GL Noble Denton

TECHNICAL POLICY BOARD

GUIDELINES FOR MARINE TRANSPORTATIONS

0030/ND

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PREFACE

This document has been drawn with care to address what are likely to be the main concerns based on the experience of the GL Noble Denton organisation. This should not, however, be taken to mean that this document deals comprehensively with all of the concerns which will need to be addressed or even, where a particular matter is addressed, that this document sets out the definitive view of the organisation for all situations. In using this document, it should be treated as giving guidelines for sound and prudent practice on which our advice should be based, but guidelines should be reviewed in each particular case by the responsible person in each project to ensure that the particular circumstances of that project are addressed in a way which is adequate and appropriate to ensure that the overall advice given is sound and comprehensive.

Whilst great care and reasonable precaution has been taken in the preparation of this document to ensure that the content is correct and error free, no responsibility or liability can be accepted by GL Noble Denton for any damage or loss incurred resulting from the use of the information contained herein.

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a. Cargoes on ships or towed barges

b. Towage of self-floating marine and oilfield equipment, civil engineering structures and ships

but are not normally intended to apply to "standard" cargoes such as bulk liquids, bulk solids, refrigerated cargoes, vehicles or containers.

1.1.2 This Revision 4 includes changes described in Section 2.7. 4

1.1.3 It should be noted that this document cannot cover every case of all transportation types. The reader should satisfy himself that the guidelines used are fit for purpose for the actual transportation under consideration.

1.1.4 In general, in addition to compliance with these Guidelines, towing operations should comply with the mandatory parts of relevant IMO documents. The approval of any transportation by GL Noble Denton does not imply that approval by any other involved parties would be given. These Guidelines are intended to ensure the safety of the transported equipment. They do not specifically apply to the safety of personnel or protection of the environment, for which more stringent guidelines may be appropriate.

1.1.5 These Guidelines are not intended to exclude alternative methods, new technology and new equipment, provided an equivalent level of safety can be demonstrated.

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2 INTRODUCTION

2.1 This document describes the guidelines for approval of specialised marine transportations, including:

a. Transportation of cargoes on towed barges

b. Transportation of specialised cargoes on ships

c. Transportation of specialised cargoes on submersible, heavy lift vessels

d. Towage of ships including demolition towages

e. Towages of self-floating marine and oilfield equipment such as mobile offshore drilling units (MODUs), self floating jackets, floating docks, dredgers, crane vessels and Floating Production Storage and Offload vessels (FPSOs)

f. One-off towages of self-floating civil engineering structures such as caissons, power plants, bridge components and submerged tube tunnel sections.

2.2 Where GL Noble Denton is acting as a consultant rather than a Warranty Surveyor, these Guidelines may be applied, as a guide to good practice.

2.3 These Guidelines are not intended to be applicable to “standard” cargoes such as bulk liquids, bulk solids, refrigerated cargoes, vehicles or containers.

2.4 The document refers to other GL Noble Denton guidelines as appropriate.

2.5 Revision 2 included an additional Section 22, relating to towages in ice covered waters. It also superseded and replaced earlier Noble Denton guidelines:

a. Guidelines for the transportation of specialised cargoes on ships and heavy transport vessels - 0007/NDI

b. Self-elevating platforms - guidelines for operations and towages (towage section only) - 0009/ND [Ref. 1]

c. Guidelines for Marine Transportations - 0014/NDI

d. Guidelines for the Towage of Ships - 0026/NDI.

2.6 Revision 3 superseded Revision 2, and included:

a. Modification of spectra definition in Section 7.3.5.

b. Clarification of forward speed for motion analysis in Section 7.4.2.

c. Minor changes to loadings in Sections 8.2, 8.3, and pump capacity in Section 15.5.1.

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2.7 This Revision 4 supersedes Revision 3, and includes:

a. The addition of Transportation / Towage Manuals in Section 5.4 and Appendix G.

b. Updates to required documentation in Table 5-2.

c. Clarification of design extremes in Sections 6.5.4 and 6.8.7.

d. Clarification of Sections 7.2.2, 7.8.1 and 9.5.7.

e. An additional option for design seastates in Sections 7.3.1 to 7.3.3. 4

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h. Minor changes for stability ranges in Table 10-1.

i. Addition of towage requirements for concrete gravity units in Sections 12.1 and 14.20.

j. Additional requirements for certificates in Sections 13.2.2 and 13.12.1.

k. The addition of Section 23 for Towages in the Caspian Sea.

