Australian Transport Council

National Standard

for

Commercial Vessels

PART C

DESIGN AND CONSTRUCTION

SECTION 3

CONSTRUCTION

Edition 1
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FOREWORD

This Section of the National Standard for Commercial Vessels was prepared as part of the review of the Uniform Shipping Laws (USL) Code. It replaces Section 5A, 5B, 5G, 5H, 5K, 5L of the USL Code. It also replaces the elements of Section 5M that cover vessels built from plywood.

In drafting this Section, consideration was given to a number of factors including the following:

a) Technological developments that have occurred in the performance of vessels engaged in domestic operations in Australia.

b) Problems of application or interpretation of the USL Code and AS 4132 as referenced in the USL Code.

c) The introduction of performance-based standards as an alternative to prescriptive standards.

d) The possible adoption of existing international standards as part of this standard.

e) The development of the IMO Code of Safety for High Speed Craft applicable to vessels engaged in international operations.

This Section of the National Standard for Commercial Vessels shall be read in conjunction with Part B—General Requirements of the National Standard for Commercial Vessels (NSCV). It should also be read in conjunction with Part A—Safety Obligations.

The NMSC Secretariat drafted this Section with the assistance of a reference group comprising representatives from State Marine Safety Authorities, and the Australian Marine Safety Authority (AMSA). Prior to issue for public comment, workshops on this standard were hosted by the NMSC in November 2004 and September 2006 with the purpose of reviewing safety issues to be addressed by the standard.

A draft of this Section, along with a Regulatory Impact Statement (RIS) was released for public comment on 6 December 2006. A further series of workshops were then held and a reference group formed with representatives from industry and the marine safety authorities. The reference group met on 18 April 2007 to review and assess the public comment and to provide recommendations on the document to the NMSC.

The NMSC accepted the recommendations of the reference group and the draft subsection and RIS were revised accordingly. The Office of Best Practice Regulation approved the Final RIS on 8 August 2007.

Edition 1 was later subject to a correction amendment. Amendment 1 to Table 1 was endorsed by NMSC on 5 October 2010 and published in October 2010.

CONTENTS

CHAPTER 1 PRELIMINARY

1.1 SCOPE

This Section specifies requirements for the construction of vessels, including the hull, decks, superstructures, deckhouses and bulkheads.

1.2 APPLICATION

This section applies to all vessels, other than vessels that fall within the application of Part F—Special Vessels, unless specified otherwise in Part F.

NOTES:

1. Special vessels include Fast Craft and Novel Vessels.
2. Part F Section 2 permits the application of this section to hire and drive vessels.

1.3 OBJECTIVE

The objective of Part C Section 3 of the National Standard for Commercial Vessels (NSCV) is to specify minimum safety standards required for the construction of vessels to—

a) Withstand the loads that arise in normal operations; and

b) Survive the loads that may be encountered in abnormal conditions of operation.

NOTES:

1. Hazards relevant to the construction of a vessel include wave loads, hydrostatic heads, dynamic pressures, slamming, impact with objects (e.g. contact with cargo handling gear, wharves and other vessels), heavy loads (e.g. cargo), point loads (e.g. vehicles), rolling accelerations, collision accelerations, sloshing in tanks, causes of high stress concentration (e.g. discontinuities, misalignments, holes, securing points for rigging and mooring fittings), cyclic loading, material degradation (including corrosion), collisions and groundings.
2. Consequences that may arise from structural failure include overstressing of structural components resulting in yield or ultimate failure (including tensile, compressive, bending, shear, torsional and buckling failures), hazardous failure modes (e.g. brittle failure), excessive elastic deformation, permanent deformation, cracking, fatigue failure, loss of watertight or weather tight integrity, large-scale structural collapse, injury and death,

1.4 DEFINITIONS

For the purposes of this Part of the NSCV–

a) The definitions provided in Part B of the NSCV, in addition to the definitions in this clause, shall apply; and

b) The following definitions provided in Part B—General Requirements of the NSCV shall apply: abnormal conditions, Authority, classed vessel, Classification Certificate, Classification Society, commercial vessel, fast craft, fishing vessel, hazard, hire and drive vessel, length, may, measured length, must, nautical mile, novel vessel, operational area, owner, passenger vessel, risk, seagoing, service category, shall, should, superstructure, tanker, vessel, required outcome, deemed-to-satisfy solution, equivalent solution, vessel use category (Class 1, Class 2, etc), operational area category (Operational Area A, Operational Area B, etc) and service category (Class 1A, Class 2A, etc); and

c) Where there is any conflict between the terms defined in this Clause and Part B, the definitions in this Clause shall apply.

robust operations—

operations of a vessel that in normal circumstances may be exposed to loading arising from—

a) heavy seas (for example all Class A and Class B vessels and seagoing patrol vessels);

b) heavy loads from cargo, machinery, deck machinery or rigging (for example cargo vessels, ro-ro vessels, trawlers, crane barges, dredgers, tankers, etc.);

c) heavy or frequent impacts (for example tugs, ferries, barges, tugs);

d) frequent grounding (for example landing craft and large houseboats); or

e) large accelerations and slamming (for example vessels used for skiing and wake boarding, thrill ride vessels, and dive vessels).

light operations—

operations of a vessel that are characterised by relatively light loading in normal circumstances; i.e., operations that are not robust operations.

