

REGULATIONS AND PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

JULY 2008

VOLUMES 1-9

Lloyd's
Register

A guide to the Rules

and published requirements

Rules and Regulations for the Classification of Wing in Ground Effect Craft

Introduction

The Rules are published as a complete set.

Numbering and Cross-References

A decimal notation system has been adopted throughout. Five sets of digits cover the divisions, i.e. Part, Chapter, Section, sub-Section and paragraph. The textual cross-referencing within the text is as follows, although the right hand digits may be added or omitted depending on the degree of precision required:

- (a) In same Chapter, e.g. see 2.1.3 (i.e. down to paragraph).
- (b) In same Part but different Chapter, e.g. see Ch 3,2.1 (i.e. down to sub-Section).
- (c) In another Part, e.g. see Pt 2, Ch 1,3 (i.e. down to Section).

The cross-referencing for Figures and Tables is as follows:

- (a) In same Chapter, e.g. as shown in Fig. 2.3.5 (i.e. Chapter, Section and Figure Number).
- (b) In same Part but different Chapter, e.g. as shown in Fig. 2.3.5 in Chapter 2.
- (c) In another Part, e.g. see Table 2.7.1 in Pt 3, Ch 2.

Rules updating

The Rules are generally published annually and changed through a system of Notices. Subscribers are forwarded copies of such Notices when the Rules change.

Current changes to Rules that appeared in Notices are shown with a black rule alongside the amended paragraph on the left hand side. A solid black rule indicates amendments and a dotted black rule indicates corrigenda. A dot-dash line indicates changes necessitated by International Conventions, Code of Practice or IACS Unified Requirements.

July 2008

REGULATIONS FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

REGULATIONS

JULY 2008

VOLUME 1

PART 1

Lloyd's
Register

Chapter Contents

Volume 1, Part 1

PART 1 REGULATIONS

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PART 2 PROVISIONS OF CLASSIFICATION, PRINCIPLES AND CRITERIA

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■ Section 1

1.1 Lloyd's Register (hereinafter referred to as 'LR'), which is recognized under the laws of the United Kingdom as a corporate body and a charity established for the benefit of the community, was founded in 1760. It was established for the purpose of producing a faithful and accurate Classification of Merchant Shipping. It now primarily produces Classification Rules.

1.2 Classification services are delivered to clients by a number of other members of the Lloyd's Register Group, including: Lloyd's Register EMEA, Lloyd's Register Asia, Lloyd's Register North America, Inc., and Lloyd's Register Central and South America Limited.

1.3 The Lloyd's Register Group (hereinafter referred to as 'the LR Group') comprises charities, other forms of organisation and non-charitable companies, with the latter supporting the charities in their main goal of enhancing the safety of life and property, at sea, on land and in the air, for the benefit of the public and the environment.

■ Section 2

2.1 LR remains the sole classification society in the LR Group. LR is managed by a corporate trustee Lloyd's Register Trustees Limited (hereinafter referred to as 'LR's trustee').

LR's trustee has:

Appointed a Classification Committee and determined its powers and functions;
Appointed Technical Committees and determined their powers, functions and duties.

2.2 The LR Group has established National and Area Committees in the following:

Countries:

Australia (via Lloyd's Register Asia)
Canada (via Lloyd's Register North America, Inc.)
China (via Lloyd's Register Asia)
Egypt (via Lloyd's Register EMEA)
Federal Republic of Germany
(via Lloyd's Register EMEA)
France (via Lloyd's Register EMEA)
Italy (via Lloyd's Register EMEA)
Japan (via Lloyd's Register Asia)
New Zealand (via Lloyd's Register Asia)
Poland (via Lloyd's Register (Polska) Sp zoo)
Spain (via Lloyd's Register EMEA)
United States of America (via Lloyd's Register North America, Inc.)

Areas:

Benelux (via Lloyd's Register EMEA)
Central America (via Lloyd's Register Central and
South America Ltd)
Nordic Countries (via Lloyd's Register EMEA)
South Asia (via Lloyd's Register Asia)
Asian Shipowners (via Lloyd's Register Asia)
Greece (via Lloyd's Register EMEA)

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Section 3

Section 3

3.1 LR's Technical Committee is at present composed of:

Ex officio members:

• The Chairman of LR	1
• The Chairman of the Classification Committee	1

Nominated by:

• The General Committee of Trustees of LRH	18
• The Royal Institution of Naval Architects	2
• The Institution of Engineers and Shipbuilders in Scotland	2
• The Institute of Marine Engineers	2
• The Institution of Mechanical Engineers	2
• The Shipbuilders' and Shiprepairs' Association	2
• The Short Sea Group of the Chamber of Shipping	1
• The Society of Consulting Marine Engineers and Ship Surveyors	1
• The Institute of Materials	1
• The UK Steel Association	1
• The Honourable Company of Master Mariners	2
• The Institution of Electrical Engineers	1
• Federation of British Electrotechnical and Allied Manufacturers' Associations	1
• The Technical Committee	18
• The Technical Committee (from other countries)	18
• The Institute of Refrigeration	1
• International Oil Companies	2
• Association of European Shipbuilders and Shiprepairs	1
• Greek Shipping Co-operation Committee	1
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3.2 In addition to the foregoing:

- (a) Each National or Area Committee may appoint a representative to attend meetings of the Technical Committee.
- (b) A maximum of five representatives from National Administrations may, with the consent of the Technical Committee, be co-opted to serve on the Technical Committee. Such representatives may also be elected as members of the Technical Committee under one of the categories identified in 3.1.
- (c) Further persons may, with the consent of the Technical Committee, be co-opted to serve on the Technical Committee.

3.3 All elections are subject to confirmation by LR's trustee.

3.4 The function of the Technical Committee is to consider any technical problems connected with LR's business and with the exception of changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies, any proposed alterations in the existing Rules and to frame new Rules for classification as deemed necessary.

3.5 The term of office of the Chairman and of all members of the Technical Committee is five years. Members may serve one additional term of office with the approval of LR's trustee. The term of the Chairman may be extended with the approval of LR's trustee.

3.6 In the case of continuous non-attendance of a member, the Technical Committee may withdraw his/her membership.

3.7 Meetings of the Technical Committee are convened as often and at such times and places as is necessary, but there is to be at least one meeting in each year.

3.8 Any proposal of the Technical Committee involving any alteration in, or addition to, Rules for Classification is referred to LR's Trustee which has agreed to seek the comments of the Lloyd's Register Holding's General Committee of Trustees before adopting the proposal.

3.9 The Technical Committee is empowered to:

- (a) appoint sub-Committees or panels; and
- (b) co-opt to the Technical Committee, or to its sub-Committees or panels, representatives of any organization or industry or private individuals for the purpose of considering any particular problem.

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Sections 4 & 5

■ Section 4

- 4.1 LR's Naval Ship Technical Committee (hereinafter referred to as 'the NSTC') is at present composed of up to 50 members and includes nominees of:
- The Royal Navy and the UK Ministry of Defence;
 - The Defence Evaluation and Research Agency;
 - UK Shipbuilders, Ship Repairers and Defence Industry;
 - Overseas Governments and Governmental Agencies;
 - Overseas Shipbuilders, Ship Repairers and Defence Industries;
 - Various maritime bodies and institutions, nominated by the NSTC;
 - The Chairman of LRH and Chairman of the Classification Committee who are ex officio members.
- 4.2 All elections are subject to confirmation by LR's trustee.
- 4.3 All members of the NSTC are to hold security clearance from their National Authority for the equivalent of NATO CONFIDENTIAL. All material is to be handled in accordance with NATO Regulations or, for non-NATO countries, an approved equivalent. No classified material shall be disclosed to any third party without the consent of the originator.
- 4.4 The term of office of the NSTC Chairman and of all members of the NSTC is five years. Members may serve one additional term of office with the approval of LR's trustee. The term of the Chairman may be extended with the approval of LR's trustee.
- 4.5 In the case of continuous non-attendance of a member, the NSTC may withdraw that person's membership.
- 4.6 The function of the NSTC is to consider technical issues connected with Naval Ship matters and to approve proposals for new Naval Ship Rules, or amendments to existing Naval Ship Rules.
- 4.7 Meetings of the NSTC are convened as necessary but there will be at least one meeting per year.
- 4.8 Following approval by the NSTC, details of new Rules (or amendments) will be submitted to LR's trustee which will seek comments from LRH's General Committee of Trustees before adopting any changes.

■ Section 5

- 5.1 LR has the power to adopt, and publish as deemed necessary, Rules relating to Classification and has (in relation thereto) provided the following:
- (a) Except in the case of a special directive by LR's trustee, no new Regulation or alteration to any existing Regulation relating to classification or to class notations is to be applied to existing ships.
 - (b) Except in the case of a special directive by LR's trustee, or where changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies are concerned, no new Rule or alteration in any existing Rule is to be applied compulsorily after the date on which the contract between the ship builder and shipowner for construction of the ship has been signed, nor within six months of its adoption. The date of 'contract for construction' of a ship is the date on which the contract to build the ship is signed between the prospective shipowner and the ship builder. This date and the construction number (i.e. hull numbers) of all the vessels included in the contract are to be declared by the party applying for the assignment of class to a newbuilding. The date of 'contract for construction' of a series of sister ships, including specified optional ships for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective shipowner and the ship builder. In this section a "series of sister ships" is a series of ships built to the same approved plans for classification purposes, under a single contract for construction. The optional ships will be considered part of the same series of sister ships if the option is exercised not later than 1 year after the contract to build the series was signed. If a contract for construction is later amended to include additional ships or additional options, the date of 'contract for construction' for such ships is the date on which the amendment to the contract is signed between the prospective shipowner and the ship builder. The amendment to the contract is to be considered as a 'new contract'. If a contract for construction is amended to change the ship type, the date of 'contract for construction' of this modified vessel, or vessels, is the date on which the revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder. Where it is desired to use existing approved ship or machinery plans for a new contract, written application is to be made to LR. Sister ships may have minor design alterations provided that such alterations do not affect matters related to classification.
 - (c) That it will, in all cases, consult with LRH's General Committee of Trustees before passing any Rule amendment.
 - (d) All reports of survey are to be made by Surveyors authorised by members of the LR Group to survey and report (hereinafter referred to as 'the Surveyors') according to the form prescribed, and submitted for the consideration of the Classification Committee.

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Sections 5 to 8

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- (e) Information contained in the reports of classification and statutory surveys will be made available to the relevant owner, National Administration, Port State Administration, P&I Club, hull underwriter and, if authorized in writing by that owner, to any other person or organization.
 - (f) Information relating to the status of classification and statutory surveys and suspensions/withdrawals of class together with any associated conditions of class will be made available as required by applicable legislation or court order.
 - (g) A Classification Executive consisting of senior members of LR's Classification Department staff shall carry out whatever duties that may be within the function of the Classification Committee that the Classification Committee assigns to it.
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■ Section 6

6.1 No LR Group employee is permitted under any circumstances, to accept, directly or indirectly, from any person, firm or company, with whom the work of the employee brings the employee into contact, any present, bonus, entertainment or honorarium of any sort whatsoever which is of more than nominal value or which might be construed to exceed customary courtesy extended in accordance with accepted ethical business standards.

■ Section 7

7.1 LR has power to withhold or, if already granted, to suspend or withdraw any class (or to withhold any certificate or report in any other case), in the event of non-payment of any fee to any member of the LR Group.

■ Section 8

8.1 When providing services LR does not assess compliance with any standard other than the applicable LR Rules, international conventions, and other standards agreed in writing.

8.2 In providing services, information or advice, the LR Group does not warrant the accuracy of any information or advice supplied. Except as set out herein, LR will not be liable for any loss, damage or expense sustained by any person and caused by any act, omission, error, negligence or strict liability of any of the LR Group or caused by any inaccuracy in any information or advice given in any way by or on behalf of the LR Group even if held to amount to a breach of warranty. Nevertheless, if the Client uses LR's services or relies on any information or advice given by or on behalf of the LR Group and as a result suffers loss, damage or expense that is proved to have been caused by any negligent act, omission or error of the LR Group or any negligent inaccuracy in information or advice given by or on behalf of the LR Group, then a member of the LR Group will pay compensation to the client for its proved loss up to but not exceeding the amount of the fee (if any) charged for that particular service, information or advice.

8.3 Notwithstanding the previous clause, the LR Group will not be liable for any loss of profit, loss of contract, loss of use or any indirect or consequential loss, damage or expense sustained by any person caused by any act, omission or error or caused by any inaccuracy in any information or advice given in any way by or on behalf of the LR Group even if held to amount to a breach of warranty.

8.4 Any dispute about LR's services is subject to the exclusive jurisdiction of the English courts and will be governed by English law.

Classification Regulations

Volume 1, Part 1, Chapter 2

Section 1

Section

- 1 **Conditions for Classification**
- 2 **Character of Classification and Class notations**
- 3 **Surveys – General**
- 4 **IACS QSCS Audits**

■ Section 1 Conditions for Classification

1.1 General

1.1.1 The *Provisional Rules and Regulations for the Classification of Wing-In-Ground (WIG) Effect Craft*, hereinafter referred to as the Rules, define the conditions for Lloyd's Register (hereinafter referred to as 'LR') classification of WIG effect craft and are applicable to those types of craft that are defined in 1.3.

1.1.2 Before proceeding on a detailed analysis of the craft to verify compliance with the *Provisions of Classification* (see 1.2), three items of information are required to be (i) submitted to LR for preliminary review and, (ii) found to be acceptable to LR.

- (a) Design concept, including operating envelope, see Vol 4, Pt 1, Ch 2.
- (b) Design statement.
- (c) Details of designers, Builders, operators/intended Owners and maintenance crews.

1.1.3 Where a craft complies with the *Provisions of Classification*, the craft will be assigned an appropriate class notation and will continue to be classed so long as compliance with the *Provisions of Classification* is maintained and all associated obligations to LR fulfilled including payment of LR's fees. Craft assigned a class notation will be recorded in the *Register Book*. Classification will be conditional upon compliance with LR's requirements for structures and engineering systems.

1.1.4 The Rules do not, unless stated or implied in the Class notation, provide for special distributions or concentrations of loading associated with the operation of the craft. LR may require additional strengthening to be fitted in any craft which may be subjected to severe stresses due to particular features in the design or operation, or where it is desired to make provision for exceptional loading conditions. In such cases particulars and details of the required loads are to be submitted for consideration.

1.1.5 Compliance with the Rules does not relieve the Design Organisation of its responsibilities for compliance with the specification and the requirements for the overall design and in-service performance of the craft.

1.1.6 In addition to confirming compliance with the Rules, LR will, in conjunction with the Maritime Administration, require to be satisfied that the craft is suitable for the geographical or other limits or conditions of the service requested.

1.1.7 Any requirements of a Maritime Administration for craft design, construction and operation are to be complied with. The requirements are to be declared to LR by the Design Organisation.

1.1.8 Preparations required to permit a craft with a service area restriction specifying some service limitation to undertake duties that take the craft beyond the specified service restriction involving transit, either from place of construction to its service area or from one service area to another, are to be in accordance with arrangements agreed in writing by LR prior to the journey.

1.1.9 Any damage, defect, breakdown or grounding, which affect the Provisions of Classification and the conditions for which classification has been assigned, must be reported to LR without delay.

1.1.10 Flight stability calculations including stall characteristics with support from applicable model testing will be required to comply with defined assessment criteria.

1.1.11 Calculations to determine the effect of hard landing on water will be required to comply with defined assessment criteria.

1.1.12 Fire protection arrangements will be required to comply with specified standard(s).

1.1.13 Damage and intact stability calculations will be required to comply with specified standard(s).

1.1.14 First of type craft will be required to undergo type testing in accordance with a schedule agreed by LR.

1.1.15 Where LR is acting on behalf of a Maritime Administration, any relevant requirements of the Maritime Administration are to be identified and advised to LR in writing.

1.1.16 All submissions made by Builders, Design Organisation or other parties in respect of demonstrating compliance with the Provisions of Classification are to be made in the English language.

1.2 Provisions of Classification

1.2.1 The Provisions of Classification for Wing-In-Ground Effect Craft are the development and world-wide implementation of published Rules and Regulations, which, in conjunction with proper care and conduct on the part of the Owner will provide for:

- (a) The structural strength, buoyancy, controllability and arrangements on board for safe and effective operation of the craft for berthing, airborne, water transit and take off/landing operations.
- (b) The watertight and weathertight integrity of the craft when afloat and airborne.

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Section 1

- (c) The dependability and functioning of engineering systems installed for manoeuvrability and operational requirements of the craft.
- (d) The effectiveness of other defined features and systems that have been built into the craft in order to establish and maintain basic conditions on board whereby appropriate stores, fuels, equipment and personnel can be safely carried whilst in transit and at transit terminals.

1.2.2 Part 2 of this Volume defines the Principles that pertain to the material state of the craft and the methodology by which this is realised and maintained. Criteria illustrating application of the Principles identifies the necessary technical characteristics of the craft and associated processes for assessment.

1.2.3 Volume 2 of the Rules provides the methodology that facilitates compliance with the Principles and Criteria that pertain to the material state of the craft. Craft arrangements are to comply with these Rules or are to be demonstrably equivalent thereto.

1.2.4 The methodology for realising and maintaining a satisfactory material state of the craft is predicated on a lifecycle model. This model identifies the key stages and processes in the development and operation of the craft and thereby serves to facilitate LR's verification that the *Provisions of Classification* have been satisfied.

1.3 Application

1.3.1 LR Classification is only applicable to Type A and Type B WIG effect craft intended for maritime operations. For the purpose of these Rules, WIG effect craft are categorised as:

- (a) **Type A:** A WIG effect craft that is not capable of being flown above its declared ground effect altitude.
- (b) **Type B:** A WIG effect craft that is capable of unsustained flight above its declared ground effect altitude in order to avoid an obstacle or for another purpose.
- (c) **(Type C:** A WIG effect craft that is capable of self-propelled sustained flight above its declared ground effect altitude.)

Type C craft are not within the scope of these Rules.

1.3.2 LR Classification of WIG effect craft is subject to craft operating:

- (a) Within a specified range from a place of refuge.
- (b) Within an area where there will be suitable rescue facilities readily available.
- (c) Within an area where weather forecasts and maintenance facilities are readily available.
- (d) Landing and take off locations having basic meteorological information available, e.g. wind magnitude/ direction and sea states.

1.3.3 Except in the case of a special directive by LR no new Regulation or alteration to any existing Regulation relating to the character of Classification or to Class notations is to be applied to existing craft.

1.3.4 Except in the case of a special directive by LR no new Rule or alteration in any existing Rule materially affecting Classification is to be applied compulsorily within six months of its adoption, nor after final appraisal of the structural plans. Where it is desired to use existing previously appraised plans for a new contract, written application is to be made to LR.

1.4 Interpretation of the Rules

1.4.1 The interpretation of the Rules is the sole responsibility, and at the sole discretion, of LR.

1.4.2 For the purpose of the Rules and Class notations, the definitions in Vol 3, Pt 1, Ch 1 will apply.

1.5 Owner's and Operator's responsibilities

1.5.1 The Owner and Operator is responsible for proper care and conduct in operating and maintaining the craft within the scope of classification requirements relating to the *Provisions of Classification* for a defined operational envelope.

1.5.2 The Owner and Operator is responsible for ensuring that the craft is operated with no more than the maximum number of passengers and/or no more than the maximum payload for which the craft has been designed. The Owner and Operator is also responsible for ensuring that passengers and cargo are arranged as defined in the craft operating manual.

1.5.3 The Owner and Operator are to give LR's Surveyors every facility and necessary access to carry out their survey duties. The Owner and Operator should familiarise themselves with the relevant LR Rules and, where appropriate, arrange that all sub-contractors, suppliers of components, materials or equipment do the same.

1.5.4 Where the Owner and Operator identifies standards, conducts audits or issues statutory certificates, and the responsibility has not been delegated to LR, LR is to be advised of the identity of the Maritime Administration and is to be furnished with all appropriate standards and is to have full access to the Maritime Administration at all times.

1.5.5 Evident malfunctions or defects that may affect the *Provisions of Classification* are to be reported in writing to LR and the Design Organisation for assessment as soon as is reasonably practical.

1.6 Design Organisation's responsibilities

1.6.1 The Design Organisation is to have design competence for all aspects of craft design. Details of experience, qualifications and authorising organisations are to be advised to LR at the preliminary review stage.

1.6.2 The Design Organisation is responsible for establishing the technical capability of the craft with a defined design statement.

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1.6.3 The Design Organisation is responsible for co-ordination of all matters relating to demonstrating compliance with LR Rules and statutory requirements of the Maritime Administration throughout the life of the craft.

1.6.4 Compliance with the Rules does not relieve the Design Organisation of its responsibilities for compliance with the specification and the requirements for the overall design and in-service performance of the craft.

1.7 Builder's responsibilities

1.7.1 The Builder is to have the capability, organisation and facilities for manufacture, construction, installation and testing of the craft and its installed systems in accordance with the Design Organisation's, Maritime Administration's and LR's requirements.

1.7.2 The survey procedures undertaken by LR when providing services are on the basis of periodical visits involving both monitoring and direct survey. LR's Surveyors will not be in continual attendance. As construction, outfitting and refitting are continuous processes, the Builder has the overall responsibility to his client to ensure and document that the requirements of the Rules, appraised plans and any agreed amendments made by the attending LR Surveyors, have been complied with.

1.8 Verification by LR

1.8.1 It is the responsibility of the party seeking LR Classification to ensure that adequate and timely evidence is available to demonstrate that the *Provisions of Classification* have been satisfied.

1.8.2 The method of verification employed by LR will depend on the lifecycle stage and partly on the nature of the evidence provided, but in general will be limited to:

- (a) Document appraisal (of necessary information submitted to LR, e.g. concept definition, design and development plans, design statement, etc.)
- (b) Audit of records (at place of design and construction, e.g. Quality Schemes, Technical Construction Files, test records, etc.)
- (c) Survey under construction (installation, testing and harbour manoeuvring/flight trials).

1.9 Documentation

1.9.1 Construction documentation required by the Rules includes a design submission where required by the Rules and it may include:

- (a) Design plans and plans register.
- (b) Calculations and technical reports relating to strength, operational stability, stall characteristics, manoeuvrability, buoyancy, performance and system design.
- (c) Development tests and trials programmes reports.
- (d) Weight and Centre of Gravity calculations and reports.
- (e) Technical and Process Specifications.
- (f) Technical Construction File.
- (g) Design deviations.

- (h) Defect investigation reports.
- (i) Modifications.
- (k) Testing and trials documents and trials register.

1.9.2 Construction documentation required by the Rules includes plans and information necessary for the construction of the craft and equipment and systems that will enable LR to verify that the product and processes are in accordance with the Rules and to confirm that the *Provisions of Classification* have been satisfied.

1.9.3 It is acknowledged that the Owner may wish to retain the originals of Certificates issued by LR, however, WIG effect craft are required to carry the following documentation available so that the attending surveyor is able to carry out his duties (certified copies of Certificates are acceptable):

- (a) Endorsable Certificate of Class.
- (b) Maintenance Logbook.
- (c) C11(W) – Record of watertight and weathertight closing arrangements.
- (d) Stability information and damage control plan and the following as applicable.
- (e) Pollution Prevention Certificate.
- (f) Register of Flexible Hoses.
- (g) Maintenance Register.
- (h) Lifting Appliance Certificates.
- (i) Payload Certificate.
- (k) Safety Equipment record of equipment.
- (l) Fire safety plan.
- (m) Record of engine running hours.

1.10 Pre-Contract and Through-Life advice

1.10.1 LR will provide advice on the potential Conditions of Classification for a WIG craft, so that the Owner may specify design, construction and operation parameters that satisfy the requirements for Classification whilst being consistent with the intended application. LR will also advise on Modifications, Alterations and Additions and other matters that may affect the Conditions for Classification, and to liaise with the Owner on any other matter of concern for the purpose of assisting the Owner in establishing the parameters applicable to the craft's operational needs.

■ Section 2

Character of Classification and Class notations

2.1 General

2.1.1 This section provides details of the character symbols for Class notations that identify the Class assigned to a WIG effect craft.

2.1.2 The character symbols identify whether the craft is built under LR Class and survey, the suitability for marine flight operations, the provision of anchor handling equipment and the Rules used for the construction of the craft. The character symbols are described in 2.2.

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2.1.3 The Class notations also detail the particular features of the craft which are required to be considered in order to verify where additional attention has been taken in particular aspects of the design of the craft. These Class notations are subject to an appraisal process in order to satisfy Classification requirements.

2.1.4 Optional notations detail particular features of the craft that may not form part of the craft appraisal process required for Classification. Typically they may include details of enhanced safety/environmental aspects of the craft.

2.1.5 The following are examples of character symbols, and Class notations as they would appear in the *Register Book*:

*100A1 WIG MCH, Type A Passenger,
WTL0.5/WEL2.0, WSC10

2.2 Character symbols

2.2.1 All WIG effect craft, when Classed, will be assigned a character of Classification comprising one or more character symbols as applicable.

2.2.2 A full list of character symbols for which a WIG effect craft may be eligible and are to be assigned for classification purposes is as follows:

- * This distinguishing mark will be assigned, at the time of Classing, to new WIG effect craft constructed under LR's survey requirements, in compliance with the Rules, and to the satisfaction of LR.
- 100** This character figure will be assigned to all WIG effect craft considered suitable for maritime operations.
- A** This character letter will be assigned to all WIG effect craft which have been built or accepted into Class in accordance with LR's Rules and Regulations, and which are maintained in good and efficient condition.
- 1** This character figure will be assigned to:
 - (a) WIG effect craft having on board, in good and efficient condition, anchoring and/or mooring equipment in accordance with the Rules.
 - (b) WIG effect craft Classed for a specific service, having on board, in good and efficient condition, anchoring and/or mooring equipment appraised by LR as suitable and sufficient for the particular service.
- E** This character letter will be assigned to WIG effect craft on which LR has agreed that anchoring and mooring equipment need not be fitted in view of their particular service.
- MCH** This character will be assigned when the machinery for craft movement and other essential engineering systems have been constructed, installed and tested under LR's survey requirements, in compliance with the Rules, and to the satisfaction of LR.

2.2.3 For Classification purposes either the character figure **1** or the character letter **E** is to be assigned.

2.2.4 In cases where the anchoring and/or mooring equipment is found to be seriously deficient in quality or quantity, the Class of the craft will be liable to be withheld.

2.3 Class notations

2.3.1 When considered necessary by LR, or when requested by an Owner and agreed by LR, a Class notation will be appended to the character of Classification assigned to the craft. The Class notation may consist of any of the following:

- (a) WIG effect craft type notation, see 2.4.
- (b) Wave height Take-Off/Landing notation, see 2.5.
- (c) Wind speed Take-Off/Landing notation, see 2.6.
- (d) Other notations, see 2.7.

2.4 WIG craft type notations

2.4.1 The craft type notation will be recorded in the appropriate *Register Book* indicating the primary purpose for which the craft has been designed and constructed.

2.4.2 Craft type notations for which a WIG effect craft may be eligible are:

Type A This notation will be assigned to Type A category craft, as defined in Section 1.3.1(a)

Type B This notation will be assigned to Type B category craft, as defined in Section 1.3.1(b).

2.4.3 The craft type notation will be followed by a description that indicates the operational role for which the craft is designed and the craft configuration form type, if of unusual form. The following are examples of the description of the craft's role:

- Passenger carrier.
- Cargo carrier.
- Passenger/Cargo combination carrier.

2.5 Wave height Take-Off/Landing notations

2.5.1 All WIG effect craft Classed under the Rules will be assigned a wave height take-off/landing notation **WTL/WEL** followed by a number, e.g. **WTL0.5/WEL2.0**. The figures refer to the significant wave height defined in Vol 3, Pt 1, Ch 1 for Sea States. **WTL** indicates the acceptable wave height sea conditions for normal take-off and landing and **WEL** the maximum extreme wave height conditions for landing without causing damage to the craft.

2.6 Wind speed Take-Off/Landing notations

2.6.1 All WIG effect craft Classed under these Rules will be assigned a wind speed take-off/landing notation **WSC** followed by a number, e.g. **WSC10**. The figures refer to the maximum cross wind conditions for normal take-off in terms of knots.

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2.7 Craft operational design notations

2.7.1 WIG effect craft may have operational design features that may be recognised by class notations:

MOD Notation for craft that have moveable modular units for passenger and/or cargo operations installed.

■ Section 3 Surveys – General

3.1 New construction – Plan Appraisal

3.1.1 When it is intended to build a WIG effect craft for Classification with LR, and subject to 1.1.2, constructional plans and all particulars relevant to the craft structure, equipment and machinery, as detailed in the Rules, are to be submitted for appraisal by LR before the work is commenced. Any additional plans submitted will not be subject to appraisal without separate agreement. Any subsequent modifications or additions to the scantlings, arrangements or equipment shown on the LR appraised plans are also to be submitted for appraisal, under separate arrangements.

3.1.2 Where the proposed construction of any part of the craft structure or machinery is of novel design, or involves the use of unusual material, assembly or construction technique, or where experience has not sufficiently justified the principle or mode of application involved, special tests or examinations before and during service may be required.

3.1.3 Where the Design Organisation has imposed a limit on the life of a WIG effect craft structure or system/equipment/component arrangement, details are to be included in the submission for appraisal.

3.1.4 The materials used in the construction of craft structures and machinery intended for Classification are to be of good quality and free from defects and are to comply with the requirements of the Rules. Material is to be manufactured by works approved by LR or by works that have quality standards for the products that are acceptable to LR. Alternatively, tests to the satisfaction of LR will be required to demonstrate the suitability of the material.

3.1.5 Copies of the latest LR appraised plans, essential certificates and records, required loading and other instruction manuals are to be readily available for use when required by LR's Surveyors and are thereafter required to be kept in a form that is readily accessible.

3.2 New construction – Survey

3.2.1 The Surveyor is to be satisfied that the capability, organisation and facilities of the Builder are such that acceptable standards can be obtained for the construction of the craft and machinery.

3.2.2 In addition to 3.1.3, the structural construction of craft is to be controlled by a documented quality control system covering the Builder's management, organisation and relevant construction processes and inspection procedures.

3.2.3 New WIG effect craft intended for Classification are to be built under LR Survey. The Surveyors are to be satisfied that the materials, workmanship and arrangements are in accordance with the Rules. Any items found not to be in accordance with the Rules or the appraised plans, or any material, workmanship or arrangements found so to be, are to be rectified or concession sought from LR.

3.2.4 For compliance with 3.2.3, LR will consider methods of survey and inspection for structural construction of craft which formally include procedures involving the Builder's management, organisation and quality systems.

3.2.5 New craft intended for LR Classification are to have had satisfactory testing and trials to the satisfaction of LR Surveyors.

3.2.6 The Surveyor will prepare a report C11(W) Record of craft watertight, weathertight arrangements and closing appliances.

3.2.7 The date of completion of the Survey during construction of craft built under LR's supervision will normally be taken as the date of build to be entered in the *Register Book*. If the period between completion and commissioning is, for any reason, unduly prolonged, the dates of completion and commissioning may be separately indicated in the *Register Book*.

3.2.8 When a craft, upon completion, is not immediately commissioned but is laid-up for a period, LR, upon application by the Owner, prior to the craft proceeding into use, will direct an examination to be made by LR's Surveyors which may include a survey on dry land. If, as the result of such survey, the craft structure and machinery is reported in all respects free from deterioration, in compliance with the Rules, the subsequent Special Survey will date from the time of such examination.

3.3 Existing craft – Survey

3.3.1 **Classification of craft not built under survey.** The requirements of LR for the Classification of WIG effect craft that have not been built under LR's Survey are indicated in Ch 3.10. Special consideration will be given to craft transferring Class to LR from another recognised Classification Society that have appropriate WIG effect craft Rules.

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3.3.2 Reclassification. When reclassification or Class reinstatement is desired for a WIG effect craft for which the Class previously assigned by LR has been withdrawn or suspended, LR will direct that a survey, appropriate to the age of the craft and the circumstances of the case, be carried out by LR's Surveyors. If, at such survey, the craft is found or placed in a good and efficient condition in accordance with the Rules and Regulations, LR will be prepared to consider reinstatement of the original Class or the assignment of such other Class as may be deemed necessary. The date of any reclassification will be recorded in the Supplement to the *Register Book*.

3.3.3 Existing craft intended for LR Classification are to have had satisfactory testing and trials to the satisfaction of LR Surveyors.

3.3.4 LR reserves the right to decline an application for Classification or reclassification where the prior history or condition of the craft indicates this to be appropriate.

3.4 Damages, repairs and alterations

3.4.1 All repairs to the craft structure, equipment and machinery which may be required in order that a craft may retain Class (see 1.1.9) are to be carried out to the satisfaction of LR's Surveyors. When repairs are effected at a location where the services of a Surveyor to LR are not available, the repairs are to be surveyed by LR Surveyors at the earliest opportunity thereafter.

3.4.2 When at any survey the Surveyor considers repairs to be immediately necessary, either as a result of damage, or wear and tear, they are to communicate their recommendations at once to the Owner, or his representative. When such recommendations are not complied with, immediate notification is to be given to LR's London Office by the Surveyor.

3.4.3 When at any survey it is found that any damage, defect, or breakdown (see 1.1.9) is of such a nature that it does not require immediate permanent repair, but is sufficiently serious to require rectification by a prescribed date in order to maintain Class, a suitable Condition of Class is to be imposed by the Surveyors and recommended for consideration by LR's Classification Committee. This condition may be designated as an operational defect, under the Owners and Operator's control, but LR needs to be kept advised as to proposed actions. The technical impact of any deficiency on the operational needs of the craft must be considered by the Surveyor in liaison with the Owner/Operator/Maritime Administration/Design Organisation before a decision is made with regard to corrective action.

3.4.4 If a craft which is Classed with LR is to leave harbour limits or protected waters under tow, the Owner is to advise LR of the circumstances prior to her departure.

3.4.5 If a craft which is Classed with LR is taken in tow whilst at sea, the Owner is to advise LR of the circumstances at the first practicable opportunity.

3.4.6 Plans and particulars of any proposed alterations to scantlings and arrangements of the craft structure, machinery and engineering systems that have been previously appraised/accepted by LR are to be examined and found acceptable by the Design Organisation before submission to LR. Such alterations are to be carried out to the satisfaction of LR's Surveyors.

3.5 Existing craft – Periodical Surveys

NOTE

See Ch 3.1.1.1 for frequency of surveys based on engine running hours.

3.5.1 Annual Surveys are to be held on all craft within three months, before or after each anniversary of the completion, commissioning or Special Survey. The date of the last Annual Survey will be recorded in the Supplement to the *Register Book*.

3.5.2 The Owner is to notify LR whenever a craft can be examined on a slipway. The maximum period between Slipway Surveys is not to exceed [two] years, and should coincide with the Special Survey. Consideration may be given at the discretion of LR to any special circumstances justifying an extension of this interval. A Slipway Survey is considered to coincide with the Special Survey when held within the six months prior to the due date of the Special Survey.

3.5.3 The date of the last Slipway Survey will be recorded in the Supplement to the *Register Book*.

3.5.4 All craft Classed with LR are also to be subjected to Special Surveys. These Surveys become due at [two]-yearly intervals, the first one [two] years from the date of build or date of Special Survey for Classification as recorded in the *Register Book*, and thereafter [two] years from the date recorded in the Supplement to the *Register Book* for the previous Special Survey. Consideration can be given, at the discretion of LR, to any exceptional circumstances justifying an extension of craft Classification to a maximum of three months beyond the [second] year. If an extension is agreed the next period of craft Classification will start from the due date of the Special Survey before the extension was granted.

3.5.5 Special surveys may be commenced at the [first] Annual Survey or anniversary, as appropriate, after completion, or previous Special Survey, and be progressed during the succeeding year with a view to completion by the due date of the Special Survey.

3.5.6 Special Surveys which are commenced prior to their due date are not to extend over a period greater than twelve months, except with the prior approval of LR's London office.

3.5.7 Craft that have satisfactorily passed a Special Survey will have a record entered in the Supplement to the *Register Book* indicating the date. Where the Special Survey is completed more than three months before the due date, the new record of Special Survey will be the final date of survey. In all other cases the date recorded will be the (second) anniversary.

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3.5.8 At the request of an Owner, LR may agree that the Special Survey of the craft structure be carried out on the Continuous Survey basis, all compartments of the craft being opened for survey and testing, in rotation, with an interval of (two) years between consecutive examinations of each part. In general, approximately one (half) of the Special Survey is to be completed each year and all the requirements of the particular craft Special Survey must be completed at the end of the [two] year cycle. Craft which have satisfactorily completed the cycle will have a record entered in the Supplement to the *Register Book* indicating the date of completion which will not be later than (two) years from the last assigned date of Complete Survey of the craft.

3.5.9 If any examination during Continuous Survey reveals defects, further parts are to be opened up and examined as considered necessary by the Surveyor, and the defects are to be made good to his satisfaction.

3.5.10 Alternative arrangements for survey will be considered by LR upon request. Requests from the Owner, at build or during service, need to be supported by adequate evidence of satisfactory performance before survey arrangements can be changed. These requests could be based upon Reliability Centred Maintenance or other forms of planned maintenance.

3.5.11 Complete Surveys of machinery and engineering systems become due at [two] yearly intervals, the first one, (two) years from the date of build or date of first classification as recorded in the *Register Book*, and thereafter (two) years from the date recorded in the Supplement to the *Register Book* for the previous Complete Survey. Consideration can be given at the discretion of LR to any exceptional circumstances justifying an extension of machinery class to a maximum of three months beyond the (second) year. If an extension is agreed to, the next period of machinery class will start from the due date of Complete Survey of machinery before extension was granted. Surveys which are commenced prior to their due date are not to extend over a period greater than 12 months, except with the prior approval of LR. On satisfactory completion of a survey, an appropriate record will be made in the Supplement to the *Register Book*. Where the complete survey is completed more than three months before the due date, the new date recorded will be the final date of survey. In all other cases the date recorded will be the (second) anniversary, see also 3.5.17.

3.5.12 Upon application by an Owner, LR may agree to the extension of the survey requirements for mobility category machinery, which, by the nature of the craft's normal service, do not attain the number of running hours recommended by the machinery manufacturer for major overhauls within the survey periods given in 3.5.11.

3.5.13 When, at the request of an Owner, it has been agreed by LR that the Complete Survey of the machinery may be carried out on the Continuous Survey basis, the various items of machinery are to be opened for survey in rotation, so far as is practicable, to ensure that the interval between consecutive examinations of each item will not exceed (two) years. In general, approximately one-(half) of the machinery is to be examined each year. A record indicating the date of satisfactory completion of the Continuous Survey cycle will be made in the Supplement to the *Register Book*, see also 3.5.17.

3.5.14 If any examination during Continuous Survey reveals defects, further parts are to be opened up and examined as considered necessary by the Surveyor, and the defects are to be made good to their satisfaction.

