEC® Power Grout™ is a breakthrough in grout technology. It maximizes performance while providing ease of use. Its unique formulation is highly stain resistant and provides strong, color consistent joints by resisting efflorescence, fading, cracking and shrinking. TEC Power Grout provides excellent performance in virtually any environment, including high traffic and wet conditions, and in residential and commercial applications. One universal formula for joints 1/16" to 1/2" wide.

- Highly stain resistant, never needs sealing
- Fast setting; open to traffic in 4 hours
- Color accurate and resistant to efflorescence
- Universal formula for wall and floor applications
- Crack and shrink resistant
- Mold and mildew resistant
- Exceeds ANSI A118.7 specifications
- Residential to Extra Heavy Commercial Applications
- Interior/exterior use
- Zero VOC

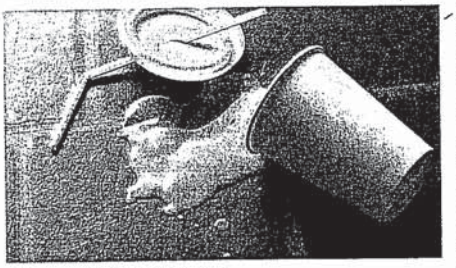


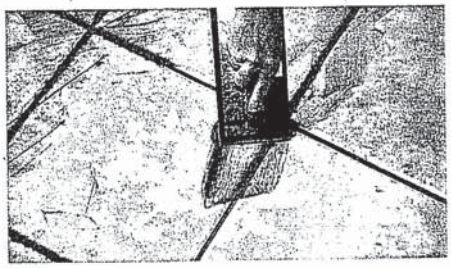
Product contains zero VOC.

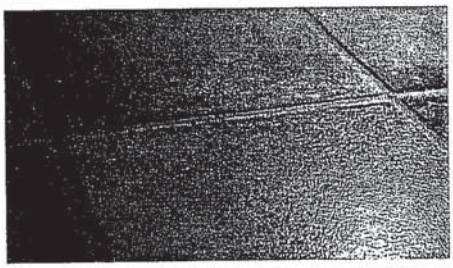
Available in:

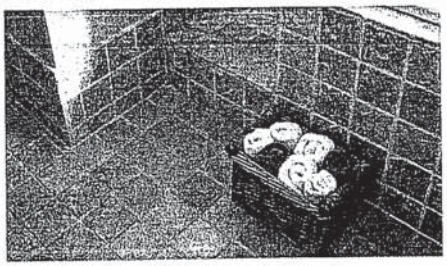
5 lb. jar (12 colors)
10 lb. bag (19 colors)
25 lb. bag (19 colors)

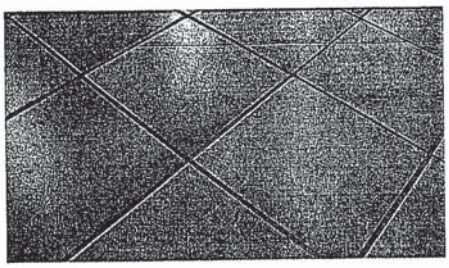
See page 32 for color options

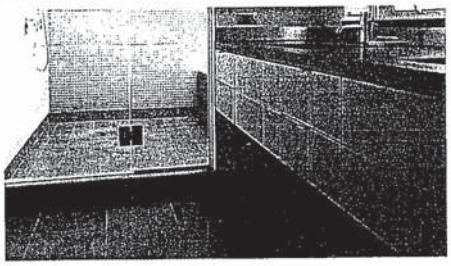

Permanently Stain Resistant


Fast And Easy To Install


Color Consistent


Single Formula For Walls And Floors


Crack Resistant


Mold And Mildew Resistant

Trim and Stability Book Production for CCG Vessels

Prepared by:

Hull, Mechanical & Electrical
Marine Engineering
Integrated Technical Services

Canadian Coast Guard
200 Kent Street, 7th Floor
Ottawa, ON
K1A 06E

Revision History

Rev. #	Description	Page	Authority	Date
0	Draft	All	VK	Oct. 2014.

Table of Contents

List of Tables

List of Figures

1 General

1.1 Measurement System

Stability Books are produced using the same measurement system to which the vessel was built. They can be produced in metric (SI) or Imperial measurement system.

1.2 Reference Coordinate System

All data and calculations presented in the Trim and Stability Book shall use the following coordinate system:

Vertical:	Positive (+) above baseline. Negative (-) below baseline.
Transverse:	Positive (+) to starboard of centreline. Negative (-) to port of centreline.
Longitudinal:	Positive (+) fwd of longitudinal origin. Negative (-) aft of longitudinal origin.

The vertical origin is typically at the flat of bottom, however, it may be located elsewhere for convenience. Drafts on many vessels refer to the bottom or underside of the keel. Drafts on some small boats are referred to the rake of keel (a line connecting the intersection of forward and aft perpendicular and keel line). In this case origin would typically be located at the intersection of aft perpendicular and projected rake of keel.

The transverse origin is typically at the centreline plane.

The longitudinal origin is typically at midship, however, it may be located elsewhere for convenience.

Trim by stern is positive.

Heel to starboard is positive.

1.3 Software

Primary software tool for stability analysis used by Canadian Coast Guard (CCG) is the General Hydro Statics (GHS) program created by Creative Systems, Inc. The Contractor shall use the latest version of GHS at the time of contract for Trim and Stability Book production.

1.4 Deliverables

Final Stability Books shall be submitted to the CCG in the following formats:

1) Hard Copy: Six hard copies presented in a three ring binders. Each section shall be separated by tabbed dividers with the section numbers clearly marked on each tab.

2) Soft Copy: A CD which includes the Trim and Stability Book in both Adobe PDF and Microsoft Word format. Source files for any tables and graphics embedded in the Word file shall also be included on CD (e.g. Excel tables, photographs etc.). In addition, this CD shall include all stability

program files required to generate the information within the Trim and Stability Book including all hull geometry, tank & compartment definition, library, macro, loading, intact stability and damaged stability run files.

2 Front and Introductory Pages

2.1 Cover Page

'Cover Page' shall be the first page of the Trim and Stability Book and will include the following information:

1) Name of vessel (or Class of vessels),
2) Date of the Trim and Stability Book production, and
3) Name of the organization that prepared the Stability Book.

2.2 Revision Page

'Revision page' shall be the page behind the 'Cover Page' and will include the document 'Revision History Table' identifying revision number, description of revision and the date of the revision publication.

2.3 Table of Contents

These pages will include the document table of contents followed by the list of annexes, list of tables and list of figures.

2.4 Nomenclature

This section shall provide an alphabetical listing of nomenclature used in this stability book. This shall include definitions of all acronyms, engineering symbols, mathematical variables and abbreviations

3 Section 1: Notes Regarding Stability and Safe Operation of the Vessel

'Notes Regarding Stability and Safe Operation of the Vessel' shall be the first section in Stability Book. This section shall present summary of the vessel's stability and information required to safely operate the vessel. Each note shall provide clear and unambiguous detailed instruction on the safe operation of the vessel and shall be presented as a sub-section. Examples of the notes are given in Annex A. Notes shall be grouped by topic and include the following as appropriate:

3.1 Statement of the Master's Responsibility Regarding Stability

This sub-section shall provide general information about ship stability (commentary on the vessel's compliance with the intact, damage and any special stability criteria if required by stability standard) and the statement on the Master's responsibilities regarding stability.

3.2 Summary of Vessel Loading

This sub-section shall provide summary of vessel loading. This note shall provide information about loading conditions, trim and tank usage.

1. A descriptive summary of all intact loading conditions followed by a table itemizing solid and liquid loads shall be presented at the beginning of this note. This table shall indicate weight both in units of measurement and as a percentage of maximum. The total displacement (lightship + solid load + liquid load) for each condition shall be given.

2. The operational values for trim for all intact loading conditions shall be stated and the trim limits quoted if there are any.

3. If applicable a tabular form tank usage plan shall be presented. This table shall list all major tanks and their percentage full for all operational loading conditions. If not already required by a stability standard, an additional 'Mid-voyage' loading condition shall be presented. This additional 'Mid-voyage' condition will present the vessel with 50% consumables and stores and some liquids at the operational level. The tank usage table generally defines fuel conditions so as to minimize vessel trim & heel, free surface moment and liquid VCG. The driving principles behind the development of a tank usage plan shall be discussed. If necessary, guidance shall be provided regarding the order to filling/emptying tanks to arrive at each fuel condition.

3.3 Stowage of Cargoes/Scientific/Fishing Equipment

This sub-section shall provide notes on stowage of cargoes/scientific equipment.

3.4 Watertight Doors and Hatches

This sub-section shall provide notes on operation of watertight doors and hatches.

3.5 Safety Equipment

This sub-section shall provide notes on safety equipment.