2.8 It should be noted that this document cannot cover every case of all transportation types. The reader should satisfy himself that the guidelines used are fit for purpose for the actual transportation under consideration.

2.9 Further information referring to other phases of marine operations may be found in:

a. Self-elevating platforms – Guidelines for Elevated Operations 0009/ND [Ref. 1]

b. Guidelines for Loadouts - 0013/ND [Ref. 2]

c. Concrete Offshore Gravity Structures – Guidelines for Approval of Construction, Towage and Installation - 0015/ND [Ref. 3]

d. Seabed and Sub-Seabed Data Required for Approvals of Mobile Offshore Units (MOU) - 0016/ND [Ref. 4]

e. Guidelines for the Approvability of Towing Vessels - 0021/ND [Ref. 5]

f. Guidelines for Lifting Operations by Floating Crane Vessels - 0027/ND [Ref. 6]

g. Guidelines for the Transportation and Installation of Steel Jackets 0028/ND - [Ref. 7].

2.10 All current GL Noble Denton Guidelines can be downloaded from www.gl-nobledenton.com.

2.11 The approval of any transportation by GL Noble Denton does not imply that approval by designers, regulatory bodies, harbour authorities and/or any other involved parties would be given, nor does it imply approval of the seaworthiness of the vessel.

2.12 These Guidelines are intended to ensure the safety of the transported equipment. They do not specifically apply to the safety of personnel or protection of the environment, which are covered by other International and National Regulations. In some cases more stringent guidelines may be appropriate in order to protect personnel and the environment.

2.13 These Guidelines refer both to towages of barges and other self-floating equipment, and to voyages of self-propelled vessels. Where applicable, and unless particular distinction is required, the term “vessel” may include “barge”, and “voyage” may include “towage”, and vice versa.

2.14 The “Special Considerations” Sections 19 through 23 may amend, add to or contradict the general sections. Care should be taken to ensure that the special requirements are considered as appropriate.

2.15 These Guidelines are not intended to exclude alternative methods, new technology and new equipment, provided an equivalent level of safety can be demonstrated.

3 DEFINITIONS & ABBREVIATIONS

3.1 Referenced definitions are underlined.

Term or acronym	Definition
24-hour Move	A jack-up move taking less than 24 hours between entering the water and reaching a safe airgap with at least two very high confidence good weather forecasts for the 48 hours after entering the water, having due regard to area and season.
ABS	American Bureau of Shipping
AISC	American Institute of Steel Construction
API	American Petroleum Institute
Approval	The act, by the designated GL Noble Denton representative, of issuing a 'Certificate of Approval'.
ASPPR	Arctic Shipping Pollution Prevention Regulations
Assured	The Assured is the person who has been insured by some insurance company, or underwriter, against losses or perils mentioned in the policy of insurance.
Barge	A non-propelled vessel commonly used to carry cargo or equipment.
Benign area	An area that is free from tropical revolving storms and travelling depressions, (but excluding the North Indian Ocean during the Southwest monsoon season, and the South China Sea during the Northeast monsoon season). The specific extent and seasonal limitations of a benign area should be agreed with the GL Noble Denton office concerned.
BL / Breaking Load	Breaking load (BL) = Certified minimum breaking load of wire rope, chain or shackles, measured in tonnes.
BP / Bollard Pull	Bollard pull (BP) = Certified continuous static bollard pull of a tug measured in tonnes.
BV	Bureau Veritas
Cargo	Where the item to be transported is carried on a barge or a vessel, it is referred to throughout this report as the cargo. If the item is towed on its own buoyancy, it is referred to as the tow.
Cargo ship safety certificates (Safety Construction) (Safety Equipment) (Safety Radio)	Certificates issued by a certifying authority to attest that the vessel complies with the cargo ship construction and survey regulations, has radiotelephone equipment compliant with requirements and carries safety equipment that complies with the rules applicable to that vessel type. Certificate validities vary and are subject to regular survey to ensure compliance.
CASPRR	Canadian Arctic Shipping Pollution Prevention Regulations
Certificate of Approval	A formal document issued by GL Noble Denton stating that, in its judgement and opinion, all reasonable checks, preparations and precautions have been taken to keep risks within acceptable limits, and an operation may proceed.
Class	A system of ensuring ships are built and maintained in accordance with the Rules of a particular Classification Society. Although not an absolute legal requirement the advantages (especially as regards insurance) mean that almost all vessels are maintained in Class.