3.5.15 Upon application by an Owner, LR may agree to an arrangement whereby, subject to certain conditions, some items of machinery may be examined by the qualified engineering personnel responsible to the Owners/Operators of the craft, followed by a limited confirmatory survey and annual audit of maintenance and repairs records. Particulars of this arrangement may be obtained from LR's London Office. Where an approved planned maintenance scheme is in operation the confirmatory surveys of machinery may be held at annual intervals, at which time the records will be checked and the operation of the scheme verified. Particulars of this arrangement may also be obtained from LR's London Office.

3.5.16 Where condition monitoring techniques are applied, LR, upon application by the Owner, will be prepared to amend applicable Periodical Survey requirements where details of the equipment are submitted and found satisfactory. Where machinery installations are accepted for this method of survey, it will be a requirement that an Annual Survey be held, at which time monitored records will be analysed and the machinery examined under working conditions. An acceptable lubricating oil trend analysis programme may be required as part of the condition monitoring procedures.

3.5.17 Where machinery installations include a 'lifed item' (an item of machinery, component or equipment necessary for the safety and reliability of craft mobility equipment or other essential auxiliary engineering system) which is subject to an overhaul and/or ultimate life limitation, i.e. a period (expressed in operating hours or cycles and/or calendar time) at which the item is to be overhauled or scrapped, the life limitations are to be observed and take precedence over the periodicity of 3.5.11 and 3.5.13 where the life limitation is less than the survey periodicity. Examples may include rolling element bearings, gas turbines, turbo-chargers, flexible couplings, clutch units, belt drives, flexible pipes and gear box elements. The manufacturer's maintenance and service instructions are to be strictly observed. Where machinery installations include a 'lifed item' details will be noted in the classification records as a Memorandum (Machinery) record.

3.5.18 Where propulsion and auxiliary machinery is maintained using an approved 'upkeep by exchange' system, the craft operators are to maintain records of all exchanges carried out. At the first convenient opportunity after exchange, a running test on load is to be witnessed by a LR Surveyor (this may typically be the time of annual survey). Where prime movers are maintained by an 'upkeep by exchange' system, details will be noted in the classification records as a Memorandum (Machinery) record.

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3.6 Certificates

3.6.1 When survey reports have been received from the Surveyors and appraised by LR, a Certificate of First Entry of Classification, signed by the Chairman or Chairman of the Sub-Committee of Classification, will be issued to the Builders or Owners.

3.6.2 A Certificate of Class subject to endorsement for Annual and Special Surveys, as appropriate, will also be issued to the Owners and a certified copy placed on board. A new certificate will be issued when no further endorsement spaces remain.

3.6.3 LR's Surveyors will issue provisional (interim) certificates, after survey, to enable a craft Classed with LR to proceed on marine flight operations provided that it is in a satisfactory condition. Such certificates will embody the Surveyors' recommendations for continuance of Class, and are subject to confirmation by LR.

3.7 Notice of surveys

3.7.1 It is the responsibility of the Owners to ensure that all surveys necessary for the maintenance of Class are carried out at the proper time.

3.7.2 LR will give timely notice to an Owner about forthcoming surveys by means of a letter or a quarterly computer print-out. The omission of such notice, however, does not absolve the Owner from his responsibility to comply with LR's survey requirements for maintenance of Class.

3.7.3 The Owner will give timely notice of the availability of craft for survey. Should a craft not be available at the due time, the agreement for postponement of the survey should be sought from LR.

3.8 Withdrawal/Suspension of Class

3.8.1 When the Class of a craft, for which the Regulations as regards surveys on the craft structure, equipment and machinery have been complied with, is withdrawn by LR in consequence of a request from the Owner, the notation 'Class withdrawn at Owner's request' (with date) will be assigned.

3.8.2 When the Regulations as regards surveys on the craft structure, equipment and machinery have not been complied with and the craft is thereby not entitled to retain Class, the Class will be suspended or withdrawn after consultation with the Owner and a corresponding notation will be assigned.

3.8.3 Class will be automatically suspended and the Certificate of Class will become invalid if the Annual or Special Survey is not completed within three months of the due date of survey.

3.8.4 LR will consider requirements from the Owner to continue Class where exceptional circumstances curtail surveys being held.

3.8.5 When in accordance with 3.4.2 and 3.4.3 a Condition of Class is imposed, this will be assigned a due date for completion and the ship's Class will be subject to a suspension procedure if the condition of Class is not dealt with, or postponed by agreement, by the due date.

3.8.6 When it is found, from the reported condition of the structure, equipment or machinery of a craft, that an Owner has failed to comply with paragraphs 1.1.9, 3.4.1 or 3.4.5, the Class will be liable to be suspended or withdrawn, at the discretion of LR, and a corresponding notation assigned.

3.8.7 When any craft proceeds on maritime flight operations with a payload greater than that appraised, the Class will be liable to be withdrawn or suspended for the voyage.

3.8.8 In all instances of Class withdrawal or suspension, the assigned notation, with date of application, will initially appear in the Supplement to the *Register Book* and subsequently in the *Register Book*. In cases where Class has been suspended by LR and it becomes apparent that the Owners are no longer interested in retaining LR's Class, the notation will be amended to withdrawn status. After Class withdrawn status has been established in the *Register Book* for one year, it will be automatically amended to 'Classed LR until' (with date).

3.8.9 For reclassification and reinstatement of Class, see 3.3.2 and 3.3.3.

3.9 Survey of craft out of commission

3.9.1 The Classification requirements for laid up craft will be specially considered. Surveys for continuation of Class may be required at the request of the Owners and the discretion of LR.

3.10 Appeal from Surveyor's recommendation

3.10.1 If the recommendations of LR's Surveyors are considered in any case to be unnecessary or unreasonable, appeal may be made to LR, who may direct a Special Examination to be held.

■ Section 4 IACS QSCS Audits

4.1 Audit of Surveys

4.1.1 The surveys required by the Regulations may be subject to audit in accordance with the requirements of the International Association of Classification Societies Quality System Certification Scheme.

Section

- 1 **General**
- 2 **Annual Surveys – Craft structures, machinery and optional requirements**
- 3 **Slipway Surveys**
- 4 **Special Survey – Craft structure requirements**
- 5 **Special Survey – General machinery requirements**
- 6 **Gas turbines – Detailed requirements**
- 7 **Oil engines – Detailed requirements**
- 8 **Electrical equipment**
- 9 **Propeller shafts and propellers**
- 10 **Classification of craft not built under survey**

■ **Section 1
General**

1.1 Frequency of surveys

1.1.1 The requirements of this Chapter are applicable to the Periodical Surveys set out in Ch 2,3.5. Except as amended at the discretion of the Committee, the periods between such surveys are as follows:

- (a) Annual Surveys – annually within three months of the anniversary date or 2400 hours engine running time, whichever occurs first.
- (b) Slipway Surveys – at (two)-yearly intervals concurrent with special survey or 4800 hours engine running time, whichever occurs first.
- (c) Special Surveys at (two)-yearly intervals or 4800 hours engine running time, whichever occurs first.
For alternative arrangements, see also Ch 2,3.5.8, 3.5.9, 3.5.10 and 1.1.4.
- (d) Complete Surveys of machinery at (two)-yearly intervals or 4800 hours running time, whichever occurs first, see Ch 2,3.5.11.
For alternative arrangements, see also Ch 2,3.5.12 to 3.5.16.

1.1.2 When it has been agreed that the complete survey of the craft structure and machinery may be carried out on the Continuous Survey basis, all compartments of the craft and all items of machinery are to be opened for survey in rotation to ensure that the interval between consecutive examinations of each part will not exceed (two) years, see Ch 2,3.5.8 and 3.5.13.

1.2 Surveys for damage or alterations

1.2.1 At any time when a craft is undergoing alterations or damage repairs, any exposed parts of the structure normally difficult to access are to be specially examined, e.g. if any part of the mobility category machinery or auxiliary machinery or fittings is removed for any reason, the craft structure in way is to be carefully examined, or when any sheathing is removed, the structure in way is to be examined before replacement.

1.2.2 This examination should normally be carried out by a Surveyor, and the Owners should give as much notice as possible to Lloyd's Register (hereinafter referred to as 'LR') so that arrangements can be made for attendance. In the absence of a Surveyor, a suitably trained, qualified and authorised person is to carry out suitable examination and report the findings to LR as soon as practicable.

1.3 Unscheduled surveys

1.3.1 In the event that LR has cause to believe that its Rules and Regulations are not being complied with, LR reserves the right to perform unscheduled surveys.

1.3.2 In the event of significant damage or defect affecting any craft, LR reserves the right to perform unscheduled surveys of the craft structure of other similar craft classed by LR and deemed to be vulnerable.

1.4 Documentation

1.4.1 The Owner may wish to retain the originals of certificates issued by LR, however, WIG effect craft are required to carry the following documentation on board so that the attending Surveyor is able to carry out his duties (certified copies of certificates are acceptable):

- (a) Endorsable Certificate of Class.
- (b) Maintenance Logbook.
- (c) C11(W) – Record of watertight and weathertight closing arrangements.
- (d) Stability information and damage control plan and the following as applicable.
- (e) Pollution Prevention Certificate.
- (f) Register of Flexible Hoses.
- (g) Maintenance Register.
- (h) Lifting Appliances Certificate.
- (i) Payload Certificate.
- (k) Safety Equipment record.
- (l) Fire safety plan.
- (m) Record of engine running hours.

1.5 Definitions

1.5.1 **Spaces** are all separate compartments within the craft. Integral tanks are considered to be separate spaces.

1.5.2 **Representative spaces** are those which may be expected to reflect the condition of other spaces of similar type and service. When selecting representative spaces account should be taken of the service and repair history onboard and identifiable critical areas.

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1.5.3 **Critical areas** are locations which are known to be vulnerable to damage, buckling and/or fatigue cracking. These will be identified by the Design Organisation and at the LR plan appraisal stage.

1.5.4 **Suspect areas** are locations within the craft structure vulnerable to increased likelihood of structural deterioration and may include:

- (a) For aluminium alloy structures, areas of fatigue cracking and areas in the vicinity of bimetallic connections.
- (b) For composite structures, areas subject to impact damage or fatigue as a result of cyclic loading.

1.5.5 **Dangerous spaces** are those spaces where flammable gas or vapour and/or combustible dust may accumulate.

1.5.6 **Protective coatings** for aluminium and composite structures in WIG effect craft are to be hard coatings. Other coating systems (e.g. soft coating) may be considered acceptable as alternatives provided they are applied and properly maintained in compliance with the manufacturer's specification.

1.5.7 **A prompt and thorough repair** is a permanent repair carried out in accordance with an approved procedure and completed at the time of survey to the satisfaction of the Surveyor, therein removing the need for the imposition of any associated condition of class.

1.6 Repairs

1.6.1 Any damage in association with wastage over the allowable limit (including buckling, grooving, detachment or fracture) or extensive wastage over the allowable limits, which in the opinion of the Surveyor, will affect the watertight or weathertight integrity or the flight capability, is to be promptly and thoroughly repaired. Areas to be considered include:

- Shell frames, wings, tail fins, their end attachments or adjacent structure.
- Bottom structure and any plating.
- Watertight or oiltight bulkheads.
- Openings into the craft.

For locations where adequate repair facilities are not available, consideration may be given to allow the craft to proceed directly to a repair facility. This may require discharging the cargo and/or temporary repairs for the intended voyage.

1.6.2 Additionally, when a survey results in the identification of substantial corrosion or structural defects, either of which, in the opinion of the Surveyor, will impair the craft's fitness for continued services, remedial measures are to be implemented before the craft continues in service.

■ Section 2

Annual Surveys – Craft structures, machinery and optional requirements

2.1 General

2.1.1 Annual Surveys are to be held concurrently with any relevant maintenance period and in consultation with the Owner with regard to operational needs.

2.1.2 At Annual Surveys, the Surveyor is to examine the craft structure, so far as necessary and practicable, in order to be satisfied as to its general condition.

2.1.3 Particular attention is to be paid to critical areas.

2.2 Craft structure

2.2.1 The Surveyor is to be satisfied regarding:

- (a) The efficient condition of doors, openings, ventilation arrangements, windows, guard rails, life-lines, ladders, pressure relief plates and other openings, together with all closing appliances and any flame screens.
- (b) The efficient operating condition of mechanically operated covers including stowage, fit, securing, locking, sealing and operational testing of hydraulic power components.
- (c) The efficient condition of scuppers and sanitary discharges (so far as is practicable); valves on discharge lines (so far as is practicable) and their controls.
- (d) All wing and airfoil root connections and surfaces subject to impact and/or abrasion.

2.2.2 Any doors, lifts or ramps which form part of the watertight integrity of the craft structure are to be examined to ensure that no alterations have been made to the appraised arrangements. Mechanically operated lifts or doors are to be tested for tightness to confirm the satisfactory condition of securing and sealing arrangements; drainage channels; operating mechanisms.

2.2.3 The anchoring and mooring equipment is to be examined so far as is practicable.

2.2.4 The watertight doors/closures in watertight bulkheads and any indicators or alarms are to be examined and operationally tested locally and where applicable remotely. Other watertight bulkhead penetrations, are to be examined so far as is practicable.

2.2.5 The Surveyor is to be satisfied regarding the draught marks on the craft's side.

2.2.6 The Surveyor is to be satisfied that no alterations have been made to the craft that affect stability and strength.

2.2.7 The Surveyor is to check the C11(W) (record of watertight and weathertight closing arrangements) on board the vessel and verify with the actual arrangement on board.

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2.2.8 The first Annual Survey should include a review of the year's service, taking into account feedback from the Owner. Special attention needs to be given to areas of the structure where defects have become apparent. It is important that this information is fed back to the Design Organisation and the Builder for follow-on craft.

2.2.9 The anchor is to be partially lowered and raised using the capstan/windlass where fitted.

2.2.10 Internal spaces, machinery compartments, bilges, etc., are to be generally examined. These spaces should include all suspect areas, see 1.5.4.

2.3 Machinery

2.3.1 The Surveyor is to examine the machinery compartments with particular attention being given to the craft movement machinery system(s), auxiliary machinery and to the existence of any fire and explosion hazards. Sea suctions and overboard discharges are to be generally examined.

2.3.2 The Surveyor is to examine and test in operation all craft directional control arrangements including their associated equipment and control systems.

2.3.3 The bilge pumping and dewatering systems and any bilge wells, including operation of extended spindles and level alarms, where fitted, are to be examined so far as is practicable. Satisfactory operation of the bilge pumps and dewatering equipment is to be proven, including access to all bilge areas.

2.3.4 Piping systems containing oil fuel, lubricating oil or other flammable liquids are to be examined and operated as far as practicable, with particular attention being paid to tightness, fire precaution arrangements, flexible hoses and sounding devices. The Register of Flexible Hoses is to be examined and the records of any hose changes inspected.

2.3.5 The Surveyor is to be satisfied regarding the condition of non-metallic joints in piping systems which penetrate the craft structure, where both the penetration and the non-metallic joint are below the waterline.

2.3.6 The Surveyor is to be satisfied regarding the following items associated with machinery installations.

- (a) Locking arrangements for locked valves and inspection covers.
- (b) Integrity of guards for rotating machinery.
- (c) Lighting arrangements, particularly at control and instrumentation panels.
- (d) Operation of automatic start-up of pumps and systems for essential systems where they are required by the Rules.
- (e) Condition of machinery securing and mounting arrangements.
- (f) The condition of bulkhead glands.

2.3.7 Pressure vessels and their accessories and associated fittings including safety devices, foundations, controls, relieving gear and gauges, are to be generally examined. Surveyors should confirm that Periodical Surveys of pressure vessels have been carried out as required by the Rules and that the safety devices have been tested.

2.3.8 The craft Maintenance Logbook and records of 'upkeep by exchange' are to be audited annually by the LR Surveyor.

2.3.9 Spaces deemed dangerous and compartments adjacent to such spaces are to be examined for the following:

- (a) Defective and non-certified safe electrical equipment.
- (b) Improperly installed, defective and dead-end wiring.
- (c) Effective operation of any ventilation arrangements.
- (d) Adequacy of arrangements for battery stowage and protection.

An electrical insulation resistance test of the circuits terminating in, or passing through dangerous spaces is to be carried out.

2.3.10 Bonding straps for the control of static electricity and earthing arrangements are to be examined where fitted.

2.3.11 An examination of automation equipment is to be carried out. Satisfactory operation of safety devices and control systems is to be verified.

2.4 Electrical and control engineering

2.4.1 The electrical equipment and cabling forming the main and emergency electrical installations are to be generally examined under operating conditions as far as is practicable. Particular checks are to be made on the integrity of electrical enclosures and cleanliness of switchboards and bus bars. The satisfactory operation of the main and emergency sources of power and electrical services essential for safety in an emergency is to be verified; where the sources of power are automatically controlled they should be tested in the automatic mode.

2.4.2 Electrical generators are to be examined under working conditions with a representative load to verify compliance with the Rules.

■ **Section 3**
Slipway Surveys

3.1 General

3.1.1 At Slipway Surveys the Surveyor is to examine the craft and machinery so far as necessary and practicable, in order to be satisfied as to the general condition.

Periodical Survey Regulations

Volume 1, Part 1, Chapter 3

Sections 3 & 4

3.2 Slipway Surveys

3.2.1 Where a craft is on a slipway it is to be placed on blocks of sufficient height, and proper staging is to be erected as may be necessary for the examination of the outside of the craft structure, undercarriage arrangements and underwater fittings. The outside surface of the craft structure is to be cleaned as may be required by the Surveyor.

3.2.2 Attention is to be given to parts of the external craft structure particularly liable to structural deterioration from causes such as high stresses, chafing and lying on the ground, and to areas of structural discontinuity.

3.2.3 The following parts of the external hull structure are to be specially examined:

- (a) For aluminium alloy craft structures attention is to be given to areas adjacent to any bimetallic connections at skin fittings, etc.
- (b) For composite craft structure the gelcoat or other protective finish is to be examined for surface cracking, blistering, abrasion or other damage which may impair the efficiency of the protection to the underlying laminate.

3.2.4 The sea connections and overboard discharge valves, their attachments to the craft structure and the gratings, at the sea inlets are to be examined. References must be made to the C11(W) document carried on board.

3.2.5 The rudder and aileron bearings and pintles are to be examined. Where considered necessary by the Surveyor, rudders and ailerons are to be removed for examination. The securing of rudder and aileron couplings is to be confirmed.

3.2.6 Special attention is to be given to the craft structure in way of underwater fittings such as thrusters and their attachments.

3.2.7 Where applicable, attention is to be given to the connection and/or intersection of the wing structures to the main craft structure.

3.2.8 When chain cables are ranged, the anchors and cables are to be examined by the Surveyor.

3.2.9 The Surveyor is to verify all draught markings as applicable at the time of slipway survey.

3.2.10 Where harbour manoeuvring thruster units are fitted, the arrangements are to be examined as far as practicable. The work is to be carried out in accordance with maintenance manuals and the manufacturer's recommendations for servicing and renewals observed.

■ Section 4

Special Survey – Craft structure requirements

4.1 General

4.1.1 The survey is to be of sufficient extent to ensure that the craft structure and related equipment is in satisfactory condition and is fit for its intended purpose, subject to proper maintenance and operation and to Periodical Surveys being carried out as required by the Regulations.

4.1.2 The requirements of Section 2 are to be complied with so far as applicable.

4.1.3 A Slipway Survey in accordance with the requirements of 3.2 is to be carried out as part of the Special Survey.

4.2 Preparation

4.2.1 The preparation for survey is to be of sufficient extent to facilitate an examination to ascertain any excessive corrosion, erosion, deformation, fractures, damages and other structural deterioration.

4.2.2 Where the craft is opened out by removal of linings, etc., and defects are found, further opening out may be required in order that the Surveyor can confirm the full extent of the defects.

4.3 Examination and testing – General

4.3.1 All spaces within the craft structure including integral tanks are to be examined.

4.3.2 Where repairs are effected to the craft structure or bulkheads, any integral tanks in way are to be tested to the Surveyor's satisfaction on completion of these repairs.

4.3.3 All superstructures are to be examined.

4.3.4 Attention is to be given to the corners of openings and other discontinuities in the craft structure.

4.3.5 The anchor(s) are to be examined, the chain cables are to be ranged and they are to be examined together with the chain locker and clench plate. If any length of chain cable is found to be reduced in mean diameter at its most worn part by 12 per cent or more from its nominal diameter, it is to be renewed. Cables are to be changed 'end-for-end'. Anchor handling arrangements are to be examined.

4.3.6 Representative fastenings on the craft structure are to be tested to ascertain their soundness and may require to be drawn for examination at the discretion of the Surveyor.

4.3.7 The structure in way of bimetallic connections, e.g. to aluminium alloy structures, is to be examined and the efficiency of the insulation arrangements confirmed.

Periodical Survey Regulations

Volume 1, Part 1, Chapter 3

Sections 4, 5 & 6

4.3.8 For composite construction craft the following are also applicable:

- (a) The bonded attachments of frames, floors, bulkheads, structural joinery, engine bearers, and integral tank boundaries are to be examined.
- (b) The craft structure to wing joints, together with any joints between the craft structure and other fittings are to be examined.
- (c) The structure in way of the bolted attachment of fittings including guardrail stanchions, capstan/windlass, fendering, mooring bitts, etc is to be examined.

5.2.6 The valves, cocks and strainers of the bilge and salvage system are to be opened up as considered necessary by the Surveyor and together with pipes, are to be examined and tested under working conditions. The oil fuel, lubricating oil, hydraulic oil and cooling water systems together with all pressure filters, heaters and coolers used for essential services, are to be opened up and examined or tested, as considered necessary by the Surveyor. All safety devices for the foregoing items are to be examined.

5.2.7 Fuel tanks that do not form part of the craft's structure are to be examined, and if considered necessary by the Surveyor, they are to be tested to the pressure specified for new tanks. The tanks need not be examined internally at the first survey if they are found satisfactory on external inspection. The mountings, fittings and remote controls of all oil fuel tanks are to be examined, so far as is practicable.

5.2.8 Where remote and/or automatic controls are fitted for essential machinery, they are to be tested under trial conditions, where applicable, to demonstrate that they are in good working order and enable effective control.

5.2.9 In addition to the above, detailed requirements for gas turbines, oil engines and electrical installations are given in Sections 6, 7 and 8 respectively. In certain instances, upon application by the Owner or where indicated by the maker's servicing recommendations, LR will give consideration to the circumstances where deviation from these detailed requirements is warranted, taking account of design, appropriate indicating equipment (e.g. vibration indicators) and operational records.

5.2.10 Where machinery installations include a 'lifed item' the requirements of Ch 2.3.5.17 are applicable.

■ Section 5

Special Survey – General machinery requirements

5.1 Annual and Slipway Survey

5.1.1 For Annual and Slipway Surveys, see Sections 2, 3 and 4.

5.2 Complete Survey

5.2.1 While the craft is on a slipway, any openings to the sea in the machinery compartments, together with the valves, cocks and the fastenings with which these are connected to the craft structure are to be examined.

5.2.2 All shafts (except propeller shafts, for which special arrangements are detailed in Section 9), and all bearings are to be examined. The lower halves of bearings need not be exposed if alignment and wear are found to be acceptable.

5.2.3 An examination is to be made of all reduction gears complete with all wheels, pinions, shafts, bearings and gear teeth, thrust bearings and incorporated brake and clutch arrangements where fitted.

5.2.4 The following auxiliaries and components are also to be examined:

- (a) Auxiliary engines, auxiliary air compressors with their intercoolers, filters and/or oil separators and safety devices, and all pumps and components used for essential services.
- (b) Directional control equipment and machinery.
- (c) Capstan/windlass and associated driving equipment, where fitted.
- (d) The holding down bolts, chocks of all engines, gearcases, thrust blocks and intermediate shaft bearings.

5.2.5 All air receivers for essential services, together with their mountings, valves and safety devices, are to be cleaned internally and examined internally and externally. If internal examination of the air receivers is not practicable, they are to be tested hydraulically to 1,3 times the working pressure.

■ Section 6

Gas turbines – Detailed requirements

6.1 Complete Survey

6.1.1 The relevant requirements of Section 5 are to be complied with.

6.1.2 Impellers or blading, rotors and casings of the air compressors, the combustion chambers, burners, intercoolers, heat exchangers, gas and air piping and fittings, starting and reversing arrangements are to be examined.

6.1.3 The operation of gas turbines is to be tested under working conditions. Initial starting arrangements are to be tested.

Periodical Survey Regulations

Volume 1, Part 1, Chapter 3

Sections 7, 8 & 9

■ Section 7

Oil engines – Detailed requirements

7.1 Complete Survey

7.1.1 The relevant requirements of Section 5 are to be complied with.

7.1.2 The following parts are to be opened out and examined as applicable:

Cylinders, covers, valves and valve gear, pistons and piston rods, crossheads, guides, connecting rods and crankshafts and all bearings, crankcases, bedplates, entablatures, crankcase door fastenings and explosion relief devices, scavenge relief devices, scavenge pumps, scavenge blowers, superchargers and their associated coolers, air compressors and their intercoolers, filters and/or separators and safety devices, fuel pumps and fittings, camshaft drives and balancer units, vibration dampers or detuners, flexible couplings and clutches, reverse gears, attached pumps and cooling arrangements.

7.1.3 The operation of engines is to be tested under working conditions. Initial starting arrangements are to be tested.

■ Section 8

Electrical equipment

8.1 Annual Surveys

8.1.1 The relevant requirements of 2.3 and those in 2.4 are to be complied with as far as applicable.

8.2 Complete Surveys

8.2.1 An electrical insulation resistance test is to be made on the electrical equipment and cables. The installation may be sub-divided, or equipment which may be damaged disconnected, for the purpose of this test.

8.2.2 The fittings on the main and emergency switchboards, section boards and distribution boards are to be examined and over-current protective devices and fuses inspected to verify that they provide suitable protection for their respective circuits.

8.2.3 Generator circuit-breakers are to be tested, so far as practicable, to verify that protective devices including preference tripping relays, if fitted, operate satisfactorily.

8.2.4 The electric cables and their securing arrangements are to be examined, so far as is practicable, without undue disturbance of fixtures or casings unless opening up is considered necessary as a result of observation or of the tests required by 8.2.1. The Surveyor is also to be satisfied regarding the condition of glands at watertight and gastight bulkheads.

8.2.5 The generator prime movers are to be surveyed as required by Sections 6 and 7 and the governing of the engines tested. The motors concerned with essential services together with associated control and switch gear are to be examined and if considered necessary, are to be operated, so far as is practicable, under working conditions. All generators are to be examined and are to be operated under working conditions, though not necessarily under full load or simultaneously.

8.2.6 The emergency sources of electrical power, where fitted, together with their automatic arrangements and associated circuits are to be tested under load.

8.2.7 Emergency lighting, transitional emergency lighting, supplementary emergency lighting, general emergency alarm and public address systems are to be tested as far as practicable.

8.2.8 An examination of the electrical equipment in dangerous spaces which may contain flammable gas or vapour and/or combustible dust is to be made to ensure that the integrity of the safe type electrical equipment has not been impaired owing to corrosion, missing bolts, etc., and that there is not an excessive build-up of dust on or in dust protected electrical equipment. Cable runs are to be examined for sheath and armouring defects, where practicable, and to ensure that the means of supporting the cables are in good order. Tests are to be carried out to demonstrate the effectiveness of bonding straps for the control of static electricity. Alarms and interlocks associated with pressurised equipment or spaces are to be tested for correct operation.

■ Section 9

Propeller shafts and propellers

9.1 Frequency of surveys

9.1.1 Shafts with keyed or keyless or solid flange propeller attachments are to be surveyed at intervals of [two] years.

9.1.2 Propellers are to be surveyed at the same intervals as the propeller shaft.

9.1.3 Propellers for harbour manoeuvring purposes are to be surveyed at intervals not exceeding [two] years.

9.1.4 Thruster assisted mooring and shafting arrangements are to be surveyed at intervals not exceeding [two] years.

Periodical Survey Regulations**Volume 1, Part 1, Chapter 3**

Sections 9 & 10

9.2 Complete Surveys

9.2.1 All propeller shafts are to be opened up for examination by LR's Surveyors at the intervals prescribed in 9.1.1. The after end of the cylindrical part of the shaft and forward one third of the shaft cone, or fillet of the flange, is to be examined by a magnetic particle crack detection method. In the case of a keyed propeller attachment at least the forward one third of the shaft cone is to be examined with the key removed. Bearings, oil glands, propellers and fastenings are to be examined. Controllable pitch propellers where fitted are to be opened up and the working parts examined, together with the control gear.

9.2.2 Directional propellers are to be dismantled for examination of the propellers, shafts, gearing, control, electrical and monitoring equipment.

■ **Section 10** **Classification of craft not built under survey**

10.1 General

10.1.1 When classification is desired for a craft not built under the supervision of LR's Surveyors, application is to be made in writing.

10.1.2 Periodical Surveys of such craft, when classed, are subsequently to be held as in the case of craft built under survey.

10.1.3 Where classification is desired for a craft that is classed by another recognised Society, special consideration will be given to the scope of the survey.

10.1.4 The information required by Ch 2,1.1.2 is to be submitted for review and found acceptable to LR before proceeding with submission of the plans and details required by 10.2 and 10.3.

10.1.5 Information that demonstrates that LR's *Provisions of Classification* have been addressed and are complied with are to be submitted for consideration.

10.1.6 Unless specifically required by 10.3, plans of machinery, electrical and control engineering arrangements are not required to be submitted for appraisal.

10.2 Craft structure, arrangements and equipment

10.2.1 Plans showing the main scantlings and arrangements of the actual craft together with any proposed alterations are to be submitted for appraisal.

10.2.2 Particulars of the process of manufacture and the testing of the material of construction are to be supplied.

10.2.3 Details of any limits on the life of any structures are to be submitted for information.

10.2.4 The full requirements of Section 4 are to be carried out as applicable.

10.2.5 During the survey, the Surveyors are to satisfy themselves regarding the workmanship and verify the appraised scantlings and arrangements. Full particulars of the anchors, chain cables and equipment are to be submitted.

10.2.6 When the full survey requirements indicated in 10.2.4 and 10.2.5 cannot be completed at one time, LR may consider granting an interim record for a limited period. The conditions regarding the completion of the survey will depend on the merit of each particular case, which should be submitted for consideration.

10.3 Machinery, electrical and control engineering

10.3.1 To facilitate the acceptance and survey, plans of the following items (plans of piping, electrical and control systems are to be diagrammatic), together with the particulars of the materials used in the construction of the transmission systems, air receivers and important forgings are to be furnished:

- (a) Piping system arrangements (Design Organisation's and Builder's plan), together with a Register of Flexible Hoses installed in the craft.
- (b) Bilge, dewatering and oil fuel piping arrangements.
- (c) Arrangement of oil fuel pipes and fittings at fuel tanks.
- (d) Arrangement of oil fuel piping in connection with oil engines and gas turbines.
- (e) Oil fuel filling and transfer systems.
- (f) Oil fuel tanks not forming part of the craft structure.
- (g) Air receivers.
- (h) Propeller and drive shafting.
- (i) Clutch and reversing gear with methods of control.
- (k) Reduction gearing.
- (l) Propeller.
- (m) Electrical circuits.
- (n) Details of batteries together with their installation and compartment ventilation arrangements.
- (o) Arrangement of compressed air systems for main and auxiliary services.
- (p) Arrangement of lubricating oil, hydraulic oil and other systems containing flammable liquids.
- (q) Arrangements of cooling water systems for main and auxiliary services.
- (r) Directional control system and control system arrangements together with manufacturer, model and rating information.
- (s) Craft movement engine details including manufacturer, model and rating information.
- (t) Undercarriage arrangements.
- (u) Details of any "lifed" or "upkeep by exchange" items installed within Mobility and Craft Function category systems.
- (v) Electrical generator engine details including manufacturer, model and rating information.
- (w) Control and monitoring systems covering:
 - Fire alarm system.
 - Instrumentation list.
 - Plans for systematic maintenance and function testing.
 - Test schedule.

- (x) Copy of the Maintenance Logbook for Mobility category systems.

LR Surveyors are to be satisfied that the arrangements comply with the Rules and the *Provisions of Classification*.

10.3.2 Plans additional to those detailed in 10.3.1 are not to be submitted unless the machinery is of a novel or special character affecting classification.

10.3.3 Where remote and/or automatic controls are fitted to craft movement machinery and essential auxiliaries, a description of the scheme is to be submitted for appraisal.

10.3.4 For new craft and craft which have been in service less than two years, calculations of the torsional vibration characteristics of the craft movement machinery are to be submitted for consideration, as required for craft constructed under Special Survey. For older craft the circumstances will be specially considered in relation to their service record and type of machinery installed. Where calculations are not submitted, LR may require that the machinery certificate be endorsed to this effect. When desired by the Owner, the calculations and investigation of the torsional vibration characteristics of the machinery may be carried out by LR upon special request.

10.3.5 The machinery, compressed air pipes and hydraulic actuating systems are to be examined as required at Complete Surveys. Working pressures are to be determined from the actual scantlings in accordance with the Rules.

10.3.6 Each propeller shaft is to be examined.

10.3.7 The bilge, dewatering and oil fuel arrangements are to be examined.

10.3.8 The electrical equipment is to be examined as required at Complete Surveys.

10.3.9 The whole of the machinery, including essential controls, is to be tested under working conditions to the Surveyor's satisfaction.

10.3.10 Relevant reports are to be prepared by the Surveyors.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

PROVISIONS OF CLASSIFICATION, PRINCIPLES AND CRITERIA

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Chapter Contents

Volume 1, Part 2

PART 1 REGULATIONS

PART 2 PROVISIONS OF CLASSIFICATION, PRINCIPLES AND CRITERIA

Chapter 1 Provisions and Principles of Classification

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Section

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**■ Section 1
General**

1.1 Scope

1.1.1 This Part of the Rules identifies the classification principles and associated development criteria for craft systems and structure to enable the *Provisions of Classification* to be addressed. It identifies objectives to be achieved so as to attain the safety and dependability required for Classification and provides a framework for assessment against the technical requirements of Volumes 4, 5, 6, 7, 8 and 9 of these Rules.

1.1.2 The classification principles address the Provisions of Classification of WIG effect craft that provide for:

- (a) The structural strength, buoyancy, controllability and arrangements on board for safe and effective operation of the craft for berthing, airborne, water transit and take off/landing operations.
- (b) The watertight and weathertight integrity of the craft when afloat and airborne.
- (c) The dependability and functioning of engineering systems installed for manoeuvrability and operational requirements of the craft.
- (d) The effectiveness of other defined features and systems that have been built into the craft in order to establish and maintain basic conditions on-board whereby appropriate stores, fuels, equipment and personnel can be safely carried whilst in transit and at transit terminals.

1.1.3 There are eleven Principles of Classification for WIG effect craft:

- (a) Assessment.
- (b) Concept.
- (c) Design, construction and installation.
- (d) Operability.
- (e) Structural arrangements.
- (f) Flight characteristics.
- (g) Systems dependability.
- (h) Trials and testing.
- (i) Operation.
- (k) Modifications and repair.
- (l) Decommissioning.

1.1.4 For each Principle of Classification there are a number of criteria that are required to be addressed for Lloyd's Register (hereinafter referred to as 'LR') Classification of WIG effect craft.

**■ Section 2
Assessment**

2.1 Principle

2.1.1 The craft development process as defined in these Rules, is to be conducted in a transparent manner so as to facilitate assessment by LR.

2.2 Criteria

2.2.1 The assessment process is to ensure conformity of structures and engineering systems to the *Provisions of Classification* by assessing such items against LR's *Rules and Regulations for Classification of Wing-in-Ground Effect Craft*, or their equivalent, and specified Codes or Standards.

2.2.2 The assessment process of structures and engineering systems is to extend over the whole life cycle of the craft.

2.2.3 For the purposes of Classification, the craft is to be considered as an assembly of structures and engineering systems categorised as either:

- (a) structure and arrangements;
- (b) mobility;
- (c) craft function; or
- (d) ancillary.

(The assessment requirements for each of the categories are detailed in Vol 2, Part 1.)

2.2.4 All systems are to be assembled from acceptable components, equipment and materials. (Details of materials and equipment acceptance are contained in Vol 8, Part 2.)

■ **Section 3 Concept**

3.1 Principle

3.1.1 The crafts' development and operations are to be based on a defined and agreed concept.

3.2 Criteria

3.2.1 Prior to detailed consideration of WIG effect craft for classification, a concept statement addressing the following topics is to be acceptable to LR.

- (a) Operating envelope, see Vol 4, Pt 1, Ch 2.
- (b) Stakeholders affecting craft development and their level of interest.
- (c) Intended Maritime Administration (permission to operate).

3.2.2 An overall design statement for the craft that addresses all anticipated modes of operation is to be acceptable to LR and is to contain the following information.

- (a) Capability and functionality of the craft under defined operating conditions.
- (b) Dimensions of craft.
- (c) Materials to be used in the crafts' construction.
- (d) Power and configuration of propulsion, directional control and auxiliary machinery.
- (e) Codes and Standards to be applied.
- (f) Safety assessment methodology.
- (g) Through life inspection requirements.

3.2.3 The concept of lifecycle development from design to disposal of the craft with details of designers, Builders, Operators/intended Owners and maintenance personnel are to be declared to LR.

3.2.4 Where the Maritime Administration has defined human factors that interface with the Provisions of Classification, a concept of operation that includes roles and responsibilities is to be declared to LR.

■ **Section 4 Design, construction and installation**

4.1 Principle

4.1.1 The design, construction and installation processes are to ensure the safety of passengers and all responsible crew and the protection of the environment, both during normal operation and foreseeable failure conditions.

4.2 General criteria

4.2.1 The craft is to be designed, constructed and installed in accordance with the requirements of the relevant parts of the Rules.

4.2.2 In general materials used in the craft are to be suitable for the intended purpose and are not to have hazardous effects on personnel or the environment. Where materials are considered hazardous, their use is to be regulated so that the possibility of a hazardous situation occurring is as low as is reasonably practicable.

4.2.3 Materials are to be approved and manufactured and tested in accordance with a standard acceptable to LR.

4.2.4 The machinery, associated piping systems and fittings relating to main machinery and auxiliary power units are to be of a design and construction suitable for the service for which they are intended and are to be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards. The design is to have regard to materials used in construction, the purpose for which the equipment is intended, the working conditions to which it will be subjected and the environmental conditions on board the craft.

4.3 Design criteria

4.3.1 The craft is to be designed to provide for the safety of passengers and responsible crew provided that the craft is maintained in accordance with the *Provisions of Classification*.

4.3.2 Systems are to be designed for the defined operating conditions that are to include static and dynamic loads.

4.3.3 The mechanical properties of materials used for the design of the craft and equipment are to be realistic and achievable.

4.4 Construction criteria

4.4.1 Construction is to be in accordance with plans appraised by LR in accordance with the requirements of the relevant parts of the Rules.

4.4.2 The place of construction is to have suitable facilities for the construction and testing of structures, engineering equipment and systems.