3.6 Topside Icing

This sub-section shall provide commentary on acceptable topsides icing load and hazards of icing if topside icing assessment is required by stability standard. Descriptive text shall be given indicating the coverage and thickness of icing this represents. Table containing weight and location of topsides icing

shall be presented. Commentary may be made regarding various icing conditions (light, moderate, heavy or extreme) and what exposure time in each is required to attain the icing weight used. This note shall also include guidance for mitigation and avoidance of vessel icing.

3.7 Lifting of Heavy Weights

This sub-section shall give notes on lifting of heavy weights from aspects of stability and safe operation of the vessel during the lifting if lifting assessment is required by stability standard.

3.8 Icebreaking Requirements

This sub-section shall cover any requirements in regards of ship stability and safe operation during icebreaking.

3.9 Limiting VCG Curve

This sub-section shall discuss the ship's "Limiting VCG" curve. Limiting VCG curves shall be generated for all primary loading conditions for intact stability. A graph illustrating the ship's limiting VCG curve(s) shall be provided. To generate the graph, lightship weight and VCG is modified for a given loading condition and longitudinal and transverse center of gravity is maintained constant. Over a series of displacement values, the ship VCG is varied and the maximum possible value before the failure of stability criteria is plotted.

4 Section 2: Vessel Information

The second section of the Trim and Stability Book shall be titled 'Vessel Information' and shall provide basic information about the vessel including all data needed for stability analysis. This section shall be divided into a number of sub-sections as outlined below.

4.1 Vessel Particulars

1. This sub-section shall provide the principle particulars of the vessel including, as a minimum:

    1) Length overall;
    2) Length between perpendiculars;
    3) Breadth overall;
    4) Breadth moulded;
    5) Depth moulded;
    6) All major deck heights above reference baseline at midships;
    7) Camber of decks;
    8) Rise of floor at the midships section;
    9) Location of midships;
    10) Positions of forward and aft draftmarks relative to midships;
    11) Deep departure condition draft and trim;
    12) Keel plate thickness;
    13) Height of highest point above reference baseline;
    14) Height of lowest point below reference baseline.

This sub-section should include a photograph of the vessel.

4.2 Frame Spacing

This sub-section shall provide a table of frame spacing spans throughout the ship.

4.3 Stability Drawing

'Stability Drawing' of the vessel shall be included in this sub-section. This is a standardized format drawing, a sample of which is given in Annex F. The Stability Drawing shall include the following:

1) Profile and deck views of vessel showing all compartments and tanks;
2) Markers showing key bulkheads, location of aft & fwd perpendiculars, midships and location of draft marks; frame scale shall be added below each vessel view;
3) Indication of key dimensions (e.g. distance below baseline of propellers, rudder, sonar, etc.);
4) Stability software (GHS) names for tanks and compartments with description;
5) Icon indicating coordinate system origin with orientation for both trim and stability book and stability software;
6) Location of down-flooding points;
7) Location of lightship centre of gravity (CoG);
8) Legend identifying shading used to indicate tank contents and line style used to indicate water tight bulkheads (WTBs);
9) List of all vessel particulars (from sub-section 4.1) shall be added to the drawing;
10) Table with frame spacing from sub-section 4.2 shall be added to the drawing;

11) Title block with vessel name and date.

If required by drawing size, a plastic holder shall be inserted in the hard copy Trim and Stability Book to accommodate the folded full size drawing.

4.4 Downflooding Points

This sub-section shall present a table summarizing the downflooding points considered in the stability analysis. This table shall identify, for each downflooding point, a brief description and the longitudinal, transverse and vertical coordinates. Table 4-4 provides an example of the format of this table. This sub-section should also include photographs of the primary downflooding points.

5 Section 3: Stability Criteria

This section shall identify the intact and damage stability standards used to assess the ship's stability capability. It will provide basic information about specific loading conditions, vessel stability requirements and hazards considered in the assessment. CCG vessels are typically assessed against criteria set in IMO codes, Transport Canada Regulations or Classification Society Rules.

6 Section 4: Intact Stability Assessment

This section shall detail ship's stability and hydrostatic characteristics for all intact conditions.

This section shall present a summary table of intact conditions, listing: condition name, loaded displacement, loaded heel and trim angle, the value attained for each stability criterion for each condition and the limit required. Table 6.1 shows an example of this summary table.

Intact Stability: Transport Canada TP 7301 STAB 7 Criteria									
Condition	Displacement [t]	Trim [deg]	Heel [deg]	Area from 0 To 30 deg > 0.055 m-rad	Area from 0 To 40 deg or Flood > 0.09 m-rad	Area from 30 To 40 deg or Flood > 0.03 m-rad	Righting Arm at 30 deg > 0.2 m	Absolute Angle at Max RA > 25	GM at 0 deg > 0.15 m
Departure	264.4	0.106	0.030	0.151	0.242	0.091	0.514	34.31	1.088
Load Line	268.6	0.111	0.030	0.149	0.239	0.090	0.510	33.97	1.067
Arrival	236.9	0.439	0.100	0.142	0.225	0.083	0.464	35.10	1.122
Arrival with Ice	269.6	0.436	0.160	0.091	0.136	0.045	0.290	28.63	0.648
Departure - Launching RHIB	264.4	0.123	4.050	0.145	0.222	0.077	0.455	34.93	1.083
Arrival - Launching RHIB	236.9	0.457	4.540	0.132	0.200	0.068	0.404	35.47	1.117
Departure - RHIB Departed	263.0	0.067	0.400	0.156	0.249	0.094	0.528	35.40	1.131
Arrival - RHIB Departed	235.5	0.437	0.300	0.149	0.236	0.087	0.487	35.30	1.170

Table 6.1: Summary of Intact Stability Assessment (for TC TP 7301 Stab 7 Criteria)

The rest of this section shall present a detailed summary of each loading condition. Each summary shall be arranged on two pages. Each page shall have the full condition title at the top of the page. As a recommendation, these two pages should be arranged in a way to be seen simultaneously.

The first page shall include three tables as outlined below. All tables shall have units and reference system clearly identified. First two tables are referred as Condition tables and the third one as Hydrostatic Properties table.

1) The first table shall summarize the solid weights. For each weight item the percentage of full load, weight, centres of gravities (CoG) and weight moments shall be provided. The weight items listed shall include the following as appropriate:
    a) crew,
    b) effects,
    c) provisions & consumables,
    d) stores,
    e) cargo.

    In addition to the above listed solid weights two other solid weights shall be listed:
    a) lightship weight,
    b) icing weight.

    This table shall include a 'totals' line showing the total solid load weight and net CoG.

2) The second table shall summarize the liquid loads of structural and large tanks. The data presented for each tank shall include the following:
    a) tank description and GHS name (in brackets),
    b) specific gravity,

c) percentage full,
d) weight of liquid in tank,
e) vertical, longitudinal and transverse liquid centres and moments, and
f) free surface moment (FSM).

This table shall include a 'totals' line showing the total tank weight, net liquid CoG and total FSM.

A line of 'deadweight' and a line 'condition displacement' shall be placed below the second table. The first line ('deadweight') equals the sum of the liquid and solid loads noted in the previous two tables and the net CoG. The second line ('condition displacement') equals the sum of the lightship, icing weight (if exists) and deadweight and the net CoG. FSM from tanks loads shall also be added at this line.

3) This table shall continue with the presentation of hydrostatic particulars based on the condition displacement including:
   a) Longitudinal Centre of Flotation (LCF),
   b) Longitudinal Centre of Buoyancy (LCB),
   c) Vertical Centre of Buoyancy (VCB),
   d) Moment to Change Trim (MCT),
   e) Metric tonnes per centimetre immersion (TPI) (or long tons per inch immersion - TPI),
   f) Metacentric height transversal and longitudinal KM_T, KM_L.
   g) Free Surface Correction (FSC),
   h) GM fluid and solid (GM_F, GM_S),
   i) Draft at the LCF,
   j) Draft at forward and aft draft marks, referenced to draft vertical datum (as per ship markings),
   k) Draft at forward and aft perpendiculars,
   l) Trim over length between perpendiculars.

Example of the first page (condition and hydrostatic properties tables) is given in Figure B.1 in Annex B.

The second page shall include three figures as listed below:

1) The first figure shall be a diagram showing the ship profile and tank plan. The diagram shall be subdivided by watertight bulkhead, with tank boundaries clearly presented. The intact waterline shall be displayed and identified on the profile. This profile and tank plan shall be shaded indicating the location of liquid and select solid loads. A legend shall be provided identifying the shading used for the following loads:
    a) fuel,
    b) salt water,
    c) fresh water,
    d) black/grey water,
    e) stores and provisions, and
    f) scientific equipment/cargo

2) The second figure shall be table with the list of all intact stability criteria assessed with the required and attained vales.