Term or acronym	Definition	
COSHH	Control of Substances Hazardous to Health	
Cribbing	An arrangement of timber baulks, secured to the deck of a barge or vessel, formally designed to support the cargo, generally picking up the strong points in vessel and/or cargo.	
Demolition towage	Towage of a "dead" vessel for scrapping.	
Deratisation	Introduced to prevent the spread of rodent borne disease, Certification attesting the vessel is free of rodents (Derat Exemption Certificate) or has been satisfactorily fumigated to derat the vessel (Derat Certificate). Certificates are valid for 6 months unless further evidence of infestation found.	
Design environmental condition	The design wave height, design wind speed, and other relevant environmental conditions specified for the design of a particular transportation or operation.	
Design wave height	Typically the 10-year monthly extreme significant wave height, for the area and season of the particular transportation or operation.	
Design wind speed	Typically the 10-year monthly extreme 1-minute wind velocity at a reference height of 10 m above sea level, for the area and season of the particular transportation or operation.	
DNV	Det Norske Veritas	
Double tow	The operation of towing two tows with two tow wires by a single tug. See Section 18.3.	
Dry Towage (or Dry Tow)	Transportation of a cargo on a barge towed by a tug. Commonly mis-used term for what is actually a voyage with a powered vessel, more properly referred to as 'Dry Transportation'	
Dry Transportation	Transportation of a cargo on a barge or a powered vessel.	
Dunnage	See cribbing.	
EPIRB	Emergency Position Indicating Radio Beacon	
Flagged vessel	A vessel entered in a national register of shipping with all the appropriate certificates.	
Floating offload	The reverse of floating onload	
Floating onload	The operation of transferring a cargo, which itself is floating, onto a vessel or barge, which is submerged for the purpose.	
FPSO	Floating Production, Storage and Offload vessel	
GL	Germanischer Lloyd	
GL Noble Denton	Any company within the GL Noble Denton Group including any associated company which carries out the scope of work and issues a Certificate of Approval, or provides advice, recommendations or designs as a consultancy service.	4
GMDSS	Global Maritime Distress and Safety System	
GPS	Global Positioning System	
Grillage	A steel structure, secured to the deck of a barge or vessel, formally designed to support the cargo and distribute the loads between the cargo and barge or vessel.	
GZ	Righting arm	4
IACS	International Association of Classification Societies	

Term or acronym	Definition
IMDG Code	International Maritime Dangerous Goods Code
IMO	International Maritime Organisation
Independent leg jack-up	A jack-up where the legs may be raised or lowered independently of each other.
Insurance Warranty	A clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house.
IOPP Certificate	International Oil Pollution Prevention Certificate (see also MARPOL)
ISM Code	International Safety Management Code - the International Management Code for the Safe Operation of Ships and for Pollution Prevention - SOLAS Chapter IX [Ref. 8]
Jack-up	A self-elevating MODU, MOU or similar, equipped with legs and jacking systems capable of lifting the hull clear of the water.
Line pipe	Coated or uncoated steel pipe sections, intended to be assembled into a Pipeline
LOA	Length Over All
Load line	The maximum depth to which a ship may be loaded in the prevailing circumstances in respect to zones, areas and seasonal periods. A Loadline Certificate is subject to regular surveys, and remains valid for 5 years unless significant structural changes are made.
Loadout	The transfer of a cargo onto a barge or vessel by horizontal movement, lifting, floatover etc.
Location move	A move of a MODU or similar, which, although not falling within the definition of a field 24-hour move, may be expected to be completed with the unit essentially in 24-hour field move configuration, without overstressing or otherwise endangering the unit, having due regard to the length of the move, and to the area (including availability of shelter points) and season.
LRFD	Load and Resistance Factor Design
LRS	Lloyds Register of Shipping
Marine operation	See Operation
MARPOL	International Convention for the Prevention of Pollution from Ships 1973/78, as amended.
Mat-supported jack-up	A jack-up which is supported in the operating mode on a mat structure, into which the legs are connected and which therefore may not be raised or lowered independently of each other.
MBL	Minimum Breaking Load (see Sections 13.2.1 and 22.7.3.2)
MODU	See MOU
MOU	Mobile Offshore Unit. For the purposes of this document, the term may include mobile offshore drilling units (MODUs), and non-drilling mobile units such as accommodation, construction, lifting or production units