NOTES:

1. Light operations would be applicable to most hire and drive vessels (Class 4) and vessels intended primarily for sport and recreation.
2. A vessel designed for light operations may be limited as to its suitability for other purposes.

1.5 REFERENCED DOCUMENTS

STANDARDS AUSTRALIA

AS/NZS 1554.1—*Structural steel welding* - Part 1:*Welding of steel structures*

AS/NZS 1665—*Welding of aluminium structures*

AS 1720.1—*Timber structures* - Part 1: *Design methods*

AS/NZS 1734—*Aluminium and aluminium alloys - Flat sheet, coiled sheet and plate*

AS 1799.4—*Small pleasure boats code* - Part 4: *Reinforced plastics construction*

AS 1799.5—*Small pleasure boats code* - Part 5: *Aluminium construction*

AS/NZS 1866—*Aluminium and aluminium alloys - Extruded rod, bar, solid and hollow shapes*

AS/NZS 2272—*Plywood - Marine*

AS 3572.7—*Plastics - Glass filament reinforced plastics (GRP) - Methods of test* - Method 7: *Determination of extension to failure of unreinforced resins*

AS/NZS 3678—*Structural steel - Hot-rolled plates, floorplates and slabs*

AS/NZS 3679.1—*Structural steel* - Part 1: *Hot-rolled bars and sections*

AS 5604—*Timber - Natural durability ratings*

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO 12215-1—*Small craft - Hull construction and scantlings - Part 1: Materials: Thermosetting resins, glass-fibre reinforcement, reference laminate*

ISO 12215-2—*Small craft - Hull construction and scantlings - Part 2: Materials: Core materials for sandwich construction, embedded materials*

ISO 12215-3—*Small craft - Hull construction and scantlings - Part 3: Materials: Steel, aluminium alloys, wood, other materials*

ISO 12215-4—*Small craft - Hull construction and scantlings - Part 4: Workshop and manufacturing*

ISO 12215-5—*Small craft - Hull construction and scantlings - Part 5: Design pressures, design stresses, scantling determination*

ISO 12215-6—*Small craft - Hull construction and scantlings - Part 6: Structural arrangements and details*

ISO 12215-7—*Small craft - Hull construction and scantlings - Part 7: Scantling determination of multihulls*

ISO 12215-8—*Small craft - Hull construction and scantlings - Part 8: Rudders*

ISO 12215-9—*Small craft - Hull construction and scantlings - Part 9: Sailing boats - Appendages and rig attachment*

LLOYD'S REGISTER OF SHIPPING

Rules and Regulations for the Classification of Inland Waterways Ships

Rules and Regulations for the Classification of Ships

Rules and Regulations for the Classification of Special Service Craft

Rules and Regulations for the Construction of Wooden Yachts

AUSTRALIAN TRANSPORT COUNCIL

National Standard for Commercial Vessels

Part A—*Safety Obligations*

Part B—*General Requirements*

Part F—*Special Vessels*

Uniform Shipping Laws Code: Section 5 Subsection M *Construction—Wood*

CHAPTER 2 REQUIRED OUTCOMES

2.1 SUFFICIENT STRENGTH TO WITHSTAND STATIC LOADING

A vessel must be designed and constructed to withstand all static loading in both normal and abnormal conditions of operation.

NOTE: The term *abnormal conditions* is defined in NSCV Part B.

2.2 SUFFICIENT STRENGTH TO WITHSTAND DYNAMIC LOADING

A vessel must be designed and constructed to withstand the dynamic loading that may arise in both normal and abnormal conditions of operation.

NOTE: Dynamic loading includes loading from slamming, rolling, pitching and planning.

2.3 SUITABILITY FOR OPERATING ENVIRONMENT

A vessel must be designed and constructed to withstand the loads that arise from the intended operating environment, in normal and abnormal conditions.

NOTE: Environmental factors include waves, wind and extremes of temperature,

2.4 CONCENTRATED LOADING

A vessel must be designed and constructed to withstand any concentrated loading that might occur in normal or abnormal conditions of loading.

NOTE: Concentrated loads include those arising from vehicles, dry docking, cargoes, groundings, lifting appliances, and attachment points for rigging, mooring and lashing systems. Where appropriate, structure shall be strengthened or reinforced to withstand concentrated loading.

2.5 DEFORMATION

The structure of a vessel must be designed and constructed to—

a) avoid permanent deformation in normal operations unless specifically designed to do so; and

b) limit the extent of deformation in normal or abnormal conditions of operation where such deformations would compromise the safety of the vessel or damage to adjacent structure.

NOTE: The serviceability of machinery, structure, essential systems, watertight and weather tight integrity, securing devices, and other components can be seriously reduced if deformation is excessive.

2.6 REDUNDANCY

A vessel must be designed and constructed to incorporate a measure of redundancy to maintain serviceability in the event of structural degradation that might be expected over a period of time in normal operation.

NOTE: Such degradation includes corrosion, erosion, rot, deformation and delamination.

2.7 IMPACT RESISTANCE

A vessel must be designed and constructed to reduce the risks of impact loading that could cause structural failure and/or loss of watertight integrity.

NOTE: Impact loads may arise from contact with wharf structures, other vessels, floating objects, grounding and dropped cargo or cargo handling gear.