3) The third figure shall be a graph showing the intact righting arm and any heeling arm curves if required by standard. The curves shall be drawn to show positive range of the righting arm curve. If the down-flooding angle is governing, the figure shall show location of the down-flooding point. If the vessel has an initial list, care shall be exercised to ensure that the righting arm presented is for the vessel heeled in the same direction as the initial list.

Example of the second page is given in Figure 6.2.

7 Section 5: Damage Stability Assessment

This section shall detail ship's stability and buoyancy characteristics for all damage conditions if required by stability standard.

If damage stability assessment is not required by stability standard, Section 7: Damage Stability Assessment, Section 10: Watertight Compartments and parts of Section 1: Notes Regarding Stability and Safe Operation of the Vessel and Section 3: Stability Criteria related to damage stability shall be provided in a separate document as addendum to the Trim and Stability Book. Any additional damage stability requirements specified by Coast Guard and not required by damage stability standard shall be assessed and presented in the addendum.

A statement of the vessel's damage survivability shall be given to clearly identify any damage cases that are close to the stability limits.

This section shall contain a narrative describing how damage cases were derived including discussion on damage extents applied and asymmetric, symmetric and low buoyancy damage scenarios considered. The naming convention used for damage cases shall be defined.

This section shall include a damage case flooding table. This table shall explicitly identify which tanks and/or watertight compartments are flooded in each damage case. Table 7.1 provides an example of this table.

Damage Case	Flooded spaces
D001	steering gear compartment, tank 14, tank 16, AMR
D002	steering gear compartment, tank 14, AMR, atbd tube comp
D003	AMR, stbd tube comp, MMR
D004	MMR, aft accomodation space, tank 3
D005	aft accomodation space, tank 3, fwd accomodation space, tank 12
D006	fwd accomodation space, tank 12, bow thrust compartment, tank 1
D007	bow thrust compartment, chain locker voids, chain locker, fore peak void, fore peak
D008	fwd accomodation space, tank 11, bow thrust compartment, tank 1
D009	aft accomodation space, tank 2, fwd accomodation space, tank 11
D010	MMR, aft accomodation space, tank 2, tank 4
D011	AMR, port tube comp, MMR, tank 8A
D012	steering gear compartment, tank 13, AMR, port tube comp
D013	steering gear compartment, tank 13, tank 17, AMR

Table 7.1: Damage Case Flooding Table

This section shall present a summary table of damage conditions listing: damage case name, displacement in damage condition, the value attained for each stability criterion for each damage case and the limit required. Table 7.2 shows an example of this summary table. This table may be split into a number of sub-tables to organize results by loading condition (e.g. Departure, Arrival conditions).

This section shall also include a graphical summary presentation of select damage cases. As a recommendation, each of these cases shall be arranged on two pages that may be viewed simultaneously in the open trim and stability book (i.e. left and right side pages). Each page shall have the full damage case name at the top of the page. The content of these two pages is shown in Annex C.

Damage Stability Criteria																
Damage Case: Departure	Displacement (tonnes)	Angle at Equilibrium < 12°		GM_T at Equilibrium≥ 0.05m		Minimum Freeboard to margin line > 0 (m)	P/F	Angle from Equilibrium to RA_{ZERO} or Flood > 15°		Area from Equilibrium to 27° or Flood ≥ 0.015 rad-m		GZ_{MAX} ≥ 0.1m		GZ_{MAX} ≥ 0.04m (with wind heeling moment)		Case P/F
D001	265.3	1.00	P	0.679	P	0.177	P	38.80	P	0.068	P	0.257	P	0.226	P	PASS
D002	265.3	0.50	P	0.679	P	0.238	P	39.59	P	0.071	P	0.266	P	0.234	P	PASS
D003	266.2	0.88	P	0.587	P	0.140	P	34.90	P	0.051	P	0.172	P	0.140	P	PASS
D004	258.0	0.83	P	0.505	P	0.637	P	35.54	P	0.053	P	0.181	P	0.147	P	PASS
D005	254.8	1.38	P	0.786	P	0.566	P	31.80	P	0.084	P	0.335	P	0.301	P	PASS
D006	256.0	1.67	P	1.134	P	0.945	P	40.56	P	0.115	P	0.480	P	0.449	P	PASS
D007	266.2	0.03	P	1.106	P	1.420	P	53.01	P	0.128	P	0.533	P	0.503	P	PASS
D008	256.0	1.74	P	1.135	P	0.941	P	46.24	P	0.115	P	0.483	P	0.451	P	PASS
D009	254.8	1.45	P	0.786	P	0.562	P	31.70	P	0.084	P	0.336	P	0.303	P	PASS
D010	258.1	1.24	P	0.525	P	0.599	P	34.86	P	0.052	P	0.180	P	0.147	P	PASS
D011	265.3	0.00	P	0.598	P	0.191	P	35.91	P	0.055	P	0.182	P	0.149	P	PASS
D012	265.3	0.01	P	0.678	P	0.266	P	40.54	P	0.074	P	0.275	P	0.243	P	PASS
D013	265.3	0.39	P	0.681	P	0.213	P	40.00	P	0.071	P	0.263	P	0.231	P	PASS

Table 7.2: Summary of Damage Stability Assessment (for TC TP 10943 Sections 7 and 9 Criteria)

The first page shall include:

1) A schematic plan views showing all tanks and watertight compartments. Various hatches shall be used to indicate tanks and compartments that are flooded and the contents of intact tanks.
2) A table shall be given that lists all tanks and/or compartments that are flooded. This table shall also identify intact tanks which are not empty and their contents and percentage of full load.

The second page shall include:

1) A schematic centerline profile view showing tanks and watertight compartments. Various hatches shall be used to indicate tanks and compartments that are flooded and the contents of intact tanks. The damaged waterline will be shown on the profile schematic.
2) A number of section views showings tanks and watertight compartments. These sections will be shaded to indicate tanks and compartments that are flooded and the contents of intact tanks. Typically five section views will suffice, these should be located at approximately AP, 0.25LBP, midships, 0.75LBP and FP. However, location may be altered to capture points of interest (i.e. specific main tanks). The damaged waterline (preferably for zero heel) shall be shown on all section views.
3) A table listing each damaged stability criterion, the minimum or maximum limit for the criterion and the value attained for the damage case.
4) A graph showing the damaged case righting arm and heeling arm curves. The curves shall be drawn to show positive range of the righting arm curve or the down flooding angle.

It is not necessary to present all damage cases evaluated. The following guidelines shall apply:

1) The worst condition for reserve of buoyancy (minimum margin line freeboard) shall be presented for all cases of symmetric flooding.
2) All cases of flooding which engendered modifications to vessel loading in order to meet stability criteria shall be presented.

8 Section 6: Special Stability Requirements

This section shall cover special ship's stability requirements for ships such as icebreakers, vessels involved in lifting, towing, additional hazard of topside icing or any other non-typical service requirement.

9 Section 7: Hydrostatic Data

This section shall present hydrostatic data in both tabular and graphical format.

Hydrostatics shall be presented for a displacement range that starts 10% below the lightship condition and ends at 110% of the heaviest condition displacement. Draft increment should be around 10 cm (4 in). It can set to other value depending on the vessel's size. Data shall be presented for the minimum of three trim values that covers the range of trims that vessel has in all considered loading conditions. As a general rule the following trims are recommended: 0.5 % LBP stern trim, level trim and 0.5 % LBP bow trim.

The hydrostatic data tables shall include the following:

1) Draft (at mid-ships, usually referenced to vertical draft's datum),
2) Displacement,
3) LCB longitudinal centre of buoyancy,
4) VCB vertical centre of buoyancy,
5) LCF longitudinal centre of flotation,
6) TPC metric tonnes per centimetre immersion (or TPI = long tons per inch immersion),
7) MCT moments to change trim,
8) KMT transverse metacentre, and
9) KML longitudinal metacentre.

The hydrostatic tables and graphs shall be reported in the same units, reference system and water density used throughout the stability book.

Guidance, in the same section of this stability book, shall be provided explaining the use of hydrostatic data. An example of the guidance is provided in Annex D.

10 Section 8: Cross Curves of Stability

This section shall present cross curves of stability in both tabular and graphical format.

Cross curves should be reported at the same displacement's range and bow and stern trims as reported in the hydrostatic data tables. Heel angles reported should be at least up to 70 degrees in 5 degree increments. If the damage stability assessment is required by stability standard then a cross curve at the flooding shall also be added in both table and graph.

The cross curve data tables and graphs shall be reported in the same units, reference system and water density used throughout the stability book.

Guidance, in separate section or annex of this stability book, shall be provided explaining the use of cross curves and righting arm calculation. An example of the guidance is provided in Annex E.