Term or acronym	Definition
MPME / Most Probable Maximum Extreme	The value of the maximum of a variable with the highest probability of occurring over a period of 3 hours. NOTE The most probable maximum is the value for which the probability density function of the maxima of the variable has its peak. It is also called the mode or modus of the statistical distribution. It typically occurs with the same frequency as the maximum wave associated with the design seastate.
Multiple tow	The operation of towing more than one tow by a single tug. See Section 18.1.
NDT	Non Destructive Testing
Ocean towage	Any towage which does not fall within the definition of a restricted operation, or any towage of a MODU or similar which does not fall within the definition of a 24-hour move or location move.
Ocean transportation	Any transportation which does not fall within the definition of a restricted operation
Off-hire survey	A survey carried out at the time a vessel, barge, tug or other equipment is taken off-hire, to establish the condition, damages, equipment status and quantities of consumables, intended to be compared with the on-hire survey as a basis for establishing costs and liabilities.
Offload	The reverse of loadout
On-hire survey	A survey carried out at the time a vessel, barge, tug or other equipment is taken on-hire, to establish the condition, any pre-existing damages, equipment status and quantities of consumables. It is intended to be compared with the off-hire survey as a basis for establishing costs and liabilities. It is not intended to confirm the suitability of the equipment to perform a particular operation.
Operation, marine operation	Any activity, including loadout, transportation, offload or installation, which is subject to the potential hazards of weather, tides, marine equipment and the marine environment,
Operational reference period	The planned duration of an operation including a contingency period.
Parallel tow	The operation of towing two tows with one tow wire by a single tug, the second tow being connected to a point on the tow wire ahead of the first tow with the catenary of its tow wire passing beneath the first tow. See Section 18.1.4.
PIC	Person In Charge
Pipe carrier	A vessel specifically designed or fitted out to carry Line pipe
Port (or point) of shelter	See Shelter point
Port of refuge	A location where a towage or a vessel seeks refuge, as decided by the Master, due to events occurring which prevent the towage or vessel proceeding towards the planned destination. A safe haven where a towage or voyage may seek shelter for survey and/or repairs, when damage is known or suspected.
Procedure	A documented method statement for carrying out an operation

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Term or acronym	Definition
Registry	Registry indicates who may be entitled to the privileges of the national flag, gives evidence of title of ownership of the ship as property and is required by the need of countries to be able to enforce their laws and exercise jurisdiction over their ships. The Certificate of Registry remains valid indefinitely unless name, flag or ownership changes.
Restricted operation	See Weather-restricted operation.
Risk assessment	A method of hazard identification where all factors relating to a particular operation are considered.
SART	Search and Rescue Radar Transponder
Seafastening	The means of preventing movement of the cargo or other items carried on or within the barge, vessel, or tow.
Semi-submersible	A MODU or similar designed to operate afloat, generally floating on columns which reduce the water-plane area, and often moored to the seabed when operating.
Shelter point (or shelter port, or point of shelter)	An area or safe haven where a towage or vessel may seek shelter, in the event of actual or forecast weather outside the design limits for the transportation concerned. A planned holding point for a staged transportation
Single tow	The operation of towing a single tow with a single tug.
SLS	A design condition defined as a normal Serviceability Limit State / normal operating case.
SMC / Safety Management Certificate	A document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved SMS.
SMS / Safety Management System	A structured and documented system enabling Company personnel to implement the Company safety environmental protection policy.
SOPEP	Shipboard Oil Pollution Emergency Plan
Staged transportation	A transportation which can proceed in stages between shelter points, not leaving or passing each shelter point unless there is a suitable weather forecast for the next stage. Each stage may, subject to certain safeguards, be considered a weather-restricted operation.
Submersible transport vessel	A vessel which is designed to ballast down to submerge its main deck, to allow self-floating cargoes to be on-loaded and off-loaded.
Suitability survey	A survey intended to assess the suitability of a tug, barge, vessel or other equipment to perform its intended purpose. Different and distinct from an on-hire survey.
Survey	Attendance and inspection by a GL Noble Denton representative.
Surveyor	The GL Noble Denton representative carrying out a Survey. An employee of the fabrication or loadout contractor or Classification Society performing, for instance, a dimensional, structural or Class survey.
Tandem tow	The operation of towing two or more tows in series with one tow wire from a single tug, the second and subsequent tows being connected to the stern of the tow ahead.