4.4.3 Equipment, structures and systems are to be constructed from materials having mechanical properties as specified in the design stage.

4.5 Installation criteria

4.5.1 Installation is to be in accordance with plans and procedures appraised by LR in accordance with the requirements of the relevant parts of the Rules.

4.5.2 Equipment and systems are to be installed so that they will not become loose during all normal operating conditions and foreseeable failure conditions.

■ **Section 5** **Operability**

5.1 Principle

5.1.1 The craft's systems and structure are to be integrated in such a manner so as to support safe and effective task performance.

5.2 General criteria

5.2.1 Provision is to be made to facilitate cleaning, inspection, and maintenance necessary for the safe operation of the craft.

5.3 System integration criteria

5.3.1 System integration is to be managed by a single designated party, and is to be carried out in accordance with a defined procedure identifying the roles, responsibilities and requirements of all parties involved.

5.3.2 Where the integration involves control functions for essential services or safety functions, including fire, passenger, crew, and craft safety, a Failure Mode and Effects Analysis (FMEA) is to be carried out in accordance with the applicable section in the Rules. The FMEA is to demonstrate that the integrated system will 'fail-safe', and that essential services in operation will not be lost or degraded beyond acceptable performance criteria where specified by these Rules.

5.4 Ergonomics and human interaction criteria

5.4.1 Where information is required by the Rules or by a Maritime Administration requirement to be continuously displayed, the system configuration is to be such that the information may be viewed without manual intervention, e.g. the selection of a particular screen page or mode of operation.

5.4.2 All systems requiring manual intervention for their correct function, are to be so designed that the controls are:

- (a) clearly visible and appropriately marked;
- (b) positioned and adjusted so that they are easily accessible and operable by the operator;
- (c) located outside of danger zones;
- (d) their action is consistent with their effect;
- (e) are to be able to withstand foreseeable strain; and
- (f) positioned so that they cannot be accidentally activated where their activation could cause additional risk.

5.4.3 Under the intended conditions of use, the discomfort, fatigue and psychological stress faced by the Operator is to be reduced to as low as reasonably practicable taking ergonomic principles into account.

5.4.4 The design of the craft systems and structure is to take account of the constraints to which the Operator is subject as a result of the necessary or foreseeable use of personal protection equipment (such as footwear, gloves, etc.)

5.5 Safety arrangement criteria

5.5.1 The craft is to be fitted with integral lighting suitable for all defined operations where inadequate lighting may introduce a hazard.

5.5.2 The design and layout of the crew compartment is to be such as to:

- (a) permit operating crew members to perform the duties for which they are responsible in a correct manner without unreasonable difficulty, fatigue or concentration; and
- (b) minimise the likelihood of injury to operating crew members in both normal and emergency conditions.

5.5.3 Passenger, crew and other personnel compartments are to be designed and arranged so as to minimise the risk of injury to occupants during normal and emergency conditions. The arrangements are to be such that:

- (a) all occupants can leave and enter the craft safely under normal condition; and
- (b) all occupants can leave the craft with an acceptably low risk of injury in foreseeable emergency conditions.

■ **Section 6** **Structure and arrangements**

6.1 Principle

6.1.1 The structure and arrangements are to provide for safe and effective operation of the craft for all defined operating conditions and foreseeable failure conditions.

6.2 Criteria

6.2.1 The structure is to be capable of tolerating all loads that can act on the craft under all normal operating conditions in which the craft is permitted to operate, without such loading resulting in unacceptable deformation or diminution of watertightness or interfering with the safe operation of the craft.

6.2.2 The structure is to be arranged such that in the event of damage from striking an airborne or floating object, the structural and watertight integrity is not compromised sufficiently to cause dangerous degradation of stability, mobility or flying capabilities, so far as is reasonably practicable.

6.2.3 The craft structure is to have sufficient strength to support the craft whilst on its dry land landing gear or temporary supports.

6.2.4 The craft is to be designed so that the flying and handling qualities are such that they provide adequate task performance and flight safety in all normal operation and foreseeable failure conditions.

■ **Section 7** **Flight characteristics**

7.1 Principle

7.1.1 The flying and handling qualities of the craft are to be such to provide safe and effective task performance in all phases of flight.

7.2 Criteria

7.2.1 The craft systems and structure are to be designed so that the aerodynamic characteristics and weight distribution are such that the craft will be stable in all directions during all normal operating and foreseeable failure conditions. For the purposes of these Rules, wing stall may be considered as a stable condition, so long as the craft can be safely recovered from such a situation.

7.2.2 The craft is to be statically stable and any dynamic instabilities are to be such that they do not cause an unacceptable increase in pilot work-load or otherwise endanger the craft.

7.2.3 The control forces applied by the pilot to maintain course in all normal operating conditions are not to cause undue fatigue to the pilot.

7.2.4 The craft's flying qualities are not to be rated less than Level 1 on the flying quality scale by appropriately qualified independent WIG effect craft test pilots, in normal operation. Level 2 may be acceptable in degraded performance conditions.

7.2.5 The craft is to be capable of asymmetric flight in so far as the failure of one propulsion device will not render the craft inoperable.

7.2.6 Craft operation is not to be endangered by the loss of craft aerodynamic characteristics, particular attention is to be paid to wing stall and wing lift in all normal operating conditions.

8.2.2 In the event of failure of any part of an integrated engineering system, only those functions that depend on the failed part are to be affected.

8.2.3 All categories of engineering systems are to 'fail-safe' when failure occurs.

8.2.4 The probability of total failure of all systems is to be extremely remote when the craft is operating normally, i.e. excluding emergency situations such as collision or major fire.

8.2.5 All categories of engineering systems and equipment are to be such that they can be maintained and repaired effectively and safely.

8.2.6 All categories of engineering systems are to be provided with effective means of operation and control for all intended functions under all normal and abnormal operational modes.

8.2.7 All categories of engineering systems are to be such that the risk of fire and environmental pollution is at a level that is as low as reasonably practicable.

8.2.8 All categories of engineering systems are to be such that a single failure will not result in the flooding of a watertight compartment that is intended to be dry.

8.2.9 All engineering systems are to be arranged so that a single failure in equipment or loss of an associated sub-system will not result in failure, contamination or degradation of another system leading to a dangerous situation or loss of a Mobility or Craft Function category system.

8.2.10 Mobility and Craft Function category systems are to be such that key functions can be maintained in the event of a single failure in an operational sub-system.

8.2.11 Mobility and Craft Function category engineering systems are to be provided with means to monitor and identify potential failures that could lead to catastrophic hazardous or major consequences and to notify users of degradation in systems performance that could lead to failures.

8.2.12 Mobility and Craft Function category engineering systems are to be provided with means to detect failures that could lead to catastrophic, hazardous or major consequences and to notify users of such failures.

8.2.13 Mobility category engineering systems are to be such that the service can be maintained in the event of a single failure of an item of operational equipment.

8.2.14 Means are to be provided so that Mobility category engineering systems can retain normal operation status when one of the essential auxiliary systems becomes inoperative.

8.2.15 Means are to be provided so that Mobility category engineering systems can be brought into normal operation from the dead craft condition without external aid.

■ **Section 8** **Systems dependability**

8.1 Principle

8.1.1 Engineering systems are to be dependable and function so that hazards to personnel and the environment are as low as reasonably practicable.

8.2 Criteria

8.2.1 The dependability of machinery and equipment installed in the craft is to be adequate for its intended purpose.

8.2.16 All categories of engineering system are to be such they are physically stable under the foreseen operating conditions (taking climatic conditions into account) for use without risk of overturning, falling or unexpected movement.

■ **Section 9** **Trials and testing**

9.1 Principle

9.1.1 The trials and testing are to demonstrate that the craft satisfies the *Provisions of Classification*.

9.2 Criteria

9.2.1 Trials and tests are to be conducted in accordance with LR requirements.

9.2.2 A trials schedule is to be agreed between the Builder, Owner and LR and is to address LR Rule requirements detailed in Volume 7.

9.2.3 The trials are to be conducted in agreed operating conditions and are to demonstrate the functional capability of materials, structure and engineering systems, throughout the life of the craft, to ensure the *Provisions of Classification* are maintained.

9.2.4 Satisfactory operation and load testing is to be witnessed by LR where required by the Rules.

9.2.5 The trials records are to be documented with sufficient detail to ascertain that the specified functional requirements of the craft and engineering systems have been satisfied. The records are to be available to enable any future trials to identify any significant degradation after in-service operation.

9.2.6 Where a FMEA report has identified the need to prove the conclusions, testing and trials are to be carried out as necessary to investigate the following:

- (a) the effect of a specific component failure;
- (b) the effectiveness of automatic/manual isolation systems; and
- (c) the behaviour of any interlocks that may inhibit operation of essential services.

9.2.7 All parts of machinery, hydraulic, pneumatic and other systems and their associated fittings which are under internal pressure are to be subjected to appropriate tests including a pressure test before being put into service for the first time.

9.2.8 Verification and validation activities are to be employed throughout the life of the craft to ensure compliance with the *Provisions of Classification*.

9.2.9 Documentation is to be available to demonstrate that the *Provisions of Classification* can be satisfied effectively.

■ **Section 10** **Operation**

10.1 Principle

10.1.1 Structures, engineering systems and equipment are to be operated and maintained such that the *Provisions of Classification* are maintained at all times throughout the life of the craft.

10.2 Criteria

10.2.1 Persons authorised to conduct activities that may affect the *Provisions of Classification* are to be competent and qualified to carry out those responsibilities.

10.2.2 The quantity and quality of information presented to the Operator is to be managed to assist situational awareness in all operating conditions. Excessive or ambiguous information that may adversely affect the operator's ability to reason or act correctly is to be avoided, but information needed for corrective or emergency actions is not to be suppressed or obscured in satisfying this requirement.

10.2.3 Operating and maintenance manuals and other relevant documentation for the craft and all structures and engineering systems are to be provided on board and are to include the following information:

- (a) Particulars of structural arrangements and engineering systems.
- (b) Operating instructions for all engineering systems.
- (c) Maintenance instructions for structures, engineering systems and equipment.
- (d) The operating conditions for the craft covering climate, operating hours, flight altitude, sea states, wind speeds, inclinations, number of passengers, weight distribution of cargo (C of G constraints) etc, thrust, acceleration, collision loads and anchoring, towing and berthing arrangements. The arrangements for passengers and cargoes are also to be included.
- (e) Procedures for the use of anchoring, towing and berthing equipment.

■ **Section 11** **Modifications and repairs**

11.1 Principle

11.1.1 All modifications are to be carried out so that the *Provisions of Classification* are not affected.

11.2 Criteria

11.2.1 Any alterations to LR appraised plans are to be appraised by LR.

11.2.2 Modifications and repairs that may affect the *Provisions of Classification* are to be appraised by LR.

11.2.3 Surveyable items not complying with appraised plans or LR requirements are to be replaced or rectified.

■ **Section 12**
De-commissioning

12.1 Principle

12.1.1 The craft and its equipment are to be disposed of in such a manner so that any adverse environmental effects are kept to a level acceptable to the appropriate Administration.

12.2 Criteria

12.2.1 The proposed means of disposal of structures and equipment is to be agreed by the Maritime Administration and advised to LR.

12.2.2 Instruction manuals are to include details of materials that require arrangements for disposal to mitigate hazards to personnel and the environment.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

ASSESSMENT REQUIREMENTS AND APPRAISAL PROCESSES

JULY 2008

VOLUME 2

PART 1

Lloyd's
Register

Chapter Contents

Volume 2, Part 1

PART 1 ASSESSMENT REQUIREMENTS AND APPRAISAL PROCESS

Chapter 1 General Requirements and Assessment Process

2 Appraisal and Acceptance

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General Requirements and Assessment Process

Volume 2, Part 1, Chapter 1

Sections 1, 2 & 3

Section

- 1 **Scope**
- 2 **Information required**
- 3 **Assessment**

■ Section 1 Scope

1.1 General

1.1.1 The requirements of this Volume are applicable only to craft structures and engineering systems.

1.1.2 The requirements recognise the processes whereby all equipment, components and materials used in the construction and assembly of systems and structures are approved/accepted for classification in accordance with the applicable requirements of Volume 8 of these Rules.

1.1.3 This Part details the assessment requirements for systems in terms of the category to which they belong. Table 1.3.1 details the requirements for each system category at the different stages of the craft life cycle.

■ Section 2 Information required

2.1 Submissions to Lloyd's Register

2.1.1 All units and formula used for submission of plans and information to Lloyd's Register (hereinafter referred to as 'LR') are to be in SI units.

2.1.2 It is the responsibility of the Builder to ensure that the information required is prepared and submitted.

2.1.3 Individual Chapters list plans to be submitted for specific structural arrangements, machinery and electrical systems or components.

2.1.4 At least three copies of plans and specifications as required by the Rules are to be submitted before commencement of manufacture.

2.1.5 Plans are to indicate clearly the major scantlings and materials of construction. Any design alteration to a plan formally appraised by LR is to be recorded as a new drawing revision and is to be resubmitted for appraisal, indicating clearly the alteration.

2.1.6 A Failure Modes and Effects Analysis (FMEA) is to be performed and submitted for all safety critical systems as identified in the relevant sections of the Rules.

■ Section 3 Assessment

3.1 Assessment process

3.1.1 For the purpose of classification a WIG effect craft structure or engineering system is defined as any arrangement or system that forms part of the structure or is installed in the craft where such an arrangement or system comprises one or more components. For the purpose of determining the appropriate assessment process for the arrangements, structure or engineering system in WIG effect craft, there are four categories as specified in Vol 1, Pt 2, Ch 1,2.1:

- (a) Structure and Arrangements.
- (b) Mobility.
- (c) Craft Function.
- (d) Ancillary.

3.1.2 Structure and Arrangements category includes all elements that are designed and built into the craft for:

- (a) The structural strength necessary to fulfil its design capability and functionality under defined operating and emergency conditions.
- (b) The inherent buoyancy and control of the craft under all operating conditions.
- (c) The recognition of the inherent stall characteristics of the craft under all operating conditions.
- (d) The layout and arrangements that support the safety of personnel and the safe and effective operation by persons involved in operational and emergency procedures.

3.1.3 Mobility category includes those engineering systems installed in order for the craft to proceed on operations and are necessary for:

- (a) The watertight and weathertight integrity of the craft structure and spaces within the craft.
- (b) The safety and dependability of power systems for movement, directional control and other essential auxiliary steering systems.

3.1.4 Craft Function category systems are those engineering systems installed in order for the craft to carry out its role and necessary for:

- (a) The operation and functioning of systems installed for purposes relating to the craft function.
- (b) The operation and functioning of emergency machinery and equipment.

3.1.5 Ancillary category systems are all those systems, other than part of the Structure and Arrangements, Mobility, or Craft Function category and failure of which may compromise the Provisions of Classification, and are necessary for the provision of basic conditions on board for the carriage of stores, fuels, equipment and personnel when the craft is airborne, landing and taking off, or moored in harbour.

3.1.6 The assessment requirements applicable to structures and engineering systems are dependent upon the process to be addressed and the system designation and are detailed in Table 1.3.1.

General Requirements and Assessment Process**Volume 2, Part 1, Chapter 1**

Section 3

Table 1.3.1 Assessment process for craft structures and engineering systems

CATEGORY PROCESS	STRUCTURES AND ARRANGEMENTS	MOBILITY	CRAFT FUNCTION	ANCILLARY
CONCEPT	The Design and Operational Concept Statements as required by Chapter 2, Section 1 are to be agreed by LR.			
DESIGN REVIEW	<ul style="list-style-type: none"> Plans of all structures, as required by the Rules are to be appraised by LR. 	<ul style="list-style-type: none"> In general, plans of all systems are to be appraised by LR. Procedure for component appraisal is to be agreed between the producer and LR. See Note 1. 	<ul style="list-style-type: none"> In general, plans are to be appraised by LR when required by the Rules and where additional class notations are requested by Owners. Procedure for component appraisal is to be agreed. See Note 1. 	<ul style="list-style-type: none"> Plans of system arrangements are to be reviewed by LR where required by the Rules.
CONSTRUCTION	<ul style="list-style-type: none"> All major fabrications and assemblies are to be constructed under survey in accordance with the plans appraised by LR, as required by the Rules. 	<ul style="list-style-type: none"> In general, all major components and items of equipment are to be constructed under survey in accordance with the plans appraised by LR and Rule requirements. See Note 1. 	<ul style="list-style-type: none"> In general, to be constructed under survey when required by the Rules or Regulations. See Note 1. 	<ul style="list-style-type: none"> No requirements unless required by the Rules
INSTALLATION	<ul style="list-style-type: none"> To be constructed under survey in accordance with the plans and LR Rule requirements. 	<ul style="list-style-type: none"> To be installed under survey in accordance with plans appraised by LR and Rule requirements. 	<ul style="list-style-type: none"> To be installed under survey in accordance with plans appraised by LR and Rule requirements. 	<ul style="list-style-type: none"> No requirements unless required by the Rules.
TRIALS	<ul style="list-style-type: none"> Trials are to be conducted in accordance with the Rule requirements under specified load conditions. 	<ul style="list-style-type: none"> To be tested under specified load conditions. 	<ul style="list-style-type: none"> To be tested under normal working conditions. 	<ul style="list-style-type: none"> Running test of systems under working conditions.
IN SERVICE	<ul style="list-style-type: none"> Subject to survey. 	<ul style="list-style-type: none"> Subject to survey. 	<ul style="list-style-type: none"> Subject to survey where required by the Rules or Regulations. 	<ul style="list-style-type: none"> No requirements unless required by the Rules or Regulations or requested by the Owner or Maritime Administration.
MODIFICATIONS	<ul style="list-style-type: none"> Details of any modifications are to be appraised by LR. Construction, installation, and trials are to be carried out under survey. 	<ul style="list-style-type: none"> Details of any modifications are to be appraised by LR. Construction, installation, and trials are to be carried out under survey. 	<ul style="list-style-type: none"> Details of any modifications are to be appraised and construction, installation and trials are to be carried out under survey when required by the Rules or Class Notation. 	<ul style="list-style-type: none"> Details of any modifications are to be recorded to enable review by LR Surveyors.
DE-COMMISSIONING	<ul style="list-style-type: none"> Details are to be submitted for consideration 	<ul style="list-style-type: none"> Details are to be submitted for consideration. 	<ul style="list-style-type: none"> Details are to be submitted for information. 	<ul style="list-style-type: none"> Details are to be recorded by the Owner.
NOTE For details, see Ch 2,2.1.1.				

Section

- 1 Scope**
- 2 Routes to conformance**
- 3 Survey**
- 4 Installation**
- 5 Trials**
- 6 In-Service Survey**
- 7 Modifications**
- 8 De-commissioning**
- 9 Upkeep by exchange**

■ **Section 1**
Scope

1.1 Concept acceptance of craft development and operation

1.1.1 Lloyd's Register (hereinafter referred to as 'LR') concept acceptance of the craft's development and operation is a prerequisite to commencement of the classification procedure, as described in the Regulations.

1.1.2 In general, LR acceptance of the concept is achieved by the Builder demonstrating that the concept principle (see Vol 1, Pt 2, Ch 1,3) has been satisfactorily addressed.

1.1.3 The Builder is to submit the following information to LR for review:

- (a) General arrangement plans of the craft, detailing all major spaces and the machinery and equipment therein.
- (b) Design concept that includes the operating envelope, see Vol 4, Pt 1, Ch 1.
- (c) Details of designers, Builders, Operators/intended Owners and maintenance crews.

■ **Section 2**
Routes to conformance

2.1 Routes to conformance

2.1.1 Plans/procedures as required by the Rules are to be appraised by LR.

2.1.2 In general, LR acceptance of engineering systems and craft structures is to be through design appraisal/review and/or audit by LR, together with the assurance that the construction is in accordance with the design requirements by the application of quality schemes and/or survey acceptable to LR.

2.1.3 All craft structures and operating systems are to use materials, machinery and equipment that is acceptable to LR for the intended purpose.

2.1.4 All equipment, components and materials used in the construction and assembly of systems and structures are to be in accordance with the requirements of Volumes 8 and 9 as applicable.

2.1.5 Compliance with the Rules for items of machinery and equipment is normally to be demonstrated through one of the following processes:

- (a) Type Approval, construction under LR survey or in accordance with an acceptable quality scheme, followed by an agreed testing procedure.
- (b) Technical Construction File (TCF), followed by acceptable testing.

Alternatively, where requested by the manufacturer, machinery and equipment can be appraised on an individual basis, and constructed under LR survey, or in accordance with an acceptable quality scheme, see also 3.3.

2.1.6 Compliance with the requirements for craft structures is to be demonstrated through design appraisal followed by construction in accordance with an appropriate and acceptable quality scheme.

2.1.7 All workmanship is to be of good quality and in accordance with good practices for lightweight structures and associated equipment. Any defect is to be rectified to the satisfaction of the Surveyor before material covered with paint or other composition.

■ **Section 3**
Survey

3.1 Structures to be constructed under survey

3.1.1 All primary and secondary structures and those structures supporting machinery are to be constructed under LR survey.

3.1.2 The primary, secondary and structures for supporting machinery are to be declared as required in Vol 5, Pt 1, Ch 1.

3.1.3 In addition, composite structures are to be constructed in accordance with a quality scheme acceptable to LR as detailed in Vol 3, Pt 3, Ch 1.

3.1.4 The craft assembly is to be such that the Surveyor has clear access to permit safe and effective measurements as necessary.

Appraisal and Acceptance

Volume 2, Part 1, Chapter 2

Sections 3 to 7

3.2 Survey for classification

3.2.1 Surveyors are to examine and test the materials and workmanship as required by the Rules from the commencement of work until the final test of the craft under full power and any other specified working conditions. Any defects are to be indicated as early as possible. On completion, a certificate will be issued and an appropriate notation will be assigned in accordance with the Regulations.

- (d) Type Approval Certificates.
- (e) Quality Scheme Certificates.
- (f) Certificates of Construction.
- (g) LR appraised plans.
- (h) Technical Construction Files.

3.3 Alternative system of inspection

3.3.1 Where items of machinery and equipment are manufactured as individual or series produced units, consideration will be given to the adoption of a survey procedure based on quality assurance concepts utilising regular and systematic audits of the approved manufacturing and quality control processes and procedures as an alternative to the direct survey of individual items.

3.3.2 The Principles and Criteria in Vol 1, Pt 2 are to be addressed in any alternative system of inspection.

3.4 Machinery and equipment to be constructed under survey

3.4.1 All major units of equipment within the Mobility category and where specifically required within the Craft Function category and Ancillary category, are to be individually surveyed at the manufacturer's works, be manufactured in accordance with the requirements of the Quality Scheme for Machinery, or satisfy the TCF requirements for quality control when using the TCF route to compliance. The workmanship is to be to the Surveyor's satisfaction and the Surveyor is to be satisfied that the components are suitable for the intended purpose and duty.

3.4.2 The Surveyors are to examine and test the materials and workmanship from the commencement of work until the final test of the machinery under full power and any other specified working conditions. Any defects, etc., are to be indicated as early as possible.

■ Section 4 Installation

4.1 Engineering systems installation

4.1.1 Where required by the assessment process in Table 1.3.1 in Chapter 1, engineering systems are to be installed under survey in accordance with appraised plans and relevant LR Design Appraisal documentation and LR Rules.

4.1.2 Documentation required during installation is to be available for inspection by the Owners and LR Surveyors. Such documentation may include:

- (a) Design Appraisal Documents.
- (b) Type Test Certificates.
- (c) Materials Certificates.

■ Section 5 Trials

5.1 Trials

5.1.1 Craft structures and engineering systems are to be tested on completion of installation to demonstrate functionality and suitability for purpose in accordance with LR Rules. Records of trials and testing required by the assessment process in Table 1.3.1 in Chapter 1 are to be maintained on board the craft.

5.1.2 Records of trials and testing required by the assessment process in Table 1.3.1 in Chapter 1 are to be maintained and be available when required.

■ Section 6 In-Service Survey

6.1 In-service survey

6.1.1 Where required by the assessment process in Table 1.3.1 of Chapter 1 and in the Regulations, structures and engineering systems are to be surveyed at intervals defined in the Regulations.

6.1.2 Records of in-service survey where carried out by authorised personnel are to be maintained on board the craft, as defined in the Regulations.

6.1.3 A maintenance register is to be maintained with records of planned or unscheduled maintenance carried out on craft structures, systems and equipment.

■ Section 7 Modifications

7.1 Modifications

7.1.1 Details of modifications to engineering systems or equipment are, as required by Table 1.3.1 in Chapter 1, to be submitted to LR for consideration.

7.1.2 Records of all modifications to in-service engineering systems that may alter the *Provisions of Classification*, are to be maintained on board the craft.

■ **Section 8**
De-commissioning

8.1 De-commissioning

8.1.1 Details of de-commissioning of engineering systems, as required by Table 1.3.1 in Chapter 1, are to be submitted to LR for consideration.

8.1.2 Records of de-commissioning of all equipment and systems that may alter the *Provisions of Classification* are to be maintained on the craft.

■ **Section 9**
Upkeep by exchange

9.1 Upkeep by exchange

9.1.1 Where Mobility Category is maintained using an 'upkeep by exchange' policy, details of the system are to be submitted to LR for appraisal.

9.1.2 Where an 'upkeep by exchange' system has been approved, plans of individual replacement units are not required to be submitted provided there have been no changes since the original appraisal.

9.1.3 The manufacture and testing of the replacement units is to be in accordance with the relevant Rule requirements.

9.1.4 Records of each 'upkeep by exchange' are to be maintained on the craft and LR is to witness running tests on load after each exchange. A record history is to be maintained for each exchange unit in the form of a log-book.

9.1.5 Flexible tube lengths in Mobility and Craft Function category systems are within the scope of the requirements of this section and a Flexible Hose Register of all flexible tube lengths is to be maintained with the following information.

- (a) Position in craft.
- (b) Hose specification including end fittings.
- (c) Purpose.
- (d) Date of manufacture.
- (e) Date of installation.
- (f) Due date for renewal.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

DEFINITIONS AND MARITIME ADMINISTRATION

JULY 2008

VOLUME 3

PART 1

Lloyd's
Register

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Definitions

Volume 3, Part 1, Chapter 1

Section 1

Section

1 Scope

2 Primary WIG effect craft attributes

■ Section 1 Scope

1.1 General

1.1.1 For the purposes of these Rules, unless expressly stated otherwise, the terms used therein have the meanings defined in the following definitions. These definitions are also to be used when corresponding with Lloyd's Register (hereinafter referred to as 'LR') in connection with WIG effect craft classification.

Accident is an unintended event involving fatality, injury, craft damage or loss or environmental damage.

Aircraft mode denotes the long-term flight of a WIG craft of Type C above the minimal safe altitude for an aircraft prescribed by ICAO regulations. (Type C WIG effect craft are outside the scope of these classification Rules.)

Air Speed is the speed of the craft relative to the air mass in which it is flying.

Augmented stabilisation is a combination of self-stabilisation and forced (artificial) stabilisation.

Automatic safety control is a logic unit for processing data and making decisions to put the craft into the displacement or other safe mode if a condition impairing safety arises.

Availability is the ability of an item to perform its required function at a stated instant or period of time.

Base port is a specific port identified in the route operational manual and provided with appropriate facilities providing continuous radio communications with the craft at all times while in ports and at sea which also possesses:

- means for obtaining a reliable weather forecast for the corresponding region and its due transmission to all craft in operation;
- access to facilities provided with appropriate rescue and survival equipment; and
- access to craft maintenance services with appropriate equipment.

Base Port State means the State or Country in which the base port is located.

Breadth (B) means breadth of the broadest part of the moulded watertight envelope of the rigid hull, excluding appendages, at or below the design waterline in the displacement mode with no lift or propulsion machinery active.

Bridge-to-bridge communications means safety communications between craft and ships from the position from which the craft is normally navigated.

Calm water design altitude is the flight altitude in the ground effect mode with the service speed in calm water.

Catastrophic effect is an effect that results in the loss of the craft and/or in fatalities.

Cargo craft is any WIG effect craft other than passenger craft.

Cargo spaces are all spaces other than special category spaces used for cargo and trunks to such spaces.

Casualty is damage to life, property or the environment.

Clear water. Water having sufficient depth to permit the normal development of wind generated waves.

Cooper – Harper ratings. The levels of handling qualities which quantify the degree of acceptability of an airborne vehicle in terms of its ability to complete a task for which it is designed. There are ten levels on the Cooper – Harper scale that seek to indicate the pilot workload in the execution of a flight, these are defined in Table 1.1.1.

Continuous watch means that the radio watch concerned should not be interrupted other than for brief intervals when the craft's receiving capability is impaired or blocked by its own radio communications or when the facilities are under periodical maintenance or checks.

Continuously manned control station is a control station which is continuously manned by a suitably qualified member of the crew while the craft is in normal service.

Control stations are those spaces in which the craft's radio or navigating equipment or the emergency source of power and emergency switchboard are located, or where the fire recording or fire control equipment is centralised, or where other functions essential to the safe operation of the craft such as propulsion control, public address, stabilisation systems, etc., are located.

Cosmetic structure is that structure or fitting that has no intentional influence on the strength or stiffness of the main structure, and is fitted for aesthetic purposes only. Where failure of such structure may result in a catastrophic effect, it shall not be identified as cosmetic structure.

Crew compartments are those spaces allocated for the use of the crew, and include cabins, sick bays, offices, lavatories, lounges and similar spaces.

Cross wind speed is the velocity of the wind speed vector component acting perpendicular to the nose-tail axis of the craft.

Critical design conditions means the limiting specified conditions, chosen for design purposes, which the craft keeps in displacement mode. Such conditions should be more severe than the 'worst intended conditions' by a suitable margin to provide for adequate safety in the survival condition.

Definitions**Volume 3, Part 1, Chapter 1**

Section 1

Table 1.1.1 Cooper – Harper ratings

Adequacy for selected task	Craft characteristic	Demand on pilot (Workload)	Pilot rating
Satisfactory	Excellent	Very low	1
Satisfactory	Good	Low	2
Satisfactory	Fair	Minimal pilot compensation required	3
Unsatisfactory - warrants improvements	Minor deficiencies	Moderate pilot compensation required	4
Unsatisfactory - warrants improvements	Moderate deficiencies	Considerable pilot compensation required	5
Unsatisfactory - warrants improvements	Tolerable deficiencies	Extensive pilot compensation required	6
Unacceptable - requires improvements	Major deficiencies	Adequate performance not attainable	7
Unacceptable - requires improvements	Major deficiencies	Considerable pilot compensation required for control	8
Unacceptable - requires improvements	Major deficiencies	Intense pilot compensation required for control	9
Catastrophic - Improvement mandatory	Major deficiencies	Loss of control likely	10

This scoring system is internationally used and recognized by all qualified test pilots in assessing the mission performance of a new aircraft.

Damping device denotes a device designed to reduce the effects of vertical loads during take-off and landing modes of operation of a WIG effect craft.

Dead craft condition means that the entire machinery installation, including the power supply, is out of operation and that the auxiliary services (e.g. compressed air, batteries, etc.) for bringing the main propulsion systems into operation and for the restoration of the main power supply are not available.

Design concept. A statement provided by the Builder/Owner, which is to include intended purpose of craft, i.e. number of crew/passengers, nature of cargo, intended limits of operation, i.e. range and ambient conditions, and areas of operation including weather and sea states. See also Pt 2, Ch 1,3.

Design organisation. The organisation that provides the design and construction plans.

Design waterline means the waterline corresponding to the maximum operational weight of the craft with no lift or propulsion machinery active.

Digital selective calling (DSC) means a technique using digital codes which enables a radio station to establish contact with, and transfer information to, another station or group of stations, and complying with the relevant recommendations of the International Radio Consultative Committee (CCIR).

Displacement mode means the regime, whether at rest or in motion, where the weight of the craft is fully or predominantly supported by hydrostatic forces.

Docking workstation is a place equipped with necessary means for docking the craft.

Down flooding point means any opening through which flooding of the reserve buoyancy spaces could take place while the craft is in the intact or damage condition, and heels to an angle past the angle of equilibrium.

Dynamic air cushion means a high pressure region originating between the airfoil and a water surface or some other surface as the airfoil moves within the zone of the aerodynamic effect of this surface.

Dynamically stable means that the craft has no tendencies to diverge from the manoeuvre commanded by the pilot.

Effect is a situation arising as a result of an occurrence.

Embarkation ladder is the ladder provided at survival craft embarkation stations to permit safe access to survival craft after launching.

Embarkation station is the place from which a survival craft is boarded. An embarkation station may also serve as a muster station, provided there is sufficient room, and the muster station activities can safely take place there.

Engineering system is a series of elements, including all equipment and associated sub-systems necessary to provide specified functions within the intended context of use in the system. Typical sub-systems include control and monitoring arrangements and their user interfaces, data communications, power supplies (electrical, hydraulic or pneumatic), fuel, lubricating, cooling, etc.

Error is an occurrence arising as a result of incorrect action by the operating crew or maintenance personnel.

Essential services are those necessary for the propulsion, directional control and safety of the craft within the Mobility and Craft Function categories.

Exposed person is any person wholly or partly in a danger zone.

Definitions

Volume 3, Part 1, Chapter 1

Section 1

Failure condition exists where a system functions incorrectly in a particular manner (i.e. the Failure Condition is the resultant condition of the system rather than the cause(s) of that condition). A particular Failure Condition may arise:

- (a) as a result of a single failure;
- (b) as a result of independent failures in combination within a system; or
- (c) as a result of independent failures in combinations involving more than one system, taking into account:
 - (i) any undetected failure that is already present;
 - (ii) such further failures as would be reasonably expected to follow the failure under condition.

(NB: In assessing the further failures which follow, account should be taken of any resulting more severe operating conditions for items that have not up to that time failed.)

where the overall effect of the functioning of the system is the same in each case.

Fail safe is the principle by which a failure or malfunction of a component in a system causes its output to automatically adjust to a predetermined safe state. The safe state, according to the application, will be predetermined in terms of priority for the safety of the craft and may be generally taken as the least critical one for the main components and auxiliaries of, for example, the propulsion plant.

Fetch. The extent of clear water across which a wind has blown before reaching the craft.

Flap means an element formed as an integrated part of, or an extension of, a foil, used to adjust the hydrodynamic or aerodynamic lift of the foil.

Flashpoint means the temperature at which a liquid heated in a closed-cup apparatus referenced in the International Maritime Dangerous Goods (IMDG) Code, gives off sufficient vapour to flash momentarily when exposed to a naked flame.

Float-free launching is that method of launching a survival craft whereby the craft is automatically released from a sinking craft and is ready for use.

Fly-over mode denotes increase of the flying altitude for WIG effect craft of the Types B and C within limited period that exceeds the vertical extent of the ground effect.

Flying qualities qualify the degree of acceptability of a airborne vehicle in terms of its ability to complete a task for which it is designed. There are three levels on the Flying Quality scale that seek to indicate quality of flight, these are defined as follows:

- Level 1** Flying qualities clearly adequate for the task flight phase.
- Level 2** Flying qualities adequate to accomplish the mission flight phase, but with an increased pilot work load and/or degradation in mission effectiveness.
- Level 3** Degraded flying qualities, but such that the craft can be controlled, inadequate mission performance or high and limiting pilot workload.

This scoring system is internationally used and recognised by all qualified test pilots in assessing the mission performance of a new aircraft and is formulated from pilot perception. See also Handling qualities.

Foil means a profiled plate or three-dimensional construction at which hydrodynamic lift is generated when the craft is under way.

Forced (artificial) stabilisation of the craft is stabilisation achieved by:

- an automatic control system; or
- a manually assisted control system; or
- a combined system incorporating elements of both automatic and manually assisted control systems.

Free-fall launching is that method of launching a survival craft whereby the craft with its complement of persons and equipment on board is released and allowed to fall into the sea without any restraining apparatus.

Fully submerged foil means a foil having no lift components piercing the surface of the water in the foil-borne mode.

General radio communications means operational and public correspondence traffic other than distress, urgency and safety messages, conducted by radio.

Ground effect altitude is the maximum altitude at which a Type A or Type B WIG effect craft can sustain continuous flight under its own power. If a craft has the ability to sustain self-propelled flight outside of ground effect mode, the craft is considered to be of Type C, and outside the scope of these Rules. See also Vol 4, Pt 1, Ch 2, 1.14.2.

Ground effect mode is the steady state main operation mode of flying the WIG effect craft near to free water surface or to other supporting surface in the range of altitude of acting the 'ground effect altitude'.

Ground speed is the absolute speed of the craft relative to the ground.

Handling qualities are a qualitative measure of the response of the aeroplane through pilot manipulation of the flight control system. This is usually formulated from pilot perception. See also Flying qualities and Cooper-Harper ratings.

Hazard is a potential threat to human life, health, property or the environment.

Heading means the direction in which the craft's longitudinal axis is directed, relative to a defined parameter which may be:

- Wind /wave direction
- Compass direction
- Current direction

Head wind speed is the velocity of the wind speed vector component acting parallel to longitudinal axis of the craft in the opposite direction to craft motion.

Definitions

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Section 1

Hull. Unless the context states otherwise, the term 'Hull' is to be taken to include the main structure of the WIG effect craft, its superstructures, cabins, control surfaces and similar parts, including anchoring and mooring equipment.

Immersion suit is a protective suit that reduces the body heat-loss of a person wearing it in cold water.

Launching appliance or arrangement is a means of transferring a survival craft or rescue boat from its stowed position safely to the water.

Length (L) means the overall length of the underwater watertight envelope of the rigid hull, excluding appendages, at or below the design waterline in the displacement mode with no lift or propulsion machinery active.

Lift power limitations are those limitations imposed on the machinery and components which provide lift.

Light weight is the displacement of the craft in tonnes without cargo, fuel, lubricating oil, ballast water, and fresh water in tanks, consumable stores, passengers and crew and their effects.

Locating means the finding of the ships, craft, aircraft, units or persons in distress.

Machinery. Means an assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits etc. joined together for a specific application.

Machinery mounting structure is that structure which is used for supporting or aligning machinery or used for transmitting load to the primary structure.

Major effect is an effect which produces:

- (a) a significant increase in the operational duties of the crew or in their difficulty in performing their duties which by itself should not be outside the capability of a competent crew provided that another major effect does not occur at the same time; or
- (b) significant degradation in handling characteristics; or
- (c) significant modification of the permissible operating conditions, but will not remove the capability to complete a safe journey without demanding more than normal skill on the part of the operating crew.

Maritime Administration. The administration responsible for providing regulation associated with procurement, operation and support of the craft. The Maritime Administration may also be responsible for identifying appropriate standards, auditing and certification. The Maritime Administration could be a Government department, Statutory Authority, LR or an independent organisation with appropriate standing.

Marine evacuation system (MES) is an appliance designed to rapidly transfer persons from an embarkation station by means of a passage to a floating platform for subsequent embarkation into associated survival craft or directly into associated survival craft.

Maritime safety information means navigational and meteorological warnings, meteorological forecasts and other urgent safety-related messages broadcast to ships and craft.