11 Section 9: Tank Tables

This section shall detail information regarding ship tanks. At the beginning of section a summary table shall be provided followed by the detailed tank loading tables.

This section shall include a summary table which lists each major tank by name, its contents, the assumed specific gravity and the 100% liquid load weight.

Detailed loading tables shall be provided for each tank. Each loading table shall give the tank name, tank number, frame station range, contents, assumed specific gravity and reference point for tank soundings. Capacities from 10% to 100% in increments of 10% including 95% shall be given. For each capacity, the following parameters shall be listed:

a) tank sounding,
b) fluid weight,
c) tank volume,
d) vertical centre of gravity,
e) transverse centre of gravity,
f) longitudinal centre of gravity,
g) free surface moment.

All parameters in individual tank loading tables shall be reported at the same bow and stern trims as in the hydrostatic data tables.
~~calculated for zero heel and trim condition (ship in upright and even keel position).~~

Individual loading tables shall be presented in the same order as listed in the summary table at the beginning of the section.

12 Section 10: Watertight Compartments

This section shall provide detailed information regarding all watertight compartments including general information notes and identification of spaces within the boundaries of each watertight compartment. Compartment names should correspond to that used on the stability drawing presented in sub-section 4.3.

This section shall give instruction for interpolating weight and centres of partially flooded compartments. Guidance shall be provided for estimating free surface correction of flooded compartments.

This section shall include a watertight compartment table that lists all watertight compartments on and below the weather deck. For each watertight compartment the following information shall be given:

1) frame span of watertight compartment,
2) gross dimensions of watertight compartment,
3) permeability,
4) fully flooded weight (assuming sea water flooding),
5) Centre of Gravity,
6) A list of all spaces within the compartment.

Annex A: Examples of Notes Regarding Stability and Safe Operation of the Vessel

A.1 Statement of the Master's Responsibility Regarding Stability

Vessel has good initial stability in all specified loading conditions and fully meets requirements of Transport Canada TP 7301, Part I, Stab 7. Vessel meets additional requirements for stability with topside icing prescribed in the same standard.

Vessel has good damage stability in Departure and Arrival loading conditions for all damage cases and fully meets requirements of SOLAS, Chapter II-1, Part B-1 Subdivision and damage stability of cargo ships.

*Notwithstanding the above, compliance with the stability criteria **does not** ensure immunity against capsizing regardless of the circumstances, or absolve the vessel master from his responsibility. The Master should therefore exercise prudence and good seamanship having regard to the season of the year, weather forecasts and the navigational zone and should take the appropriate action as to speed and course warranted by the prevailing circumstances.*

A.2 Summary of Vessel Loading

The Departure condition is the heaviest operational state for the ship. In this condition, the ship is fully stored and fuelled and ballast tanks are empty. Arrival condition is the lightest condition and the least stable. Ship consumables, fuel tanks are at 10% and 14% respectively, while black and grey water, bilge and dirty oil tanks are at 90% level. Fresh water tanks are at 10% level. Ballast water tanks are empty. Deck cargo and SAR equipment are at 100% level.

Table A.1 summarizes the load items for the Departure and Arrival loading conditions.

Loading Condition	Departure		Arrival	
Load Item	**Loading (%)**	**Weight (tonne)**	**Loading (%)**	**Weight (tonne)**
Lightship	100	218.29	100	218.29
Stores	100	1.5	10	0.15
Crew and Equipment	100	1.8	100	1.8
SAR Equipment	100	0.3	100	0.3
Deck Cargo	100	2.4	100	2.4
Fuel Oil	94	31.2	14	4.65
Fresh Water	100	6.42	10	0.64
Ballast Water	0	0	0	0
Gasoline	95	1.86	10	0.19
Lube Oil	100	0.63	10	0.07
Black and Grey Water	0	0	90	4.68
Bilge Water	0	0	90	1.46
Other Liquids	0	0	90	2.29
Displacement	N/A	**264.4**	N/A	**236.92**

Table A.1: Loading Conditions Summary

In the Departure loading condition the vessel has a 0.07 m trim by the stern. The Arrival condition has a 0.281 m trim by the stern.

Acceptable trim for this vessel is between 0 meters by the bow and 0.3 meters by the stern. Bow trim is not acceptable. Excessive stern trim will reduce reserve of buoyancy. Therefore, cargo storage and tank usage should be optimized to maintain, as far as practicable, a level trim for the vessel.

Victory Class ships are fitted with five fuel and one emergency fuel tanks, two fresh water tanks, two gasoline tanks. Other tanks including black and grey water, lube oil, bilge water dirty oil, sludge and two water ballast tanks are not included in tank usage plan.

Tank usage plan specify tank levels for fuel, gasoline and fresh water loads. These levels have been for three loading conditions: departure (95% fuel), mid-voyage (50% fuel) and the arrival (14% fuel) condition. The tank usage plan is outlined in Table A.2.

Tank Name	Condition		
	Departure	Mid-Voyage	Arrival
FO STORAGE	95%	95%	57%
FO SERVICE PORT	95%	30%	0%
FO SERVICE STBD	95%	30%	0%
FO DAY	90%	90%	10%
FO STORAGE/OVERFLOW	92%	60%	0%
FW PORT	100%	50%	15%
FW STBD	100%	50%	5%
GASOLINE PORT	95%	75%	20%
GASOLINE STBD	95%	25%	0%
EMERGENCY FUEL	95%	95%	95%

Table A.2: Tank Usage Plan

A.3 Stowage of Cargoes/Scientific/Fishing Equipment

The C&P variant of the Victory Class ships is outfitted with only a single Zodiac H753 OB RHIB, fitted on the port side. The starboard side RHIB, RHIB cradle and RHIB painter jib are not fitted. The C&P variant fitted with the removable fishing gear appliance, the RAPP KB-08 power block and the MARCO J0117 pot line hauler has a useable deck cargo capacity of 2.4 tonne. If the fishing equipment is removed from the vessel the resulting deck cargo capacity is 3.0 tonne.

Prior to operation, ensure items of equipment and cargo have been properly stowed and/or lashed so as to minimize the possibility of both longitudinal and lateral shifting while underway, under the effect of acceleration caused by rolling or pitching.

A.4 Watertight Doors and Hatches

Hatches, doors, etc. which give access to the main deck should be kept closed during navigation, except when necessarily opened for the working of the vessel, and should always be ready for immediate closure and be clearly marked to indicate that these fittings are to be kept closed except for access. Flush hatches to the: fore peak; chain locker void; main machinery room; auxiliary machinery room; and forward deck house at the Bridge Deck level should be kept closed while the vessel is at sea.

Hinged watertight doors in bulkheads at frames 4, 9, 17, 25 and 31 are to be kept closed at sea except when opened for access.

A.5 Safety Equipment

A.6 Topside Icing

Calculation of Ice Accretion:

Ice accretion for the vessel has been calculated in accordance TP 7301E, Stability, Subdivision, and Load Line Standards, Part I, STAB 7. Table A.3 below provides details of icing coverage and thickness.

Description	Area (m^2)	Rate ($kg/m^{2)}$	Weight (tonnes)	Ice Thickness (cm)	VCG (m)	LCG (m)	TCG (m)
Main Deck	144.8	54	7.819	5.9	3.9	17.8	0
Bridge Deck	69.2	54	3.738	5.9	6.25	19.5	0
Top of Bridge Deck	44.8	54	2.419	5.9	8.6	17	0
Superstructure Front	7.5	37	0.278	4.0	5.4	32.2	0
Superstructure Sides (P&S)	142.4	37	5.27	4.0	5.05	21.5	0
Superstructure Back	10.7	37	0.396	4.0	5.2	13	0
Bridge Front & Back	24.4	37	0.905	4.0	7.5	18.5	0
Bridge Sides (P&S)	25.2	37	0.932	4.0	7.5	18.5	0
Bulwarks (P&S)	38.2	37	1.415	4.0	4.9	33	0
Mast	2.5	48	0.12	5.2	14.5	15	0
Guardrails (P&S)	110	78	8.58	8.5	6	8	0
Small Items	10	78	0.78	8.5	6	8	0
TOTAL:	**629.8**	**N/A**	**32.652**	**N/A**	**5.62**	**16.48**	**0**

Table A.3: Icing Coverage and Thickness Calculation

The resulting ice load is approximately 32.65 tonnes. Loading conditions including ice accretion are only intended to show compliance with the stability criteria. Excessive ice accretion must be avoided and all opportunities to remove ice shall be utilized.

Prediction of Ship Icing:

Table A.4 provides information about icing conditions (light, moderate, heavy and extreme) and rates.