Term or acronym	Definition
T_e / Tug efficiency (Te)	Defined as: $\frac{\text{Effective bollard pull produced in the weather considered}}{\text{Certified continuous static bollard pull}}$
Tonnage	A measurement of a vessel in terms of the displacement of the volume of water in which it floats, or alternatively, a measurement of the volume of the cargo carrying spaces on the vessel. Tonnage measurements are principally used for freight and other revenue based calculations. Tonnage Certificates remain valid indefinitely unless significant structural changes are made.
Tow	The item being towed. This may be a barge or vessel (laden or un-laden) or an item floating on its own buoyancy. Approval by GL Noble Denton of the tow will normally include, as applicable: consideration of condition and classification of the barge or vessel; strength, securing and weather protection of the cargo, draught, stability, documentation, emergency equipment, lights, shapes and signals, fuel and other consumable supplies, manning.
Towage	The operation of transporting a non-propelled barge or vessel (whether laden or not with cargo) or other floating object by towing it with a tug.
Towing (or towage) arrangements	The procedures for effecting the towage. Approval by GL Noble Denton of the towing (or towage) arrangements will normally include consideration of towlines and towline connections, weather forecasting, pilotage, routeing arrangements, points of shelter, bunkering arrangements, assisting tugs, communication procedures.
Towing vessel	See Tug
Towline connection strength	Towline connection strength (TC) = ultimate load capacity of towline connections, including connections to barge, bridle and bridle apex, in tonnes.
TPR / Towline pull required	The towline pull computed to hold the tow, or make a certain speed against a defined weather condition, in tonnes.
Transportation	The operation of transporting a tow or a cargo by a towage or a voyage.
Tug	The vessel performing a towage. Approval by GL Noble Denton of the tug will normally include consideration of the general design; classification; condition; towing equipment; bunkers and other consumable supplies; emergency and salvage equipment; communication equipment; manning.
TVAC / Towing Vessel Approvability Certificate	A document issued by GL Noble Denton stating that a towing vessel complied with the requirements of Ref [5] at the time of survey, or was reportedly unchanged at the time of revalidation, in terms of design, construction, equipment and condition, and is considered suitable for use in towing service within the limitations of its Category, bollard pull and any geographical limitations which may be imposed.
TVAS / Towing Vessel Approvability Scheme	The scheme whereby owners of towing vessels may apply to have their vessels surveyed, leading to the issue of a TVAC.

Term or acronym	Definition
ULC / Ultimate Load Capacity	Ultimate load capacity of a wire rope, chain or shackle or similar is the certified minimum breaking load, in tonnes. The load factors allow for good quality splices in wire rope. Ultimate load capacity of a padeye, clench plate, delta plate or similar structure, is defined as the load, in tonnes, which will cause general failure of the structure or its connection into the barge or other structure.
ULS	A design condition defined as Ultimate Limit State / survival storm case.
Vessel	A self-propelled marine craft designed for the purpose of transportation by sea.
Voyage	For the purposes of this report, the operation of transporting a cargo on a powered vessel from one location to another.
Watertight	A watertight opening is an opening fitted with a closure designated by Class as watertight, and maintained as such, or is fully blanked off so that no leakage can occur when fully submerged.
Weather un-restricted operation	An operation with an operational reference period generally greater than 72 hours. The design environmental condition for such an operation shall be set in accordance with extreme statistical data.
Weather-restricted operation	A marine operation which can be completed within the limits of an operational reference period with a favourable weather forecast (generally less than 72 hours), taking contingencies into account. The design environmental condition need not reflect the statistical extremes for the area and season. A suitable factor should be applied between the design weather conditions and the operational weather limits.
Weathertight	A weathertight opening is an opening closed so that it is able to resist any significant leakage from one direction only, when temporarily immersed in green water or fully submerged.
WMO	World Meteorological Organisation
WPS	Welding Procedure Specification
WSD	Working Stress Design

4 THE APPROVAL PROCESS

4.1 GENERAL

4.1.1 GL Noble Denton may act as a Warranty Surveyor, giving Approval to a particular operation, or as a Consultant, providing advice, recommendations, calculations and/or designs as part of the Scope of Work. These functions are not necessarily mutually exclusive.

4.2 GL NOBLE DENTON APPROVAL

4.2.1 GL Noble Denton approval means approval by any company within the GL Noble Denton Group including any associated company which carries out the scope of work and issues a Certificate of Approval.

4.2.2 GL Noble Denton approval may be sought where the towage, voyage or operation is the subject of an Insurance Warranty, or where an independent third party review is required.

4.3 An Insurance Warranty is a clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house. The requirement is normally satisfied by the issue of a Certificate of Approval. Responsibility for interpreting the terms of the Warranty so that an appropriate Scope of Work can be defined rests with the Assured.

4.3.1 GL Noble Denton approval may be required for the loadout and offload operations, either in addition to the transportation, or where such operations are deemed to be part of the transportation.