Maximum operational weight means the overall weight up to which operation in the intended mode is permitted by the Maritime Administration.

Maximum speed is the speed achieved at the maximum continuous propulsion power for which the craft is certified at maximum operational weight and in smooth water.

Minor effect is an effect that may arise from a failure, an event, or an error, which can be readily compensated for by the operating crew. It may involve:

- (a) a small increase in the operational duties of the crew or in their difficulty in performing their duties; or
- (b) a moderate degradation in handling characteristics; or
- (c) slight modification of the permissible operating conditions.

Multihull craft means a craft that, in any normally achievable operating trim or heel angle, has a rigid hull structure that penetrates the surface of the sea over more than one discrete area.

Muster station is an area where passengers can be gathered in the event of an emergency, given instructions and prepared to abandon the craft, if necessary.

Novel life-saving appliance or arrangement is a life-saving appliance or arrangement which embodies new features not fully covered by the provisions of the Rules but which provides an equal or higher standard of safety.

Oil fuel unit is the equipment used for delivery of oil fuel to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure of more than 0,18 N/mm².

Open vehicle spaces are spaces:

- to which any passengers carried have access;
- intended for carriage of motor vehicles with fuel in their tanks for their own propulsion; and
- either open at both ends or open at one end and provided with adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead or from above.

Operating compartment means the enclosed area from which the navigation and control of the craft is exercised.

Operating station means a confined area of the operating compartment equipped with necessary means for either navigation, manoeuvring or communication, and from where the functions of either navigating, manoeuvring, communication, commanding, conning - or lookout are carried out.

Operator. The Operator of the craft. The Operator may also be the Owner.

Owner. The legal owner of the craft and holds ultimate responsibility of ensuring the craft is correctly certified, operated and maintained.

Definitions

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Section 1

Passenger is every person on board, embarking or disembarking the craft, other than:

- the master and members of the crew or other persons employed or engaged in any capacity on board a craft on the business of that craft; and
- a child under one year of age.

Passenger craft is a craft that is designed to carry passengers.

Place of refuge is any naturally or artificially sheltered area which may be used as a shelter by a craft under conditions likely to endanger its safety.

Polar orbiting satellite service means a service that is based on polar orbiting satellites which receive and relay distress alerts from satellite EPIRBs and which provides their position.

Porpoising. Oscillating symmetrical movements of a craft when planing; pitching instability on the water as distinct from instability under airborne conditions.

Primary structures are those structural members supporting secondary members and will be the primary load bearing element.

Probability of occurrences are standardised as follows:

- **Frequent event** is an event that is likely to occur often during the operational life of a particular craft.
- **Reasonably probable** is one which is unlikely to occur often but which may occur several times during the total operational life of a particular craft.
- **Recurrent** is a term embracing the total range of frequent and reasonably probable.
- **Remote** is one that is unlikely to occur to every craft but may occur to a few craft of a type over the total operational life of a number of craft of the same type.
- **Extremely remote** is one which is unlikely to occur when considering the total operational life of a number of craft of the type, but nevertheless should be considered as being possible.
- **Extremely improbable** is one that is so extremely remote that it should not be considered as possible to occur.

Public spaces are those spaces allocated for the passengers and include, main seating areas, lavatories and similar spaces allocated for passengers.

Radio Regulations mean the Radio Regulations annexed to, or regarded as being annexed to, SOLAS.

Reasonable weather. Wind strengths of force six or less on the Beaufort scale, associated with sea states sufficiently moderate to ensure that wave height is less than the WIG effect craft – surface clearance, and do not impair operation of the craft.

Rescue boat is a boat designed to assist and rescue persons in distress and to marshal survival craft.

Retrieval is the safe recovery of survivors.

Retro-reflective material is a material that reflects in the opposite direction a beam of light directed on it.

Sea area A1 means an area within the radiotelephone coverage of at least one VHF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government to the Convention.

Sea area A2 means an area, excluding sea area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government to the Convention.

Sea area A3 means an area, excluding sea areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available.

Sea area A4 means an area outside sea areas A1, A2 and A3.

Sea States. World Meteorological Organisation (WMO) sea state code:

Sea state code	Significant Wave Height (m)		Description
	Range	Mean	
0	0	0	Calm (glassy)
1	0–0,1	0,050	Calm (rippled)
2	0,1–0,5	0,30	Smooth (wavelets)
3	0,5–1,25	0,875	Slight
4	1,25–2,5	1,875	Moderate
5	2,5–4,0	3,250	Rough
6	4,0–6,0	5,000	Very rough
7	6,0–9,0	7,500	High
8	9,0–14,0	11,500	Very high
9	Over 14,0	Over 14,00	Phenomenal

Secondary structures are those structural members supporting shell, deck or bulkhead plating.

Service spaces are those enclosed spaces used for pantries containing food warming equipment but no cooking facilities with exposed heating surfaces, lockers, store-rooms and enclosed baggage rooms.

Service speed is the maximum continuous forward air speed, over water in calm conditions, during normal operations, at maximum certified weight and with the centre of gravity within the design limits.

Sheltered water. Where the fetch is six nautical miles or less.

Sideslip. The component of the motion of the craft in the plane of its lateral axis, the angle of sideslip is that between the craft's longitudinal axis and the airspeed vector.

Significant wave height is the average height of the one third highest observed wave heights over a given period.

Skeg is a vertical or inclined profiled plate or a volumetric construction, which is attached to the air wing or made as its part and which serves for decreasing the inductive aerodynamic resistance and for limitations of static and dynamic air cushions.

Definitions

Volume 3, Part 1, Chapter 1

Section 1

Skimming mode denotes the mode of steady state operation of a craft on water surface by which the craft's weight is supported mainly by hydro-dynamic forces.

Special-Category Spaces are those enclosed spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access for embarking and disembarking, including spaces intended for the carriage of cargo vehicles.

Stabilisation control system is a system intended to stabilise the main parameters of the craft's attitude. The main elements of a stabilisation control system may include the following devices such as rudders, foils, flaps, fans, pumps for moving fluids; power drives actuating stabilisation devices; and stabilisation equipment for accumulating and processing data for making decisions and giving commands such as sensors, logic processors and automatic safety control.

Stabilisation device means a device which generates the forces for controlling the craft's attitude.

Statically stable means that the craft has no tendencies to diverge from its current state when travelling in static equilibrium, i.e. at constant velocity.

Stick fixed refers to the design of a control lever that hold the control surfaces in a fixed position where there is no pilot intervention.

Stick free refers to the design of a control lever that allows the control surfaces to take up a natural position in the aerodynamic form of the craft when there is no intervention from the pilot.

Survival craft is a craft capable of sustaining the lives of persons in distress from the time of abandoning the craft.

SOLAS means the International Convention for the Safety of Life at Sea, 1974, as amended.

Take off/Landing denotes the transitional mode from the skimming to the ground effect mode and vice versa.

Tail wind speed is the velocity of the wind speed vector component acting parallel to the nose-tail axis of the craft.

Terminal is any beach, ramp, quay, harbour or other place at which a WIG makes scheduled or contracted calls in ordinary service conditions, i.e. excluding emergencies.

Thermal protective aid is a bag or suit of waterproof material with low thermal conductance.

Track means the locus of the neutral point of the craft.

Transitional mode denotes the transient mode from the displacement one to the skimming mode and vice versa.

Trim means the ability to adjust the control settings of a craft to achieve a steady state flight condition with no control forces required by the pilot.

Turning is the rate of change of direction of a craft.

Watertight in relation to a structure, means capable of preventing the passage of water through the structure in any direction under the head of water likely to occur in the intact or damage condition.

Weathertight means that water will not penetrate into the craft in any wind and wave conditions up to those specified as Critical Design Conditions.

Weight Maximum Weight = Basic Weight + Variable Load +
Disposable Load

Light weight = Basic Weight + Variable Load

Basic Weight includes:

Weight of structure, power plants, systems, etc. integral to the vessel.

Unusable fuel and oil.

Other non-consumable liquids including non-consumable ballast.

Portable fire fighting equipment.

Portable emergency equipment.

Radio, radar, navaids.

Permanent ballast, lead weights, etc.

Plus the following, except where they are included in 'role equipment'.

Passenger and crew seats.

Trim and furnishings, etc.

Toilet washing and galley facilities.

Buoyant life saving equipment.

Long range tankage systems.

Variable Load Includes:

Crew.

Crews baggage and equipment.

Role equipment.

Disposable Load includes:

Domestic and windscreens water.

Food, drinks, bonded stores.

Consumable liquid ballast.

Main fuel.

Reserve fuel.

Long range fuel.

Passengers and passenger's baggage.

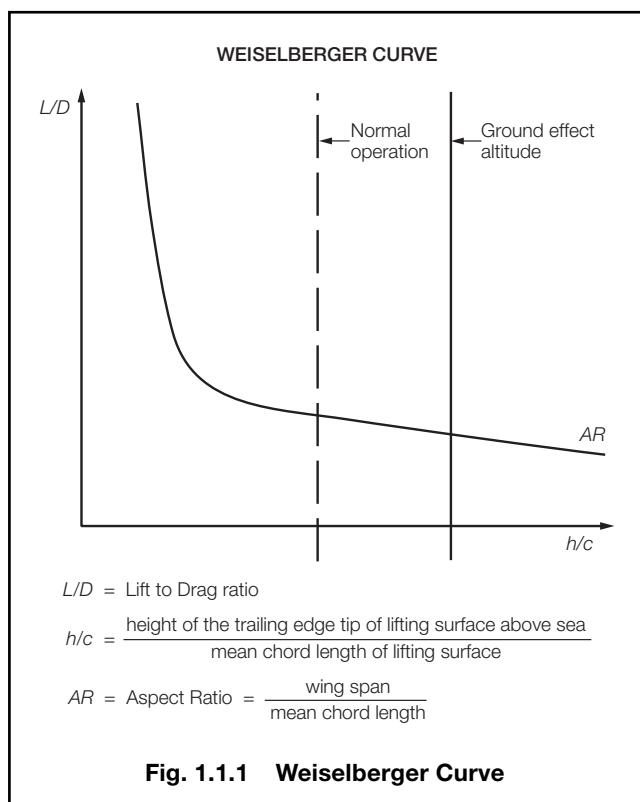
Cargo/freight.

Weiselberger Curve. Diagrammatic representation of the theoretical relationship between the lift to drag ratio and the height of the craft above the surface, with respect to mean chord length for any particular craft. For the purposes of these Rules, the pilot is also to include the actual ground effect altitude and h/c factor for normal operation (see Fig. 1.1.1).

Definitions

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Sections 1 & 2



WIG effect craft is a dynamic air-cushion high-speed vehicle whose weight in the main service mode of motion is mainly supported by an aerodynamic lift developed at an airfoil (airfoils) utilising the effect resulting from the proximity of water surface or some other surface. WIG effect craft are defined as Type A, Type B or Type C.

Type A A WIG effect craft that is not capable of being flown above its declared ground effect altitude.

Type B A WIG effect craft that is capable of unsustained short-term flight above its declared ground effect altitude.

Type C A WIG effect craft that is capable of self-propelled sustained flight above its declared ground effect altitude.

Wind speed the absolute mean speed of the air relative to the ground. For WIG effect craft assessment, this relates to the wind speed at a height of 10 metres above the surface.

Wing denotes a lift generating surface to support the weight of the craft in flight and may include sections of the fuselage.

Wing angle of incidence is the angle between the chord line of the wing and the velocity vector of the air inflow to the wing.

Workstation is a position at which one or several tasks constituting a particular activity are carried out.

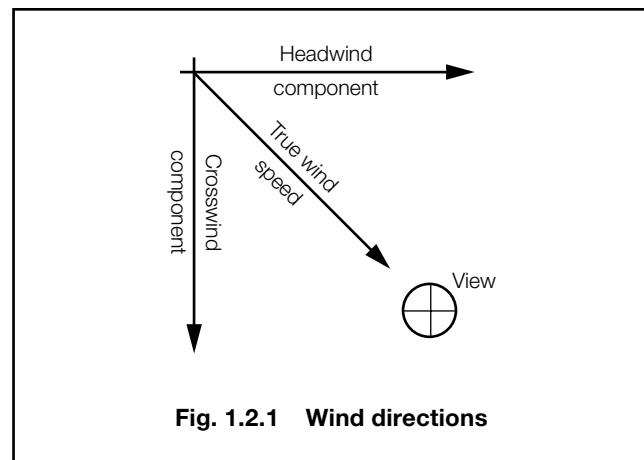
Worst intended conditions means the specified environmental conditions within which the intentional operation of the craft is provided for in the certification of the craft. This takes into account parameters such as the worst conditions of wind force allowable, significant wave height (including unfavourable combinations of length and direction of waves), minimum air temperature, visibility and depth of water for safe operation and such other parameters as the Maritime Administration may require in considering the type of craft in the area of operation.

Worst permitted design altitude is the flight altitude in the ground effect mode with the service speed and in waves corresponding to the worst permitted conditions.

■ Section 2 Primary WIG effect craft attributes

2.1 General

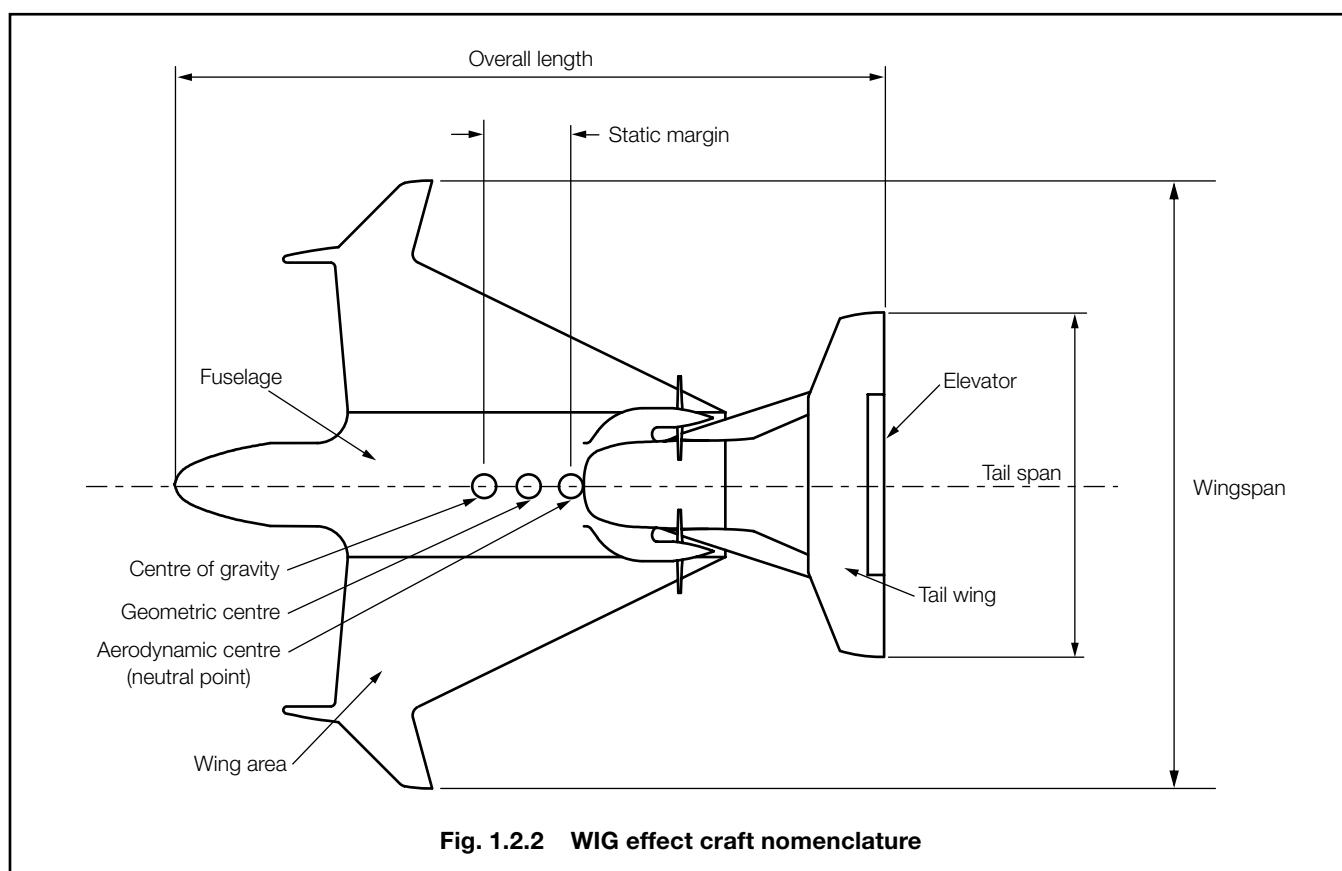
2.1.1 Fig. 1.2.1 shows details of wind directions for assessment of maximum cross wind condition for the **WSC** notation.



2.1.2 Fig. 1.2.2 shows nomenclature used to describe craft attributes.

Definitions**Volume 3, Part 1, Chapter 1**

Section 2



Maritime Administration Safety and Environmental Issues

Volume 3, Part 1, Chapter 2

Section 1

Section

1 Scope

■ Section 1 Scope

1.1 Scope

1.1.1 This Chapter is for guidance only and is intended to identify requirements in addition to those provided by the *Provisions of Classification*.

1.1.2 The contents of this Chapter are normally the concern of the Maritime Administration or a recognised Organisation, who may be Lloyd's Register (hereinafter referred to as 'LR') where specifically authorised by a Maritime Administration. For the purposes of LR Classification, all the issues are to be addressed to the satisfaction of the Maritime Administration and LR. Where the issues are not addressed by the Maritime Administration, details are to be submitted to LR and these will be assessed against an applicable code or standard.

1.1.3 The following safety and environmental issues are normally the concern of the Maritime Administration.

- (a) Fire Protection.
- (b) Intact and Damage Stability.
- (c) Crew Certification/Manning Levels.
- (d) Life Saving Arrangements.
- (e) Navigation Systems.
- (f) Communication Systems.
- (g) Pollution Prevention.
- (h) International Safety Management Code.
- (i) Carriage of dangerous goods.
- (k) Noise levels.

This list is not exhaustive and may be extended depending on the declared operating envelope and as may be identified in future IMO requirements for WIG effect craft safety.

1.1.4 The Maritime Administration is responsible for defining the standards and processes to be applied for assessment of arrangements and certification for the safe in-service operation of WIG effect craft for the items identified in 1.1.3.

1.2 Human factors

1.2.1 In addition to the general human factor considerations in these Rules, the Maritime Administration will be responsible for defining the requirements relating to the human element covering safety, effectiveness, efficiency and user response while the craft is in service.

1.2.2 The following aspects will need to be considered for machinery and engineering systems installed on board:

- (a) **Manpower.** The number of people required and available to operate and maintain the craft and its systems.

(b) **People.** The definition and selection of aptitudes, experience and other human characteristics necessary to achieve the required performance of the craft and its systems.

(c) **Training.** The combination of activities required to develop the competence needed by the available people to operate and maintain the craft and its systems at the required level of performance under the required range of operating conditions.

(d) **Human Factors Engineering.** The comprehensive integration of human characteristics into the definition and development of the craft layout, systems and use in order to optimise the performance of available people under the required range of operating conditions.

(e) **System safety.** The risk of injury to people or damage to equipment occurring as a result of the craft or its systems being operated or functioning in normal or abnormal manner.

(f) **Health hazards.** The conditions inherent in the operation, use and maintenance of the craft or its systems which can cause death, injury, illness, disability or reduce human performance.

1.2.3 The aspects defined above will be required to recognise the *Provisions of Classification* and incorporate the Principles and Criteria as defined in Vol 1, Part 2 where applicable.

1.2.4 Demonstrations that the requirements relating to the human element have been met will need to be made under operational conditions with representative personnel. The demonstrations will be required to address all significant aspects of operation and maintenance. The scope of assessment will need to be agreed between the Builder, Maritime Administration and LR.

1.2.5 Where the Maritime Administration has stipulated human factors that interface with the *Provisions of Classification* the following information is to be submitted for review.

- (a) The human factors management and integration plan.
- (b) Context of use statement (including target audience description).
- (c) User requirements specification.
- (d) User interaction specification.
- (e) Evaluation procedures and reports.
- (f) Training, operations and support manual.

1.2.6 Where LR is requested by the Maritime Administration to assess the treatment of human factors, the reference standard will be ISO PAS 18152 A *specification for the process of human system issues* unless advised otherwise.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

RULE APPLICATION DOCUMENTATION – INFORMATION AND GUIDANCE

JULY 2008

VOLUME 3

PART 2

Lloyd's
Register

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Technical Construction Files (TCF) (Information and Guidance)

Volume 3, Part 2, Chapter 1

Section 1

Section

1 Scope

■ Section 1 Scope

1.1 Introduction

1.1.1 This Chapter describes the content of a Technical Construction File (TCF) for machinery and engineering equipment to be installed in WIG effect craft classed or intended to be classed with Lloyd's Register (hereinafter referred to as 'LR').

1.1.2 The TCF procedure is an alternative process for validating that the design and construction are in accordance with the Rules and is applicable to items of machinery and equipment within the Mobility and Craft Function categories.

1.1.3 A TCF is a set of documentation that is compiled to demonstrate that an item of machinery or equipment is compliant with the Rules for the purposes of Classification. Typically this will detail the equipment's design intent and intended modes of operation.

1.1.4 The criteria for the eleven Principles of Classification in Vol 1, Part 2 identify the objectives that the craft as a whole has to achieve, and the requirements that are to be designed for. In order to ensure that machinery systems meet the requirements of the Rules the equipment and components are to be designed to address the technical requirements in Volume 6 for system design and Volume 9 for component design.

1.2 General requirements

1.2.1 The manufacturer of the machinery or equipment is responsible for assembling the TCF.

1.2.2 The TCF is to remain available while any item of machinery or equipment remains in service.

1.2.3 The TCF is to address all of the Principles of Classification defined in Vol 1, Part 2. Generally this will be achieved by satisfying all of the criteria and relevant technical requirements required by the relevant sections of the Rules.

1.2.4 It is the responsibility of the manufacturer to identify all other hazards that are applicable to machinery or equipment, which are not specifically identified by the Rules.

1.2.5 In general, the TCF is to only contain the information required by this Chapter and the remainder of these Rules. Any additional information submitted with the TCF is to be pertinent to the design and be presented in such a way that it does not hinder the review of the required TCF information.

1.3 TCF contents

- 1.3.1** The TCF is to contain the following:
 - (a) An overall plan of the machinery or equipment together with plans of the control circuits; such plans are to contain sufficient detail and be accompanied by any calculations, test results etc. which will allow the machinery to be appraised for conformity with the relevant technical requirements of the Rules.
 - (b) A list of:
 - (i) The technical requirements applicable to the machinery or equipment in addition to those identified by the Rules.
 - (ii) Standards used to demonstrate compliance with the technical requirements.
 - (iii) Other technical specifications that were used when designing the machinery or equipment.
 - (c) A description of methods adopted to eliminate hazards presented by the machinery or equipment.
 - (d) Any technical report or certificate relating to testing where declaring conformity with a standard, any technical report giving the results of tests carried out either by the manufacturer or by another authority.
 - (e) A copy of the instructions for the machinery or equipment.
 - (f) A proposed test schedule.
 - (g) Details of the quality control procedures for the manufacturers of the machinery or equipment.

1.4 Equipment instruction manual

1.4.1 The manufacturer or his authorised representative is to prepare relevant instructions for the machinery or equipment.

1.4.2 The following provide guidance on the general aspects to be covered in the instructions:

- (a) Details of the data and information marked on the machinery or equipment;
- (b) intended use of the machinery and its operation;
- (c) instructions for safe installation, commissioning, adjustment and maintenance;
- (d) handling and transportation;
- (e) details of tools required for operation and maintenance;
- (f) training instructions as relevant, and
- (g) where necessary, attention should be drawn to ways in which the machinery or equipment should not be used.

1.5 Quality control

1.5.1 Machinery and equipment supplied under the TCF route is to be manufactured at a works that has a quality management system that has been recognised and accepted by LR. Recognition and acceptance of the works quality control processes can be by one of the following routes:

- (a) Approval under the LR approved manufacturer scheme.
- (b) Approval of an alternative quality scheme recognised by LR.
- (c) Approval by LR through auditing the manufacturer's quality system.

1.6 Series production equipment

1.6.1 A single TCF can be used for a series of machinery or equipment items and hybrids of those items. Where the design differs from that of the approved TCF, the deviations from the original design can be documented and managed with Annexes to the TCF.

1.6.2 For series manufacture, the TCF is to also contain details of the internal measures to be implemented to ensure that the machinery remains in conformity with the requirements of the Rules.

1.7 Review and validation of information

1.7.1 On receipt of the TCF, LR will review the information to confirm that:

- (a) all the requirements have been covered;
- (b) all applicable technical requirements have been taken into consideration;
- (c) methods applied for verifying compliance with the technical requirements are satisfactory;
- (d) instructions are clear and do not contradict any of the technical requirements;
- (e) standards and Rules have been correctly applied;
- (f) data and markings are given and are acceptable; and
- (g) necessary tests to demonstrate conformity, if not already carried out and supported with acceptable test reports, are included in the test programme.

1.7.2 Any discrepancies found during the review will be advised to the manufacturer for the necessary corrective action. The amendments will be reviewed for confirmation.

1.7.3 After the content of the TCF has been reviewed and verified for compliance with the Rules pertaining to the specific requirements for equipment or machinery, LR will issue the client with a Design Appraisal Document (DAD). Acceptance of machinery or an item of equipment for installation into a WIG effect craft classed or intended to be classed with LR will be subject to satisfactory testing in the presence of an LR Surveyor in accordance with an agreed test schedule required by 1.3.1(g).

Failure Modes and Effects Analysis (FMEA)

Volume 3, Part 2, Chapter 2

Information and Guidance

Section 1

Section

1 Scope

■ Section 1 Scope

1.1 Introduction

1.1.1 This Chapter describes a failure mode and effect analysis, and how it is to be applied to WIG effect craft engineering systems by:

- (a) explaining basic principles;
- (b) providing the procedural steps necessary to perform an analysis;
- (c) identifying appropriate terms, assumptions, measures and failure modes; and
- (d) providing a typical example of the necessary worksheet.

1.1.2 The FMEA technique is based on a single-failure concept, whereby the effect that a single failure in equipment has on higher levels in the systems hierarchy, is systematically investigated.

1.1.3 The FMEA will provide a systematic and documented investigation that establishes the important failure conditions of the craft and assesses their significance with regard to the safety of the craft, personnel and the environment.

1.2 General requirements

1.2.1 FMEA is only acceptable as an assessment technique when required by the Rules.

1.2.2 Before proceeding with a detailed FMEA into the effects of the failure of the system elements on the system functional output it is necessary to perform a functional failure analysis of the craft's important systems. In this way only systems which fail the functional failure analysis need to be investigated by a more detailed FMEA.

1.2.3 Failure detection means e.g. audible or visual alarms are to be identified in the FMEA.

1.2.4 The response of any back-up equipment, or corrective action initiated to mitigate or reduce the effect of failure, are also to be identified.

1.2.5 Where a design relies on operator intervention to mitigate the effects of failure, an FMEA is to be conducted considering the effect of the operator not responding in the designed time.

1.2.6 The FMEA is always to take due cognisance of the operational mode, it may be necessary to repeat the FMEA for several operating conditions.

1.2.7 At sub-system level it is acceptable, for the purpose of these Rules, to consider failure of equipment items and their functions, e.g. failure of a pump to produce flow or pressure head. It is not required that the failure of a component within that pump be analysed. In addition, failure need only be dealt with as a cause of failure of the pump.

1.2.8 Where FMEA is used for consideration of systems that depend on software based functions for control or co-ordination, the analysis is to investigate failure of a function rather than the software code.

1.3 Developing the contents of an FMEA

1.3.1 The following steps are necessary to perform an FMEA:

- (a) define the system to be analysed;
- (b) illustrate the interrelationships of functional elements of the system by means of block diagrams;
- (c) identify all potential failure modes and their causes;
- (d) evaluate the effects of each failure mode on the system;
- (e) identify failure detection methods;
- (f) identify corrective measures for failure modes;
- (g) assess the probability of failures causing hazardous or catastrophic effects where applicable, document the analysis;
- (h) develop a test programme; and
- (i) prepare the FMEA report.

1.3.2 A narrative description of the system is to be drawn up containing, as a minimum, the following information:

- (a) general description of the system operation and structure;
- (b) functional relationship among the system elements;
- (c) functional performance limit of the system and its constituent parts in each of the typical operational modes; and
- (d) system constraints.

1.3.3 For the purposes of functional understanding of the system and aiding analysis, a block diagram of the system is to be drawn up, to include but not be limited to:

- (a) breakdown of the system into major sub-systems or equipment;
- (b) all appropriate labelled inputs and outputs and identification numbers by which each sub-system is consistently referenced; and
- (c) all redundancies, alternative signal paths and other engineering features which provide 'fail-safe' measures.

1.4 The use of the probability concept in FMEA

1.4.1 If the FMEA demonstrates that after a failure, the system does not deploy corrective measures, or provide for system redundancy, then the following criteria are to be met:

- (a) a failure mode which results in a catastrophic effect is to be assessed to be extremely improbable;
- (b) a failure mode assessed as extremely remote is not to result in worse than hazardous effects; and
- (c) a failure mode assessed as either frequent or reasonably probable is not to result in worse than minor effects.

1.5 FMEA test programme

1.5.1 A FMEA test programme is to be drawn up to prove the conclusions of the FMEA. As a minimum the test programme will include all systems or system elements whose failure will lead to:

- (a) major or more severe events;
- (b) restricted operations; or
- (c) any other corrective action by the operator or by system self-correction.

1.5.2 The trials are also to consider:

- (a) the layout of control panels which may be used to instigate corrective action; and
- (b) the effects of the major failure modes as prescribed in the theoretical analysis.

1.6 Presentation of information

1.6.1 The FMEA report is to be a self contained document, presenting all the information required by this Chapter and the remaining parts of the relevant Rules.

1.6.2 The FMEA is to be presented on a worksheet as shown in Fig. 2.1.1. The worksheets are to be organised to first display the highest system level and then proceed down through decreasing system levels. Analysis in accordance with IEC 60812, *Analysis for System Reliability – Procedures for Failure Mode and Effect Analysis*, or IMO MSC Resolution 36(63) Annex 4 – *Procedures for Failure Mode and Effects Analysis*, would also be acceptable.

Failure Modes and Effects Analysis (FMEA) (Information and Guidance)

Volume 3, Part 2, Chapter 2

Section 1

- #1 Mode of operation
 - Landing and take-off
 - Normal operation in ground effect
 - Flight outside of ground effect
 - Emergency conditions

#2 Severity category

- A. Catastrophic
- B. Hazardous
- C. Major
- D. Minor

Fig. 2.1.1 Failure Mode and Effects Analysis

Section**1 General****■ Section 1
General****1.1 Scope**

1.1.1 LR Type Approval is an impartial certification system that provides independent third-party Type Approval Certificates attesting to a product's conformity with specific standards or specifications. It is based on a design review and type testing or where testing is not appropriate, a thorough independent design analysis.

1.1.2 The LR Type Approval System is a process whereby a product is assessed in accordance with the Rules, a specification, standard or code to check that it meets the stated requirements and through selective testing to prove its suitability for its intended operation. The testing is carried out on a prototype or randomly selected products which are representative of the manufactured product under approval. Thereafter, the manufacturer testifies that each item delivered is in conformity with that which has been type tested.

1.1.3 Details of LR's Type Approval System are contained in the following LR publications:

- (a) Procedure TA96.
- (b) Test Specification 1: Electrical and control engineering products that are environmentally tested.
- (c) Test Specification 2: Piping systems components.
- (d) Test Specification 3: Electrical components that do not require environmental testing.
- (e) Test Specification 4: Internal Combustion Engines.
- (f) Test Specification GT98: Gas Turbines.
- (g) LR Software Conformity Assessment System. Assessment Module GEN:1994.

1.1.4 LR Type Approval does not preclude inspection and survey procedures required by these Rules for equipment to be installed in WIG effect craft classed or intended to be classed with LR.

1.1.5 LR Type Approval is subject to the understanding that the producer's recommendations and instructions for the product and any relevant requirements of these Rules are to be fulfilled.

1.1.6 Where equipment or components have been Type Approved in accordance with procedures other than LR's, details of the product, certification and testing are to be submitted for information.

Section

1 General

■ **Section 1**
General

1.1 Scope

1.1.1 As an alternative to the Type Approval or the Technical Construction File routes to conformance for certain items of machinery and equipment, LR, at the request of the Client, will carry out a design appraisal of items of machinery or equipment in accordance with the requirements of these Rules.

1.2 Design appraisal

1.2.1 LR will conduct a design appraisal against the requirements of these Rules to confirm that the Principles of Classification with any relevant Criteria and technical requirements have been satisfactorily addressed.

1.3 Testing review

1.3.1 LR will review the test programme and results to confirm that the Principles of Classification with any relevant Criteria and technical requirements as recorded in the design appraisal have been addressed and the item functions satisfactorily.

1.3.2 Where there is insufficient evidence to confirm that the design adequately addresses the technical requirements, extended testing may be required to demonstrate an acceptable level of safety, dependability and functionality.

1.4 Design appraisal document

1.4.1 On completion of a satisfactory design review, LR will issue a design appraisal document for the machinery or equipment highlighting the key parameters and details of its design.

Section**1 Application****2 Guidelines****■ Section 1
Application****1.1 General**

1.1.1 For the purposes of these Rules, model tests are understood to be small-scale tests that are used to predict the WIG effect craft behaviour and confirm design assumptions or provide design data. These requirements are not relevant to prototype testing.

1.1.2 Where the results of model test are to be used to prove the characteristics of a WIG effect craft, the tests are to be conducted in accordance with the guidelines of this Chapter.

1.1.3 The testing facility is to be equipped and staffed to perform accurate and meaningful tests with measuring capability for all key parameters that require to be assessed for prediction of craft behaviour.

**■ Section 2
Guidelines****2.1 Tests and simulation**

2.1.1 Proposals for tests and simulation of WIG effect craft behaviour are to be submitted for review before being carried out. The proposals are to identify the objectives of the tests and the key parameters that are to be assessed.

2.1.2 Simulation should accurately reflect the effects of the earth's boundary layer, wind sheer and surface areas/shapes.

2.1.3 Wind tunnel tests carried out at a lower Reynolds Number than that at which the full-scale craft will operate are to be justified for applicability to the higher Reynolds Number.

2.1.4 Ground effect simulation is to be described and justified for its application to the full-scale craft.

2.1.5 Proposals for the acceptance of the results of testing and simulation are to be accompanied by a report from a recognised authority with experience in the assessment of WIG effect craft behaviour.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

QUALITY SCHEMES

JULY 2008

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CHAPTER 1 LR QUALITY SCHEME FOR CRAFT CONSTRUCTION IN FIBRE REINFORCED PLASTICS

Section 1 General

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Section 1 Quality Scheme

1.1 General

1.2 Requirements for approval

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1.6 Approval of works

1.7 Maintenance of approval

1.8 Suspension or withdrawal of approval

1.9 Identification of products

Section**1 General****■ Section 1
General****1.1 Quality control**

1.1.1 The Builder's mandatory quality systems for composite construction, will be subject to inspection and audit, and are to be in accordance with the requirements of one of the following:

- (a) Quality Assurance System in accordance with an International or National Standard (i.e. ISO 9000 and BS ENISO 9001) with assessment and certification carried out by a nationally accredited body and must reflect the minimum quality control requirements under (c) being complied with.
- (b) Lloyd's Register's (hereinafter referred to as 'LR') Quality Assurance Scheme for the Construction of Special Service Craft.
- (c) LR's locally accepted Quality Control System – The Builder is implementing a documented Quality Control System that controls the activities as indicated below.
 - (i) Receipt storage and issue of materials, equipment, etc.
 - (ii) Moulding shop.
 - (iii) Care and preparation of mould tools, etc.
 - (iv) Lay-up process control.
 - (v) Inspection of FRP mouldings on release.
 - (vi) Installation of machinery and essential systems.
 - (vii) Fitting-out.
 - (viii) Tests and trials.
 - (ix) Plans and document control.
 - (x) Records.

1.1.2 LR's involvement is only in respect of that part of the Quality System that controls the standards required to meet the classification requirements.

1.1.3 The mandatory 'documented' quality control system, in general, requires the Builder to have written down procedures that describe clearly and unambiguously how each of the above activities is carried out, when it is carried out and by whom. These procedures will form part of the system manual that is also to contain a statement of management policy, organisation chart and statements of responsibilities. The manual is to be controlled covering formal issue and revision.

Section**1 Quality Scheme**

**■ Section 1
Quality Scheme**

1.1 General

1.1.1 This certification scheme is applicable to both individual and series produced items manufactured under closely controlled conditions and will be restricted to works where the employment of quality control procedures is well established. LR will have to be satisfied that the practices employed will ensure that the quality of finished products is to standards that would be demanded when using traditional survey techniques.

1.1.2 The Committee will consider proposed designs for compliance with LR's Rules or other appropriate requirements and the extent to which the manufacturing processes and control procedure ensure conformity of the product to the design. A comprehensive survey will be made by the Surveyors of the actual operation of the quality control programme and of the adequacy and competence of the staff to implement it.

1.1.3 The procedures and practices of manufacturers that have been granted approval will be kept under review.

1.1.4 Approval by another organisation will not be accepted as sufficient evidence that a manufacturer's arrangements comply with LR's requirements.

1.2 Requirements for approval

1.2.1 Facilities. The manufacturer is required to have adequate equipment and facilities for those operations appropriate to the level of design, development and manufacture being undertaken.

1.2.2 Experience. The manufacturer shall demonstrate that the firm has experience consistent with the technology and complexity of the product type for which approval is sought and that the firm's products have been of a consistently high standard. Where a manufacturer does not have this existing experience, increased auditing may be required as part of the approval process.

1.2.3 Quality policy. The manufacturer shall define management policies and objectives for quality and ensure that these policies and objectives are implemented and maintained throughout all phases of the work.

1.2.4 Quality system documentation. The manufacturer shall establish and maintain a documented quality system capable of ensuring that material or services conform to the specified requirements, including the requirements of this Section.

1.2.5 Management representative. The manufacturer shall appoint a management representative preferably independent of other functions, who shall have defined authority and responsibilities for the implementation and maintenance of the quality system.

1.2.6 Responsibility and authority. The responsibilities and authorities of senior personnel within the quality system shall be clearly documented.

1.2.7 Internal audit. The manufacturer shall conduct internal audits to ensure continued adherence to the system. An audit programme shall be established with audit frequencies scheduled on the basis of the status and importance of the activity and adjusted on the basis of previous results.

1.2.8 Management review. The quality system established in accordance with the requirements of this Section shall be systematically reviewed at appropriate intervals by the manufacturer to ensure its continued effectiveness. Records of such management reviews shall be maintained and be made available to the Surveyors.