Icing Condition	*None*	*Light*	*Moderate*	*Heavy*	*Extreme*
Icing Rates (cm/hour) (inches/hour)	*0*	*<0.7 <0.3*	*0.7-2.0 0.3-0.8*	*2.0-4.0 0.8-1.6*	*>4.0 >1.6*

Table A.4: Icing Conditions and Rates

Actual icing rates depend on various parameters. Values provided in table should be used as guide for crew to monitor ice accumulation and mitigate dangerous situation associated. Table A.5 below provides times to reach ice thickness for areas considered in Table A.3. Icing rates considered in calculation are 0.7, 2 and 4 cm/h.

			Ice accreation time (h) for the following icing rates (cm/h)		
Description	Weight (tonnes)	Ice Thickness (cm)	0.7	2	4
Main Deck	7.819	5.9	8.4	2.9	1.5
Bridge Deck	3.738	5.9	8.4	2.9	1.5
Top of Bridge Deck	2.419	5.9	8.4	2.9	1.5
Superstructure Front	0.278	4.0	5.8	2.0	1.0
Superstructure Sides (P&S)	5.27	4.0	5.8	2.0	1.0
Superstructure Back	0.396	4.0	5.8	2.0	1.0
Bridge Front & Back	0.905	4.0	5.8	2.0	1.0
Bridge Sides (P&S)	0.932	4.0	5.8	2.0	1.0
Bulwarks (P&S)	1.415	4.0	5.8	2.0	1.0
Mast	0.12	5.2	7.5	2.6	1.3
Guardrails (P&S)	8.58	8.5	12.2	4.3	2.1
Small Items	0.78	8.5	12.2	4.3	2.1

Table A.5: Times to Reach Ice Thicknesses on Various Areas for Icing Rates of 0.7, 2 and 4 cm/h.

Avoidance and mitigation of ship icing:

Vessel icing is associated with the following weather conditions: cold air advection and cold sea temperatures. Monitor weather and these two factors. Especially be aware of polar low pressure cyclones as they can create severe icing due to their high winds and formation of cold air.

When the danger of ship damage and instability arises due to ice formation immediate steps should be taken to remove the ice from large surfaces of the vessel, beginning with the upper structures. Crew should be organized and all the means for combating ice formation should be ready for use.

Freeing ports should be kept clear of debris and ice accretion at all times.

Recommended tools for physical removal are recommended: baseball bats, wooden mallets, steel-bladed ice scrapers, straight bottom shovels, spades, hoes, picks, brooms, snow shovels. Wooden tools are good as they are efficient and make no damage to ship.

The following chemicals can also be used for ice removal: rock salt, calcium chloride, urea, ethylene glycol, methanol and other de-icers including alcohols. The following devices ca also be used for ice removal: hot air guns, hair dryers and steam lances.

A.7 Lifting of Heavy Weights

Exercise due diligence and extreme caution in hoisting items with the crane while at extension.

The vessel's stability is influenced by the lifting of weights over the side, as the weight acts as a point load under the tip of the extended crane boom. Lifting weights over the side of the vessel has two impacts on vessel stability. The first is a significant impact on the vertical centre of gravity as the load is taken on the tip of the crane boom. The second is a heeling moment caused by lifting a weight some distance away from the vessel centreline.

The heaviest weight lifted with the crane on the vessel is an estimated weight of 1500 kg and an outreach of 10 m. It is assumed that the crane lifts to starboard, creating the least favourable stability case. Vessel stability is marginal when lifting this heavy load.

A.8 Icebreaking Requirements

A.9 Limiting VCG Curve

Vessel's limiting VCG was examined in the four loading conditions: Departure, Arrival, Departure with Ice Accretion and Arrival with Ice Accretion. To obtain the curves lightship weights and VCGs for each condition were modified and longitudinal and transverse centers of gravity were maintained constant. Over a series of displacement values, the ship VCG was varied and the maximum possible value before the failure of stability criteria was plotted. Current values for all four loading conditions are added to the plot in addition to the limiting VCG curves. Both Arrival conditions (with and without ice) has less reserve in the lightship and VCG growth due to free surface effects and reducing the weights located low in the ship. Ice accretion significantly reduces vessel's weight and VCG margin before failing any of stability criteria. Arrival Condition with Ice Accretion has the least reserve in the lightship and VCG growth of all four conditions.