4.4 CERTIFICATE OF APPROVAL

4.4.1 The deliverable of the approval process will generally be a Certificate of Approval.

4.4.2 The Certificate of Approval is the formal document issued by GL Noble Denton when, in its judgement and opinion, all reasonable checks, preparations and precautions have been taken to keep risks within acceptable limits, and an operation may proceed.

4.4.3 A Certificate confirming adequate preparation for a transportation will normally be issued by the attending surveyor immediately prior to departure, when all preparations including seafastening and ballasting are complete, the barge or vessel, cargo, tug and towing connections (as applicable) have been inspected, and the actual and forecast weather are suitable for departure.

4.5 SCOPE OF WORK LEADING TO AN APPROVAL

4.5.1 In order to issue a Certificate of Approval, GL Noble Denton will typically require to consider, as applicable, the following topics:

a. History, condition and documentation of the tow or cargo

b. Voyage or towage route, season and design environmental conditions, with shelter points if applicable

c. Capability of the vessel or barge to carry the cargo

d. Vessel, barge or tow motions

e. Strength of the tow, cargo, seafastening and cribbing to withstand static and motion induced transportation loads

f. Stability of the vessel, barge or tow

g. Towing resistance and required bollard pull

h. Towing vessel specification and documentation

i. Towing connections and arrangements

j. Weather protection of the tow or cargo

k. Seafastening of items and substructures within the tow or cargo

l. Arrangements for receiving weather forecasts along the route

m. Transportation or towing manual (see Section 5.4 and Appendix G). 4

4.5.2 If approval is also required for the onload and/or offload operations of a self-floating cargo onto/from a submersible vessel or barge, then the following will typically require consideration:

a. Location details, water depth, tidal conditions and meteorological exposure.

b. Vessel or barge moorings.

c. Stability and ballasting conditions during the load transfer operation and the critical parts of the deballasting/ballasting operation.

d. Cribbing position and securing during submergence.

e. Towing and handling arrangements for the cargo.

f. Cargo positioning arrangements.

g. Reactions between vessel or barge and cargo.

h. Limiting weather conditions for the operation.

4.5.3 If approval is required for loadout from the shore onto a vessel or barge, offload from a vessel or barge to the shore, or lifting from a vessel or barge to a platform, reference should be made to documents 0013/ND [Ref. 2] and 0027/ND [Ref. 6] as appropriate.

4.5.4 Technical studies leading up to the issue of a Certificate of Approval for transportation may consist of:

a. Reviews of specifications, procedures and calculations submitted by the client or his contractors, or

b. Independent analyses carried out by GL Noble Denton to verify the feasibility of the proposals, or

c. A combination of third party reviews and independent analyses.

4.5.5 Surveys required in order to issue a Certificate of Approval will typically include:

a. Survey of the transport vessel or barge

b. Survey of the tow or cargo

c. Survey of completed seafastenings and other voyage preparations including vessel or barge readiness, ballast condition, cargo securing, weather-tightness and internal seafastening

d. Survey of tug and towing connections, if applicable

e. Inspection of documentation for vessel, barge and tug as appropriate

f. Review of actual and forecast weather for departure

4.5.6 The above surveys may be carried out immediately before departure, but the client may consider it in his interests to have initial surveys carried out in advance, to reduce the risk of rejection of any major item.

4.5.7 Tugs in possession of a GL Noble Denton Towing Vessel Approvability Certificate (TVAC) may be pre-approved in principle in advance. It may be advisable to request a survey of an unknown tug prior to mobilisation.

4.5.8 Whilst not forming part of the surveys required for approval, the client may also consider it in his interests to have on- and off-hire surveys performed of equipment taken on charter, in order to establish inventories of equipment and consumables, and liability for degradation or damage.

4.6 LIMITATION OF APPROVAL

4.6.1 A Certificate of Approval is issued for a specific towage, voyage or operation only.

4.6.2 A Certificate of Approval is issued based on external conditions observed by the attending surveyor of hull, machinery and equipment, without removal, exposure or testing of parts.

4.6.3 A Certificate of Approval shall not be deemed or considered to be a general Certificate of Seaworthiness.

4.6.4 A Certificate of Approval for a towage or voyage does not include any moorings prior to the start of the towage or voyage, or at any intermediate shelter, bunkering or arrival port, unless specifically approved by GL Noble Denton.

4.6.5 No responsibility is accepted by GL Noble Denton for the way in which the towage or voyage is conducted, this being solely the responsibility of the master of the tug or vessel.