2.8 FATIGUE

Structure subject to cyclical loadings or repeated stress fluctuations must be designed and constructed to avoid or control the risks of fatigue failure.

2.9 AVOIDANCE OF CAUSES OF HIGH STRESS CONCENTRATION

The structure of a vessel must be designed and constructed to avoid or minimise the effect of discontinuities, abrupt changes in section of structural members, misalignments, penetrations and other causes of high stress concentration.

CHAPTER 3 DEEMED-TO-SATISFY SOLUTIONS FOR DETERMINATION OF SCANTLINGS

3.1 VESSELS OF MEASURED LENGTH 35 M OR MORE

Vessels of 35 m or more in measured length shall be classed, i.e., designed, constructed and maintained in accordance with the rules of a Classification Society.

NOTE: Classification Society is a term that is defined in NSCV Part B.

3.2 VESSELS OF MEASURED LENGTH LESS THAN 35 M

3.2.1 General

The construction of a commercial vessel shall be deemed to satisfy the required outcomes in Chapter 2 if it—

a) is classed, i.e., designed, constructed and maintained in accordance with the rules of a Classification Society; or

b) complies with Clause 3.2.2.

3.2.2 Deemed-to-satisfy alternatives to class

As an alternative to being in class, a vessel of less than 35 m is deemed-to-satisfy the requirements of this Section if it complies with the standards specified in Table 1.

Table 1 — Deemed-to-satisfy alternative construction standards for vessels not in class and less than 35 m in measured length

Measured length	Robust operations	Light operations
< 35 m and > 13 m	The relevant Lloyd's Rules (Clause 3.3) USL Code Subsection 5M	The relevant Lloyd's Rules (Clause 3.3)
≤ 13 m and > 7.5 m	The relevant Lloyd's Rules (Clause 3.3) USL Code Subsection 5M	The relevant Lloyd's Rules (Clause 3.3) ISO 12215 (Clause 3.4.4) (1)
≤ 7.5 m	The relevant Lloyd's Rules (Clause 3.3) USL Code Subsection 5M	The relevant Lloyd's Rules (Clause 3.3) ISO 12215 (Clause 3.4.4) (1) AS1799 (Clause 3.5) (2)

KEY:

1. At the time of development of this standard, Parts 5 and 6 of ISO 12215 were still in draft form. Only the final published versions of Parts 5 and 6 of ISO 12215 are deemed-to-satisfy solutions for the standard, not the draft versions.
2. It is anticipated that the various Parts of AS 1799 will be revised, in due course.

A1

3.3 LLOYD'S RULES

3.3.1 General

For the purposes of this Section of the NSCV, and subject to Table 1 and Table 2, a vessel designed and constructed to comply with the specified parts of the rules of Lloyd's Register of Shipping shall be deemed to satisfy the required outcomes of this Section.

3.3.2 Application

The particular set of Lloyd's rules applied shall be only that intended by those rules for direct application to a vessel of the specified type, size, operation and construction material.

Table 2 — Application of Lloyd's Rules as a deemed-to-satisfy solution

Title	Applicable parts	Applicable ship types
Rules and Regulations for the Classification of Ships	Part 3 and Part 4	Barges; bulk carriers; container ships; oil tankers; dredgers; ferries; roll-on roll-off ships; fire fighting ships; fishing vessels; general cargo ships; offshore supply ships; ore carriers; passenger vessels; pontoons; reclamation craft; trawlers; tugs
Rules and Regulations for the Classification of Special Service Craft	Part 5, Part 6, Part 7, Part 8	High speed craft (fast craft); amphibious air-cushion vehicle; catamaran; foil-assisted craft; hydrofoil; ribs; service craft; wooden craft; yachts
Rules and Regulations for the Classification of Inland Waterways Ships	Part 3, Part 4	General cargo ships; bulk carriers; container ships; ferries and roll-on roll-off ships; pontoons; tugs; pusher tugs and launches; passenger vessels; ships intended for the carriage of liquids in bulk; oil and chemical tankers; oil tankers; chemical tankers; liquefied gas carriers; water tankers, wine tankers, edible oil tankers
Rules and Regulations for the Construction of Wooden Yachts		Traditional planked wooden vessels engaged in light operations

3.3.3 Definitions

For the purposes of applying the Lloyd's rules, including calculation and interpretation of clauses, the definitions and meanings contained within the Lloyd's rules apply except as follows:

society—

the Authority or an entity accredited by the Authority

3.3.4 Relationship between NSCV operational area categories and Lloyd's service area restrictions

The relationships specified in Table 3 shall apply for the purposes of applying the Lloyd's Rules and Regulations for the Classification of Special Service Craft to vessels within the application of this national standard.

The application of equivalent Lloyd's service area restrictions are subject to the additional conditions in Table 3.

NOTE: Operational area categories are defined in NSCV Part B.