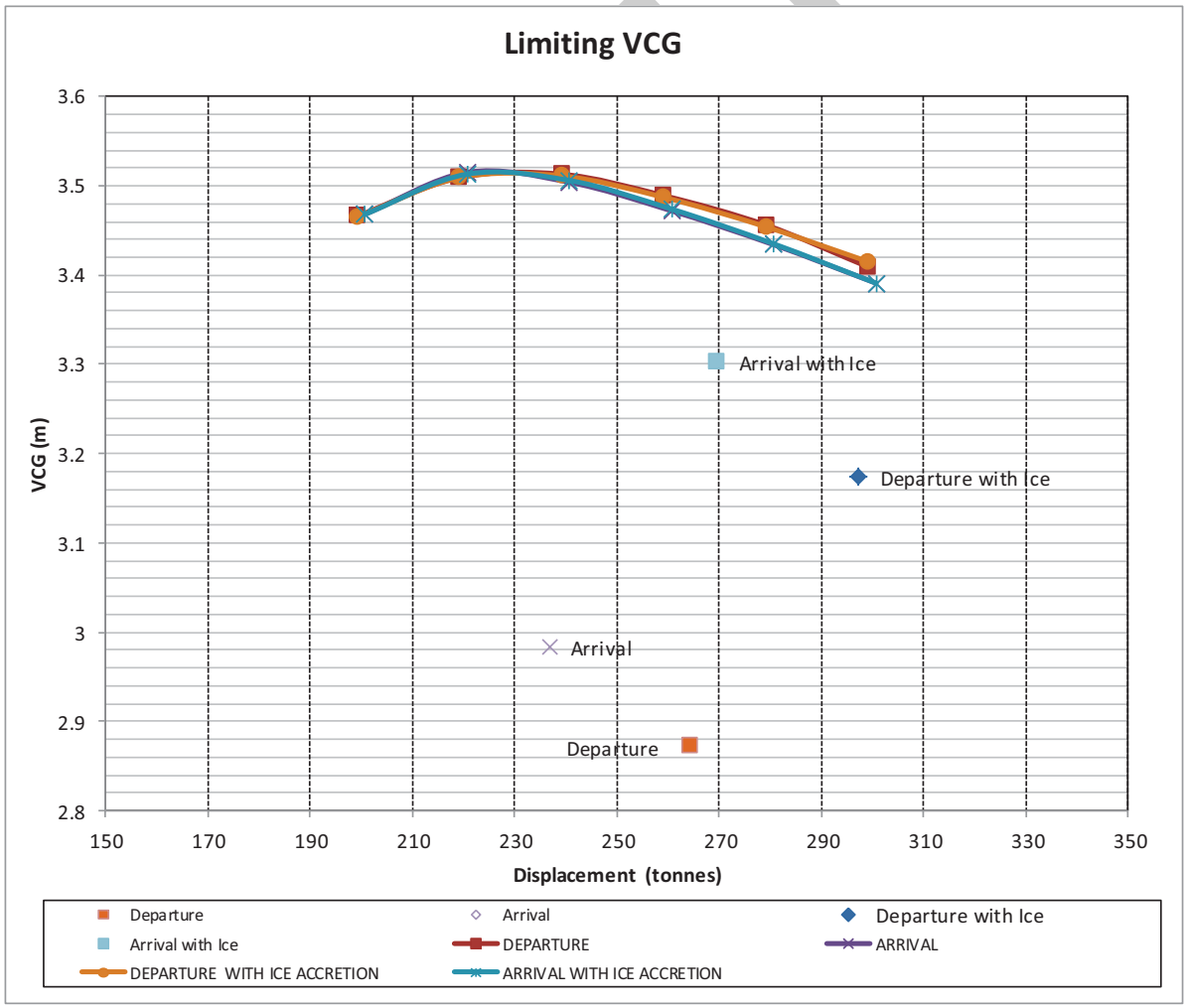


Figure A.1: Limiting VCG Curve

Annex B: Samples of Intact Stability Assessment Tables

Condition: Arrival with Ice Accretion										
Weight Item	**Specific Gravity**	**% Full**	**Weight [t]**	**VCG [m]**	**LCG [m]**	**TCG [m]**	**V.Mom. [mt]**	**L.Mom. [mt]**	**T.Mom. [mt]**	**FSM [mt]**
Lightship			**218.29**	**3.08**	**16.21**	**-0.01**	**672.77**	**3539.35**	**-1.31**	
Solid Weights										
Crew and Equipment	N/A	100	0.90	4.270	24.800	-0.300	3.843	22.320	-0.270	
Effects	N/A	100	0.90	4.270	24.800	-0.300	3.843	22.320	-0.270	
Stores	N/A	10	0.15	4.900	15.500	-1.450	0.735	2.325	-0.218	
Emergency Generator Fuel Oil	N/A	95	0.31	5.600	15.580	0.610	1.736	4.830	0.189	
SAR Equipment - GFE	N/A	100	0.30	4.710	17.952	-0.150	1.413	5.386	-0.045	
Deck Cargo	N/A	100	2.40	4.400	5.000	1.650	10.560	12.000	3.960	
Total Solid Weight			**4.96**	**4.462**	**13.948**	**0.675**	**22.130**	**69.180**	**3.347**	
Icing Weight	N/A	N/A	**32.65**	**16.475**	**0**	**5.618**	**537.909**	**0.000**	**183.428**	
Liquid Loads										
FO STORAGE (FO-TK1.C)	0.840	57	4.23	28.237	0.005	0.604	119.443	0.021	2.555	4.110
FO SERVICE PORT (FO-TK2.P)	0.840	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FO SERVICE STBD (FO-TK3.S)	0.840	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FO DAY (FO-TK8A.P)	0.840	10	0.11	8.746	-1.308	2.026	0.962	-0.144	0.223	0.100
FO STORAGE/OVERFLOW (FO-TK9.C)	0.840	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FW PORT (FW-TK11.P)	1.000	15	0.48	28.572	-2.631	3.002	13.715	-1.263	1.441	0.080
FW STBD (FW-TK12.S)	1.000	5	0.16	28.453	2.629	2.920	4.552	0.421	0.467	0.080
LO MAIN ENGINE (LO-TK5.S)	0.900	10	0.06	14.522	0.855	0.528	0.871	0.051	0.032	0.010
BILGE WATER (BILGE_W-TK4.P)	1.000	90	1.46	16.036	-1.151	0.861	23.413	-1.680	1.257	0.310
SEWAGE SLUDGE (SEWAGE-TK6.C)	1.000	90	0.52	12.751	0.001	0.724	6.631	0.001	0.376	0.090
GREY WATER (GW-TK7A.C)	1.000	90	3.59	10.539	0.002	0.834	37.835	0.007	2.994	1.370
BLACK WATER (BW-TK7B.C)	1.000	90	0.57	12.244	0.001	0.759	6.979	0.001	0.433	0.130
DIRTY OIL SLUDGE (DIRTY_O-TK15.C)	1.000	90	2.29	14.015	-0.001	0.703	32.094	-0.002	1.610	0.380
WATER BALLAST STBD (WB-TK16.S)	1.025	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WATER BALLAST PORT (WB-TK17.P)	1.025	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GASOLINE PORT (GAS-TK13.P)	0.735	20	0.20	2.243	-2.872	2.898	0.449	-0.574	0.580	0.090
GASOLINE STBD (GAS-TK14.S)	0.735	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DG LUBE OIL RESEVOIR (DG_LO_TK.S)	0.900	10	0.01	7.824	0.188	2.685	0.078	0.002	0.027	0.000
Total Tanks			**13.68**	**18.057**	**-0.231**	**0.877**	**247.021**	**-3.161**	**11.994**	**6.750**
Deadweight	N/A	N/A	**18.64**	**14.439**	**3.542**	**0.823**	**269.151**	**66.020**	**15.341**	
Condition Totals	N/A	N/A	**269.58**	**5.489**	**13.374**	**0.732**	**1479.830**	**3605.374**	**197.459**	**6.750**

LCF (m)	16.514	KM_T (m)	3.591	Draft at LCF (m)	2.205
LCB (m)	16.284	KM_L (m)	76.853	Draft at Aft Mark (m)	2.341
VCB (m)	1.513	FSC (m)	6.75	Draft at Fwd Mark (m)	2.061
MCT (t/cm)	5.4	GM_S (m)	0.673	Draft at AP (m)	2.35
TPC (t/cm)	2.14	GM_F (m)	0.648	Draft at FP (m)	2.047
		Trim (m)	0.279	Draft at MS (m)	2.201

Table B.1: Example of the First Page (Condition and Hydrostatic Properties Table)

LIM	STAB 7 CRITERION		Min/Max		Attained	
(1)	Area from abs 0.157 deg to 30	>	0.0550	m.-Rad	0.0905	P
(2)	Area from abs 0.157 deg to 40 or Flood	>	0.0900	m.-Rad	0.1356	P
(3)	Area from 30 deg to 40 or Flood	>	0.0300	m.-Rad	0.0451	P
(4)	Righting Arm at 30 deg	>	0.200	m.	0.290	P
(5)	Absolute Angle at MaxRA	>	25.00	deg	28.63	P
(6)	GM Upright	>	0.150	m.	0.648	P

Relative angles measured from 0.157

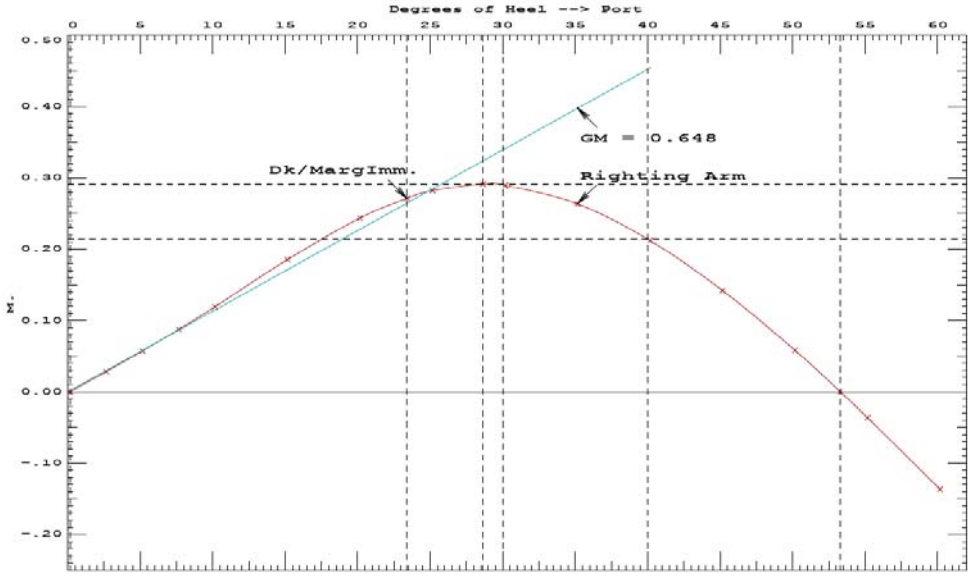
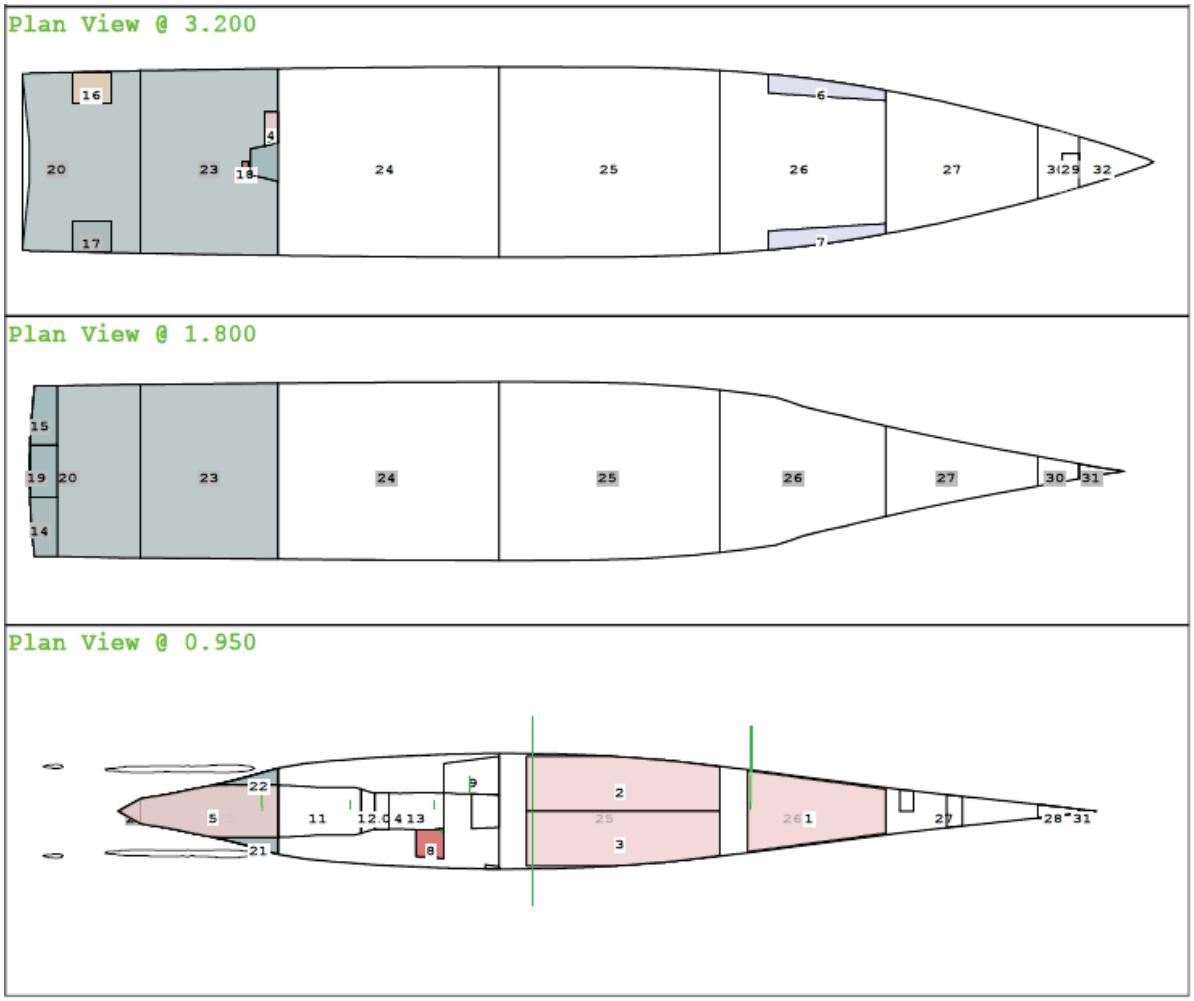