1.2.9 Contract review. The manufacturer shall establish and implement procedures for conducting a contract review prior to and after acceptance to ensure that:

- (a) The requirements of the contract are adequately defined and documented.
- (b) Any requirements differing from those specified in the original enquiry/tender are resolved.
- (c) The manufacturer has the capability to meet and verify compliance to the specified requirements.

1.2.10 Work instruction. The manufacturer shall establish and maintain clear and complete written work instructions that prescribe the communication of specified requirements and the performance of work in design, development and manufacture which would be adversely affected by lack of such instructions.

1.2.11 Documentation and change control. The manufacturer shall establish and maintain control of all documentation that relates to the requirements of this scheme. This control shall ensure that:

- (a) Documents are reviewed and approved for adequacy by authorised personnel prior to use, are uniquely identified and include indication of approval and revision status.
- (b) All changes to documentation are in writing and are processed in a manner that will ensure their availability at the appropriate location and preclude the use of non-applicable documents.
- (c) Provision is made for the prompt removal of obsolete documentation from all points of issue or use.
- (d) Documents shall be re-issued after a practical number of changes have been issued.

1.2.12 Records. The manufacturer shall develop and maintain a system for collection, use and storage of quality records. The period of retention of such records shall be established in writing and shall be subject to agreement by LR.

1.2.13 Design. The manufacturer shall establish and maintain a design control system appropriate to the level of design being undertaken. Documented design procedures shall be established which:

- (a) Identify the design practices of the manufacturer's organisation including departmental instructions to ensure the orderly and controlled preparation of design and subsequent verification.
- (b) Make provision for the identification, documentation and appropriate approval of all design change and modifications.
- (c) Prescribe methods for resolving incomplete, ambiguous or conflicting requirements.
- (d) Identify design inputs such as sources of data, preferred standard parts or materials and design information and provide procedures for their selection and review by the manufacturer for adequacy.

1.2.14 Purchasing. The manufacturer shall ensure that purchased material and services conform to specified requirements.

1.2.15 Selection and approval of sub-contractors and suppliers. The manufacturer shall establish and maintain records of acceptable suppliers and sub-contractors. The selection of such sources and the type and extent of control exercised shall be appropriate to the type of product or service and the suppliers' or sub-contractors' previously demonstrated capability and performance. Documented procedures for approval of new suppliers shall be established and records of vendor assessments (where carried out) shall be maintained and made available to the Surveyors upon request.

1.2.16 Purchasing data. Each purchasing document should contain a clear description of the material or service ordered including as applicable, the following:

- (a) The type, class, grade, or other precise identification.
- (b) The title or other positive identification and applicable issue of specifications, drawings, process requirements, inspection instructions and other relevant data.

1.2.17 Verification of purchased material and services. The manufacturer shall ensure that the Surveyors are afforded the right to verify at source or upon receipt that purchased material and services conform to specified requirements.

1.2.18 Verification by the Surveyors shall not relieve the manufacturer of his responsibility to provide acceptable material nor shall it preclude subsequent rejection.

1.2.19 Product identification. The manufacturer shall establish and maintain a system for identification of the product to relevant drawings, specifications or other documents during all stages of production, delivery and installation.

1.2.20 Manufacturing control. The manufacturer shall ensure that those operations that directly affect quality are carried out under controlled conditions. These shall include the following:

- (a) Written work instructions wherever the absence of such instructions could adversely affect compliance with specified requirements. These should define the method of monitoring and control of product characteristics.
- (b) Established criteria for workmanship through written standards or representative samples.

1.2.21 Special processes. Those processes where effectiveness cannot be verified by subsequent inspection and test of the product shall be subjected to continuous monitoring in accordance with documented procedures in addition to the requirements specified in 1.2.20.

1.2.22 Receiving inspection. The manufacturer shall ensure that all incoming material shall not be used or processed until it has been inspected or otherwise verified as conforming to specified requirements. In establishing the amount and nature of receiving inspection, consideration shall be given to the control exercised by the supplier and documented evidence of quality conformance supplied.

1.2.23 In-process inspection. The manufacturer shall:

- (a) Perform inspection during manufacture on all characteristics that cannot be inspected at a later stage;
- (b) inspect test and identify products in accordance with specified requirements;
- (c) establish product conformance to specified requirements by use of process monitoring and control methods where appropriate;
- (d) hold products until the required inspections and tests are completed and verified; and
- (e) clearly identify non-conforming products to prevent unauthorised use, shipment, or mixing with conforming material.

1.2.24 Final inspection. The manufacturer shall perform all inspections and tests on the finished product necessary to complete the evidence of conformance to the specified requirements. The procedures for final inspection and test shall ensure that:

- (a) All activities defined in the specification, quality plan or other documented procedure have been completed;
- (b) all inspections and tests that should have been conducted at earlier stages have been completed and that the data is acceptable; and
- (c) no product shall be dispatched until all the activities defined in the specifications, quality plan or other documented procedure have been completed, unless products have been released with the permission of the Surveyors.

1.2.25 Inspection equipment. The manufacturer shall be responsible for providing, controlling, calibrating and maintaining the inspection, measuring and test equipment necessary to demonstrate the conformance of material and services to the specified requirements or used as part of the manufacturing control system required by 1.2.20 and 1.2.21.

1.2.26 Inspection and test status. The manufacturer shall establish and maintain a system for the identification of inspection status of all material, components and assemblies by suitable means which distinguish between conforming, non-conforming and uninspected items. The relevant inspection and test procedures and records shall identify the authority responsible for the release of conforming products.

1.2.27 Control of non-conforming material. The manufacturer shall establish and maintain procedures to ensure that material that does not conform to the specified requirements is controlled to prevent inadvertent use, mixing or shipment. Repair, rework or concessions on non-conforming material and reinspection shall be in accordance with documented procedures. Records clearly identifying the material, the nature and extent of non-conformance and the disposition shall be maintained.

1.2.28 Sampling procedures. Where sampling techniques are used by the manufacturer to verify the acceptability of groups of products, the procedures adopted shall be in accordance with the specified requirements or shall be subject to agreement by the Surveyors.

1.2.29 Corrective action. The manufacturer shall establish and maintain documented procedures for the review of non-conformances and their disposition. These should provide for:

- (a) monitoring of process and work operations and analysis of records to detect and eliminate potential causes of non-conforming material;
- (b) continuing analysis of concessions granted and material scrapped or reworked to determine causes and the corrective action required;
- (c) an analysis of customer complaints;
- (d) the initiation of appropriate action with suppliers or subcontractors with regard to receipt of non-conforming material; and
- (e) an assurance that corrective actions are effective.

1.2.30 Purchaser supplied material. The manufacturer shall establish and maintain documented procedures for the control of purchaser supplied material.

1.2.31 Handling, storage, and delivery. The manufacturer shall establish and maintain a system for the identification, preservation, segregation and handling of all material from the time of receipt through the entire production process. The system shall include methods of handling that prevent abuse, misuse, damage or deterioration. Secure storage areas or rooms shall be provided to isolate and protect material pending use. To detect deterioration, at an early stage, the condition of material shall be periodically assessed. The manufacturer shall arrange for the protection of the quality of his product during transit. The manufacturer shall ensure, in so far as it is practicable, the safe arrival and ready identification of the product at destination.

1.2.32 Training. The manufacturer is to follow a policy for recruitment and training which provides an adequate labour force with such skills as are required for each type of work operation. Appropriate records shall be maintained to demonstrate that all personnel performing process control, special processes inspection and test or quality system maintenance activities have appropriate experience or training.

1.3 Arrangements for acceptance and certification of purchased material

1.3.1 The manufacturer shall establish and maintain procedures and controls to ensure compliance with LR's requirements for certification of materials and components at the supplier's plant. The manufacturer's system for control of such purchased material may be based on one of the following alternatives subject to the approval of the Committee:

- (a) Product certification by LR's Surveyors at the supplier's works in accordance with the requirements of Vol 1, Part 2.
- (b) Agreed Inspection Procedures at the manufacturer's plant combined with documentary evidence of vendor assessments, vendor rating records and annual surveillance visits to the suppliers.
- (c) Recognition of quality Agreements between the manufacturer and his suppliers which shall provide for initial vendor assessments and regular surveillance visits (a minimum of four per year). The quality agreement must identify the individual in the supplier's plant who is charged with the responsibility for release of materials or components and the procedures to be adopted.

1.3.2 The alternatives proposed in 1.3.1(b) and (c) are not acceptable to LR for the following items:

- (a) Engine components for which testing is a Rule requirement, and
 - (i) the cylinder bore is equal to or exceeds 250 mm; or
 - (ii) which are made by open forging techniques.
- (b) Cast crankshafts where the journal diameter exceeds 85 mm.

1.3.3 Where the manufacturer's system for control of purchased material is based upon 1.3.1(b) or (c) the Surveyors shall also make surveillance visits to the supplier's works at the minimum specified intervals. The manufacturer shall also make available to the Surveyors documentary evidence of the operation of Quality Agreements or Agreed Inspection Procedures where applicable.

1.4 Information required for approval

1.4.1 Manufacturers applying for approval under this scheme are to submit the following information:

- (a) A description of the products for which certification is required including, where applicable, model or type number.
- (b) Applicable plans and details of material used.
- (c) An outline description of all important manufacturing plant and equipment.

- (d) A summary of equipment used for measuring and testing during manufacture and completion.
- (e) The Quality Manual.
- (f) A typical production flow chart and quality plan covering all stages from ordering of materials to delivery of the finished product.
- (g) The system used for the identification of raw materials, semi-finished and finished products.
- (h) The number and qualifications of all staff engaged in testing, inspection and quality control duties.
- (i) A list of suppliers of components and manufacturers, proposed procedures to ensure compliance with LR's requirements for certification, of materials and components at the supplier's plant.

1.5 Assessment of works

1.5.1 After receipt and appraisal of the information requested in 1.4 an inspection of the works is to be carried out by the Surveyors to examine in detail all aspects of production, and in particular the arrangements for quality control.

1.5.2 The Surveyors will not specify in detail acceptable quality control procedures, but will consider the arrangements proposed by the works in relation to the manufacturing processes and products.

1.5.3 In the event of procedures being considered inadequate, the Surveyors will advise the manufacturer how such procedures are to be revised in order to be acceptable to LR.

1.5.4 Gauging, measuring and testing devices are to be made available to the Surveyors, and where appropriate, personnel for the operation of such devices.

1.6 Approval of works

1.6.1 If the initial assessment of the works confirms that the manufacturing and quality control procedures are satisfactory, the committee will issue to the manufacturer a Quality Assurance Approval Certificate which will include details of the products for which approval has been given. This Certificate will be valid for three years with renewal subject to satisfactory performance and to a satisfactory triennial re-assessment.

1.6.2 An extension of approval in respect of product type may be given at the discretion of the Committee without any additional survey of the works.

1.6.3 LR will publish a list of manufacturers whose works have been approved.

1.7 Maintenance of approval

1.7.1 The arrangements authorised at each works are to be kept under review by the Surveyors in order to ensure that the approved procedures for manufacture and quality control are being maintained in a satisfactory manner. This is to be carried out by:

- (a) regular and systematic surveillance;
- (b) intermediate audits at intervals of six months;
- (c) triennial re-assessment of the entire quality system.

1.7.2 For the purpose of regular and systematic surveillance the Surveyors are to visit the works at intervals determined by the type of product and the rate of production. The Surveyors are to advise a senior member of the quality control department in regard to any matter with which they are not satisfied.

1.7.3 When minor deficiencies in the approved procedures are disclosed during the systematic surveillance the Surveyors may, at their discretion, apply more intensive supervision, including the direct inspection of products.

1.7.4 Any noteworthy departures from the approved plans of specifications are to be reported to the Surveyors and their written approval obtained prior to dispatch of the item.

1.7.5 Minor alterations in the approved procedures may be permitted provided that the Surveyors are advised and that their prior concurrence obtained.

1.7.6 In addition to the regular visits by the Surveyors, an intermediate audit is to be carried out every six months. This will normally be carried out by Surveyors other than those regularly in attendance at the works. This audit is to consist of an examination of part of the manufacturer's quality system. An audit plan will be established indicating those areas of the quality system which will be examined during every intermediate audit and the frequency of examination of other areas such that all areas are subject to audit before re-assessment is due.

1.7.7 The manufacturer's entire quality system shall be subject to re-assessment at three-yearly intervals. This shall be conducted by Surveyors nominated by LR's London office.

1.8 Suspension or withdrawal of approval

1.8.1 When the Surveyors have drawn attention to significant faults or deficiencies in the manufacturing or quality control procedures and these have not been rectified, approval of the works will be suspended. In these circumstances the manufacturer will be notified in writing of the Committee's reasons for the suspension of approval.

1.8.2 When approval has been suspended and the manufacturer does not effect corrective measures within a reasonable time, the Committee will withdraw the Quality Assurance Approval Certificate.

1.9 Identification of products

1.9.1 In addition to the normal marking by the manufacturer, all certified products are to be hard stamped on a principal component with a suitable identification, LR's brand and the number of the approved works.

1.9.2 After issue of the Quality Assurance Approval Certificate, products may be dispatched with certificates signed on behalf of the manufacturer by an authorised senior member of the quality control department or by an authorised deputy. These certificates are to be countersigned by the Surveyor to certify that the approved arrangements are being kept under review by regular and systematic auditing of the manufacturer's quality system.

1.9.3 The following declarations are to be included on each certificate:

- (a) 'This is to certify that the items described above have been constructed and tested with satisfactory results in accordance with the Rules of Lloyd's Register of Shipping.

Signed.....

Manager of QC Department.'

- (b) 'This certificate is issued by the manufacturer in accordance with the arrangements authorised by Lloyd's Register of Shipping in Quality Assurance Approval Certificate No. QA.M..... I certify that these arrangements are being kept under review by regular and systematic auditing of the approved manufacturing and quality control procedures.

Signed.....

Surveyor to Lloyd's Register of Shipping'.

1.9.4 In the event of noteworthy departures from the approved plan or specification being accepted, a standard 'Concession' form is to be completed and signed by the following authorised persons: the Design Manager, the Quality Control Manager or their deputies. In all cases, where strength or functioning may be affected, the form is to be submitted to the Surveyors for approval and endorsement.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

GENERAL REQUIREMENTS AND OPERATING CONDITIONS

JULY 2008

VOLUME 4

PART 1

Lloyd's
Register

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Chapter 1 General Requirements

2 Operating Conditions

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Volume 4, Part 1, Chapter 1

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1 Application

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3 General

■ Section 1 Application

1.1 Scope and information

1.1.1 The requirements of this Volume 4 make provision for the physical arrangements and craft operability to demonstrate that they satisfy the Principles of Classification and Criteria described in Volume 1, Part 2.

1.1.2 To confirm that all the technical requirements have been satisfied it is the responsibility of the Builder to obtain acceptance of the craft's physical arrangements from Lloyd's Register (hereinafter referred to as 'LR'). Acceptance will be advised when LR is satisfied that the craft arrangements are in accordance with the requirements of this Volume.

1.1.3 To effect the acceptance process, the Builder is to make all plans and information required in this Volume available to LR.

■ Section 2 Submission of information

2.1 Plans and information

2.1.1 At least three copies of plans, information, and specifications as listed are to be submitted for consideration before commencement of manufacture.

2.1.2 Plans are to indicate clearly the scantlings and materials of construction. Any design alteration to the plan is to be resubmitted for appraisal, indicating clearly the alteration.

2.1.3 Individual Chapters list plans to be submitted for specific machinery and electrical systems or components. Also required are the following arrangement plans where applicable:

- (a) Plans showing the arrangement of machinery compartments indicating the location of machinery and equipment together with means of access and ventilation.
- (b) Plans showing the maintenance envelope and removal routes of machinery and equipment where routine removal for maintenance is proposed.
- (c) Plans showing dangerous spaces where flammable gas or vapour and/or combustible dust may accumulate.

2.1.4 Design statements covering the following are to be submitted:

- (a) Operating crew compartments.
- (b) Passenger compartments.
- (c) Cargo space arrangements.
- (d) Machinery compartment arrangements.
- (e) Access arrangements.
- (f) Escape route arrangements.
- (g) Arrangements for maintenance, inspection and survey.
- (h) Arrangements for anchoring, towing and mooring.

2.1.5 Where machinery system components have been approved under LR's Type Approval System for the proposed design conditions or service, plans of the components are not required to be submitted for appraisal. Full details of the components and the existing LR approval are to be submitted.

■ Section 3 General

3.1 System operability/physical arrangements

3.1.1 The Rules provide for system operability and the physical arrangements on WIG effect craft and deals with the two independently. It is to be recognised that the physical arrangements of a craft complement the craft operability and due cognisance is to be taken of this in the craft design.

3.1.2 Chapters 2 and 3 of this Part of the Rules deal with operating conditions and systems operability. Parts 2 and 3 cover the physical arrangements on board the craft.

Operating Conditions

Volume 4, Part 1, Chapter 2

Section 1

Section

1 General

■ Section 1 General

1.1 Scope

1.1.1 The requirements of this Chapter make provision for defining the craft's operational envelope for all the normal operating and foreseeable failure conditions.

1.1.2 The information required by this Chapter is to be compiled in a single document and submitted to Lloyd's Register (hereinafter referred to as 'LR') for information purposes. The information is required to aid in the assessment of craft structures, engineering systems and equipment.

1.2 Particulars to be submitted

1.2.1 The operating envelope of the craft that includes all the information described in 1.3 to 1.14 is to be submitted for information.

1.3 Climate

1.3.1 All climatic conditions in which the craft may be required to operate are to be declared. This is to include extremes of atmospheric air pressures, air and sea temperatures, relative humidity and solar radiation.

1.4 Hours/natural light

1.4.1 The operating hours of the craft together with the minimum (and maximum where applicable) natural light intensity (lux) for which operation is to be permitted.

1.5 Range

1.5.1 The range of the craft is to be specified in nautical miles and is to include:

- (a) Flight range at given flight height.
- (b) Taxi step mode.
- (c) Displacement mode.
- (d) Auxiliary water drive mode.
- (e) Flight range from a place of refuge.

1.6 Sea states

1.6.1 The maximum sea states that include the significant wave heights for over-water operations and the maximum spilling and plunging surf that may be safely traversed during transitional operations for which the craft has been designed are to be declared. This is to be submitted for normal flight operations and take off and landing.

1.7 Wind speeds

1.7.1 The maximum mean wind speeds for head, cross and tail winds for which the craft has been designed relating to all stages of flight operations are to be declared. This is to be defined for normal flight operation and take off and landing.

1.8 Inclinations

1.8.1 The maximum inclinations in all directions, in which the craft is expected to operate are to be declared. This is to be defined for normal flight operation and take off and landing.

1.9 Number of passengers/payload

1.9.1 The maximum payload and/or number of passengers/crew for which the craft is designed to operate is to be declared. The arrangements for passengers and cargo stowage are also to be declared.

1.9.2 The design range of position of C of G for trim settings when craft is in its loaded condition.

1.10 Thrust, acceleration/deceleration collision loads

1.10.1 The maximum deceleration or collision loads with the craft at full payload are to be declared.

1.10.2 The maximum engine thrust and corresponding acceleration with craft at its lightest possible condition are to be declared.

1.11 Anchoring, towing and berthing

1.11.1 All anchoring, towing and berthing loads are to be estimated and declared.

1.12 Landing and take off distances

1.12.1 All landing and take off distances in both light weight and full weight are to be declared.

1.13 Physical craft parameters

1.13.1 The light weight and full weights of the craft are to be declared.

1.13.2 The position of the centre of gravity is to be declared for all normal operating conditions.

1.14 Design flight altitudes

1.14.1 Design flight altitudes are to be declared.

1.14.2 The ground effect altitude is to be determined by calculation and represented on the craft's Weiselberger Curve.

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter states the classification requirements for the operability of engineering systems.

1.2 Particulars to be submitted

1.2.1 A description of system operation, including arrangements for the user interface, is to be submitted for mobility and craft type category systems. The details are to demonstrate that the functionality, performance and usability requirements of this Chapter have been satisfied.

1.2.2 A system integration plan is to be submitted, describing the methodology, roles and responsibilities involved in the integration of mobility and craft type category systems where systems are supplied by more than one manufacturer or supplier and are mutually dependent in use.

1.3 Functionality and performance

1.3.1 Systems are to fulfil all required functions for all defined operating conditions.

1.3.2 The set of functions (monitoring, controlling, reporting, protecting, information processing, security), provided by the system is to be consistent with the task and operational profile.

1.3.3 Suitable means are to be provided to select and execute functions as and when required.

1.3.4 The functions provided by the system are to take account of user characteristics.

1.3.5 The complexity of user allocated functions is to be matched to user skills and abilities.

1.3.6 The functions allocated to the user are to form a meaningful set in terms of the task goals and user workload.

1.3.7 Systems are to maintain the accuracy, frequency and duration of all outputs at the required levels for each specified operational and environmental condition.

1.3.8 Systems are to maintain the required speed of response for all provided functions.

1.3.9 Incorrect or abnormal inputs from other systems are to be rejected or corrected, as appropriate.

1.3.10 Systems are to assist the user in avoiding errors, in detecting errors where they are made and alerting the user when they occur.

1.3.11 Systems are to minimise the corrective actions needed to achieve results despite faults and input errors.

1.3.12 Systems are to have specific features to detect and take actions to tolerate failures in use.

1.3.13 Means are to be provided to prevent unauthorised use or modification.

1.3.14 Means are to be provided to detect dangerous failures before they lead to a hazardous condition.

1.3.15 Systems are to remain in, or revert to, a safe state when dangerous failures occur within a system.

1.3.16 Means are to be provided to notify users of failures.

1.3.17 Systems are to be modular and hierarchical with simple interfaces to other systems or equipment.

1.3.18 Systems are to support effective diagnosis to identify faulty components and allow for effective inspection and testing following repair or modification.

1.4 Usability

1.4.1 User interfaces are to take account of the task environment, performance requirements and the characteristics of typical users.

1.4.2 Information presented to the user is to be understandable, accurate and acceptable under all operational circumstances.

1.4.3 Unnecessary or complex operational sequences are to be avoided.

1.4.4 Systems are to ensure effective and efficient operation under specified task conditions.

1.4.5 Systems are to be designed to meet the needs and expectations of typical users.

1.4.6 The means by which the user interacts with the system are to be matched to the characteristics and competence of typical users.

1.4.7 The behaviour and appearance of the user interface are to be consistent throughout the system.

1.4.8 The codes and symbols used in system interfaces are to be defined and consistent.

1.4.9 Information provided by the system for the user is to be accurate, understandable and relevant.

1.4.10 The user is to be able to control the sequence and speed of interaction with the system in order to achieve safe and effective control.

1.5 Integration

1.5.1 System integration is to be managed by a single designated party, and is to be carried out in accordance with a defined procedure identifying the roles, responsibilities and requirements of all parties involved.

1.5.2 In the event of failure of any part of the integrated system, only those functions that depend on the failed part are to be affected. Reversionary modes of operation are to be provided to ensure safe and graceful degradation in the event of one or more failures.

1.5.3 The operation of protective functions and equipment is not to be impaired by failure of other functions and equipment.

1.6 Testing requirements

1.6.1 The operation of systems, including functionality, performance and usability, is to be demonstrated to the satisfaction of the attending Surveyor during trials of the completed installation.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

COMPARTMENTS AND SPACES

JULY 2008

VOLUME 4

PART 2

Lloyd's
Register

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- 1.9 Personnel safety

Operating Crew Compartments

Volume 4, Part 2, Chapter 1

Section 1

Section

1 General

■ Section 1 General

1.1 Scope and information

1.1.1 This Chapter describes the Classification requirements for crew operating compartments.

1.1.2 Plans showing the layout of all operating crew compartments and the associated instruction manuals are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the compartments and location of the equipment required in the technical requirements described in 1.2 and 1.3.

1.1.4 Survey of the craft at completion by LR is to confirm that the physical arrangements of operating crew compartments are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements

1.2.1 The arrangement of the pilot's compartment is to be such as to afford a sufficiently extensive, clear and undistorted field of vision for the safe operation of the craft, and prevent interference with this field of vision from glare and reflection.

1.2.2 The windscreens and windows serving the pilots compartment are to be maintained in a clear condition during operation in conditions of spray, precipitation, icing or condensation inside the compartment. The cleared portion of the windscreens and windows is to be adequate for the field of vision necessary for normal conditions and reasonably foreseeable failure conditions. The arrangements providing these functions are within Mobility category systems.

1.2.3 The design and arrangement of the operating crew compartment and in particular the relative positions of controls and seats are to be such that each operating crew member, with their seat and any adjustable controls suitably adjusted, can:

- (a) without interference, produce full and unrestricted movement of each control which they are responsible for operating, both separately and with all practical combinations of movements of other controls; and
- (b) at all control positions exert adequate control forces for the operation to be performed.

1.2.4 The craft is to incorporate flight instrumentation and displays such that the pilot has at all times sufficient information to avoid putting the craft into a dangerous flight condition.

1.2.5 Windshield panes directly in front of the pilot(s) in the normal conduct of duties, and supporting structures of these panes are to be capable of withstanding, without penetration, any foreseeable impact with foreign objects, under all normal operating conditions.

1.2.6 Operating crew compartment lighting is to be arranged to ensure:

- (a) A general intensity of illumination under all normal conditions which allows for efficient performance of duties.
- (b) That only a limited degradation in the illumination of essential instruments and control will occur under system fault conditions.

1.2.7 Windows are to be made of a material that will not break into dangerous fragments if fractured.

1.2.8 Means are to be provided to enable the operating crew to communicate between, and have access to each other and with other occupants of the craft in both normal and emergency conditions.

1.2.9 Means are to be provided to maintain the ambient conditions in which the operating crew work within limits such as not to unduly affect their skill, alertness or concentration. In general the systems providing for the habitable environment are to be in accordance with Vol 6, Part 5.

1.2.10 Floors are to be slip resistant during all normal operating and emergency conditions.

1.2.11 Seats are to be attached to the craft frame, so that they will not become detached during all normal operating and emergency conditions.

1.2.12 Each seat is to be fitted with a multi-point seat belt or other suitable device capable of retaining a person in the seat with no adverse effects to their health, during all normal operating and emergency conditions.

1.3 Instrumentation

1.3.1 Instruments required for use by any member of the operating crew are to be plainly visible and clearly legible:

- (a) with the minimum practical movement from the normal seating position and line of vision; and
- (b) with the minimum risk of confusion under all operating conditions and foreseeable emergency situations.

1.3.2 The following instrumentation is required as a minimum:

- (a) Wing incidence indicator (a means of direct and accurate measurement of wing incidence to provide timely warning of wing stall).
 - (b) Compass.
 - (c) Side slip indicator.
 - (d) Roll angle indicator.
 - (e) Means of accurately determining wind speed and direction for take-off and landing.
 - (f) Air speed (forward).
 - (g) Ground clearance.
 - (h) Propeller speed and pitch.
 - (j) Flap position.
 - (k) Engine speed and health parameters.
-

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter describes the Classification requirements for passenger compartments.

1.1.2 Plans showing the layout of all passenger compartments and the associated instruction manuals are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the compartments and location of equipment required in the technical requirements described in 1.2.

1.1.4 Survey of the craft at completion is to confirm that the physical arrangements of passenger compartments are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements

1.2.1 The passenger compartment is to be designed and constructed so that passengers are not exposed to unnecessary risk in all operating conditions and foreseeable failure conditions.

1.2.2 Arrangements are to be such that failure of controls, electrical wiring, pipelines, accessories and other items which could affect the safe operation of the craft, are not to be located in passenger compartments, unless such items are adequately shielded, isolated, or otherwise protected.

1.2.3 Operating controls essential to the safety or integrity of the craft are not to be located in passenger compartments unless the operating controls are so located that their operation by a crew member is unlikely to be impeded by passengers during normal and emergency conditions of operation.

1.2.4 Where controls and systems for the safe operation of the craft are necessarily located in passenger compartments, arrangements are to be made to prevent unauthorised operation by means of shielding, isolation or protection of the controls and systems.

1.2.5 Passenger compartments are not to contain or have adjacent to them high temperature parts or pipelines, rotating assemblies, electrical items or other items from which injury to passengers could result, unless such items are adequately guarded.

1.2.6 Means are to be provided to ventilate and control the temperature of the passenger compartment adequately, under all normal operating conditions.

1.2.7 Seats are to be attached to the craft frame, so that they will not become detached during all normal operating and emergency conditions.

1.2.8 Each seat is to be fitted with a lap seat belt or other suitable device capable of retaining a person in the seat during all normal operating and emergency conditions.

1.2.9 Systems and equipment are to be constructed and arranged so that in the event of failure or foreseeable misuse no hazardous quantities of smoke or toxic vapours will be distributed in passenger compartments.

1.2.10 Floors are to be slip resistant during all normal operating and emergency conditions.

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter describes the Classification requirements for cargo space arrangements.

1.1.2 Plans showing the layout of all cargo space compartments and associated instruction manuals are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the compartments and location of equipment required by the technical requirements of 1.2.

1.1.4 Survey of the craft at completion by LR is to confirm that the physical arrangements of cargo spaces are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements

1.2.1 Cargo spaces are to be arranged and located in the craft, so that any shifting of cargo or baggage during flight, does not adversely affect the stability of the craft.

1.2.2 Cargo spaces are to be arranged so as to prevent shifting of baggage, stores and cargo, having due regard to occupied compartments and accelerations likely to arise. If safeguarding by positioning is not practicable, adequate means of restraint for baggage stores and cargo are to be provided. Shelves and overhead shelves for carry on baggage in passenger accommodation are to be provided with adequate means to prevent the luggage from falling out in any conditions that are foreseeable.

1.2.3 Cargo spaces are to be arranged so they do not contain any high temperature parts, pipelines or other items that could affect the safe operation of the craft if damaged.

1.2.4 Cargo spaces are not to contain any controls which crew members require during a flight, unless such items are adequately protected so they cannot be damaged or, where applicable, operated inadvertently by loading, by unloading or by movement of the contents of the compartment.

1.2.5 Loading limits are to be durably marked in those compartments and are to indicate correct loading to ensure that Centre of Gravity of the craft is within the design limits.

1.2.6 Closures on luggage and cargo spaces are to be watertight.

Section**1 General****Section 1
General****1.1 Scope and information**

1.1.1 This Chapter describes the Classification requirements for machinery compartments.

1.1.2 Plans showing the layout of all machinery compartments and the associated instruction manuals are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the compartments and location of equipment required in the technical requirements described in 1.2 to 1.9.

1.1.4 Survey of the craft at completion by LR is to confirm that the physical arrangements of the machinery compartments are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements

1.2.1 Information necessary to ensure the effective monitoring of machinery for all normal craft operating conditions and reasonably foreseeable failure conditions is to be made available at the relevant control stations.

1.2.2 Instruments required for use by any member of the operating crew are to be plainly visible and clearly legible:

- (a) with the minimum practical deviation from their normal seating position and line of vision; and
- (b) with the minimum risk of confusion under all operating conditions and foreseeable emergency situations.

1.2.3 Means are to be provided to enable the operating crew to communicate between, and have access to each other in both normal and emergency conditions.

1.2.4 Means are to be provided to maintain the ambient conditions in which the operating crew work within limits such as not to unduly affect their skill, alertness or concentration.

1.2.5 Batteries and their housings are to be arranged to avoid electrolyte being ejected and to avoid the accumulation of vapours in places occupied by personnel in all normal operating and foreseeable failure conditions.

1.2.6 Movable guards are to be provided such that:

- (a) moving parts cannot start up while they are within the Operator's reach;
- (b) the exposed person cannot reach moving parts once they have started up;

- (c) they can be adjusted only by means of an intentional action, such as the use of a tool, key, etc.;
- (d) protection against any risk of ejection is proved by means of an appropriate barrier.

1.3 Electromagnetic compatibility

1.3.1 Systems are to be designed and installed such that they do not degrade from defined criteria stemming from susceptibility to electromagnetic interference sources. Reference may be made to IEC Publication 60533: *Electrical Installations in Ships, Electromagnetic Compatibility*.

1.4 Machinery fastenings

1.4.1 Bedplates, thrust seatings and other fastenings are to be of robust construction, and the machinery is to be securely fixed to the craft's structure to withstand all loads anticipated for normal operation and emergency conditions.

1.4.2 Machinery may be installed on rafts of rigid construction and these are to be of robust construction to ensure that alignment is maintained under all conditions of craft motion. The rafts are to be securely fixed to the craft's structure.

1.5 Resilient mountings

1.5.1 The Design Organisation is to ensure that the vibration levels of flexible pipe connections, shaft couplings and mounts remain within the limits specified by the component manufacturer for the conditions of maximum dynamic inclinations to be expected during service, start-stop operation and the natural frequencies of the system. Due account is to be taken of any creep that may be inherent in the mount.

1.5.2 Limit stops are to be fitted as necessary to ensure that manufacturers' limits are not exceeded. Suitable means are to be provided to accommodate the engine/propeller thrust.

1.5.3 Mounts are to be shielded from the possible detrimental effects of oil and where appropriate, paint and other contaminants.

1.6 Resin chocks

1.6.1 Synthetic resin compounds as materials for chocks under machinery where alignment is important are to be of a type accepted by LR.

1.6.2 The use of resin for chocking gas turbine casings or similar high temperature applications is not acceptable.

1.7 Ventilation

1.7.1 All spaces including machinery and pump spaces, where flammable or toxic gases or vapours may accumulate, are to be provided with adequate ventilation under all conditions.

1.7.2 Machinery compartments are to be sufficiently ventilated so as to ensure that when machinery therein is operating at full power in all normal operating conditions a sufficient supply of air is maintained to the spaces for operation of machinery.

1.7.3 The selection and arrangements of machinery and associated equipment are to minimise the emission of noxious substances into machinery compartments.

1.8 Fire protection

1.8.1 Means are to be provided to prevent the unintentional ignition of flammable liquids by ensuring they do not come into contact with surfaces sufficiently hot to cause ignition.

1.9 Personnel safety

1.9.1 All moving parts of machinery are to be provided with suitable grilles and/or guards to prevent injury to personnel.

1.9.2 Protection is to be provided to prevent injury from hot surfaces, i.e. by suitable lagging or guards.

1.9.3 Assemblies incorporating pre-loaded springs are to be engineered such that spring forces can be released in a controlled and safe manner during the removal and/or disassembly process.

1.9.4 Sufficient deck plates, platforms and handholds are to be fitted to provide safe access to all parts of the machinery and ensure safe passageway between machinery and adjacent equipment.

1.9.5 Materials used in the construction of machinery and installation of engineering systems are not to be a recognized hazard to personnel.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

ARRANGEMENTS FOR ACCESS, ESCAPE AND MAINTENANCE

JULY 2008

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Access Arrangements and Escape Routes

Volume 4, Part 3, Chapter 1

Section 1

Section

1 General

■ Section 1 General

1.1 Scope and information

1.1.1 This Chapter describes the Classification requirements for access and escape arrangements.

1.1.2 Plans showing the layout of all access and escape arrangements for all compartments are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the arrangements and the location of the equipment required in the technical requirements in 1.2.

1.1.4 Survey of the craft at completion by LR is to confirm that the physical arrangements are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements

1.2.1 An unobstructed passage, having dimensions at least equal to those of the normal exit, is to be provided between the exit and normal point of boarding.

1.2.2 It is to be possible to open normal exit doors from both inside and outside the craft. The means of operation are to be robust, rapid and obvious and are to be arranged so that it can be operated readily.

1.2.3 Emergency exits are to be capable of being operated during all foreseeable evacuation conditions.

1.2.4 Means are to be provided for securing normal exit doors in the open position.

1.2.5 Exit doors are to open outwards and are to remain attached to the craft at all times.

1.2.6 Exit doors are not to be capable of being opened during normal craft operation.

1.2.7 The craft is to have exits that are suitable to facilitate the escape of all occupants in emergency conditions. To this end, the number, size, location of and access to these exits is to be such that rapid evacuation of the occupants is possible when they are wearing life jackets. Where life jackets are of the inflatable type, it is to be assumed that they are inflated when occupants pass through the exit.

1.2.8 The edges of all emergency exits are to be designed to minimise the risk to occupants and to the puncture of inflatable life jackets.

1.2.9 In general at least two unobstructed evacuation paths are to be available for each occupant.

1.2.10 Evacuation paths are to be such that they cannot easily be obstructed and adequate evacuation facilities will be available in the event of any likely failure or emergency condition.

1.2.11 The dimensions of passages that form evacuation paths are to be such as to allow movement of occupants when wearing life jackets. There are to be no protrusions on evacuation paths that could snare clothing or damage life jackets.

1.2.12 Evacuation paths are to be arranged with due regard to the disposition of life saving equipment and the need to avoid regions where dangerous conditions are likely to exist.

1.2.13 Adequate notices are to be provided to direct passengers to emergency exits.

1.2.14 The arrangements are to be such that there is adequate space for a crew-member to stand adjacent to the exits to aid passenger disembarkation.

1.2.15 Escape routes and exits are to be clearly indicated using reflective signs, and where required by the Maritime Administration, audible and visual guides.

Arrangements for Maintenance, Inspection and Survey

Volume 4, Part 3, Chapter 2

Section 1

Section

1 General

■ Section 1 General

1.1 Scope and information

1.1.1 This Chapter describes the Classification requirements for maintenance, inspection and survey arrangements.

1.1.2 Plans showing the layout of all spaces and compartments requiring access arrangements for maintenance, inspection and survey are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to indicate the layout of the arrangements and the location of equipment required in the technical requirements of 1.2 and 1.3.

1.1.4 Survey of the craft at completion by LR is to confirm that the physical arrangements are in accordance with the design statement and the technical requirements of this Chapter.

1.2 Technical requirements – Machinery

1.2.1 Adjustment, lubrication and maintenance points are to be located to be readily accessible and minimise the hazards to those using those points.

1.2.2 It is to be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill.

1.2.3 Arrangements are to be such that authorised flight and maintenance crew have safe and effective access to parts and equipment that have to be changed routinely.

1.2.4 All machinery and equipment is to be fitted with means to isolate it from all energy sources. Such isolators are to be clearly identified. The isolators are to be capable of being locked if re-connection could endanger exposed persons.

1.2.5 After the energy supply has been cut off, there is to be provision to safely and effectively dissipate any remaining stored energy.

1.2.6 The isolator is to be capable of being locked also where an operator is unable, from any of the points to which they have access, to check that the energy is still cut off. After the energy is cut off, it is to be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to exposed persons. As an exception to the above requirements, certain circuits may remain connected to their energy sources in order, for example, to hold parts, protect information, light interiors, etc.

1.2.7 Provisions are to be made for inspecting visually and maintaining all items of equipment that have been identified as requiring visual inspection.

1.2.8 Removal routes for items of machinery and equipment are to be established where routine removal of major items of equipment is envisaged.