Table 3 — Relationship between NSCV operational area categories and Lloyds Special Service Craft service area restrictions

NSCV Operational Area Category	Equivalent Lloyds service area restriction	Additional conditions
B	Service Group 5 (G5)	None
	Service Group 4 (G4)	To operate not more than 200 nautical miles seaward from the coast and where the range to refuge is 250 nautical miles or less
	Service Group 3 (G3)	To operate in waters where the range to refuge is 150 nautical miles or less
C	Service Group 3 (G3)	None
	Service Group 2 (G2)	To operate in waters where the range to refuge is 20 nautical miles or less.
D	Service Group 2 (G2)	None
	Service Group 1 (G1)	None
E	Service Group 1 (G1)	None

3.4 ISO STANDARDS

3.4.1 General

For the purposes of this Section of the NSCV, and subject to Table 1 andTable 4, a vessel designed and constructed to comply with the specified ISO standards shall be deemed to satisfy the required outcomes of this standard.

3.4.2 Application

This standard allows for the application of specified standards in the ISO 12215 series to specified craft engaged in light operations, notwithstanding that the Scope of these ISO standards limits their application to small boats used for recreational purposes only, including craft equivalent to Class 4 *hire and drive*. Except for the reference to non-commercial service, the specific ISO standard used shall be the one intended for application to a vessel of the specified type, size, design category and construction material.

Table 4 — Application of ISO Standards as a deemed-to-satisfy solution

ISO No.	Title	Applicable ship types
ISO 12215-1	Small craft - Hull construction and scantlings - Part 1: Materials: Thermosetting resins, glass-fibre reinforcement, reference laminate	FRP craft 13 m or less in measured length engaged in light operations.
ISO 12215-2	Small craft - Hull construction and scantlings - Part 2: Materials: Core materials for sandwich construction, embedded materials	FRP craft 13 m or less in measured length engaged in light operations.
ISO 12215-3	Small craft - Hull construction and scantlings - Part 3: Materials: Steel, aluminium alloys, wood, other	Steel, aluminium, plywood and composite FRP/wood craft 13 m or less in measured length engaged in

	materials	light operations.
ISO 12215-4	Small craft – Hull construction and scantlings – Part 4: Workshop and manufacturing	FRP, steel, aluminium, plywood and composite FRP/wood craft 13 m or less in measured length engaged in light operations.
ISO 12215-5 (1)	Small craft – Hull construction and scantlings – Part 5: Design pressures, design stresses, scantling determination	FRP, steel, aluminium, plywood and composite FRP/wood craft 13 m or less in measured length engaged in light operations.
ISO 12215-6 (1)	Small craft – Hull construction and scantlings – Part 6: Structural arrangements and details	FRP, steel, aluminium, plywood and composite FRP/wood craft 13 m or less in measured length engaged in light operations.
ISO 12215-7	Small craft – Hull construction and scantlings – Part 7: Scantling determination of multihulls	FRP, steel, aluminium, plywood and composite FRP/wood multihull craft 13 m or less in measured length engaged in light operations.
ISO 12215-8	Small craft – Hull construction and scantlings – Part 8: Rudders	FRP, steel, aluminium, plywood and composite FRP/wood craft 13 m or less in measured length engaged in light operations.
ISO 12215-9	Small craft – Hull construction and scantlings – Part 9: Sailing boats – Appendages and rig attachment	FRP, steel, aluminium, plywood and composite FRP/wood sailing boats 13 m or less in measured length engaged in light operations.

KEY:

At the time of development of this standard, Parts 5 and 6 of ISO 12215 were still in draft form. Only the final published versions of Parts 5 and 6 of ISO 12215 are deemed-to-satisfy solutions for the standard, not the draft versions.

3.4.3 Definitions

For the purposes of applying the ISO Standards, including calculation and interpretation of clauses, the definitions and meanings contained within these standards and other referenced ISO standards apply.

3.4.4 Relationship between NSCV operational area categories and ISO design categories

The relationships specified in Table 5 shall apply for the purposes of applying the ISO standards to vessels within the application of this Section of the NSCV.

The application of equivalent ISO design categories are subject to the additional conditions in Table 5.

NOTE: Operational area categories are defined in NSCV Part B.

Table 5 — Relationship between NSCV operational area categories and ISO design categories

NSCV Operational Area Category	Equivalent ISO Design Category	Additional conditions
A	Nil	Not applicable
B	Nil	Not applicable

C	A: Ocean	None
	B: Offshore	Not to operate in wave heights greater than 4 m significant, nor wind force exceeding 7 Beaufort
D	B Offshore	None
	C: Inshore	Not to operate in wave heights greater than 2 m significant, nor wind force exceeding 6 Beaufort
E	C: Inshore	None
	D: Sheltered waters	Except for sailing vessels, not to operate in wind force exceeding 4 Beaufort

3.5 AUSTRALIAN STANDARDS

3.5.1 General

For the purposes of this Section of the NSCV, and subject to Table 1 and Table 4, a vessel designed and constructed to comply with the specified Parts of AS 1799 shall be deemed to satisfy the required outcomes of this standard.

3.5.2 Application

This standard allows the application of the specified Australian Standards to certain craft 7.5 m measured length or less engaged in light operations, notwithstanding that under the Australian Standard, its application is limited to small boats used for recreational purposes only. Excepting the reference to non-commercial service, the specific Australian Standard applied shall be only that intended by the standard for a vessel of the specified material.

3.5.3 Definitions

For the purposes of applying the Australian Standards, including calculation and interpretation of clauses, the definitions and meanings contained within these Australian Standards and other referenced Australian Standards apply.