Figure B.1: Example of the Second Page

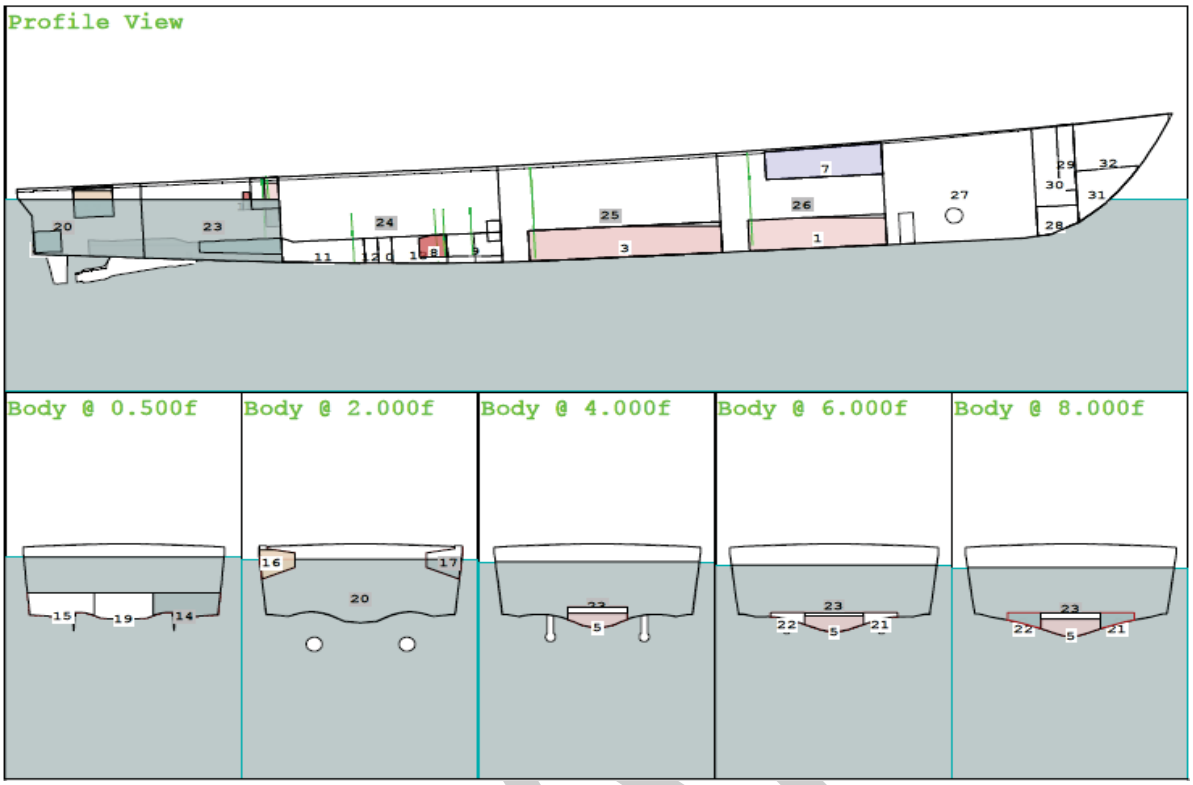
Annex C: Samples of Damage Stability Assessment Tables



Tanks

1 FO-TK1.C.....95% FUEL OIL	11 GW-TK7A.C.....0% GREY WATER	22 2-TUBE_PS.P.....0% WATER
2 FO-TK2.P.....95% FUEL OIL	12 BW-TK7B.C.....0% BLACK WATER	23 2-AMR.C.....Flooded
3 FO-TK3.S.....95% FUEL OIL	13 DIRTY_O-TK15.C...0% DIRTY OIL	24 3-MMR.C.....0% WATER
4 FO-TK8A.P.....90% FUEL OIL	14 WB-TK16.S.....Flooded	25 4-ACOMM_1725.C...0% WATER
5 FO-TK9.C.....70% FUEL OIL	15 WB-TK17.P.....0% BALLAST	26 5-ACOMM_2531.C...0% WATER
6 FW-TK11.P.....100% FRESH WATER	16 GAS-TK13.P.....95% GASOLINE	27 6-BOW_THRUST.C...0% WATER
7 FW-TK12.S.....100% FRESH WATER	17 GAS-TK14.S.....Flooded	28 7-VOID_3638.C....0% WATER
8 LO-TK5.S.....100% LUBE OIL	18 DG_LO_TK.S.....100% DG LO	29 7-CHAIN_LKR.C....0% WATER
9 BILGE_W-TK4.P....0% BILGE WATER	19 1-VOID_01.C.....0% WATER	30 7-CHAIN_VOID.C...0% WATER
10 SEWAGE-TK6.C.....0% SLUDGE	20 1-SG_COMP.C.....Flooded	31 8-VOID_3840.C....0% WATER
	21 2-TUBE_SB.S.....0% WATER	32 8-FORE_PEAK.C....0% WATER

Figure C.1: Example of the First Page (plan views showing all tanks and watertight compartments)



LIM	DAMAGE STABILITY CRITERION		Min/Max		Attained	
(1)	Absolute Angle at Equilibrium	<	12.00	deg	1.09	P
(2)	GM at Equilibrium	>	0.050	m.	0.678	P
(3)	Angle from Equilibrium to Dk/margin Immersion	>	0.00	deg	2.81	P
(4)	Angle from Equilibrium to RAzero or Flood	>	15.00	deg	38.65	P
(5)	Area from Equilibrium to abs 27 deg or Flood	>	0.0150	m.-Rad	0.0673	P
(6)	Righting Arm at MaxRA	>	0.100	m.	0.256	P
(7)	Righting Arm at MaxRA	>	0.040	m.	0.224	P

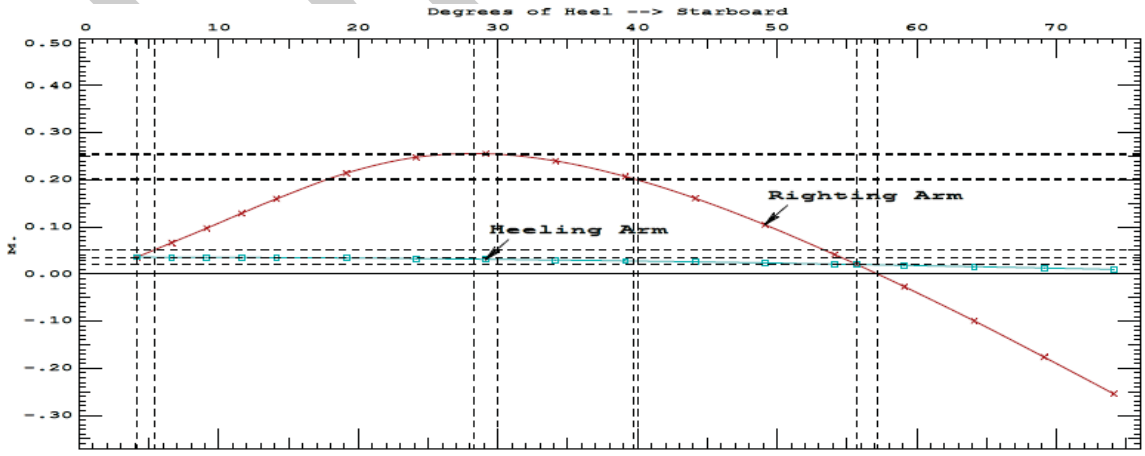


Figure C.2: Example of the Second Page (profile and section views showing all tanks and watertight compartments)