1.2.9 Provisions are to be made for all appropriate parts of the system to be adequately lubricated.

1.3 Technical requirements – Craft structures

1.3.1 Provisions are to be made for visually inspecting all areas of craft structure which have been identified by the Design Organisation and LR as requiring visual inspection.

1.3.2 Means are to be provided to allow inspection by non-destructive techniques to monitor crack growth, material thickness, etc., in areas identified as likely to require monitoring.

1.3.3 Means are to be provided to allow the replacement of parts expected to require replacement.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

LOADS AND ENVIRONMENTAL CONDITIONS

JULY 2008

VOLUME 5

PART 1

Lloyd's
Register

PART 1 LOADS AND ENVIRONMENTAL CONDITIONS

Chapter 1 General

2 Load Cases and Environmental Conditions

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*Section***1 Application**

■ **Section 1**
Application

1.1 Scope and information

1.1.1 The requirements of this Part of the Rules make provision for the structural loads and environmental conditions that are to be addressed for WIG effect craft within the scope of the applicable Principles of Classification and Criteria described in Vol 1, Part 2.

1.1.2 Design calculations covering all the load cases as required by Chapter 2 are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.1.3 The content of the submitted information is to demonstrate that, as a minimum, the technical requirements specified in this Part of the Rules have been satisfied.

1.1.4 This Chapter outlines the requirement for load-bearing structures.

1.2 Rule structural concept

1.2.1 The structure of the craft is defined as an assembly of four classes of structural arrangement:

- (a) Primary structure.
- (b) Secondary structure.
- (c) Machinery mounting structure.
- (d) Superficial structure.

1.2.2 The Rules are based on the premise that the structural and watertight integrity and general safe operation of the craft will not be compromised by static and dynamic loads experienced during all normal operating conditions and reasonably foreseeable abnormal conditions.

1.2.3 The role and duty of a WIG effect craft dictates that a certain degree of structural integrity is required for emergency conditions such as hard landing and collision, (survival conditions).

NOTE

It is recommended that, as a minimum standard, a basic level of structural redundancy is included where practicable. This is normally achieved by considering likely damage scenarios, identifying the effects on structure, assessing new loads and ensuring that the remaining structure will be satisfactory.

Load Cases and Environmental Conditions

Volume 5, Part 1, Chapter 2

Sections 1 to 5

Section

- 1 **General**
- 2 **Load cases**
- 3 **Equivalence**
- 4 **Submission of documentation**
- 5 **Request for exemption**
- 6 **Environmental conditions**

■ Section 1 General

1.1 General

1.1.1 This Chapter contains the load cases and environmental conditions that are required to be taken into account when undertaking the design of WIG effect craft.

1.1.2 All relevant combinations of loading cases are to be considered and taken into account where these are likely to result in critical loading on the craft.

■ Section 2 Load cases

2.1 Reference documents

2.1.1 The following documents or an equivalent thereto are to be used as a reference for the determination of all load cases:

- (a) Passenger or Commuter Type Craft are to be designed in accordance with the 'Joint Aviation Regulations' (JARs) Part 23, Airworthiness Standards: Normal, Utility, Aerobatic and Commuter Category Aeroplanes, Subpart C – Structure.
- (b) Transport or Freight Type Craft are to be designed in accordance with 'Joint Aviation Regulations' (JARs) Part 25, Airworthiness Standards: Transport Category Aeroplanes, Subpart C – Structure.

■ Section 3 Equivalence

3.1 Equivalence

3.1.1 Where it is proposed to use an alternative reference document to those referenced in Section 2 either in whole or in part, the Design Organisation is responsible for demonstrating that the proposed alternative provides equivalence to the requirements of Section 2.

■ Section 4 Submission of documentation

4.1 Documentation

4.1.1 The submission document is to clearly identify the critical loading case, controlling the design of a structural component, sub-assembly or unit.

4.1.2 Plans detailing the arrangements and scantlings of all primary and secondary structures and all machinery supporting structures are to be submitted for acceptance.

4.1.3 In demonstrating compliance with the requirement of 4.1.1, the document is also to identify the relevant structural drawings.

4.1.4 Design statements covering the following are to be submitted:

- (a) Craft structural configuration.
- (b) Machinery mounting structures.
- (c) Bolted structures.

■ Section 5 Request for exemption

5.1 Exemption

5.1.1 The Design Organisation may request an exemption from submitting a particular load case as required by the documents stated in Section 2.

5.1.2 A request for an exemption is to be made in writing by the Design Organisation to Lloyd's Register (hereinafter referred to as 'LR') clearly indicating the Subpart and paragraph and the reasons why an exemption should be granted.

5.1.3 Copies of correspondence agreeing to exemptions are to be incorporated into a section identified in the submission documents referred to in Section 4.

■ **Section 6**
Environmental conditions

6.1 Requirements

6.1.1 Environmental conditions relating to wind speed, sea state, ground speed and climate are to be defined for the assessments required by this Part of the Rules. There are two defined environmental conditions that require to be addressed in the design of a craft.

- (a) Survival.
- (b) Extreme.

6.1.2 There is to be an adequate margin between the Survival and Extreme environmental conditions such that there is a remote probability of encountering the Survival environmental conditions.

6.1.3 The design of the craft is to recognise Extreme environmental conditions for all flight operations within the operational envelope.

6.1.4 The craft is also to be designed to protect each occupant in an unscheduled landing in defined Survival environmental conditions.

6.1.5 Survival environmental conditions are those defined by the Design Organisation and which could be encountered due to unanticipated environmental changes in the area of operation during normal craft operating conditions.

6.1.6 Extreme environmental conditions are the most onerous conditions that may usually be encountered in the area of operation and are to be defined by the Design Organisation. The conditions are not to exceed those for which compliance with the relevant sections pertaining to handling, performance and structural requirements is required.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

STRUCTURAL STRENGTH AND WATERTIGHT INTEGRITY

JULY 2005

VOLUME 5

PART 2

Lloyd's
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	4.1	Protection

Section

- 1 Application and scope**
- 2 Technical requirements**
- 3 Fabrications and assemblies**
- 4 Protection of structure**

■ **Section 1** **Application and scope**

1.1 Application

1.1.1 This Chapter describes the Classification requirements for the design of a craft that provides for the structural strength and watertight integrity of the craft.

1.1.2 Plans, calculations and details supporting the craft structural strength and watertight integrity, are to be submitted in triplicate.

1.1.3 The content of the submitted information is to demonstrate that the craft has been designed and constructed to have strength and watertight integrity sufficient for its intended purpose in all normal operating and foreseeable failure conditions.

1.1.4 Trials, testing and survey conducted by Lloyd's Register (hereinafter referred to as 'LR') on completion of the craft will be required to confirm the design assumptions. These trials are to be in accordance with the requirements of Volume 7 of these Rules.

■ **Section 2** **Technical requirements**

2.1 Structural strength

2.1.1 The structure is to be capable of supporting defined limit loads without detrimental permanent deformation. At any load up to limit loads, the deformation is not to interfere with safe operation. Factors of safety used in the design are to be declared and agreed by LR.

2.1.2 Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application and associated load magnitude are to be considered.

2.1.3 The craft is to be designed to withstand any vibration and buffeting that might occur in any likely operating condition, including stall. This is to be shown by analysis, flight tests, or other applicable tests.

2.1.4 Unless shown to be extremely improbable, the craft is to be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system.

2.1.5 Compliance with the strength and deformation requirements of this Part of the Rules is to be shown for each critical loading condition. Structural analysis may be used only if the structure conforms to that for which experience has shown this method to be reliable. In general ultimate load tests and limit load tests are to be conducted in accordance with the requirements of Volume 7 of these Rules.

2.1.6 Each part of the craft near the propeller tips is to be of sufficient strength and stiffness to withstand the effects of the induced vibration, ice thrown from the propeller or debris arising from the collapse of the blade.

2.1.7 Craft are to be designed for the water loads developed during takeoff and landing, with the craft in any attitude likely to occur in normal operation, and at the appropriate forward and sinking velocities under the most severe sea conditions likely to be encountered.

2.1.8 The craft, although it may be damaged in emergency landing conditions on water, is to be designed to protect each occupant under those conditions.

2.1.9 Unless it can be demonstrated that the wing tips/floats cannot contact the water in flight, the tips (or floats) are to have sufficient strength to withstand water contact whilst in flight. The effects of wing tip/float contact with water on the dynamic behaviour of the craft are not to be such that the resulting motion endangers the craft or its occupants.

2.1.10 All craft are to be designed and constructed so as to minimise the risk of significant fire damage that could effect the structural strength and watertight integrity prior to landing and the complete evacuation of the craft following the event of fire.

2.1.11 The strength and fabrication of the craft are to be such that there is a very low probability of fatigue failure of any part of the primary structure under the action of repeated loads of variable magnitude expected during the specified life of the part.

■ **Section 3** **Fabrications and assemblies**

3.1 Fabrication

3.1.1 Each removable bolt, screw, nut, pin, or other removable fastener is to incorporate two separate locking devices suitable for their intended purpose, if its loss or failure would have detrimental effects on the operation of the craft.

3.1.2 The methods of fabrication employed are such as to produce a consistently sound primary structure. The structure shall also be reliable with respect to maintenance of the required strength under all conditions anticipated in operation. Where an operation requires close control to attain these objectives, the processes are to be performed according to an approved process specification. Each fabrication method is to be substantiated by a test programme.

■ **Section 4**
Protection of structure

4.1 Protection

4.1.1 Each part of the structure is to be suitably protected against deterioration or loss of strength in service due to any potential impact or abrasion source likely to be encountered during normal operation.

4.1.2 Where the materials used for craft structure can be affected by exposure to sunlight, sea spray or extreme temperatures associated with operating and climate conditions, they are to be protected against deterioration and loss of strength.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

WATERBORNE CHARACTERISTICS

JULY 2008

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Waterborne Requirements

Volume 5, Part 3, Chapter 1

Sections 1 & 2

Section

1 Application

2 Technical requirements

■ Section 1 Application

1.1 Scope and information

1.1.1 This Part of the Rules describes the Classification requirements for hydrodynamic characteristics and buoyancy of WIG effect craft, in all modes of operation.

1.1.2 Plans, calculations and details supporting the craft hydrodynamic stability and buoyancy design, are to be submitted in triplicate.

1.1.3 The content of the submitted information is to demonstrate that, as a minimum, the technical requirements specified in this Part of the Rules have been satisfied.

1.1.4 Trials and testing witnessed by Lloyd's Register (hereinafter referred to as 'LR') on completion of the craft will be required to confirm the design assumptions. These trials are to be in accordance with the requirements of Volume 7 of these Rules.

■ Section 2 Technical requirements

2.1 Buoyancy

2.1.1 Each craft is to be provided with a current Stability Book approved by LR including:

- (a) Designation and identification of craft.
- (b) Copy of actual weighing record including corrections used for weighing equipment and statement as to when the equipment was last calibrated.
- (c) Calculations made to correct for actual craft build standard at time of weighing in order to determine craft basic weight and corresponding centre of gravity position.
- (d) Lever arms to be used for items of disposable load and oil, baggage, cargo and seated passengers (75 kg plus 9 kg hand luggage) in the various seating layouts obtainable.
- (e) Maximum total useable capacities and weights of fuel and oil in their appropriate tanks and the effect, if critical, of fuel burn-off on the centre of gravity position.
- (f) Maximum weights allowed in each baggage compartment, cargo bay or passenger cabin as applicable.
- (g) The lever arms to be used and weights of removable ballast.

- (h) Instructions and advice on loading procedures and methods.
- (i) Example of a loading and centre of gravity calculation typical for the craft.

2.1.2 Where any alterations are made to a craft so as to materially affect the stability information supplied to the pilot, amended stability information should be provided. If necessary, the craft is to be re-inclined.

2.1.3 All craft are to have sufficient reserve of buoyancy at the design waterline to meet the intact and damage stability requirements. This reserve of buoyancy is calculated by including only those compartments that are:

- (a) watertight;
- (b) accepted as having scantlings and arrangements adequate to maintain their watertight integrity; and
- (c) situated in locations below a datum, which may be a watertight deck or equivalent structure of a non-watertight deck covered by a weathertight structure.

2.1.4 Arrangements are to be provided for checking the watertight integrity of those compartments taken into account in 2.1.3.

2.1.5 The design and distribution of buoyancy compartments are such that the craft, at maximum weight, shall remain substantially upright in the displacement mode with a minimum of 100% reserve buoyancy and stability when:

- (a) intact in the extreme environmental conditions; and
- (b) when damaged within the postulated limits in the worst intended environmental conditions.

2.1.6 The use of low density foam or other media to provide buoyancy in void spaces will be acceptable to LR, provided that satisfactory evidence is provided that any such proposed medium is the most suitable alternative and is:

- (a) of closed cell form if foam, or otherwise impervious to water absorption;
- (b) structurally stable under service conditions;
- (c) chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact; and
- (d) properly secured in place and easily removable for inspection of the void spaces.

2.1.7 The craft is to have accurately determined and permanent draught marks. Accuracy of the draught marks is to be demonstrated prior to the inclining experiment. Draught indication is to be provided at forward and after positions of the fuselage and at the geometric centre of the craft.

2.1.8 The craft is to be free from dangerous or uncontrollable porpoising characteristics at any normal operating speed on the water whilst the craft is airborne.

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AIRBORNE CHARACTERISTICS

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Chapter 1 Airborne Requirements

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2.1 Aerodynamic stability

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Sections 1 & 2

Section

1 Application

2 Technical requirements

■ Section 1 Application

1.1 Scope and information

1.1.1 This Part of the Rules describes the Classification requirements for aerodynamic stability, flight and handling characteristics of WIG effect craft, in all modes of operation.

1.1.2 Plans, calculations and details supporting the craft design, aerodynamic stability, flight and handling characteristics are to be submitted in triplicate.

1.1.3 The content of the submitted information is to demonstrate that, as a minimum, the technical requirements specified in this Part of the Rules have been satisfied.

1.1.4 Trials, testing and survey conducted by Lloyd's Register (hereinafter referred to as 'LR') on completion of the craft will be required to confirm the design assumptions. These trials are to be in accordance with the requirements of Volume 7 of these Rules.

■ Section 2 Technical requirements

2.1 Aerodynamic stability

2.1.1 WIG effect craft are to be safely controllable and manoeuvrable during:

- (a) takeoff;
- (b) level flight, and landing;
- (c) increasing altitude above the ground effect altitude and returning to the design flight altitude (Type B craft only).

Due cognisance is to be taken of the likely positions of the centre of gravity of the loaded craft.

2.1.2 It is to be possible to make a smooth transition from one flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of damage to the craft occurring, during all normal and foreseeable failure conditions.

2.1.3 It is to be possible in all anticipated conditions of loading, configuration, speed and power to ensure that the pilot will not be unduly fatigued or distracted by the need to apply control forces.

2.1.4 Evidence is to be provided to show that the craft has been designed and constructed such that the static margin is sufficiently large to ensure that the craft can maintain stable flight of uniform altitude without undue input by the pilot.

2.1.5 Evidence is to be provided to show that the static margin of the craft is not so large as to prevent desired manoeuvrability, without undue input from the pilot.

2.1.6 The craft is to be capable of safely recovering from sideslip with the rudder and ailerons free.

2.1.7 The craft is to be designed to ensure that the flying and handling qualities are such that they provide adequate task performance and flight safety in all phases of flight.

2.1.8 The craft is to be statically stable and all dynamic instabilities are to be such that they do not cause an unacceptable increase in pilot workload or otherwise endanger the craft.

2.1.9 The craft is to be arranged such that the pilot can trim the craft during all normal operation without undue exertion. See Vol 6, Pt 2, Ch 2 for control system requirements.

2.1.10 If the craft is capable of stall during normal operation or emergency operating conditions the following are to be satisfied:

- (a) There is to be a clear and distinctive stall warning.
- (b) The stall warning may be furnished either through the inherent aerodynamic qualities of the craft or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable in itself.
- (c) During the stall tests, it is to be demonstrated that the stall warning is to begin sufficiently in advance of the stall for the stall to be averted by pilot action taken after the stall warning first occurs.

2.1.11 It is to be possible to produce and to correct roll by unreversed use of the rolling control and to produce and to correct yaw by unreversed use of the directional control, up to the time the craft stalls.

2.1.12 After the craft has stalled, it is to be possible to regain level flight, or a safe re-entry into the water by normal use of the flight controls but without increasing power and without:

- (a) Undue pitch-up.
- (b) Exceeding the maximum permissible speed or allowable limit load factor.
- (c) During the entry into and the recovery from the manoeuvre, it is to be possible to prevent excessive roll or yaw by the normal use of controls.

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SCOPE AND PROVISIONS

JULY 2008

VOLUME 6

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General Requirements**Volume 6, Part 1, Chapter 1**

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*Section***1 Application****2 General provisions****■ Section 1
Application****1.1 Scope and information**

1.1.1 This Volume states the classification requirements for the design, construction, installation and testing of engineering systems and covers the following systems:

- (a) Propulsion and mechanical drive systems.
- (b) Directional control systems.
- (c) Electrical power generation and distribution systems.
- (d) Fluid distribution systems.
- (e) HVAC and lighting.
- (f) Anchoring, towing, berthing and ground handling systems.

1.1.2 This Part of the Rules contains the general requirements pertaining to the systems listed in 1.1.1.

1.1.3 Detailed and additional system specific requirements are contained in Parts 2 to 6 of this Volume.

**■ Section 2
General provisions****2.1 Provisions**

2.1.1 All submissions to Lloyd's Register (hereinafter referred to as 'LR') are to be in SI units.

2.1.2 It is the responsibility of the Builder to ensure that the information required, is prepared and submitted.

2.1.3 All systems covered by this Volume are to be assembled of approved equipment and components.

2.1.4 Systems are to be capable of functioning at design performance requirements for the most onerous operating conditions in which they are reasonably expected to operate in.

2.1.5 Where it is proposed to depart from the requirements of this Volume, this is to be advised to LR declaring that the requirements imposed by the relevant criteria of Vol 1, Part 2 have not been compromised.

2.1.6 A Failure Mode and Effect Analysis (FMEA) is to be carried out covering the following systems:

- (a) Propulsion and auxiliary machinery systems supporting propulsion, directional control or other essential services.
- (b) Aerodynamic control systems.
- (c) Electrical generation and distribution systems supporting (a) and (b).

2.1.7 Where a FMEA is required by this Volume, it is to be carried out in accordance with Vol 3, Pt 2, Ch 2. The analysis is to demonstrate that suitable risk mitigation has been achieved so that the system will tolerate a single failure with regard to the criteria specified in Vol 1, Pt 2, Ch 1,8.2.9 and 8.2.10.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

PROPULSION AND AERODYNAMIC CONTROL SYSTEMS

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PART	6	ANCHORING, TOWING AND ASSOCIATED HANDLING SYSTEMS

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Propulsion and other Mechanical Drive Systems

Volume 6, Part 2, Chapter 1

Section 1

Section

1 General

■ Section 1 General

1.1 Scope and information

1.1.1 This Chapter states the Classification requirements for propulsion and other mechanical drive systems.

1.1.2 Propulsion systems are those systems that are installed on the craft to generate thrust to propel the craft for flight and taxi operations.

1.1.3 Other mechanical drive systems are those systems such as generator sets, harbour manoeuvring units, motor driven pumps, etc. that are of either Mobility or Craft Function category systems.

1.1.4 Mechanical drive systems are to be constructed to deliver the designed power (P , kW) at engine speed (RPM) to the propulsion device(s) or other driven load.

1.2 Particulars to be submitted

1.2.1 Three copies of the following plans are to be submitted for mechanical drive systems:

- Details of prime movers for propulsion and electrical generators.
- Shafting arrangement.
- Details of all shafts and protection.
- Shaft bearings.
- Bearing supports.
- Couplings.
- Coupling bolts.
- All other safety critical or torque/load transmitting components such as clutches and flexible couplings.

1.2.2 The general shaft arrangement plan is to indicate the relative position of the engines, flywheel, clutches, flexible coupling, gearing, thrust arrangement, bearings and propulsion device, as appropriate.

1.2.3 Where installations include electric motors, generators or non-integral pumps, drawings showing the principal dimensions of the shaft, together with the manufacturer's estimates of mass moment of inertia for the rotating parts are to be submitted.

1.2.4 Failure Mode and Effects Analysis (FMEA) as required by Pt 1, Ch 1 is to be submitted. The FMEA is to include the following associated sub-systems:

- Clutches.
- Flexible couplings.
- Lubrication.
- Cooling arrangements.
- Fuel Systems.
- Bearing mountings.

- Control and monitoring.
- Electrical power supplies.
- Thrust blocks.

It is not necessary to consider failure modes relating to the shafting components.

1.2.5 The following calculations and specifications are to be submitted:

- (a) Calculations, or relevant documentation indicating the suitability of all components for short term high power operation, where applicable.
- (b) Fatigue endurance calculations and data of all components.
- (c) Vibration analysis and alignment analysis as detailed in 1.6 and 1.7.
- (d) The material specifications, including the minimum specified tensile strength of each shaft and coupling components are to be stated.
- (e) Where it is proposed to use composite (non-metallic) shafts, details of materials, resin, lay-up procedure and documentary evidence of fatigue endurance strength, are to be submitted.

1.3 Acceptance

1.3.1 Acceptance of the mechanical drive system will only be granted where the Design Organisation has demonstrated that the system is adequate for its intended purpose taking due account of the craft operating conditions outlined in Vol 4, Pt 2, Ch 2.

1.3.2 Where the machinery is being considered for short term high power operation full details of the power, speed and time intervals together with fatigue endurance calculations, and documentary evidence indicating the suitability of the component design under these conditions and for the intended class notation are required. Consideration is to be given to the prime mover, gearbox, flexible coupling, clutch, vibration dampers, shafting and propulsion device recognising the following:

- (a) The accrued number of load cycles and the percentage component overload are to be those recommended by the designers.
- (b) Excessive overload may require the interval between surveys to be reduced.
- (c) Plans showing the arrangement of resiliently mounted machinery which are to indicate the number, position, type and design of the mounts.
- (d) The manufacturer's requirements for machinery operation and maintenance.
- (e) Vibration damper and flexible coupling characteristics.

1.4 Performance

1.4.1 The main propulsion system is to be such that it delivers sufficient power to the propulsion unit to generate the thrust required for safe and effective flight.

1.4.2 Any auxiliary propulsion system is to be such that it delivers sufficient power to the auxiliary propulsion unit to generate the thrust necessary for safe and effective taxiing operations.

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1.5 Load transmission

1.5.1 Mechanical drive systems are to be designed and installed so that high torques arising from a component failure will not damage other components and equipment in the system.

1.5.2 Where torque overload protection is provided by failure of a 'weak-link', the component is to be such that it will not shed parts that may result in a hazard to personnel or damage the integrity of the craft structure.

1.5.3 The system is to be designed so that failure of any component part which results in flailing will not result in hazard to personnel.

1.5.4 There is to be adequate clearance between the propeller tip and other surfaces to allow for creep of the propeller in extremes of temperature and expected craft deflections.

1.6 Shaft vibration

1.6.1 The Design Organisation is to submit sufficient calculations and supporting information to demonstrate that the propulsion system has been designed and manufactured to ensure that:

- there are no critical speeds within the operating profile;
- critical speeds below the operating range can be passed through quickly; and
- all shaft system components are suitably designed for the additional loads which they are subject to due to vibrations.

1.6.2 Vibration calculations for the entire system, utilising recognised techniques are to consider torsional, lateral and axial modes of vibration, and where applicable the effects of cross coupling of these modes.

1.6.3 The submission of calculations should also contain details of the principal characteristics of machinery components such as dampers, clutches and couplings, confirming their capability to withstand the effects of vibratory loading including, where appropriate, heat dissipation. Evidence that the data that is used to represent the characteristics of components, which has been quoted from other sources, is supported by a programme of physical measurement and control.

1.6.4 Details of vibration or performance monitoring proposals are to be submitted where required.

1.6.5 Calculations are to give due consideration to the potential deviation in values used to represent component characteristics due to manufacturing/service variability.

1.6.6 The calculations are to take account of the effects of engine malfunction commonly experienced in service, such as a cylinder not firing. Calculations are also to take account of a degree of imbalance between cylinders, characteristic of the normal operation of an engine under service conditions.

1.6.7 Calculations are to include estimates of all component stress at all designated operating/service speeds, as well as at any major critical speed.

1.6.8 Calculations are to take into account the possible effects of excitation from propeller rotation. Where the system shows some sensitivity to this phenomenon, propeller makers' data should be used as a basis for calculation, and submitted.

1.6.9 Where the torsional stiffness of flexible couplings varies with torque, frequency or speed, calculations should be representative of the appropriate range of effective dynamic stiffness.

1.6.10 Where preliminary calculations indicate a possibility of a resonance in the operating range, more detailed forced damped calculations are to be performed and submitted indicating the vibratory amplitudes are within designer's limits.

1.7 Shaft and drive alignment

1.7.1 Shaft and drive alignment calculations are to be submitted to demonstrate that the design of the shaft system is such that the shafts will not be excessively deflected and that the load and relative slope of shafts through all bearings is in accordance with the design capabilities of the bearing.

1.7.2 The calculations are to be performed for all normal operating conditions taking into account structural deflections in all load and thermal conditions.

1.7.3 The Builder/Design Organisation is to submit an alignment procedure indicating installation sequences and measurements to ensure correct alignment of machinery and shafts.

1.8 Measurements

1.8.1 Where calculations indicate that the system is likely to be adversely affected by vibration and/or shaft misalignment, measurements using recognised techniques are to be performed to demonstrate that a hazardous situation does not occur in practice.

1.8.2 The measurement techniques and results are to be submitted to Lloyd's Register (hereinafter referred to as 'LR').

1.9 Testing requirements

1.9.1 The performance of mechanical drive systems is to be demonstrated at full power in accordance with an agreed trials schedule. Engine changeover arrangements are to be demonstrated where applicable.

1.9.2 It is to be demonstrated that all driven devices perform satisfactorily and without excessive vibration in all intended operating modes.

1.9.3 It is to be demonstrated that large movements of resiliently mounted machinery do not occur during normal operating conditions.

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter states the Classification requirements for directional control systems.

1.1.2 Aerodynamic control systems are those required for the purposes of controlling the direction of the craft and aerodynamic behaviour of the craft.

1.1.3 The craft control system is to have adequate strength and suitable design to enable the craft's direction of travel to be effectively controlled without undue physical effort at all speeds and in all conditions for which the craft is classed.

1.1.4 Directional control systems belong to the Mobility category engineering systems.

1.1.5 Directional control may be achieved by means of air and/or water rudders, foils, flaps, steerable propellers, yaw control port or side thrusters, differential propulsive thrust, control surfaces, variable geometry of the craft or its lift system components or by a combination of these devices.

1.2 Particulars to be submitted

1.2.1 A general statement of the intended modes of operation and the theory behind the design intent is to be submitted together with any supporting information and plans.

1.2.2 An FMEA for the directional control systems as required by Part 1, Chapter 1 is to be submitted to Lloyd's Register (hereinafter referred to as 'LR'). The FMEA is to address the failure conditions identified in this Chapter and is to include the following sub-systems:

- (a) Actuating.
- (b) Securing/mounting.
- (c) Control and monitoring.
- (d) Electrical power supplies.

1.3 Performance

1.3.1 WIG effect craft are to be shown by analysis, tests, or both, to be capable of continued safe flight and landing after any of foreseeable failure conditions in the flight control system and surfaces (including trim, lift, drag, and feel systems), within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable malfunctions are to have only minor effects on control system operation and are to be capable of being readily counteracted by the pilot.

1.3.2 Power assisted steering controls are to be capable of being operated without undue physical exertion in the event of power system failure.

1.3.3 The control systems are to be of adequate strength to withstand all the loads which the pilot can exert on them during normal operation and emergency conditions. This is to include wind gust and wing tip strike.

1.3.4 Each element of each directional control system is to be designed, or distinctively and permanently marked, to minimise the probability of incorrect assembly that could result in the malfunctioning of the system.

1.3.5 A design incorporating a power drive or an actuation system employing powered components for normal directional control is to provide a secondary means of actuating the device, which may be manually driven, unless an alternative system is provided.

1.3.6 Aerodynamic control systems are to be constructed so that a single failure in one drive or system, as appropriate, will not render any other one inoperable.

1.3.7 All directional control positions are normally to be operated from the craft's operating station.

1.3.8 If directional control systems can be operated from other positions, then two-way communication is to be arranged between the operating station and these other positions.

1.3.9 Adequate indications are to be provided at the operating station and these other positions to provide the person controlling the craft with verification of the correct response of the directional control device to this demand, and also to indicate any abnormal responses or malfunction.

1.3.10 The indications of steering response or rudder angle indicator are to be independent of the system for directional control. The logic of such feedback and indications are to be consistent with the other alarms and indications so that in an emergency, operators are unlikely to be confused.

1.3.11 Wherever practicable, the sense of motion involved in the operation of all controls is to correspond with the sense of the response either of the craft or, if the craft response is relatively unimportant, of the part operated.

1.3.12 All control systems are to be designed and installed so as to prevent any jamming, chafing, interference by passengers, cargo, or loose objects.

1.3.13 All control systems are to be provided with stops which positively limit the range of movement of the operator's controls and are so located in the control systems that the range of travel of the control surface is not appreciably affected by wear, slackness or tensioning adjustments.

1.3.14 Power operated/assisted control systems are to be designed to ensure that the malfunctioning of the power control unit or the failure of the power supply will not affect an alternate control system nor impair the safety of the vessel or its occupants.

1.3.15 The craft is to be designed so that it is controllable if it loses propulsion power. Compliance with this requirement may be shown by analysis where that method has been shown to be dependable.

1.3.16 It is to be possible to adjust and set the trim prior to flight so as to allow the pilot the necessary craft response to control lever adjustments, without unnecessary effort or concentration.

1.4 Testing requirements

1.4.1 In general, testing and trials are to be conducted to demonstrate that the control system has adequate strength and performance to enable an appropriately qualified pilot to perform the tasks for which the craft has been designed, noting that the design is in accordance with these Rules and Regulations.

1.4.2 Trials are in particular to demonstrate that the system:

- (a) Is free from jamming;
- (b) is free from excessive friction;
- (c) can be operated without excessive physical force; and
- (d) is able to tolerate the forces which may be imposed during emergency conditions.

1.4.3 Limit load tests of control surfaces are required. These tests are to include the horn or fitting to which the control system is attached.

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ELECTRICAL SYSTEMS

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Electrical Generation and Distribution Systems

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Section 1

Section

1 General

■ Section 1 General

1.1 Scope

1.1.1 This Chapter states the Classification requirements for electrical generation and distribution systems. See also Pt 1, Ch 1,2.1 for general provisions, including Failure Modes and Effect Analysis (FMEA) requirements.

1.1.2 See Vol 9, Pt 4, Ch 1 for electrical equipment requirements.

1.2 Information to be submitted

1.2.1 Single line diagrams of the electrical power generation and distribution system are to be submitted in triplicate, and are to include the following information:

- (a) ratings of machines, transformers, batteries and semiconductor converters;
- (b) all feeders connected to switchboards and distribution boards;
- (c) details of major system components including switchboards, distribution boards, cables and protective devices and their ratings under normal and fault conditions.

1.2.2 Plans detailing the protection and control arrangements are to be submitted in triplicate.

1.2.3 Short circuit calculations identifying the prospective fault current level at switchboards and distribution boards, together with supporting information to demonstrate co-ordination of protective devices (e.g. discrimination curves), are to be submitted in triplicate.

1.2.4 A schedule of electrical loads for the different operating conditions is to be submitted.

1.3 Safety and dependability

1.3.1 Electrical generation and distribution systems are to ensure the safe and dependable supply of electrical power to consumers, for all normal craft operation and foreseeable failure conditions with due regard to electromagnetic compatibility, galvanic corrosion and other such phenomena that may impact upon the *Provisions of Classification*.

1.3.2 The safety of passengers, crew and craft from electrical hazards is to be ensured.

1.3.3 Arrangements are to be such that any features required by these Rules as a Provision of Classification or by the Maritime Administration are not impaired as a result of the electrical installation, e.g. fire integrity of bulkheads with cable penetrations.

1.3.4 Where arrangements are provided to maintain specified environmental conditions, the functioning of Mobility category systems is not to be impaired as a result of their operation or in the event of failure of a single item of equipment forming part of these arrangements.

1.3.5 Information necessary to ensure the effective monitoring of electrical generation and distribution arrangements for all normal craft operation and foreseeable failure conditions is to be made available at the relevant control station(s).

1.4 Sources of electrical power

1.4.1 Electrical power sources are to be mutually independent in their operation, such that failure or malfunction of any power supply will not impair remaining supplies.

1.4.2 In the event of failure of any one supply, the remaining supplies are to be of adequate capacity such that the functioning of Mobility category systems will not be impaired for the period required for the craft to reach safe refuge.

1.4.3 An emergency source of electrical power is to be provided and installed such that the supply and distribution of emergency power is not affected by any equipment located in the space containing the main source(s) of power, or by fire or other hazards that may affect this space.

1.4.4 Equipment required by the Maritime Administration to remain operational in an emergency is to be supplied from the emergency source of power in the event of failure of the main supply. Changeover is to be effected without manual intervention within a period of 20 seconds.

1.4.5 The emergency source is to be of adequate capacity and capability to simultaneously supply all equipment remaining operational in an emergency for the period required by the Maritime Administration, with due regard to the prevailing circumstances.

1.4.6 Provisions are to be made for the testing of the emergency source of power under load.

1.5 Protection and control

1.5.1 Means are to be provided to ensure that the supply of power to consumers is automatically maintained within specified limits of frequency and voltage in normal operation under both steady state and transient conditions.

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1.5.2 Means are to be provided, independent of those required by 1.5.1, to automatically disconnect the source of power in the event of malfunction and, where applicable, under reverse power conditions after an appropriate time delay.

1.5.3 Where arrangements are made for the automatic sharing of load between sources of power, the arrangements are to be such that the sharing is proportionate and stable with due regard to load fluctuations.

1.5.4 Means are to be provided to minimise the risk of loss of supply to Mobility category systems and emergency equipment caused by the operation of other electrical loads.

1.5.5 Installations are to be adequately protected against electrical faults, including short circuit and overload.

1.5.6 The protection arrangements are to be co-ordinated to isolate and clear faults, and ensure that the Mobility category systems and other equipment required in an emergency will remain available as far as possible.

1.5.7 Each circuit is to be provided with means of isolation at the point of distribution, capable of manual operation and of withstanding, without damage, any over-current arising from a fault condition.

1.5.8 Where an external power supply may be connected, permanent means are to be provided to check the phase sequence or polarity of the incoming supply.

1.5.9 All major system components, capable of electrical conduction are to be electrically bonded to other parts of the craft.

1.6 Distribution systems

1.6.1 The distribution system is to be arranged to minimise the risk of equipment failure, fire or other hazard resulting in a loss of supply to mobility-category systems or emergency equipment.

1.6.2 Where equipment is supplied from two independent circuits, these are to be separated as widely as practicable throughout their length. Common components are to be avoided as far as is practicable. Where common components are used, these are to be arranged to minimise the risk of common mode failures of both supplies.

1.6.3 Non-current carrying parts of equipment are to be adequately earthed unless shrouded, insulated or otherwise arranged so as to prevent contact with persons or metallic parts. Equipment directly supplied at a voltage of 55V (d.c. or rms a.c.) or less, between any conductor and earth, may be exempted from this requirement.

1.6.4 Insulated distribution systems are to be provided with permanent means of monitoring resistance to earth.

1.7 Performance

1.7.1 The voltage and frequency measured simultaneously at consumer input terminals are not to exceed the following variations from their nominal value:

- (a) Voltage:
permanent variations +6%, -10%
transient variations +20%, -15%
recovery time 1,5 seconds.
- (b) Frequency:
permanent variations +5%, -5%
transient variations +10%, -11%
recovery time 5 seconds.

1.7.2 The total harmonic distortion of the voltage waveform at any switchboard is not to exceed 8 per cent for all frequencies up to 50 times the supply frequency. At frequencies above 25 times the supply frequency, no voltage is to exceed 1,5 per cent of the supply voltage.

1.8 Trials requirements

1.8.1 Before a new installation, or any alteration to an existing installation, is put into service the tests identified in 1.8.2 to 1.8.7 are to be completed to the satisfaction of the attending Surveyor. These tests are in addition to any tests carried out on items of equipment at the manufacturer's works, see Vol 9, Pt 4, Ch 1.

1.8.2 The insulation resistance is to be measured of all circuits and electrical equipment, using a direct current insulation tester, between:

- (a) all current carrying parts connected together and earth and, so far as is reasonably practicable; and
 - (b) all current carrying parts of different polarity or phase.
- The minimum values of test voltage and insulation resistance are given in Table 1.1.2 of Vol 9, Pt 4, Ch 1. The installation may be subdivided and appliances may be disconnected if initial tests produce results less than these figures.

1.8.3 Tests are to be made to verify the effectiveness of:

- (a) earth continuity conductor;
- (b) the earthing of non-current carrying exposed metal parts of electrical equipment and cables not exempted by 1.6.3;
- (c) bonding for the control of static electricity.

1.8.4 It is to be demonstrated that the Rules have been complied with in respect of:

- (a) satisfactory performance of each generator throughout a run at full rated load;
- (b) temperature of joints, connections, circuit-breakers and fuses;
- (c) the operation of engine governors, synchronising devices, overspeed trips, reverse-current, reverse-power and over-current trips and other safety devices;
- (d) voltage regulation of every generator when full rated load is suddenly thrown off and when starting the largest motor connected to the system;
- (e) satisfactory parallel operation, and kW and kVA load sharing of all generators capable of being operated in parallel at all loads up to normal working load;

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- (f) all essential and other important equipment are to be operated under service conditions, though not necessarily at full load or simultaneously, for a sufficient length of time to demonstrate that they are satisfactory.

1.8.5 Voltage drop is to be measured to verify that this is not in excess of that specified by the performance requirements of 1.7.

1.8.6 All electric equipment located in hazardous areas is to be examined to ensure that it is of an acceptable type, has been installed in compliance with its certification, and that the integrity of the protection concept has not been impaired.

1.8.7 Alarms and interlocks associated with pressurised equipment and the ventilation of spaces located in hazardous areas are to be tested for correct operation.

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FLUID SYSTEMS

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CHAPTER 1 FLUID DISTRIBUTION SYSTEMS

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- 1.8 Hydraulic system design
- 1.9 Testing requirements

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter states the Classification requirements for fluid distribution systems.

1.1.2 It is a condition of class that a Flexible Hose Register is maintained on the craft and all hoses are inspected and replaced on an agreed cycle.

1.2 Particulars to be submitted

1.2.1 Three copies of plans of all piping and pressure systems supporting or comprising Mobility or Craft Function systems and any other system containing flammable fluids are to be submitted for approval.

1.2.2 All plans are to be submitted in schematic form using internationally recognised system of symbols.

1.2.3 Design calculations for pressurised and lifed components are to be submitted for appraisal.

1.2.4 Where components are susceptible to corrosion calculations determining residual strength after critical periods of time are to be submitted.