Table 6 — Application of Australian Standards as a deemed-to-satisfy solution

AS No.	Title	Applicable ship types
AS 1799.4	Small pleasure boats code - Reinforced plastics construction	FRP craft of 7.5 m or less in measured length engaged in light operations.
AS 1799.5	Small pleasure boats code - Aluminium construction	Aluminium craft of 7.5 m or less in measured length engaged in light operations.

CHAPTER 4 DEEMED TO SATISFY SOLUTIONS FOR MATERIALS

4.1 GENERAL CHARACTERISTICS

Materials used in the construction of vessels shall be suited to the marine environment.

4.2 SPECIFIC STANDARDS

Materials used for the construction of vessels that are not classed shall comply with the material standards specified in the specific set of construction rules that are applied, see Table 7. Materials for vessels that are not classed and are built to Lloyds rules need not be certified for compliance by Lloyds Register. As an alternative to Table 7, materials may either comply with the relevant standards specified in Table 8 or materials that are accepted by a recognised Classification Society.

Table 7 — Material standards

Design standard	Material standards
Lloyd's	Part 2 of the particular set of Lloyd's Rules
ISO 12215	ISO 12215-1, -2 and -3
AS 1799	AS 1799 Parts 4 and 5
USL Code Subsection 5M	Subsection 5M Part 1

Table 8 — Alternative Australian standards for hull construction materials

Material	Australian Standard
Steel	AS/NZS 3678 AS/NZS 3679.1
Aluminium	AS/NZS 1734 AS/NZS 1866
FRP	AS 3572.7
Wood	AS 1720.1 AS 5604
Plywood	AS/NZS 2272

CHAPTER 5 WORKMANSHIP AND MANUFACTURING FACILITIES

5.1 PRODUCTION FACILITIES

Workshop conditions, material storage, and handling must be such that materials shall be free from contamination, readily accessible, and appropriate for the vessel to be built.

Materials that would deteriorate with exposure to the weather shall be stored under cover.

The builder shall have processes to effectively monitor, verify and document the quality of construction and compliance with design documentation throughout the build program and at its completion.

NOTES:

1. This would include ongoing inspections and/or tests at critical stages of construction.
2. A quality management system provides a widely recognised framework to facilitate the compliance of a vessel with quality and compliance standards.

5.2 WORKMANSHIP GENERALLY

The workmanship applied to the construction of vessels shall be of sufficient quality to achieve the outcomes of structural strength and watertight integrity required by the provisions of this standard.

5.3 STEEL AND ALUMINIUM VESSELS

5.3.1 Storage of materials

The builder shall have processes to effectively monitor, verify and document the storage of materials used in construction.

Where materials of varying alloy and/or temper are used in the construction of a vessel, they shall be clearly labelled and separately stored.

5.3.2 Welding

Welding schedules shall be included in design documentation and shall be made available in a conspicuous place for consultation by workers at all times during construction.

Where the design standard being used does not have its own welding schedule the schedules contained in Annex B shall be used.

The minimum mechanical properties for common aluminium alloys in the unwelded and welded condition are given in Annex C.

The quality of welding shall be controlled by the development and application of appropriate welding procedures that ensure the minimum requirements of strength assumed for the purposes of design are actually achieved. The filler metal used for all welded structures shall be compatible with the parent metal of components being joined.

5.3.3 Welding operators

Welding operators shall be proficient in the type of welding on which they are engaged.

The responsibility for selection, training and testing of welding operators rests with the builder. The builder shall test welding operators to a suitable recognised standard. The builder shall keep records of tests and qualifications.

A suitable standard for welding aluminium vessels is AS/NZS 1665. A suitable standard for welding steel vessels is AS/NZS 1554.1.

5.3.4 Contamination of aluminium work places

Aluminium fabrication areas shall be separated from those for steel to the extent necessary to prevent contamination. Tools and/or equipment used for steel fabrication, such as grinding wheels and wire brushes, shall not be brought into aluminium fabrication areas.

5.4 MANUFACTURE OF FRP VESSELS

5.4.1 Materials employed in laminating

The application, storage, shelf life and procedures for use of materials that are employed in the laminating process shall be in accordance with the specific instructions or recommendations specified by the manufacturer as applicable to the relevant material and its application on the vessel.

5.4.2 Control of environmental conditions during laminating

Workspaces that are used for laminating shall enable the control of environmental conditions so that—

a) mould surfaces are kept clean and dry;

b) moulds are kept away from direct sunlight and wind draughts at all times throughout the laminating process;

c) laminating is conducted within the temperature and humidity ranges recommended by the manufacturer of the fibre reinforcement, resin and core materials;

d) the moulding temperature at the commencement of moulding is uniform over the entire mould surface; and

e) temperature ranges during laminating remain within the range recommended by the resin manufacturer.

5.4.3 Control and verification of the laminating process

Laminating schedules shall be made available in a conspicuous place for consultation by workers at all times during construction.

The quality of the laminating process shall be controlled by the development and application of appropriate written procedures that ensure that actual laminate properties achieved are not less than the minimum properties of strength and stiffness assumed for the purposes of design. These procedures shall describe clearly and unambiguously how each of the laminating steps is carried out, when it is carried out and by whom.