Annex D: Guidance on Using Hydrostatic Data

D.1 Determine Vessel's Draft and Trim

Read the vessel draft marks on port and starboard, forward and aft and calculate the vessel's mean draft and using the following formulas:

$$D_F = (D_{FP} + D_{FS})/2,$$

$$D_A = (D_{AP} + D_{AP})/2,$$

$$D_{MS} = (D_F + D_A)/2.$$

$$t = D_A - D_F.$$

Where:

D_F, D_{FP}, D_{FS} – Forward drafts at CL, port and starboard side respectively,

D_A, D_{AP}, D_{AS} – Aft drafts at CL, port and starboard side respectively,

D_{MS} – Mid-ship draft,

t – trim

D.2 Determine Vessel's Displacement and Other Hydrostatic Data

The mid-ship draft (D_{MS}) and trim (t) are obtained from the calculations in sub-section D.1. Determine vessel's displacement or any other hydrostatic data from the hydrostatic tables by interpolating between appropriate displacements and trims to the actual displacement and trim. Hydrostatic tables are typically provided for three trims and draft increment of 10 cm (4 in).

Annex E: Guidance on Using Cross Curves (KN) and Righting Arm (GZ) Calculation

The approximate righting arm (GZ) curve for any intact loading condition can be obtained by reading the vessel's draft marks and using the hydrostatic curves and the cross-curves contained (please see Sections 8 and 9). The user will also need to determine the vessel's approximate vertical centre of gravity based on the Lightship and solid and liquid loads.

E.1 Determine Vessel's Draft, Trim and Displacement

Read the vessel draft marks on port and starboard, forward and aft and calculate the vessel's mean draft using the following formulas:

$$D_F = (D_{FP} + D_{FS})/2,$$

$$D_A = (D_{AP} + D_{AP})/2,$$

$$D_{MS} = (D_F + D_A)/2.$$

$$t = D_A - D_F.$$

Where:

D_F, D_{FP}, D_{FS} – Forward drafts at CL, port and starboard side respectively,

D_A, D_{AP}, D_{AS} – Aft drafts at CL, port and starboard side respectively,

D_{MS} – Mid-ship draft,

t – trim,

The mid-ship draft (D_{MS}) and trim (t) from this calculation can then be used to obtain the vessel displacement from the Hydrostatic tables or curves. Example of draft and trim calculation procedure is summarized in Table C.1.

D_{FP} (m)	D_{FS} (m)	D_F (m)	D_{AP} (m)	D_{AS} (m)	D_A (m)	D_{MS} (m)	t (m)
2.06	2.062	2.061	2.339	2.343	2.341	2.201	0.280

Table E.1: Draft and Trim Calculation Summary

E.2 Determine Vessel's Vertical Centre of Gravity

Determine the vertical centre of gravity using a condition tables similar to those presented in section 4 of this manual and as reproduced in Table C.2 below. Weight and location of deadweight items (solid and liquid loads) that are onboard the vessel should be estimated, as example below, and should be added to the lightship displacement. The resulting loaded displacement should be checked against the displacement obtained from the draft marks as a check against the accuracy of the estimate. The vertical centre of gravity corresponding to this displacement is obtained by summing the vertical moments of the individual lightship and load items and dividing this number by the total displacement of the vessel.

Condition: Arrival with Ice Accretion					
Weight Item	**Specific Gravity**	**% Full**	**Weight [t]**	**VCG [m]**	**V.Mom. [mt]**
Lightship			**218.29**	**3.08**	**672.77**
Solid Weights					
Crew and Equipment	N/A	100	0.90	4.270	3.843
Effects	N/A	100	0.90	4.270	3.843
Stores	N/A	10	0.15	4.900	0.735
Emergency Generator Fuel Oil	N/A	95	0.31	5.600	1.736
SAR Equipment - GFE	N/A	100	0.30	4.710	1.413
Deck Cargo	N/A	100	2.40	4.400	10.560
Total Solid Weight			**4.96**	**4.462**	**22.130**
Icing Weight	N/A	N/A	**32.65**	**5.618**	**183.428**
Liquid Loads					
FO STORAGE (FO-TK1.C)	0.840	57	4.23	0.604	2.555
FO SERVICE PORT (FO-TK2.P)	0.840	0	0.00	0.000	0.000
FO SERVICE STBD (FO-TK3.S)	0.840	0	0.00	0.000	0.000
FO DAY (FO-TK8A.P)	0.840	10	0.11	2.026	0.223
FO STORAGE/OVERFLOW (FO-TK9.C)	0.840	0	0.00	0.000	0.000
FW PORT (FW-TK11.P)	1.000	15	0.48	3.002	1.441
FW STBD (FW-TK12.S)	1.000	5	0.16	2.920	0.467
LO MAIN ENGINE (LO-TK5.S)	0.900	10	0.06	0.528	0.032
BILGE WATER (BILGE_W-TK4.P)	1.000	90	1.46	0.861	1.257
SEWAGE SLUDGE (SEWAGE-TK6.C)	1.000	90	0.52	0.724	0.376
GREY WATER (GW-TK7A.C)	1.000	90	3.59	0.834	2.994
BLACK WATER (BW-TK7B.C)	1.000	90	0.57	0.759	0.433
DIRTY OIL SLUDGE (DIRTY_O-TK15.C)	1.000	90	2.29	0.703	1.610
WATER BALLAST STBD (WB-TK16.S)	1.025	0	0.00	0.000	0.000
WATER BALLAST PORT (WB-TK17.P)	1.025	0	0.00	0.000	0.000
GASOLINE PORT (GAS-TK13.P)	0.735	20	0.20	2.898	0.580
GASOLINE STBD (GAS-TK14.S)	0.735	0	0.00	0.000	0.000
DG LUBE OIL RESEVOIR (DG_LO_TK.S)	0.900	10	0.01	2.685	0.027
Total Tanks			**13.68**	**0.877**	**11.994**
Deadweight	N/A	N/A	**18.64**	**1.831**	**34.124**
Condition Totals	N/A	N/A	**269.58**	**3.303**	**890.322**

Table E.2: Calculation of Vertical Centre of Gravity

E.3 Obtain Cross Curves Ordinates (KN)

Obtain cross curves ordinates (KN) from the cross curves of stability presented in Section 8.for the vessel's displacement and trim estimated in sub-sections C.1.1 and C.1.2. Interpolate between appropriate displacements and trims to the actual displacement and trim and determine the KN values

at each angle of heel including the limiting flooding angle. Insert the KN values in the table (example shown in Table C.3).

E.4 Calculate Resulting GZ Curve

Calculate righting arm (GZ) curve values for each angle of heel. Having obtained the KN values at each heel angle for the required displacement the righting arm (GZ) values can be obtained by subtracting from KN the value of KG Sinϕ using the following formula:

$$GZ = KN - KG \cdot sin\emptyset$$

Where:

GZ – righting arm (m),
KN – cross curve ordinate (m),
KG – Vertical centre of gravity,
ϕ – heel angle (^{o}).

For the loaded displacement (269.58 tonnes) and centre of gravity (3.303 m) in Table C.2, corresponding GZ values have been calculated in Table C.3.

KN	ϕ (^{o})	sin ϕ	KG sinϕ	GZ = KN - KG sinϕ
0.35	5	0.0872	0.2878	0.0622
0.699	10	0.1736	0.5735	0.1255
1.048	15	0.2588	0.8548	0.1932
1.382	20	0.3420	1.1296	0.2524
1.688	25	0.4226	1.3957	0.2923
1.953	30	0.5000	1.6513	0.3017
2.17	35	0.5736	1.8943	0.2757
2.348	40	0.6428	2.1229	0.2251
2.491	45	0.7071	2.3353	0.1557
2.602	50	0.7660	2.5300	0.0720
2.683	55	0.8192	2.7054	-0.0224
2.737	60	0.8660	2.8602	-0.1232
2.767	65	0.9063	2.9932	-0.2262

Table E. 3: Calculation of GZ

E.5 Use of Righting Arm (GZ) Curve

Righting arm (GZ) curve, once obtined for any loading condition, can be used to assess stability for that particular loading condition. Righting arm curve graph can be obtained by plotting GZ values (ordinates) against heel angles (coordinates).

GZ curve calculated using the above explained is approximate, however sufficiently accurate for quick stability assessement when no other more sofisticated tools are available. For more accurate stability assessment use stability software (GHS) or on-board stability programs (GLM).

Annex F: Stability Drawing