1.3 Fuel systems

1.3.1 Each fuel system is to provide not less than 100 per cent of the fuel flow at required pressure under each intended operating and manoeuvre condition.

1.3.2 For each engine, the fuel system is to supply the full fuel pressure to that engine as quickly as practicable after switching to any other fuel tank containing usable fuel when engine malfunctioning becomes apparent due to the depletion of the fuel supply in any tank from which the engine can be fed.

1.3.3 In addition to the manual switching required by 1.3.2, each turbine engine is to be designed to prevent interruption of fuel flow to the engine, without attention by the flight crew, when any tank supplying fuel to the engine is depleted of usable fuel during normal operation, and any other tank, that can normally supply fuel to that engine contains usable fuel.

1.3.4 Each fuel system is to be arranged so that any air which is introduced into the system will not result in power interruption resulting in forcing the craft to land.

1.3.5 Each fuel system for a turbine engine is to be capable of sustained operation throughout its flow and pressure range with fuel conditions likely to be encountered during operation.

1.3.6 Proper fuel system functioning under all normal operating conditions is to be shown by analysis and through tests identified by the Design Organisation or Lloyd's Register (hereinafter referred to as 'LR'). Tests, if required, are to be made using the craft fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

1.3.7 The likely failure of any heat exchanger using fuel as one of its fluids is not to result in a hazardous condition.

1.3.8 If fuel can be pumped from one tank to another in flight, the fuel tank vents and the fuel transfer system are to be designed so that no structural damage to the tanks can occur because of overfilling.

1.3.9 Fuel tanks are to be able to withstand, without failure, the vibration, inertia, fluid, and structural loads likely to occur during normal operation and foreseeable failure conditions.

1.3.10 Fuel tanks are to be arranged to facilitate interior inspection and repair.

1.3.11 Fuel tank covers located in an area where experience or analysis indicates a strike is likely are to be shown by analysis or tests to minimise penetration and deformation due to foreseeable strikes.

1.3.12 All fuel tank covers are to be fire resistant.

1.3.13 It is to be demonstrated that the fuel tanks, as mounted in the ground effect craft, can withstand, without failure or leakage, the critical pressures resulting from the normal operating and foreseeable failure conditions.

1.3.14 Each fuel tank is to be designed to facilitate drainage of any hazardous quantity of water from any part of the tank to its sump.

1.3.15 Each fuel tank is to be vented from the top part of the expansion space so that venting is effective under any normal operating conditions.

1.3.16 Each fuel tank filler connection is to prevent the entrance of fuel into any part of the ground effect craft other than the tank itself. Additionally:

- (a) each recessed filler connection that can retain any appreciable quantity of fuel is to have a drain that discharges clear of the craft;
- (b) each filler cap is to provide a fuel-tight seal; and
- (c) each fuel filling point, except pressure fuelling connection points, is to have a provision for electrically bonding the craft to ground fuelling equipment.

1.3.17 The probability of failure of the supply of fuel to any one engine is to be remote.

1.3.18 The fuel system on multi-engined WIG effect craft is to be arranged such that no reasonably foreseeable failure of the fuel system can result in the failure of the fuel supply to more than one engine.

1.3.19 The arrangement of fuel tanks and pumps is to be such that no quantity of air that may be introduced into the system through mishandling or through one tank becoming empty before another, will cause a loss of power that would otherwise be available.

1.3.20 Fuel tanks are to be designed, located and installed to minimise the risk of liberation of fuel in the event of a collision or emergency landing.

1.3.21 Fuel tanks are not to be located within fire hazard areas and adequate clearance is to be provided between the fire resisting boundary and the tanks.

1.3.22 Means are to be provided to prevent excessive tank pressures when refuelling at the maximum permissible supply pressure and flow rate.

1.3.23 For each main pump, provision is to be made to allow the bypass of each positive displacement fuel pump other than a fuel injection pump (a pump that supplies the proper flow and pressure for fuel injection when the injection is not accomplished in a carburettor) approved as part of the engine.

1.3.24 There are to be emergency pumps or another main pump to feed each engine immediately after failure of any main pump (other than a fuel injection pump approved as part of the engine).

1.3.25 Fuel lines are to be installed to prevent excessive vibration and are to be designed to tolerate all loads and internal pressures to which they are to be subjected.

1.3.26 Fuel lines are to be designed so that they allow for the relative movement between the components to which they are connected.

1.3.27 Fuel lines are to be designed so that if they burst or split, fuel cannot be sprayed onto hot surfaces.

1.4 Cooling systems

1.4.1 Cooling arrangements are to be designed to maintain the temperatures of system components, fluids, and within the temperature limits established for these components and fluids during all normal operating conditions, including shutdown.

1.5 Engine air and gas flow systems

1.5.1 The air inlet and exhaust systems are to be matched so as to allow flow of gas through the engine at all power and speed configurations for which the engine has been designed.

1.5.2 Each induction system duct is to be:

- (a) of sufficient strength to prevent induction system failures resulting from normal backfire conditions; and
- (b) fire-resistant if it is in any fire zone for which a fire-extinguishing system is required, except that ducts for auxiliary power units are to be fireproof within the auxiliary power unit fire zone.

1.5.3 Each duct connected to components between which relative motion could exist are to have provision for flexibility.

1.5.4 Engine bleed air duct systems are to be designed so that no hazard will result if a duct failure occurs at any point between the air duct source and the craft unit served by the air.

1.5.5 Induction system ducts are to be arranged to prevent hot gas reverse flow from burning through entering any area of the craft in which a hazard would be created resulting from the entry of hot gases.

1.5.6 Induction system ducts are to be constructed of materials that will not absorb or trap hazardous quantities of flammable fluids that could be ignited in the event of a surge or reverse flow condition.

1.5.7 Each exhaust system is to ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, an acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide.

1.5.8 Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours is to be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire hazard.

1.5.9 Each component of the exhaust system that is subject to high temperatures is to be separated from adjacent parts of the craft by a heat resistant barrier.

1.5.10 Induction systems are to be fire resistant and of sufficient strength to withstand all the loads to which they are to be subject.

1.5.11 Induction systems are to be arranged so as to prevent the accumulation of fuel and moisture. Any drains used are not to discharge to a place where this may cause a hazard.

1.5.12 The air induction system for each engine and auxiliary power unit is to be capable supplying:

- (a) the air required by that equipment under each operating condition for which LR acceptance is requested; and
- (b) the air for proper fuel metering and mixture distribution with the induction system valves in any position.

1.5.13 There are to be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine air intake system.

1.5.14 WIG effect craft are to be designed to prevent water from being directed into the engine air inlet ducts in hazardous quantities, and the air inlet ducts are to be located or protected so as to minimise the ingestion of foreign matter during all normal operation.

1.6 Lubrication systems

1.6.1 Each engine is to be designed to have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

1.6.2 The usable oil capacity is not to be less than the maximum allowable oil consumption of the engine under the normal operating conditions for the maximum flight range defined in Vol. 4, Pt 1, Ch 2,1.5.1.

1.6.3 Each oil tank is to be designed and installed so it can withstand, without failure, any vibration, inertia, and fluid loads that it may be subjected to in operation.

1.7 Bilge pumping and drainage

1.7.1 Provision is to be made to enable access to all spaces fitted with pumping or drainage arrangements.

1.7.2 Liquid accumulations which may affect the safety of the craft are to be capable of being drained.

1.7.3 Where bilge pumping is necessary for vessel safety, compartments are to be capable of being drained by a dedicated system of adequate capacity. Where the failure of any single bilge pump renders the capacity of the system inadequate, a back-up system is to be rapidly available such that the propulsion or manoeuvrability of the vessel is not significantly impaired.

1.7.4 Any compartment for which bilge pumping arrangements are required is to be provided with a method of establishing the presence of liquid accumulation in that space.

1.8 Hydraulic system design

1.8.1 The output of the pumps and hydraulic accumulators are to be sufficient to operate all essential services and other services which might be operated at the same time against the appropriate external loads and within the minimum times required.

1.8.2 The need for duplication of any part of the systems and for the systems to operate after power unit failure is to be assessed on the basis of the requirements of the particular service. If it is essential that any service is to be capable of continuous operation after the failure of any source of power, provisions are made to ensure that sufficient power is available for such services and cannot be wasted on non-essential services. Pipe lines for duplicate services or for main and emergency services are to, as far as practicable, be so located that any cause of damage to one line is unlikely to affect the other.

1.8.3 Means are to be provided to limit the maximum pressures that can be achieved during operation. These means are to ensure that the transient pressures realised in any possible condition of operation do not exceed proof pressures.

1.8.4 Provision is to be made to prevent sludge affecting the safe operation of any hydraulic system particularly where the transmission fluid is shared with another system.

1.8.5 Where a hydraulic system is required for continued controlled operation of the craft, a means to indicate failure of that system is to be provided at the flight crew station.

1.9 Testing requirements

1.9.1 All fully assembled systems are to demonstrate ability to transfer fluids at the designed rate and pressure without loss of pressure or flow rate.

1.9.2 Where a danger of overpressure exists and an automatic relief mechanism has been incorporated into the design, the safe and effective functioning of the relief mechanism is to be demonstrated.

1.9.3 Where non-metallic pipes are used for transfer of flammable substances, it is to be demonstrated that the severing or bursting of the non-metallic part will not result in flammable substances being ejected onto ignition sources.

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HABITABLE ENVIRONMENT SYSTEMS

JULY 2008

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- 1.5 Performance requirements
- 1.6 Testing requirements

Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter states the Classification requirements for HVAC and lighting systems in crew and passenger spaces.

1.2 Particulars to be submitted

1.2.1 A design statement explaining the intended methods of maintaining a habitable environment and lighting arrangements on board the craft is to be submitted for review.

1.2.2 Any schematic diagrams describing the systems intended for this purpose are to be prepared using an internationally recognised system of symbols.

1.3 Heating and ventilating systems

1.3.1 In general, all heating and ventilation systems are to be designed and installed to maintain the conditions within a space prescribed by the Design Organisation. These conditions are to be in accordance with internationally recognised standards or guidelines.

1.3.2 Heating and ventilation systems are to be designed and installed to ensure that the crew and passenger compartment air is free from harmful or hazardous concentrations of gases or vapours.

1.3.3 Effective ventilation is to be provided to prevent the accumulation of flammable gases.

1.3.4 The risk to passengers or personnel arising from the harmful concentrations of fire extinguishing agents, accruing due to intentional discharge or due to any failure which might lead to unintentional discharge of the extinguishant, is to be reduced to a minimum.

1.3.5 Provisions are to be made to enable the flow of air to a compartment to be shut off where this is necessary as part of the fire-fighting practice or procedures.

1.3.6 If accumulation of hazardous quantities of smoke in the operating compartment is reasonably probable, smoke extraction is to be capable of being readily accomplished.

1.3.7 Exhaust heat exchangers used for the heating of ventilating air are so constructed as to preclude the possibility of exhaust gasses entering the ventilating air.

1.4 Lighting arrangements

1.4.1 Lighting on the craft is to be provided in accordance with an internationally recognised standard.

1.5 Performance requirements

1.5.1 The ventilation system is to be capable of providing a minimum specified quantity of fresh air (typically not less than 5 litres per second) for each embarked person and crew into the spaces occupied by operating crew and passengers. The quality and pressure of the air is to be such that it will not cause harm to persons or equipment.

1.6 Testing requirements

1.6.1 Tests are to be conducted to confirm that the provision of HVAC and lighting systems on board is sufficient to provide air quality temperatures and light intensity in accordance with the design statement.

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Chapter 1 Anchoring, Towing and Berthing

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Section**1 General****■ Section 1
General****1.1 Scope and information**

1.1.1 This Chapter states the Classification requirements for anchoring, towing and berthing arrangements.

1.2 Particulars to be submitted

1.2.1 A design statement explaining the intended methods of anchoring, towing and berthing the craft are to be submitted for review.

1.2.2 Plans of anchoring, towing and berthing equipment and associated instruction manuals are to be submitted, in triplicate, for Lloyd's Register (hereinafter referred to as 'LR') review.

1.3 General

1.3.1 Craft are to be designed to facilitate safe and effective anchoring, towing and berthing. Due allowance is to be made for the effect of possible craft yaw angle while at anchor and the dynamically induced loads which are likely to occur due to prevailing sea and weather conditions.

1.3.2 Survey at the craft completion will be used to confirm that the physical arrangements of anchoring, towing and berthing equipment are in accordance with the design statement and technical requirements of this Chapter.

1.4 Technical requirements

1.4.1 Craft are to be furnished with an anchor or anchors, associated cables and fastenings, as necessary, capable of holding the craft in maximum sea and weather conditions which it is anticipated to operate in.

1.4.2 Means are to be provided for the safe storage of anchors to ensure that they will not be a potential hazard to passengers or crew during normal operating conditions and reasonably foreseeable abnormal conditions.

1.4.3 Means are to be provided to enable the anchor to be slipped.

1.4.4 Means are to be provided to raise the anchors and fastenings with the full length of cable deployed to their stowage positions.

1.4.5 Suitable storage is to be provided for the maximum length of anchor cable likely to be carried. The storage is to be arranged such that the anchor cable will run out freely when the anchor is let go.

1.4.6 The anchor installation is to be such that the anchor may be quickly and easily deployed when required.

1.4.7 Strong point(s) are to be provided in a suitable position(s) for the attachment of a towrope.

1.4.8 The maximum permissible speed at which the craft may be towed on water is to be established.

1.4.9 Procedures for the use of anchoring, towing and berthing equipment are to be established and scheduled in the Operating Manual, together with suitable information concerning the conditions of current, holding ground, etc., for which the anchoring equipment is suitable.

1.4.10 Arrangements are to be such as to reduce the possibility of crew being subject to unnecessary hazards during anchoring, towing and berthing operations.

1.4.11 Craft are to be furnished with suitable equipment to enable the craft to be dragged up a slip-way to enable out of water survey. Such arrangements are to be designed such that they do not hinder normal craft operation.

1.4.12 The loads imposed on the structure by docking the craft out of water are not to cause any excessive structural stresses.

1.4.13 Wheels, tyres and brakes used for berthing are to be designed for the maximum weight of the craft taking into account the centre of gravity and likely slipway inclinations.

1.5 Testing requirements

1.5.1 The mooring and anchoring arrangements are to be tested to confirm they are adequate to retain the fully loaded craft in the most onerous design environmental conditions without causing permanent deformation of the craft or its equipment.

1.5.2 It is to be demonstrated that the equipment on board is adequate to raise the anchor and fastenings with a full chain length from the seabed.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

REQUIREMENTS FOR TRIALS AND TESTING

JULY 2008

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CHAPTER 2 FIRST OF TYPE TESTING AND TRIALS**Section 1 General**

- 1.1 Scope
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2 Trials

- 2.1 Shore based trials
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CHAPTER 3 COMMISSIONING TRIALS AND TESTING**Section 1 General**

- 1.1 Scope
- 1.2 Trials procedures

2 Trials

- 2.1 Shore based trials
- 2.2 Static water trials
- 2.3 Displacement mode and step taxi trials
- 2.4 Take-off, ground effect mode and landing trials

Section**1 General****■ Section 1
General****1.1 Introduction**

1.1.1 This Volume of the Rules describes the requirements for trials and testing of fully assembled WIG effect craft.

1.1.2 The trials and testing requirements are arranged as two distinct groups of test; the first is for the first of each type of WIG effect craft in a series production and the second, for each subsequent craft in the series.

1.1.3 For both first of type and subsequent production craft, the requirements are arranged in terms of:

- (a) Shore based trials.
- (b) Static water based trials.
- (c) Displacement mode and step taxi trials.
- (d) Take off, ground effect mode and landing trials.

1.2 Testing requirements

1.2.1 All first of type WIG effect craft are to be tested in accordance with the requirements of Chapter 2 to confirm that the concept of the design is safe and to determine that the physical craft performs as desired. The first of type craft will also be subject to satisfactory testing as required in Chapter 3.

1.2.2 Each subsequent craft in the series is to be tested in accordance with the requirements of Chapter 3 only. These tests serve to confirm that each craft has been manufactured and assembled in accordance with the design specification. The tests are to be designed to confirm that the craft also performs in the manner determined in the first of type trials.

1.2.3 Trials are to be conducted using calibrated equipment and all measurements are to be taken by appropriately qualified personnel.

1.2.4 The testing and trials schedules are to be agreed between the Builder, Owner/Operator and Lloyd's Register (hereinafter referred to as 'LR').

1.3 Information to be submitted

1.3.1 A schedule of testing and trials to demonstrate that the craft is capable of being operated with machinery and systems functioning as described in the design statements is to be submitted. In addition, any testing programme that may be necessary to prove the conclusions of an FMEA is to be submitted.

1.4 Information to be available

1.4.1 The information described in 1.4.2 and 1.4.4 is to be available to personnel carrying out tests and trials.

1.4.2 Operating instructions for all engineering systems.

1.4.3 Design operating conditions for the craft covering:

- (a) Climate.
- (b) Operating hours between required overhauls.
- (c) Sea states.
- (d) Wind speeds.
- (e) Inclinations.
- (f) Number of passengers.
- (g) Weight distribution of cargo (C of G constraints).
- (h) Thrust.
- (i) Acceleration.
- (k) Collision load.
- (l) Flight altitude.
- (m) Anchoring arrangements.
- (n) Towing arrangements.
- (o) Berthing arrangements.
- (p) Turning manoeuvres
- (q) Emergency avoidance procedures

1.4.4 Procedures for use of anchoring, towing and berthing equipment.

1.5 Records

1.5.1 Testing and trials are to be documented with sufficient detail to ascertain that the specified functional requirements of the craft and engineering systems have been satisfied. The records are to be available to enable any future trials to identify any significant degradation after in-service operation.

Section**1 General****2 Trials**
**■ Section 1
General**
1.1 Scope

1.1.1 The contents of this Chapter define the required trials and testing procedure for the design validation of a first of type or newly modified WIG effect craft. The purpose of first of type testing and trials is to confirm the craft capability for the extremes of the declared operating envelope.

1.1.2 First of type craft is one of a series of craft of identical design and construction.

1.1.3 A newly modified craft is an existing WIG effect craft that has undergone modifications that significantly affect the physical characteristics of the craft.

1.1.4 All trials are to be designed, performed and recorded sufficiently to demonstrate that the relevant requirements of Vol 1, Pt 2 have been satisfied.

1.2 Trials procedures

1.2.1 All trials are to be performed in a manner so that the levels of risk to personnel are as low as reasonably practicable.

1.2.2 The proposed first of type trials procedure is to be supported by a comprehensive risk assessment and associated risk management actions for potential hazards, e.g. wing stall or engine failure.

1.2.3 The commissioning trials and testing in Chapter 3 are to be carried out in addition to the testing and trials required by this Chapter.

**■ Section 2
Trials**
2.1 Shore based trials

2.1.1 The trials detailed in 2.1.2 to 2.1.5 are to be conducted while the craft is ashore.

2.1.2 Determine and record the basic weight position of centre of gravity.

2.1.3 Determine and record the time required for change over to an alternative electrical supply circuit.

2.1.4 Determine and record the time required to change over to alternative fuel supply to engines.

2.1.5 Determine and record the effectiveness of the HVAC and lighting systems.

2.1.6 Determine that in the event of a control cable slackening or rupture, the aerodynamic control surfaces behave in a manner that would enable the craft to be controlled into a level wing descent.

2.2 Static water trials

2.2.1 The trials detailed in 2.2.2 to 2.2.5 are to be conducted while the craft is afloat in water.

2.2.2 Determine and record design waterlines for light weight and maximum payloads and most onerous loading conditions.

2.2.3 Determine and record the capability and times for operating the craft's anchoring arrangements.

2.2.4 Determine and record the capability for operation of the equipment for the craft to be towed.

2.2.5 Determine and record the capability for operation of the berthing equipment.

2.2.6 Determine and record the capability for operation of the inwater drive arrangements

2.3 Displacement mode and step taxi trials

2.3.1 The trials detailed in 2.3.2 to 2.3.12 are to be conducted while the craft is afloat in water in either displacement or step-taxi modes as appropriate.

2.3.2 Determine and record manoeuvrability on water drives in calm conditions (sea state code 0/1).

2.3.3 Determine and record the maximum craft ground maximum speed on water drives.

2.3.4 Determine and record manoeuvrability on water drives and the worst case angle of incidence.

2.3.5 Determine and record step taxi air speed and power settings at light weight and maximum weight displacement.

2.3.6 Determine and record acceleration at light weight and maximum weight displacements.

2.3.7 Measure and record internal and external noise levels at step taxi.

2.3.8 Determine and record craft handling characteristics in step taxi.

2.3.9 Confirm step taxi operations to the design operating envelope covering environmental, wind speed and sea state conditions.

2.3.10 Determine and record turning data in step taxi.

2.3.11 Determine and record operating limits diagram in step taxi:

- (a) Wind speed and direction.
- (b) Significant wave height and angle of incidence.
- (c) Rudder angle.
- (d) Angle of heel/bank.
- (e) Engine RPM.
- (f) Air speed.

2.3.12 Measure and record maximum engine compartment and exhaust temperatures.

2.4 Take-off, ground effect mode and landing trials

2.4.1 The trials detailed in 2.4.2 to 2.4.8 are to be conducted while the craft is either landing, taking off or in ground effect mode as appropriate.

2.4.2 Determine and record take-off and landing distance in light weight and maximum weight conditions.

2.4.3 Determine critical safety speeds and power settings for take off and landing in light weight and maximum weight conditions.

2.4.4 Determine and record craft operating profile and handling characteristics with respect to:

- (a) Wind speed and direction.
- (b) Significant wave height and angle of incidence.
- (c) Rudder angle.
- (d) Angle of heel/bank.
- (e) Engine RPM.
- (f) Speed.

2.4.5 Measure and record control systems operator loads and effort.

2.4.6 Determine and record acceptable banking angles, height and speed of the craft at which water contact with one wing tip is not critical.

2.4.7 Establish limits for elevator authority, confirming that in the case of a jammed elevator or runaway trim, crew action can return the craft to a safe condition.

2.4.8 Determine and record operating speeds and flare height/speed relationship across the full range.

2.4.9 Determine and record the ground effect altitude by elevating the craft to the maximum possible sustained altitude.

2.4.10 Determine and record turning manoeuvres under normal operating conditions and confirm capability of craft to perform emergency avoidance procedures.

Section**1 General****2 Trials****■ Section 1
General****1.1 Scope**

1.1.1 The contents of this Chapter define the required trials and testing procedure for the commissioning of a new or modified WIG effect craft. The purpose of these tests and trials is to confirm that the completed craft is capable of functioning and performing in accordance with the declared normal operating envelope.

1.1.2 These testing requirements are in addition to the First of Type Trials in Chapter 2.

1.1.3 All trials are to be designed, performed and recorded sufficiently to demonstrate that the relevant requirements of Vol 1, Pt 2 have been satisfied.

1.2 Trials procedures

1.2.1 All trials are to be performed in a safe and controlled environment so as not to endanger personnel and equipment.

**■ Section 2
Trials****2.1 Shore based trials**

2.1.1 The trials detailed in 2.1.2 to 2.1.14 are to be conducted while the craft is ashore.

2.1.2 Check structure for visible damage and incorrect assembly.

2.1.3 Confirm that electrical consumers can tolerate a ripple on the generator voltage.

2.1.4 Confirm electrical consumers can tolerate short term interruption during change over to a second main circuit.

2.1.5 Confirm the correct functioning of electrical consumers sensitive to EMC interference.

2.1.6 Calibrate the fuel tank level meter.

2.1.7 Confirm the bilge pump capacity.

2.1.8 Confirm that electric consumers and engine starter(s) can only be operated after adequate ventilation and when any signals from gas detectors read acceptable, where identified in the Operating Manual.

2.1.9 Check effectiveness of the battery charger shore connection.

2.1.10 Check effectiveness of earthing cable link between craft and bowser for refuelling operations.

2.1.11 Test exhaust installation for flammability and penetration of fluids.

2.1.12 Test the function of fuel tank isolating valves and confirm time to fuel starvation.

2.1.13 Test the function of lights.

2.1.14 Simulate control cable slack and for each case, establish associated operational performance and limits, and confirm safe craft behaviour.

2.2 Static water trials

2.2.1 The trials detailed in 2.2.2 to 2.2.11 are to be conducted while the craft is afloat in water.

2.2.2 Confirm the adequacy of the starting arrangements for all engines.

2.2.3 Measure in water drive static thrust.

2.2.4 Measure main drive static thrust.

2.2.5 Test function of fire pumps.

2.2.6 Test performance of engine bay ventilation system.

2.2.7 Measure and document temperatures of critical parts of exhaust gas piping system.

2.2.8 Confirm the correct functioning of electrical consumers sensitive to EMC interference.

2.2.9 Confirm adequacy of anchoring arrangements.

2.2.10 Confirm the bilge pump effectiveness.

2.2.11 Verify design waterlines for minimum and maximum payloads and most onerous loading conditions.

2.2.12 Confirm adequacy of berthing arrangements.

2.3 Displacement mode and step taxi trials

2.3.1 The trials detailed in 2.3.2 to 2.3.12 are to be conducted while the craft is afloat in water in either displacement or step-taxi modes as appropriate.

Commissioning Trials and Testing**Volume 7, Part 1, Chapter 3**

Section 2

-
- 2.3.2 Confirm manoeuvrability on water drives in calm waters (sea state code 0/1) and determine worst case wave angle of incidence.
- 2.3.3 Confirm maximum speed on water drives.
- 2.3.4 Confirm manoeuvrability on water drives.
- 2.3.5 Confirm step taxi air speed and power settings at light weight and maximum weight displacement.
- 2.3.6 Confirm acceleration at light weight and maximum weight displacements.
- 2.3.7 Confirm internal and external noise levels at step taxi.
- 2.3.8 Confirm craft handling tendencies in step taxi.
- 2.3.9 Confirm step taxi operations to the design operating envelope covering environmental, wind speed and sea state conditions.
- 2.3.10 Confirm turning data in step taxi.
- 2.3.11 Confirm operating limits diagram in step taxi:
- (a) Wind speed.
 - (b) Significant wave height and angle of incidence.
 - (c) Rudder angle.
 - (d) Angle of heel/bank.
 - (e) Engine RPM.
 - (f) Speed.
- 2.3.12 Measure and record maximum engine bay and exhaust temperatures.

2.4 Take-off, ground effect mode and landing trials

- 2.4.1 The trials detailed in 2.4.2 to 2.4.8 are to be conducted while the craft is either landing, taking off or in ground effect mode as appropriate.
- 2.4.2 Confirm take-off and landing distance in light weight and maximum weight conditions.
- 2.4.3 Confirm craft operating profile and handling characteristics with respect to:
- (a) Wind speed.
 - (b) Significant wave height and angle of incidence.
 - (c) Rudder angle.
 - (d) Angle of heel/bank.
 - (e) Engine RPM.
 - (f) Speed.
- 2.4.4 Confirm control systems operator loads and effort.
- 2.4.5 Confirm engine bay ventilation in ground effect mode by flow measurements.
- 2.4.6 Confirm identical handling characteristics from both control positions.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

GENERAL REQUIREMENTS

JULY 2008

VOLUME 8

PART 1

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Chapter 1 General Requirements

PART 2 COMPOSITE MATERIALS

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General Requirements

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- 5 **Other materials**

■ Section 1 **Application**

1.1 Scope and information

1.1.1 The requirements of this Volume make provision for the manufacture, testing and certification of materials used in the construction of WIG effect craft structure and machinery parts thereof.

1.1.2 These Rules recognise the materials sections of Lloyd's Register's *Rules and Regulations for the Classification of Ships* (hereinafter referred to as 'LR') and *Rules and Regulations for the Classification of Special Service Craft* (hereinafter referred to as LR's Rules for Materials), and materials complying with those Rules may be acceptable for use in WIG effect craft following review. Sections 3 and 4 of this Chapter provide additional information in respect of aluminium alloys and stainless steels. Part 2 provides the requirements for composite materials.

1.1.3 Other internationally recognised material standards may be used in the approval process.

1.1.4 To effect the approval process, the material manufacturer is to make all the necessary information available to LR upon request.

1.1.5 The Builder of the craft is to provide the manufacturer of the material with such information as is necessary to ensure that all necessary inspection and testing can be carried out.

1.1.6 Materials are to be manufactured at a works approved by LR. Approval of a works can be by one of the following routes:

- (a) Approval under the LR approved manufacturer scheme.
- (b) Approval by an alternative quality control scheme for identified material(s) recognised by LR.
- (c) Approval by LR auditing the manufacturer's quality control system for identified material(s).

■ Section 2

Submission of information

2.1 Plans and information

2.1.1 At least three copies of plans, information and specifications as required, are to be submitted for appraisal.

2.1.2 The following information is to be submitted by the Design Organisation:

- (a) Full plan details, including material specifications and all tolerances.
- (b) Listing of materials used.
- (c) Method and site of manufacture, and suppliers of components.
- (d) Evidence of the selected manufacturer's or sub-contractor's ability to produce laminates in accordance with the design specification. This shall be confirmed in each case by an agreed schedule of tests representative of the production being carried out in the presence of an LR Surveyor.

2.1.3 It is the responsibility of the Design Organisation to ensure that all materials and components are available to the appropriate specification prior to commencement of manufacture.

■ Section 3

Aluminium alloys

3.1 Technical requirements

3.1.1 Aluminium alloys used in the construction of the craft are to be selected based on strength, joining technique and suitability for use in a marine environment.

3.1.2 The alloys detailed in LR's Rules for Materials Chapter 8 are suitable for use in a marine environment. Alloys 6005-A and 6061 are not normally accepted for use in direct contact with seawater as the significant addition of copper to these alloys reduces their corrosion resistance.

3.1.3 Materials that comply with recognised national or proprietary specifications may be accepted provided that these specifications give reasonable equivalence and are approved for a specific application.

3.1.4 The 2000 series (Al-Cu) alloys are not permitted in WIG effect craft construction as they suffer severe corrosion in a marine environment.

3.1.5 The 7000 series (Al-Zn) alloys that offer superior strength are to be avoided due to their susceptibility to stress corrosion cracking.

3.1.6 The use of clad materials or honeycomb structures designed and assembled in accordance with an internationally recognised standard will be subject to special approval by LR.

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3.1.7 The alloys listed in LR's Rules for Materials, Chapter 8 are suitable for both riveted and welded construction. It should be noted that the fusion welded properties of strain hardened 5000 series and precipitation hardened 6000 series alloys are reduced to the annealed condition. The mechanical properties to be used at the design stage to determine scantlings are given in Table 1.3.1.

3.1.8 The use of friction stir welding is to be subject to acceptance by LR.

3.1.9 The rivets to be used for riveted construction are to be in accordance with Ch 8,2 of LR's Rules for Materials or other equivalent standard. To minimise the risk of electrolytic corrosion, 5154A alloy rivets are to be used for riveting the 5000 series alloys and 6082 alloy for riveting the 6000 series alloys.

3.1.10 The use of adhesive bonding will be subject to acceptance by LR. Adhesive bonds are typically provided with rivets to restrict peeling.

3.1.11 Where protective coatings, such as anodising or chromate conversion followed by painting are used, due consideration is to be given to their effects on the fatigue strength of the material and any limitations to subsequent fabrication techniques.

3.1.12 In order to avoid galvanic corrosion, care is to be taken to avoid electrical contact between aluminium alloys and other metals.

■ **Section 4
Stainless steels**

4.1 Technical requirements

4.1.1 The stainless steels to be used for the manufacture of bolts, cap screws, studs and nuts that are intended to be used for joining composite sub-assemblies are to be suitable for use in a marine environment.

4.1.2 The fasteners are to be manufactured, tested and inspected to a recognised national standard.

4.1.3 To minimise the risk of pitting corrosion, the stainless steels used are to have the following pitting resistance equivalent numbers (PREN):

- (a) PREN \geq 35, if liable to continuous immersion in sea water.
- (b) PREN \geq 25, for general exposure to a marine environment.
PREN = %Cr + 3,3(%Mo) + 16(%N)

Table 1.3.1 Minimum mechanical properties for aluminium alloys

Alloy	Condition	0,2% proof stress N/mm ²		Ultimate tensile strength N/mm ²	
		Unwelded	Welded (see Note 4)	Unwelded	Welded (see Note 4)
5083	O/H111	125	125	275	275
5083	H112	125	125	275	275
5083	H116/H321	215	125	305	275
5086	O/H111	100	95	240	240
5086	H112	125 (see Note 2)	95	250 (see Note 2)	240
5086	H116/H321	195	95	275	240
5754	O/H111	80	80	190	190
6005A (see Note 1)	T5/T6 Extruded: Open Profile Extruded: Closed Profile	215 215	100 100	260 250	160 160
6061 (see Note 1)	T5/T6 Rolled Extruded: Open Profile Extruded: Closed Profile	240 240 205	125 125 125	290 260 245	160 160 160
6082	T5/T6 Rolled Extruded: Open Profile Extruded: Closed Profile	240 260 240	125 125 125	280 310 290	190 190 190

NOTES

1. These alloys are not normally acceptable for application in direct contact with sea-water.
2. See also Table 8.1.4 in Chapter 8 of the Rules for Materials.
3. The mechanical properties to be used to determine scantlings in other types and grades of aluminium alloy manufactured to national or proprietary standards and specifications are to be individually agreed with LR.
4. Where detail structural analysis is carried out, 'Unwelded' stress values may be used away from heat affected zones and weld lines.

4.1.4 Stainless steel fasteners are not to be used in direct contact with aluminium alloy structures.

4.1.5 The nuts used in combination with the fasteners are to be of the same alloy group and have a minimum proof stress equal or greater than the specified minimum full size tensile strength of the externally threaded fastener.

■ *Section 5* **Other materials**

5.1 Technical requirements

5.1.1 Other materials than those identified in Sections 3 and 4 may be used in the construction of craft provided they are suitable for use in the marine environment.

5.1.2 Details of other materials, joining methods and standards to be applied are to be submitted with supporting evidence of their suitability for intended application. The use of other materials is subject to acceptance by LR.

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

COMPOSITE MATERIALS

JULY 2008

VOLUME 8

PART 2

Lloyd's
Register

Chapter Contents

Volume 8, Part 2

PART 1 GENERAL REQUIREMENTS

PART 2 COMPOSITE MATERIALS

Chapter 1 Composite Materials

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- 2.1.2 The methods of construction are to be in accordance with the appraised construction documentation.
- 2.1.3 All batches of materials are to be provided with unique identifications by their manufacturers. Furthermore manufactured components are to be similarly identified.
- 2.1.4 No batch of material is to be used later than its date of expiry.
- 2.1.5 The Builder is to ensure that all batches of materials are stored in accordance with the manufacturer's instructions and are used systematically and sequentially.
- 2.1.6 The Builder is to maintain, on a continuous basis, records of the amounts of resin and reinforcement used in order to ensure that the reinforcement fractions remain within the limits set in the construction documentation.
- 2.1.7 Records are to be kept of the sequence and orientation of the reinforcements.
- 2.1.8 The Builder is to ensure that each section of the construction is traceable to the batch or batches of material used. The unique component identifications required by 2.1.4 are to be included on all relevant quality control documentation.
- 2.1.9 Any curing system used is to be demonstrated as suitable for the intended purpose and all pyrometric equipment is to be calibrated at least annually and adequate records maintained.
- 2.1.10 The post curing temperature is to be controlled and recorded by the attachment of suitably placed calibrated thermocouples.

■ Section 1

Quality control

1.1 Scope

1.1.1 This Chapter provides the general requirements for the approval and control of material quality when used in the construction of composite WIG effect craft.

1.1.2 For composite craft built under these Rules, the survey of materials is to be conducted in accordance with the requirements of Chapter 14, Sections 1 to 3 of Lloyd's Register's (hereinafter referred to as 'LR') Rules for Materials and these Rules.

2.1.11 Vacuum/pressure measuring equipment is to be maintained in good order and compared (preferably calibrated) against a calibrated unit, according to the Quality Assurance schedule.

2.1.12 Metered mixing equipment for resin/curing agent, or adhesive mixing is to be calibrated for the mix quantities prior to the commencement of production, and at scheduled times thereafter subject to a minimum of one per shift.

2.1.13 Refrigerators used for the storage of pre-impregnated materials are to be equipped with thermostatic controls and suitable means of recording the temperature on a 24 hour basis is to be provided. Materials from this are to be used on a 'Just in Time' basis and if returned to the store the time spent at ambient temperature is to be recorded on the roll – any such roll is to be used as soon as practical thereafter.

■ Section 2

General requirements

2.1 General

2.1.1 All constructions are to be carried out using materials approved by LR. All materials are to be in accordance with the LR appraised plans/construction documentation.

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■ Section 3 Quality assurance

3.1 Quality assurance

3.1.1 Where the Builder has a quality assurance system this is to include the requirements of this Chapter.

■ Section 4 Dimensional tolerances

4.1 Dimensional tolerances

4.1.1 Dimensions and tolerances are to conform to the approved construction documentation.

4.1.2 The thicknesses of the laminates are, in general, to be measured by ultrasonic or direct means, at not less than ten points, evenly distributed across the surfaces of the laminates. In the case of large sections at least ten evenly distributed measurements are to be taken in bands a cross the width at maximum spacing of two metres along the length.

4.1.3 The responsibility for maintaining the required tolerances and making the necessary measurements rests with the Builder. Monitoring and random checking by the Surveyor does not absolve the Builders from this responsibility.

4.1.4 Where ultrasonic thickness gauges are used, these are to be calibrated against an identical laminate (of measured thickness) to that on which the thickness measurement is to be carried out. If suitable pieces are not available from the construction, then a small sample of identical lay-up is to be prepared.

■ Section 5 Material composition

5.1 Material composition

5.1.1 Prefabricated sections or components used are to be in accordance with the LR appraised construction documentation.

5.1.2 Where alternative materials are used, these are to be of approved types and the manufacturer is to demonstrate to the Design Organisation/LR's satisfaction, prior to their introduction, their suitability with respect to performance, otherwise full testing as appropriate will be required.

■ Section 6 Material testing

6.1 Material testing

6.1.1 When required the material manufacturer is to provide the purchaser with certificates of conformity for each batch of material supplied indicating the relevant values specified in 6.1.4 to 6.1.8. These values are to comply with those specified by the approved construction documentation.

6.1.2 The Builder is to ensure copies of all certificates of conformity (which must indicate the actual tested values) are obtained for all batches of materials received, and is to maintain accurate records. LR may at any time select a sample of a material for testing by an independent source and should such tests result in the material failing to meet the specification, then that batch will be rejected.

6.1.3 Irrespective of whether or not the Builder conducts his own tests or is reliant on the manufacturer for certificates of conformity the following is to be carried out, where applicable, on receipt of any material:

- (a) The consignment is to be divided into its respective batches and each batch is to be labelled accordingly.
- (b) Each batch is to be visually examined for conformity with the batch number, visual quality and date expiry.
- (c) Each batch is to be separately labelled and stored accordingly.
- (d) Each unit, within the batch, is to be labelled with the batch number.
- (e) Written records are to be maintained of the above and these are to be cross-referenced with the certificate of conformity for the material and/or the Builder's own test results.