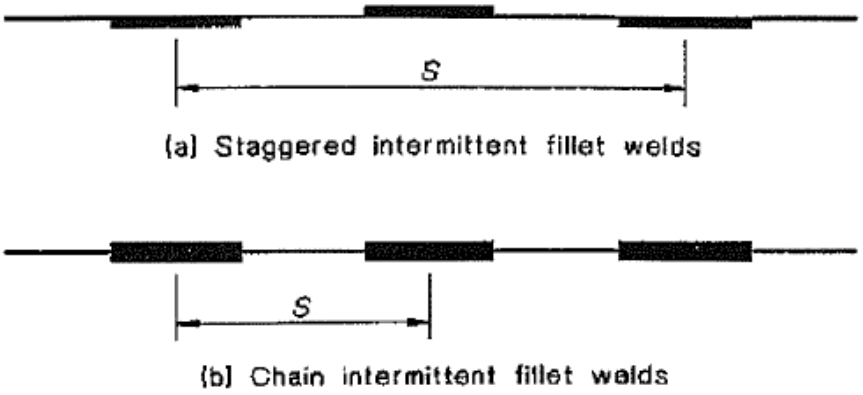
Information essential for verifying the integrity and quality of the laminating process shall be recorded including daily environmental conditions and laminating schedules, final thickness testing and testing of laminate samples.

NOTE: Annex A provides guidance on the type of information required for daily recording of laminating procedures. This type of information would normally be modified to suit specific vessels.

ANNEX A DAILY RECORD OF LAMINATING OF FRP VESSELS

Vessel:						Hull No:		Date:	
Builder:									
Owner:									
Resin Type and Batch No:									
Trade Name and Supplier:									
Reinforcement Type and Batch No:									
Trade Name and Supplier:									
Catalyst Type and Batch No:									
MEKP						Other			
Trade Name and Supplier:									
Area laminate being applied: ☐ Basic Hull ☐ Keel ☐ Chine ☐ Deck ☐ Transom ☐Internal stiffening ☐ Bulkheads									
Layer	Type	Orient-ation	Mass	Time		Temperature		Humidity	
	CSM, WR etc	0,90 etc	g/m^2	Start	Finish	Start	Finish	Start	Finish
1									
2									
3									
4									
5									
6									
7									
8									
Total Lamination Time:									
Total Resin Used:			Polyester Iso			Ortho Vinylester		Epoxy	
Percentage Catalyst:						Resin/Fibre Ratio:			
Weight of Reinforcement Per Metre^2 at the end of day:									
Application: ☐ GUN			☐ INFUSION			☐ HAND		Average Gel Time:	
Time from Gel Coat application to Hull Removal from Mould:									
I hereby certify that the information provided above is a correct record.									
Name:						Position:			
Signature:						Date:			