4.6.6 The towage is deemed to be completed and the related Certificate of Approval invalidated when the approved tug(s) is/are disconnected.

4.6.7 Fatigue damage is excluded from any GL Noble Denton approval, unless specific instructions are received from the client to include it in the scope of work.

4.6.8 Any alterations in the surveyed items or agreed procedures or arrangements, after issue of a Certificate of Approval, may render the Certificate void unless the alterations are specifically approved by GL Noble Denton.

4.6.9 The Certificate covers the surveyed items within the agreed scope of work only. It does not, for instance, cover any other cargo on board a vessel or barge, or any damage to the surveyed cargo as a consequence of inadequacy of any other cargo or its seafastenings, unless specifically included in the scope of work.

5 CERTIFICATION AND DOCUMENTATION

5.1 GENERAL

5.1.1 In general, some or all of the documentation listed in the Table 5-1 and Table 5-2 below will be required. Some documentation is mandatory to comply with international legislation and standards. The documentation and certification requirements for any particular structure, vessel or operation should be determined in advance. Where new documentation is needed, the issuing authority and the Rules to be applied should be identified.

5.2 DOCUMENTATION DESCRIPTION

5.2.1 Principal documentation and certification is described in the following Table 5-1:

Table 5-1 Principal Documentation

Document / Certificate	Description
Ship Safety Construction	Covers the hull, machinery and equipment of a ship, (over 500 gt) and shows that the ship complies with the construction and safety regulations applicable to the ship and the voyages she is to be engaged in. Issued by the Flag State, or appointed Classification Society.
Ship Safety Equipment	This is a record of the safety equipment carried on the vessel (over 500 gt), in compliance with SOLAS, including life saving appliances, fire fighting equipment, lights and shapes, pilot ladders, magnetic compass etc. Issued by the Flag State, or appointed Classification Society.
Class (Hull and machinery)	Vessels and their machinery, built and maintained in accordance with the Rules of a Classification Society will be assigned a class in the Society's Register Book, and issued with the relevant Certificates, which will indicate the character assigned to the vessel and machinery. Issued by the Classification Society.
Customs clearance	Issued by Customs confirming that so far as they are concerned the vessel is free to sail. Issued after light dues have been paid, and on production of various other mandatory documentation.
De-rat, or De-rat Exemption	A De-rat Certificate is issued after a vessel has been fumigated, or dealt with be other means to rid her of rats. A De-rat exemption is issued where inspection has shown no evidence of rats on board. Issued by a Port medical officer.
Garbage Management Plan	A Class-approved document for management of waste.
International Oil Pollution Prevention	Certifies that the vessel complies with international oil pollution regulations (MARPOL Annex 1). Unless stated otherwise, all vessels over 400 grt must comply with the requirements of the code. Issued by the Flag State, or appointed Classification Society.
Lifesaving Appliances	Normally covered under Cargo Ship Safety Equipment Certificate. Where temporary equipment, e.g. liferafts or fire fighting equipment, is placed on a structure not in possession of a Cargo Ship Safety Equipment Certificate, it is expected that each would be individually certified, with an in-date inspection.

Document / Certificate	Description
Load Line	Issued after a vessel has been marked with her assigned load line marks. The Certificate gives details of the dimensions related to the freeboard, and the various special marks, e.g. TF (Tropical Fresh), WNA (Winter North Atlantic) etc. The vessel must be periodically inspected, to confirm that no changes have occurred to the hull or superstructure which would render invalid the data on which the assignment of freeboard was made. Issued by the Flag State, or appointed Classification Society.
Load Line Exemption	Where a vessel or structure is exempt from some or all of the provisions of the above, it may be issued with a Load Line Exemption Certificate, which will include any qualifying provisions. Issued by the Flag State, appointed Classification Society, or Port Authority.
Navigation Lights and Shapes	Normally covered under Cargo Ship Safety Equipment Certificate. Where temporary lights are placed on a structure not in possession of a Cargo Ship Safety Equipment Certificate, it is expected that they would be individually certified, or in possession of a manufacturer's guarantee of compliance.
Panama Canal documentation	For transit through the Panama Canal, drawings are required showing the extent of visibility from the bridge, and the extension of bilge keels, if fitted.
Registry	The Certificate of Registry is required by all commercial vessels. It contains the details from the Flag State Register in which the vessel has been registered, including principal dimensions, tonnage, and ownership. Issued by the Flag State Register.
Safe Manning document	A document issued by Flag State, showing the minimum safe manning for a vessel
Safety Management Certificate (SMC) - Document of Compliance	A document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved Safety Management System. Issued by the Flag State, or appointed Classification Society.
Safety Radio	Issued by the Flag State after survey of the vessel's radio installation, declaring that it is satisfactory for the intended service.
SOPEP	Shipboard Oil Pollution Emergency Plan - Class approved
Tonnage	Shows the Tonnage as obtained by measurement, and is a measure of volume rather that weight. 1 ton equals 2.83 cu.m (100 cu.ft). Measured by a surveyor appointed by the Flag State.
Transportation or towing manual	A manual providing the Master with the key information that he needs, including the cargo and route. 4
Trim and Stability booklet	A booklet setting out the vessel's stability particulars, and allowing the actual draught, trim and stability characteristics and limitations to be determined for any cargo arrangement. Usually prepared by designers, and must be approved by the Flag State.