6.1.4 For thermoset resins, reinforced or otherwise, the resin manufacturer is to have determined, on samples taken from each batch, at least the following:

- (a) All resins:
 - (i) Viscosity.
 - (ii) Gel time.
 - (iii) Filler content, where applicable.
- (b) Polyester and vinyl ester resins:
 - (i) Type (orthophthalic, isophthalic, etc.).
 - (ii) Volatiles content.
 - (iii) Acid value.
- (c) Epoxide resins:
 - (i) Free epoxide content.
- (d) Phenolic resins:
 - (i) Free phenol content.
 - (ii) Free formaldehyde content.

6.1.5 For thermoplastics the polymer manufacturer is to have made the following measurements on samples taken from each batch:

- (a) Melting point.
- (b) Melt flow index.
- (c) Density.
- (d) Filler/pigment content, where applicable.
- (e) Tensile stress at yield and break.
- (f) Tensile strain at yield and break.

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6.1.6 Where the resin or polymer manufacturer mixes batches, both the original batches and the mixed batch are to be tested in accordance with 6.1.4 or 6.1.5 as appropriate. The mixed batch is then to be given an unique batch number.

6.1.7 For reinforcements, the material manufacturer is to have recorded, where applicable, the following for each batch of material:

- (a) Tex of yarn(s) or roving(s).
- (b) Ends per 100 mm in all reinforcement orientations.
- (c) Weight per square metre.
- (d) Binder/size content.
- (e) Stitch type and count.
- (f) Type of fibre used.
- (g) Surface treatment and/or finish

6.1.8 For core materials the following properties are to be recorded by the manufacturer for each batch:

- (a) Type of material.
- (b) Density.
- (c) Description (block, scrim mounted, grooved).
- (d) Thickness and tolerance.
- (e) Sheet/block dimensions.
- (f) Surface treatment.

together with the following mechanical properties:
in the case of rigid foams:

- (g) Compressive stress and modulus of elasticity.
- (h) Core shear strength.

in the case of end grain balsa:

- (j) Tensile stress.
- (k) Compressive stress and modulus of elasticity.

6.1.9 For pre-impregnated materials the following are the properties to be recorded:

- (a) Reinforcement type weight and counts.
- (b) Resin – per cent by weight or weight per square metre.
- (c) A coalescence/ cure test to confirm satisfactory characteristics.

6.1.10 For adhesives the following properties are to be recorded for each batch received as appropriate:

- (a) Type of adhesive, number of parts, respective batch numbers.
- (b) Viscosity of each part (unless thixotropic).
- (c) Pot life/Gel time.
- (d) Other tests as applicable (e.g. solids, isocyanate, amine value, volatiles, etc.) according to the adhesive specification.

6.1.11 The standards of acceptance for testing are those listed in the material manufacturer's quality control procedures as applicable.

■ Section 7 Production

7.1 Production

7.1.1 During construction, tests are to be carried out on the constituents and final product in accordance with Table 1.7.1. These tests are the minimum requirement and further tests may be included according to the manufacturer's quality control system.

7.1.2 Where the thickness measured does not correlate with the specified fibre content, by weight, laminate fibre content is to be determined by ignition.

7.1.3 If the batch of resin or polymer, or the curing agent, or their ratio is changed at least two additional measurements of the gel time are to be carried out during each shift.

Table 1.7.1 Testing during construction

Component/operation	Characteristic	Rate of testing
Resin/curing agent/catalyst	Gel time Rate of use	Two per shift Continuous
Reinforcement	Quality Orientation Rate of use	Continuous Continuous Continuous
Resin/reinforcement	Ratio	Continuous
Construction	Temperature during cure/post cure Dimensions Cure level (Barcol) against resin manufacturer's specification Laminate thickness Laminate fibre content	Continuous Continuous against approved construction documentation At least one per square metre Continuous against material usage and approved construction documentation (see also 4.1.2 to 4.1.4) At the Surveyor's request (see 6.1.11)
Adhesive bonding	Gel time Bond line thickness Core (in situ) time	One per batch plus one per shift Continuous Continuous

7.1.4 Where it is proposed to use resin transfer moulding or vacuum/pressure infusion processes, the Builder is to provide full details of the system including position of injection and venting ports together with moulding/infusion pressures intended to be used for the manufacture of each component.

■ **Section 8** **Visual examination**

8.1 Visual examination

8.1.1 All constructional mouldings and any components are to be visually examined and are to be free from surface defects and blemishes.

■ **Section 9** **Repair procedure**

9.1 Repair procedure

9.1.1 Repairs of these minor cosmetic blemishes are allowed subject to suitable approved repair procedures being made available.

9.1.2 A repair procedure for these minor blemishes is to be included in the agreed quality control procedures.

9.1.3 Other than superficial blemishes repairs are subject to individual consideration and the written agreement of LR.

■ **Section 10** **Material identification**

10.1 Material identification

10.1.1 Records of the construction are to be kept in such a manner that traceability of all the component materials used in the manufacture of the completed structure and components is ensured. The Surveyor is to be given full facilities for tracing the material's origin when required.

10.1.2 Small representative samples of each batch of material are to be retained, these being suitably labelled to ensure traceability.

10.1.3 The Builder is to ensure copies of all test data and/or manufacturers' certificates of conformity appertaining to any material used are available for inspection at any time and that these are retained for a minimum of three years after completion of the construction.

■ **Section 11** **Requirements for material approval**

11.1 Requirements

11.1.1 This Section includes the minimum property values required of a material for approval by LR and is applicable to materials cured under open mould and ambient conditions.

11.1.2 **Gel coat resins.** When the cast resin is tested according to the requirements of Ch 14,2.3 of the Rules for Materials, Table 1.11.1 states the minimum values for the respective properties.

Table 1.11.1 Gel coat resin, minimum property values

Properties	Minimum value
Tensile strength (stress at maximum load)	40 N/mm ²
Tensile stress at break	40 N/mm ²
Tensile strain at maximum load	2,5%
Modulus of elasticity in tension	As measured
Flexural strength (stress at maximum load)	80 N/mm ²
Modulus of elasticity in flexure	As measured
Barcol hardness	As measured at full cure
Water absorption	70 mg (max)
Specific gravity of cast resin	As measured

11.1.3 **Laminating resins.** When tested according to the requirements of Ch 14,2.3 and 2.4 of the Rules for Materials, Table 1.11.2 provides the minimum values for the cast resin and chopped strand mat properties.

Table 1.11.2 Laminating resins, minimum property values

Properties	Minimum value
Tensile strength (stress at maximum load)*	40 N/mm ²
Tensile stress at break*	40 N/mm ²
Tensile strain at maximum load	2,0%
Modulus of elasticity in tension	As measured
Flexural strength (stress at maximum load)	70 N/mm ²
Modulus of elasticity in flexure	As measured
Barcol hardness	As measured at full cure
Temperature of deflection under load	55°C
Specific gravity of cast resin	As measured

* This value is the minimum and is for guidance. The normal value is predicted at 55 N/mm².

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11.1.4 Laminate. Table 1.11.3 provides minimum values for the recommended glass content by weight of 0,3.

Table 1.11.3 Minimum values for properties for CSM laminate at 0,3 glass fraction by weight

Properties	Minimum value
Tensile strength (stress at maximum load)	90 N/mm ²
Secant modulus at 0,25% and 0,5% strain respectively	6,9 kN/mm ²
Compressive strength (stress at maximum load)	125 N/mm ²
Compressive modulus	6,4 kN/mm ²
Flexural strength (stress at maximum load)	80 N/mm ²
Modulus of elasticity in flexure	5,7 kN/mm ²
Apparent interlaminar shear strength (see Note)	18 N/mm ²
Fibre content	As measured (0,3)
Water absorption	70 mg (max)

NOTE
Applicable only to the special test for environmental control resins.

11.1.5 When tested to the requirements of Ch 14,2.4 of the Rules for Materials for reinforcements, Table 1.11.4 provides the minimum properties for laminates cured under ambient conditions.

Table 1.11.4 Laminates, minimum property requirements

Material type	Property	Value
Chopped strand mat	Tensile strength (stress at maximum load) (N/mm ²) Modulus of elasticity in tension (kN/mm ²)	200G _C + 25 15G _C + 2,0
Bi-directional reinforcement	Tensile strength (stress at maximum load) (N/mm ²) Modulus of elasticity in tension (kN/mm ²)	400G _C ² - 10 30G _C - 0,5
Uni-directional reinforcement	Tensile strength (stress at maximum load) (N/mm ²) Modulus of elasticity in tension (kN/mm ²)	100G _C ² - 1400G _C + 510 130G _C ² - 114G _C + 39
All	Flexural strength (stress at maximum load) (N/mm ²) Modulus of elasticity in flexural (kN/mm ²) Compressive strength (stress at maximum load) (N/mm ²) Compressive modulus (kN/mm ²) Interlaminar shear strength (N/mm ²) Water absorption (mg) Glass content (% by weight)	502G _C ² + 106,8 33,4 G _C ² + 2,2 150G _C + 72 40G _C + 6 22 - 13,5G _C (min 15) 70 (maximum) As measured

NOTES

- After water immersion, the values shall be a minimum of 75% of the above.
- Where materials have reinforcement in more than two directions, the requirement will be subject to individual consideration dependent on the construction.
- G_C = glass fraction by weight.

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■ Section 13**Closed cell foams for core construction based on PVC or polyurethane****13.1 Closed cell foams for core construction based on PVC or polyurethane**

13.1.1 Table 1.13.1 provides minimum values for closed cell forms for core construction based on PVC or polyurethane.

13.1.2 Other types of foam will be considered as appropriate. A minimum core shear strength of 0,5 N/mm² is to be achieved.

Table 1.13.1 Minimum characteristics and mechanical properties of rigid expanded foams at 20°C

Material	Apparent Density (Kg/m ³)	Strength (stress at maximum load) (N/mm ²)			Modulus of elasticity (N/mm ²)	
		Tensile	Compressive	Shear	Compressive	Shear
Polyurethane	96	0,85	0,60	0,50	17,20	8,50
Polyvinylchloride	60					

■ Section 14**End grain balsa****14.1 End grain balsa**

14.1.1 Table 1.14.1 provides the minimum property requirement for end grain balsa.

Table 1.14.1 Minimum characteristics and mechanical properties of end grain balsa

Apparent Density (kg/m ³)	Strength (stress at maximum load) (N/mm ²)				Compressive modulus of elasticity (N/mm ²)		Shear Modulus of elasticity (N/mm ²)	
	Compressive		Tensile					
	Direction of stress				Direction of stress			
	Parallel to grain	Right angle to grain	Parallel to grain	Right angle to grain		Parallel to grain	Right angle to grain	
96	5,0	0,35	9,00	0,44	1,10	2300	35,2	105
144	10,6	0,57	14,6	0,70	1,64	3900	67,8	129
176	12,8	0,68	20,5	2,00	0,84	5300	89,6	145

PROVISIONAL RULES FOR THE CLASSIFICATION OF WING IN GROUND EFFECT CRAFT

GENERAL REQUIREMENTS FOR MACHINERY AND EQUIPMENT

JULY 2008

VOLUME 9

PART 1

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General Requirements

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Section

1 Scope and application

2 General

■ Section 1 Scope and application

1.1 Application

1.1.1 Items of machinery and associated equipment within the Mobility, Craft Function and Ancillary categories are to comply with the requirements of this Volume of the Rules.

1.1.2 The technical requirements in these Rules are to be demonstrated for all equipment detailed in 1.1.1. Compliance with the requirements is to be demonstrated through one of the following recognised methods:

- (a) Technical Construction File.
- (b) Type Approval.
- (c) Lloyd's Register (hereinafter referred to as 'LR') Design Appraisal.

Details of all these methods are identified in Vol 3, Pt 2.

1.1.3 Where an item of machinery or equipment has been previously accepted by LR and falls within any of the following criteria, a new submission for acceptance is to be made to LR:

- (a) a different operating environment for the product;
- (b) an untested application;
- (c) products with a known history of operational problems;
- (d) products with known manufacturing problems;
- (e) a new technology;
- (f) a different application of the component of product.

■ Section 2 General

2.1 Submission of information

2.1.1 An engineering description of all equipment, including references to plans as necessary, is to be submitted so that the function of all essential and safety critical components and systems necessary for the equipment operation are clearly defined. It is the responsibility of the equipment manufacturer to ensure that sufficient plans and information has been submitted to demonstrate that all the technical requirements of this Volume have been suitably addressed.

2.1.2 All equipment and machinery is to address the requirements of this Part of the Rules. Evidence of compliance may be through a Type Approval programme, compilation of a Technical Construction File or by LR Design Appraisal. In addition to these the requirements of the other relevant parts of this volume are in general to be addressed.

2.1.3 All major units of equipment within the Mobility category and where specifically required within the Craft Function category and Ancillary category, are to be individually surveyed at the manufacturer's works or meet the requirements of the Quality Scheme for Machinery.

2.1.4 An engineering and safety justification for all equipment covered by these Rules stating design standards and assumptions and providing technical evidence, is to be submitted. This is to include, but not be limited to:

- (a) Possible failure modes of internal components and measures adopted to mitigate such failures that may have an effect on the internal machinery or the surrounding environment/structures/systems, taking due account of suitability of materials and the effects of stress raisers, etc.
- (b) Limiting operating parameters.
- (c) Short-term high power operation.
- (d) Details of mounting and securing arrangements.
- (e) Vibratory responses.

2.2 General design considerations

2.2.1 Machinery, equipment or each component part thereof is to:

- (a) be capable of being handled safely;
- (b) be packaged or designed so that it can be stored safely and without damage (e.g. adequate stability, special supports, etc.);
- (c) either be fitted with attachments for lifting gear; or
- (d) be designed so that it can be fitted with such attachments (e.g. threaded holes); or
- (e) be shaped in such a way that standard lifting gear can easily be attached.

2.2.2 Where machinery or one of its component parts is to be moved by hand, it is to be either:

- (a) easily movable; or
- (b) equipped for picking up (e.g. hand-grips, etc.) and moving in complete safety.

2.2.3 Equipment and machinery is to be capable of effective operation during all normal and foreseeable failure conditions, taking due cognisance of acceleration loads inclinations and ambient conditions.

2.2.4 Machinery and equipment is to be designed and constructed that any batteries can be disconnected with the aid of an easily accessible device provided for that purpose.

2.2.5 The moving parts of machinery and equipment are to be designed, built and laid out to avoid hazards or, where hazards persist, fixed with guards or protective devices in such a way as to prevent all risk of contact which could lead to accidents.

2.2.6 Where machinery or equipment has an electricity supply, it is to be designed, constructed and equipped so that all hazards of an electrical nature are or can be prevented. The specific requirements relating to electrical equipment designed for use within certain voltage limits apply to machinery that is subject to those limits.

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2.2.7 Machinery and equipment is to be so designed and constructed as to prevent or limit the build-up of potentially dangerous electrostatic charges and/or be fitted with a discharging system.

2.2.8 Machinery and equipment is to be designed and constructed to avoid all risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.

2.2.9 Machinery and equipment is to be designed and constructed to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery. To that end the manufacturer is to take steps to:

- (a) avoid a dangerous concentration of products;
- (b) prevent combustion of the potentially explosive atmosphere; and
- (c) minimise any explosion which may occur so that it does not endanger the surroundings.

2.2.10 Machinery and equipment is to be so designed and constructed that risks resulting from vibration and the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing vibration and noise, in particular at source.

2.2.11 Parts of machinery or equipment where persons are liable to move about or stand are to be designed and constructed to prevent persons slipping, tripping or falling on or off these parts.

2.2.12 Equipment made from composite materials is to be manufactured in accordance with the quality scheme for composite construction.

2.2.13 Where it is intended to use a piece of machinery designed for an aeronautical application, it is to be demonstrated that it is suitable, or has been modified for the marine environment.

2.3 Physical safeguards

2.3.1 Steps are to be taken to eliminate any risk of injury caused by contact with or proximity to machinery parts or materials at high or very low temperatures. The risk of hot or very cold material being ejected is to be assessed. Where this risk exists, the necessary steps is to be taken to prevent it or, if this is not technically possible, to render it non-dangerous.

2.3.2 Guards and protection devices are to:

- (a) be of robust construction;
- (b) not give rise to any additional risk;
- (c) not be easy to by-pass or render non-operational;
- (d) be located at an adequate distance from any danger zones; and
- (e) enable essential work to be carried out on installation and maintenance by restricting access only to the area where the work has to be done, without the guard or protection device having to be dismantled where practicable.

2.3.3 Fixed guards are to:

- (a) be securely held in place;
- (b) be fixed by systems that can be opened only with tools; and
- (c) be unable to remain in place without their fixings where practicable.

2.3.4 Movable guards are to:

- (a) remain fixed to the machinery when open where practicable;
- (b) be associated with a locking device to prevent moving parts starting up as long as these parts can be accessed and to give a stop command whenever they are no longer closed.

2.3.5 Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work are to:

- (a) be adjustable manually or automatically according to the type of work involved;
- (b) be readily adjustable without the use of tools; and
- (c) reduce the risk of ejection as far as practicable.

2.4 Controls

2.4.1 It is to be possible to start machinery only by voluntary actuation of a control provided for the purpose. The same requirement applies:

- (a) when restarting the machinery after a stoppage, whatever the cause;
- (b) when effecting a significant change in the operating conditions (e.g. speed, pressure, etc.), unless such restarting or change in operating conditions is without risk to exposed persons.

2.4.2 Where machinery has several starting controls and the operators can therefore put each other in danger, additional devices (e.g. enabling devices or selectors allowing only one part of the starting mechanism to be actuated at any one time) are to be fitted to rule out such risks.

2.4.3 It is to be possible for automated plant functioning in automatic mode to be restarted easily after a stoppage once the safety conditions have been fulfilled.

2.4.4 Each machine is to be fitted with a control whereby the machine can be brought safely to a complete stop.

2.4.5 Each workstation is to be fitted with a control to stop some or all of the moving parts of the machinery, depending on the type of hazard, so that the machinery is rendered safe. The machinery's stop control is to have priority over the start controls.

2.4.6 Once the machinery or its dangerous parts have stopped, the energy supply to the actuators concerned is to be cut off.

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Section 2

2.4.7 Each machine is to be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions may be applied:

- (a) Machines in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken;
- (b) Hand-held portable machines and hand-guided machines.

2.4.8 Once active operation of the emergency stop control has ceased following a stop command, that command is to be sustained by engagement of the emergency stop device until that engagement is specifically overridden; it is not to be possible to engage the device without triggering a stop command; it is to be possible to disengage the device only by an appropriate operation, and disengaging the device is not to restart the machinery but only permit restarting.

2.4.9 In the case of machinery or parts of machinery designed to work together, the manufacturer is to design and construct the machinery such that the stop controls, including the emergency stop, can stop not only the machinery itself but also all equipment upstream and/or downstream if its continued operation can be dangerous.

2.4.10 The control mode selected is to override all other control systems with the exception of the emergency stop.

2.4.11 If machinery has been designed and built to allow for its use in several control or operating modes presenting different safety levels (e.g. to allow for adjustment, maintenance, inspection, etc.), it is to be fitted with a mode selector which can be locked in each position. Each position of the selector is to correspond to a single operating or control mode. The selector may be replaced by another selection method that restricts the use of certain functions of the machinery to certain categories of operator (e.g. access codes for certain numerically controlled functions, etc.). If for certain operations, the machinery is to be able to operate with its protection devices neutralised, the mode selector is to simultaneously:

- (a) disable the automatic control mode;
- (b) permit movements only by controls requiring sustained action;
- (c) permit the operation of dangerous moving parts only in enhanced safety conditions (e.g. reduced speed, reduced power, step-by-step, or other adequate provision) while preventing hazards from linked sequences;
- (d) prevent any movement liable to pose a danger by acting voluntarily or involuntarily on the machine's internal sensors.

2.4.12 In addition, the operator is to be able to control operation of the parts he is working on at the adjustment point.

2.5 Alarms and other warning devices

2.5.1 Where the health and safety of exposed persons may be endangered by a fault in the operation of unsupervised machinery or equipment, it is to be equipped to give an appropriate acoustic or light signal as a warning.

2.5.2 Where machinery or equipment is equipped with warning devices (such as signals, etc.), these are to be unambiguous and easily perceived. The operator is to have facilities to check the operation of such warning devices at all times.

2.6 Instructions and notices

2.6.1 Machinery and equipment is to bear full information relevant to its type and essential to its safe use.

2.6.2 The instructions are to contain the drawings and diagrams necessary for putting into service, maintenance, inspection, checking of correct operation and, where appropriate, repair of the machinery, and all useful instructions in particular with regard to safety.

2.6.3 Where risks remain despite all the measures adopted or in the case of potential risks which are not evident (e.g. electrical cabinets, radioactive sources, bleeding of a hydraulic circuit, hazard in an unseen area, etc.), the manufacturer is to provide warnings. Such warnings are to use readily understandable pictograms and/or be drawn up in one of the languages of the country in which the machinery or equipment is to be used, accompanied, on request, by the languages understood by the operators.

2.6.4 All machinery is to be marked legibly and indelibly with the following minimum particulars:

- (a) name and address of the manufacturer;
- (b) designation of series or type;
- (c) serial number, if any; and
- (d) the year of construction.

2.6.5 Where the manufacturer constructs machinery or equipment intended for use in a potentially explosive atmosphere, this is to be indicated on the machinery.

2.6.6 All machinery is to be accompanied by instructions including at least the following:

- (a) A repeat of the information with which the machinery is marked, together with any appropriate additional information to facilitate maintenance (e.g. addresses of the importer, repairers, etc.).
- (b) Foreseen use of the machinery.
- (c) Workstation(s) likely to be occupied by Operators.
- (d) Instructions for safe; putting into service; use; handling; assembly; dismantling; adjustment; maintenance (servicing and repair); training instructions.
- (e) Where necessary, the instructions are to draw attention to ways in which the machinery are not to be used.

2.6.7 Machinery and equipment is to also bear full information relevant to its type and essential to its safe use.

2.7 Testing

2.7.1 All parts of machinery, hydraulic, pneumatic and other systems and their associated fittings which are under internal pressure are to be subjected to appropriate tests including a pressure test before being put into service for the first time.

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PRIME MOVERS AND ASSOCIATED EQUIPMENT

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1.1.9 Provision is to be made to ensure that, whenever practical, the failure of systems driven by the engine is not to unduly affect the integrity of the major components.

1.1.10 The ventilation arrangements in the machinery spaces are to be adequate under all envisaged operating conditions. Where appropriate, arrangements are to ensure that enclosed engine compartments are forcibly ventilated to the atmosphere before the engine can be started.

1.1.11 Any engines are to be so installed as to avoid excessive vibration within the craft.

■ Section 1 General requirements

1.1 General

1.1.1 All prime movers are to be designed to a standard acceptable to Lloyd's Register (hereinafter referred to as 'LR'). The suitability of all defined features is to be established with tests, experience or analysis.

1.1.2 The engines are to be fitted with adequate safety monitoring and control devices in respect of speed, temperature, pressure and other operational functions. Control of the machinery is to be from the craft's operating compartment. The machinery installation are to be suitable for operation as in an unmanned machinery space, including automatic fire detection system, bilge alarm system, remote machinery instrumentation and alarm system.

1.1.3 Engines are to be designed and installed so that they can be started on water and during flight.

1.1.4 The engines are to be protected against overspeed, loss of lubricating oil pressure, loss of cooling medium, high temperature, malfunction of moving parts and overload. Safety devices are not to cause complete engine shutdown without prior warning, except in cases where there is a risk of complete breakdown or explosion. Such safety devices are to be capable of being tested.

1.1.5 A means of stopping engines quickly from the operating compartment under any operating conditions is to be available.

1.1.6 The major components of the engine are to have adequate strength to tolerate the thermal and dynamic conditions of normal operation. The engine is not to be capable of being damaged by a limited operation at a speed or at temperatures exceeding the normal values but within the range of the protective devices.

1.1.7 The design of the engine is to be such as to minimise the risk of fire or explosion.

1.1.8 Provision is to be made to drain all excess fuel and oil to a safe position so as to avoid a fire hazard.

■ Section 2 Gas turbines

2.1 Gas turbines

2.1.1 Gas turbines are to be designed to operate in the marine environment and are to be free from surge or dangerous instability throughout its operating range up to the maximum steady speed approved for use.

2.1.2 The turbine installation is to be arranged to ensure that the turbine cannot be continuously operated within any speed range where excessive vibration, stalling, or surging may be encountered.

2.1.3 Gas turbines are to be designed and installed such that any reasonably probable shedding of compressor or turbine blades will not endanger the craft, other machinery, occupants of the craft or any other persons.

2.1.4 Turbines are to be safeguarded as far as practicable against the possibility of damage by ingestion of contaminants from the operating environment. Information regarding the recommended maximum concentration of contamination is to be made available. Provision is to be made for preventing the accumulation of salt deposits on the compressors and turbines and, if necessary, for preventing the air intake from icing.

2.1.5 In the event of a failure of a shaft or weak link, the broken end is not to hazard the occupants of the craft, either directly or by damaging the craft or its systems. Where necessary, guards are to be fitted to achieve compliance with these requirements.

2.1.6 Each engine is to be provided with an emergency overspeed shutdown device connected, where possible, directly to each rotor shaft.

2.1.7 Where an acoustic enclosure is fitted which completely surrounds the gas generator and the high pressure oil pipes, a fire detection and extinguishing system is to be provided for the acoustic enclosure.

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2.1.8 Details of the manufacturers' proposed automatic safety devices to guard against hazardous conditions arising in the event of malfunction in the turbine installation are to be provided together with the failure mode and effect analysis.

2.1.9 The manufacturers are to demonstrate the soundness of the casings. Intercoolers and heat exchangers are to be hydraulically tested on each side separately.

2.1.10 Gas turbines are to be free from harmful vibration, during all normal operation and emergency conditions. This is to be true where the inlet airflow is distorted.

■ Section 3 Piston engines

3.1 Piston engines

3.1.1 Any main propulsion system is to have satisfactory torsional vibration and other vibrational characteristics verified by individual and combined torsional and other vibration analyses for the system and its components from power unit through to propulsor.

3.1.2 All external high-pressure fuel delivery lines between high-pressure fuel pumps and fuel nozzles are to be protected with a jacketed piping system capable of containing fuel from a high-pressure line failure. A jacketed pipe incorporates an outer pipe into which the high-pressure fuel pipe is placed, forming a permanent assembly. The jacketed piping system is to include a means for collection of leakages and arrangements are to be provided for an alarm to be given of a fuel line failure.

3.1.3 Any main propulsion system is to have satisfactory torsional vibration and other vibrational characteristics verified by individual and combined torsional and other vibration analyses for the system and its components from power unit through to propulsor.

3.1.4 Engines of a cylinder diameter of 200 mm or a crankcase volume of 0,6 m³ and above are to be provided with crankcase explosion relief valves of an approved type with sufficient relief area.

3.1.5 The relief valves are to be arranged with means to ensure that discharge from them is directed so as to minimise the possibility of injury to personnel.

3.1.6 The lubrication system and arrangements are to be efficient at all running speeds, due consideration being given to the need to maintain suction and avoid the spillage of oil in all conditions of list and trim and degree of motion of the craft.

3.1.7 Arrangements are to be provided to ensure that visual and audible alarms are activated in the event of either lubricating oil pressure or lubricating oil level falling below a safe level, considering the rate of circulation of oil in the engine. Such events are to also cause automatic reduction of engine speed to a safe level, but automatic shutdown is only to be activated by conditions leading to a catastrophic effect.

3.1.8 Where diesel engines are arranged to be started, reversed or controlled by compressed air, the arrangement of the air compressor, air receiver and air starting system is to be such as to minimise the risk of fire or explosion.

3.1.9 The engine induction system shall be so designed to minimise the risk of ice formation where this may adversely effect the function of the engine.

■ Section 4 Heat exchangers and turbo-chargers

4.1 Exhaust heat exchangers

4.1.1 Exhaust heat exchangers are to be constructed and installed to tolerate each vibration, inertia, and other load to which it would be subjected in operation. In addition:

- (a) Each exchanger is to be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases.
- (b) There are to be means for the inspection of the critical parts of each exchanger.
- (c) Each exchanger is to have cooling provisions wherever it is subject to contact with exhaust gases.
- (d) No exhaust heat exchanger or muff is to have any stagnant areas or liquid traps that would increase the probability of ignition of flammable fluids or vapours that might be present in case of the failure or malfunction of components carrying flammable fluids.

4.1.2 If an exhaust heat exchanger is used for heating ventilating air, the following is to be complied with:

- (a) There is to be a secondary heat exchanger between the primary exhaust gas heat exchanger and the ventilating air system; or
- (b) other means are to be used to preclude the harmful contamination of the ventilating air.

4.2 Exhaust driven turbo-chargers

4.2.1 Each exhaust driven turbo-supercharger is to be approved or shown to be suitable for the particular application. It is to be installed and supported to ensure safe operation between normal inspections and overhauls. In addition, there are to be provisions for expansion and flexibility between exhaust conduits and the turbine.

4.2.2 There are to be provisions for lubricating the turbine and for cooling turbine parts where temperatures are critical.

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4.2.3 If the normal turbo-supercharger control system malfunctions, the turbine speed is not to exceed its maximum allowable value. Except for the waste gate operating components, the components provided for meeting this requirement are to be independent of the normal turbo-supercharger controls.

■ Section 5 Pipes and pumps

5.1 Fuel strainers and or filters

5.1.1 Fuel strainers and filters are to be accessible for draining and cleaning and are to incorporate a screen or element which is easily removable.

5.1.2 Fuel strainers and filters are to have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes.

5.1.3 Fuel strainers and filters are to be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections.

5.1.4 Fuel strainers and filters are to have the capacity to deliver sufficiently filtered fuel to the engines.

5.2 Fuel system lines and fittings

5.2.1 Joints in piping systems carrying fuel are to be kept to the lowest practical number to minimise the possibility of hazardous consequences as a result of leakage during service or as a result of a joint being remade.

5.2.2 Each fuel line is to be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

5.2.3 Each fuel line connected to components between which relative motion could exist is to have provisions for flexibility.

5.2.4 Each flexible connection in fuel lines that may be under pressure and subjected to external loading is to use an approved type of flexible hose assembly.

5.2.5 Flexible hoses and their end fittings are to be of an approved type or be shown to be suitable for the particular application.

5.2.6 No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shut-down.

5.2.7 Each fuel line within the fuselage is to be designed and installed to allow a reasonable degree of deformation without fuel leakage.

5.3 Fuel system components

5.3.1 Fuel system components in an engine nacelle or in the fuselage must be protected from damage that could result in spillage of sufficient fuel to constitute a fire hazard as a result of a wheels-up grounding on a paved runway.

5.4 Fuel valves

5.4.1 Each fuel valve is to be supported such that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

5.5 Fuel strainer or filter

5.5.1 There is to be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an engine driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter is to:

- (a) be accessible for draining and cleaning and is to incorporate a screen or element that is easily removable;
- (b) have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;
- (c) be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and
- (d) be arranged so the operation of the means of fuel shut-off does not prevent propeller feathering.

5.5.2 Each oil valve is to have positive stops or suitable index provisions in the 'on' and 'off' positions and is to be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

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*Section***1 General****■ Section 1
General****1.1 General**

1.1.1 All transmission components are to be designed to a standard acceptable to Lloyd's Register (hereinafter referred to as 'LR'). The suitability of all defined features is to be established through tests, experience or analysis.

1.1.2 Transmission components are to be of adequate strength and stiffness to enable them to tolerate the most adverse combination of the loads expected in service without exceeding acceptable stress levels for the materials concerned.

1.1.3 The design of shafting, bearings and mounts is to be such that hazardous whirling and excessive vibration could not occur at any speed up to 105 per cent of the shaft speed attained at the designed overspeed trip setting of the prime mover.

1.1.4 The strength and fabrication of the transmission components is to be such that the probability of hazardous fatigue failure under the action of the repeated loads of variable magnitude expected in service is extremely remote throughout its operational life. Compliance is to be demonstrated by suitably conducted tests, and by designing for sufficiently low stress levels, combined with the use of fatigue resistant materials and suitable detail design.

1.1.5 Torsional vibration or oscillation likely to cause failure may be acceptable if it occurs at transmission speeds which would not be used in normal craft operation, and it is recorded in the craft operating manual as a limitation.

1.1.6 Where a clutch is fitted in the transmission, normal engagement of the clutch is not to cause excessive stresses in the transmission or driven items. Inadvertent operation of any clutch is not to produce dangerously high stresses in the transmission or driven item.

1.1.7 Provision is to be made such that a failure in any part of the transmission, or of a driven component, will not cause damage that might hazard the craft or its occupants.

1.1.8 Where failure of lubricating fluid supply or loss of lubricating fluid pressure could lead to hazardous conditions, provision is to be made to enable such failure to be indicated to the operating crew in adequate time to enable them as far as practicable to take the appropriate action before the hazardous condition arises.

Section**1 General****2 Propulsion devices****■ Section 1
General****1.1 General**

1.1.1 All propulsion and lift devices are to be designed to a standard acceptable to Lloyd's Register (hereinafter referred to as 'LR'). The suitability of all defined features is to be established through tests, experience or analysis.

1.1.2 The requirements of this Chapter are based on the premise that:

- (a) Propulsion arrangements and lift arrangements may be provided by separate devices, or be integrated into a single propulsion and lift device. Propulsion devices may be air, or water propellers or water jets and the requirements apply to all types of craft.
- (b) Propulsion devices are those which directly provide the propulsive thrust and include machinery items and any associated ducts, vanes, scoops and nozzles, the primary function of which is to contribute to the propulsive thrust.
- (c) The lift devices, for the purposes of this section, are those items of machinery which directly raise the pressure of the air and move it for the primary purpose of providing lifting force for an air-cushion vehicle.

1.1.3 The propulsion and lift devices are to be of adequate strength and stiffness.

1.1.4 The design data, calculations and trials, where necessary, are to establish the ability of a device to withstand the loads which can arise during the operations for which the craft is to be certificated, so that the possibility of catastrophic failure is extremely remote.

1.1.5 The design of propulsion and lift devices are to pay due regard to the effects of allowable corrosion, electrolytic action between different metals, erosion or cavitation which may result from operation in environments in which they are subjected to spray, debris, salt, sand, icing, etc.

1.1.6 The design data and testing of propulsion and lift devices is to pay due regard, as appropriate, to any pressure which could be developed as a result of a duct blockage, to steady and cyclic loadings, to loadings due to external forces and to the use of the devices in manoeuvring and reversing and to the axial location of rotating parts.

1.1.7 Appropriate arrangements are to be made to ensure that:

- (a) ingestion of debris or foreign matter is minimised;
- (b) the possibility of injury to personnel from shafting or rotating parts is minimised; and

- (c) where necessary, inspection and removal of debris can be carried out safely in service.

**■ Section 2
Propulsion devices****2.1 Air screws**

2.1.1 Airscrews are to be designed and constructed so that the blades and mounting arrangements are of adequate stiffness and strength to withstand the maximum possible combination of loads that may arise during normal operation and emergency conditions.

2.1.2 The design is also to take due account of the fatigue and vibration loading that will arise during the design life of the equipment.

2.1.3 The suitability of a propeller for its intended purpose is to be demonstrated by centrifugal load, vibration, endurance, overspeed, strength and functional tests, or alternatively demonstration of satisfactory service experience in a comparable application.

2.1.4 Propeller pitch control mechanisms are to be designed and installed such that they are capable of actuating and maintaining the propeller pitch as required.

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ELECTRICAL AND ELECTRONIC EQUIPMENT

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Chapter 1 Electrical and Electronic Equipment

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Section**1 Equipment****■ Section 1
Equipment****1.1 General**

1.1.1 Electrical equipment is to be designed, constructed and tested in accordance with recognised National or International standards relevant to the intended application. In particular, the International Electrotechnical Commission (IEC) series of standards for electrical installations in ships (IEC 60092) may be applied.

1.1.2 Electrical equipment is to be of a type acceptable to Lloyd's Register (hereinafter referred to as 'LR'), see Vol 2, Pt 1, Ch 2, and is to be designed so as to operate satisfactorily in the specified environmental conditions and under normally occurring variations of voltage and frequency and harmonic distortion.

1.1.3 Electrical equipment is to be installed such as to mitigate hazards and ensure the availability of supplied services with due regard to the operating environment and to manufacturer's instructions.

1.2 Equipment located in hazardous areas

1.2.1 Electrical equipment located in hazardous areas is to be of a safe type and certified by an independent accredited body.

1.3 Testing requirements

1.3.1 Tests identified by this section are to be carried out on all electrical equipment.

1.3.2 A high voltage at any frequency between 25 Hz and 100 Hz is to be applied between:

- (a) all current carrying parts connected together and earth;
 - (b) all current carrying parts of opposite polarity or phase;
- For rotating machines the value of test voltage is to be 1000 V plus $2 \times$ rated voltage with a minimum of 2000 V, and for other equipment it is to be in accordance with Table 1.1.1. Where the test voltage for an item of equipment included in the assembly is lower than that required for the assembly, the equipment may be disconnected during the test and tested separately at the appropriate voltage. The test is to be commenced at a voltage of about one-third of the test voltage and increased to the full value as rapidly as is consistent with the value being indicated by the measuring equipment. The full test voltage is then to be maintained for one minute, and then reduced to one-third of the full value before switching off. The assembly is considered to have passed the test if no disruptive discharge occurs.

Table 1.1.1 Test voltage

Rated voltage U_n , V	Test voltage a.c. (r.m.s.), V
$U_n = < 60$	500
$60 < U_n = < 1000$	$2 \times U_n + 1000$
$1000 < U_n = < 2500$	6500
$2500 < U_n = < 3500$	10000
$3500 < U_n = < 7200$	20000
$7200 < U_n = < 12000$	28000
$12000 < U_n = < 15000$	38000

1.3.3 Where additional high voltage tests are to be made on equipment, which has already passed its test, the test voltage is to be 80 per cent of the voltage at which the equipment was previously tested.

1.3.4 The insulation resistance is to be measured immediately after the high voltage test using a direct current insulation tester, between:

- (a) all current carrying parts connected together and earth;
 - (b) all current carrying parts of different polarity or phase.
- The minimum values of test voltage and insulation resistance are given in Table 1.1.2.

Table 1.1.2 Test voltage and minimum insulation

Rated voltage U_n , V	Minimum voltage of the tests, V	Minimum insulation resistance, MΩ
$U_n = < 250$	$2 \times U_n$	1
$25 < U_n = < 1000$	500	1
$1000 < U_n = < 7200$	1000	$(U_n/1000) + 1$
$7500 < U_n = < 15000$	5000	$(U_n/1000) + 1$

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