ANNEX B TYPE AND SIZE OF WELDS FOR VARIOUS STRUCTURAL CONNECTIONS FOR ALUMINIUM ALLOYS AND STEEL

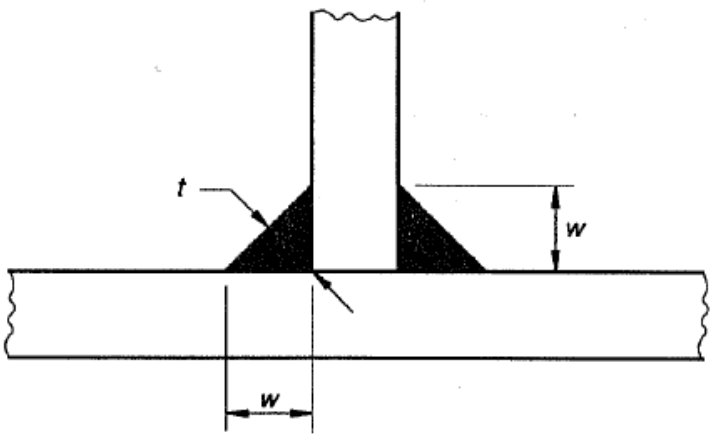


(a) Staggered intermittent fillet welds

(b) Chain intermittent fillet welds

LEGEND:
S = spacing of intermittent fillet welds

Figure B.1— Size and Spacing of Fillet Welds



LEGEND:
t = throat distance of weld
w = leg length of weld

Figure B.2—Dimensions of Intermittent Fillet Welds

Table B.1 Type and size of welds for various structural connections

Millimetres

Minimum thickness of members	≤5	>5 ≤6.5	>6.5 ≤8	>8 ≤9.5
Nominal length of fillet weld	40	65	75	75
Nominal leg length of fillet weld (*w*)	3	6.5	6.5	6.5
Nominal throat distance of fillet weld (*t*)	2	3.5	4.5	4.5
Structural connections*	**Spacing of welds (s)†**			
Single bottom:				
Centre keelson to keel plate	DC	DC	DC	DC
Floors to centre keelson	DC	DC	DC	DC
Intercostals to bar keel	DC	DC	DC	DC
Intercostals to floors	DC	DC	DC	DC
Rider bar to centre keelson on intercostals (tee joint)	260‡	260‡	280‡	300‡
Rider bar to floors (tee joint) adjacent to engines and propellers	DC	DC	DC	DC
Rider bars to floors elsewhere (tee joint)	260‡	260‡	280‡	300‡
Rider bar to floors (corner joint)	DC	DC	DC	DC
Floors to bottom adjacent to propeller	DC	DC	DC	DC
Floors to bottom adjacent to engine	DC	DC	DC	DC
Floors to bottom forward of 025 *L*	225	225	250	225
Floors to bottom in tanks	225‡	225‡	250	225
….Floor to bottom elsewhere	300‡	300‡	300	275
Frames:				
Transverse frames to side shell forward of 0.25 L	225‡‖	225‡‖	250‖	225‖
Transverse frames to side shell in tanks	225‡‖	225‡‖	250‖	225‖
Transverse frames to side shell elsewhere	300‡‖	300‡‖	300‖	275‖
Longitudinal frames to side shell forward of 0.25 L	225‡‖	225‡‖	250‖	225‖
Longitudinal frames to side shell in tanks	225‡‖	225‡‖	250‖	225‖
Longitudinal frames to side shell elsewhere	300‡‖	300‡‖	300‖	275‖
Frame brackets to frames, floors and deck beams	DC	DC	DC	DC
Riders bars to frames (tee joint)	260	260	280	300
Rider bars to frames (corner joint)	DC	DC	DC	DC
Decks:				
Peripheries of strength decks, exposed decks and all watertight or oiltight decks	DC	DC	DC	DC
Beams (transverse or longitudinal) to decks adjacent to tanks	225‡	225‡	250	225
Beams (transverse or longitudinal) to decks elsewhere	300‡	300‡	300	275
Beam knees to beams, frames and other end attachments	DC	DC	DC	DC
Hatch coamings to exposed decks	DC	DC	DC	DC
Transverse or deep beam to decks adjacent to tanks	200	200	225	200
Transverse or deep beams to decks elsewhere	225	225	250	225
Girders and webs:				
Girders and webs to shell and bulkheads or decks in tanks	200	200	225	200
Girders and webs to shell and to bulkheads or decks elsewhere	225	225	250	225
Webs to face plate where area of face plate does not exceed 64.5cm²	250‡	250‡	300	275
Webs to face plate where area of face plate exceeds 64.5 cm²	---	---	250	225
Girder to deck beams	DC	DC	DC	DC
Web to deck, side and bottom longitudinals	DC	DC	DC	DC
Girder end brackets	DC	DC	DC	DC

(Continued)

Table B1 (continued)

Bulkheads:				
Peripheries of swash bulkheads	200	200	225	200
Peripheries of non-tight structural bulkheads	200	225	250	225
Peripheries of watertight or oiltight bulkheads	DC	DC	DC	DC
Stiffeners to deep tank bulkheads	300‡	300‡	300	275
Stiffeners to watertight bulkheads (except in tanks) and deckhouse fronts §	300‡	300‡	300	275
Stiffeners to non-tight structural bulkheads, deckhouse sides and afterends §	300‡	300‡	300	275
Stiffener brackets to beams and decks	DC	DC	DC	DC
Machinery seatings:				
Machinery seatings to floors and shells	DC	DC	DC	DC
Double bottoms:				
Floors to shell forward of 0.25 *L*	225	225	250	225
Floors to shell adjacent to engines	DC	DC	DC	DC
Floors to shell elsewhere	300‡	300‡	300	275
Floors to centre vertical keel plate	DC	DC	DC	DC
Floors to margin plate	DC	DC	DC	DC
Floors to inner bottom forward of 0.25 *L*	275‡	275‡	275	250
Floors to inner bottom adjacent to engines	DC	DC	DC	DC
Floors to inner bottom elsewhere	300‡	300‡	300	275
Wide-spaced floors with longitudinal framing to shell and inner bottom	DC	DC	DC	DC
Non-watertight centre girder to inner bottom or plate keel adjacent to engines and to shell or bar keel	DC	DC	DC	DC
Non-tight centre girder to inner bottom or plate keel elsewhere	150	150	150	125
Watertight or oiltight centre girder to inner bottom, rider plate, shell or bar keel	DC	DC	DC	DC
Intercostals and continuous longitudinal girders to shell and to inner bottom adjacent to engines	DC	DC	DC	DC
Intercostals and continuous longitudinal girders to shell elsewhere and to floors	275‡	275‡	275	250
Watertight and oiltight periphery connections of longitudinal girders in double bottom.	DC	DC	DC	DC
Deckhouses and superstructures:				
The boundaries of deckhouses and superstructures to deck plate	DC	DC	DC	DC

NOTES:

* All members that are crossed by or carry the ends of structural members shall have a pair of matched intermittent welds on each side of each such intersection.

† Where double continuous welds are required for connections of plating greater than 4.8 mm in thickness or where double continuous welds are adopted for connections of plating greater than 4.8 mm in thickness, the nominal leg length of the welds may be reduced by 1.6 mm.

‡ Fillet welds shall be staggered.

§ Unbracketed stiffeners of shell, watertight and oiltight bulkheads and deckhouse fronts shall have double continuous welds for one tenth of their length at each end. Unbracketed stiffeners of non-watertight structural bulkheads, deckhouse sides and after ends shall have a pair of matched intermittent welds at each end.

‖ Frames shall have double continuous welds adjacent to brackets.

LEGEND:

DC = double continuous fillet weld

L = waterline length of vessel

ANNEX C MINIMUM MECHANICAL PROPERTIES FOR NON-WELDED AND WELDED ALUMINIUM ALLOYS

Table C.1 Minimum Mechanical Properties for Non-Welded Aluminium Alloys

Alloy and temper	Product	Thickness range	Tension		Compression yield strength	Shear		Bearing		E*
			Ultimate strength	Yield strength		Ultimate strength	Yield strength	Yield strength	Ultimate strength	
		mm	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa
5005-H12	Sheet, plate	≤50	124	96	90	76	152	55	234	69 637
5005-H14	Sheet	≤6	144	117	103	83	172	69	276	69 637
5005-H16	Sheet	≤4	165	138	124	96	206	83	331	69 637
5005-H32	Sheet	≤6	117	83	76	76	138	48	234	69 637
5005-H34	Sheet	≤6	137	103	98	83	167	59	276	69 637
5005-H36	Sheet	≤4	158	124	110	90	200	76	317	69 637
5050A-H32	Sheet	≤6	151	110	96	96	186	62	303	69 637
5050A-H34	Sheet	≤6	172	137	124	103	221	83	345	69 637
5052-H32	Sheet, plate	≤50	213	158	145	131	269	90	414	70 327
5052-H34	Sheet, plate	≤25	234	179	165	138	303	103	448	70 327
5052-H36	Sheet	≤4	255	199	179	152	317	117	483	70 327
5052-H38	Sheet	≤3.25	268	220	207	152	338	124	510	70 327
5052-H391	Sheet	≤2	290	241	227	159	358	138	524	70 327
5083-H111	Extrusions	≤125	275	165	145	159	262	97	538	71 705
5083-H321	Plate	>5 ≤40	303	213	179	179	365	124	59	71 705
5083-H321	Plate	>40 ≤75	282	199	165	165	117	538	338	71 705
5083-H323	Sheet	≤6	310	234	221	179	138	607	400	71 705
5083-H343	Sheet	≤6	344	268	255	200	159	655	455	71 705
5086-H34	Sheet, plate	≤25	303	234	221	179	138	579	400	71 705

(Continued)

Table C1 (continued)

Alloy and temper	Product	Thickness range	Tension		Compression yield strength	Shear		Bearing		E*
			Ultimate strength	Yield strength		Ultimate strength	Yield strength	Yield strength	Ultimate strength	
		mm	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa
5086-H112	Sheet	>4.8 ≤6	248	124	117	152	69	496	214	71 705
5086-H112	Plate	>6 ≤25	241	110	110	145	62	483	193	71 705
5251-H34	Sheet, plate	≤25	231	179	159	131	103	434	303	70 327
5454-H34	Sheet, plate	≤25	268	199	186	159	117	510	338	71 705
6060-T5	Extrusions	≤25	206	172	172	131	97	434	276	69 637
6061-T6	Sheet, plate	≤25	289	241	241	186	138	607	400	69 637
6061-T6	Extrusions	All	262	241	241	165	138	552	386	69 637
6061-T6	Drawn tube	≤12	293	241	241	186	138	607	386	69 637
6063-T6	Extrusions	≤12	151	110	110	90	62	317	79	69 637
6063-T83	Extrusions	≤25	206	172	172	131	97	434	276	69 637
6063-T5	Drawn tube	All	275	248	248	165	138	579	393	69 637
6351-5	Extrusions	All	262	241	241	164	138	552	386	69 637
6351-T6	Extrusions	≤150	293	255	255	172	145	607	421	69 637

**E* is compressive modulus of elasticity*

Table C.2 – Minimum Mechanical Properties for Welded Aluminium Alloys*

Alloy and temper	Product	Thickness Range	Tension		Compression Yield Strength	Shear		Bearing	
			Ultimate strength	Yield strength		Ultimate Strength	Yield Strength	Ultimate Strength	Yield strength
		mm	MPa	MPa	MPa	MPa	MPa	MPa	MPa
5005-H12, -H14, -H16, -H32, -H34, -H36	All	All	103	48	48	62	27	193	68
5050A-H32, -H34	All	All	124	55	55	82	31	248	82
5052-H32, -H34, -H36, -H38, -H39	All	All	172	89	89	110	51	344	131
5083-H111	Extrusions	All	268	144	137	158	82	537	220
5083-H321	Plate	≤40	275	165	165	165	96	551	248
5083-H321	Plate	>40 ≤75	268	159	159	165	90	538	234
5083-H323, -H343	Sheet	≤6	275	165	165	165	96	551	248
5086-H112	Sheet	>4.8 ≤6	241	117	117	144	65	482	193
5086-H112	Plate	>6 ≤25	241	110	110	144	62	482	193
5086-H112	Plate	>25 ≤50	241	96	96	144	55	482	193
5086-H32, -H34	Sheet, plate	All	241	131	131	144	75	482	193
5251-H32, H34, -H36 5454-H34	Sheet, plate	All	170	89	89	110	51	344	131
5454-H34	Sheet, plate	All	213	110	110	131	65	427	165
6061-T6‡	Extrusions, drawn tube	All	165	137	137	103	82	344	206
6063-T5, -T6, -T83	Extrusions, drawn tube	All	117	75	75	75	44	234	151
6351-T5, -T6‡	Extrusions	All	165	137	137	103	82	344	206

* Filler wires used are those given in AS 1665

† 0.2 percent offset in 250 mm gauge length across a butt weld

‡ Values when welded with 5183, 5356, or 5556 alloy filler wire