5.3 ICE CLASS

5.3.1 See the comments relating to Ice Class vessels in Section 22.2.

5.4 TRANSPORTATION OR TOWING MANUAL

5.4.1 A transportation or towing manual is required for all transportations or towages for the following reasons:

a. It shall provide the Master with the key information that he needs, including the cargo and route.

b. It shall describe the structural and any other limitations of the cargo.

c. It shall summarise contingency plans in the event of an emergency including contact details

d. It shall give approving bodies the key information that they require for approval. 4

e. It shall define the responsibilities of different parties if parts of the transport / tow and installation are performed by different contractors. The scope split between the contractors shall be clearly defined, to ensure that all parties are aware of their responsibilities, handover points and reporting lines.

5.4.2 More details are given in Appendix G.

5.5 REQUIRED DOCUMENTATION

5.5.1 In general the following documentation (shown as “✓”) will be required or recommended (those shown as “*” will depend on the regulatory bodies) for the transportation of various types of vessels and floating structures. Some regulatory bodies may require extra documentation.

Table 5-2 Required Documentation

Document	Cargo vessels (Note 1)	Tugs (Note 1)	Barges (Note 2)	FPSO /FPU etc towages	Demolition towages	Other towages
Certificate of registry	✓	✓	✓		*	*
Certificate of class (hull)	✓	✓	✓	✓		*
Certificate of class (machinery)	✓	✓	✓			*
Tonnage certificate	✓	✓	✓	*		*
Cargo ship safety construction certificate	✓	✓	✓	*		*
Cargo ship safety equipment certificate	✓	✓	✓	*		*
Certificates for navigation lights & shapes			✓	✓	✓	✓
Load line certificate or load line exemption	✓	✓	✓	*	✓	
Load line exemption (if unmanned)				✓	*	✓
Air Pollution Prevention (IAPP) certificate	*	*	*	*	*	*
IOPP Certificate	✓	✓	✓	✓	*	
Safety Management Certificate (SMC)	✓	✓				
Customs clearance	✓	✓	✓	✓	✓	✓
Deratisation certificate, or exemption	✓	✓	✓	✓		✓
Radio certificate, including GMDSS	✓	✓				
Trim and Stability booklet	✓	✓	✓	✓		
Bollard pull certificate		✓				
Certificates for bridle, tow wires, pennants, stretchers and shackles		✓	✓	✓	✓	✓
Suez or Panama Canal documentation (if relevant)	✓	✓	✓	✓	✓	✓
Transportation or Towing manual	✓	✓	✓	✓	✓	✓
Manned towed objects						
Load line or Load Line Exemption	✓	✓	✓	✓	✓	✓
Certificates for life saving appliances	✓	✓	✓	✓	✓	✓
Crew list	✓	✓	✓	✓	✓	✓
Radio Certificate	✓	✓	✓	✓	✓	✓

4

Notes:

1. Smaller vessels (typically < 500 gt) may be exempt from some Certification requirements.
2. Unmanned barges will not be required to have Safety Equipment Certificates, Derat Certificate or IOPP, unless fitted with machinery. 4
3. Some documentation is not required for inland voyages or inland towages.

6 DESIGN ENVIRONMENTAL CONDITIONS

6.1 INTRODUCTION

6.1.1 Each transportation shall be designed to withstand the loads caused by the most adverse environmental conditions expected for the area and season through which it will pass, taking account of any agreed mitigating measures.

6.1.2 For each phase of a transportation or marine operation, the design criteria should be defined, consisting of the design wave, design wind and, if relevant, design current. It should be noted that the maximum wave and maximum wind may not occur in the same geographical area, in which case it may be necessary to check the extremes in each area, to establish governing loadcases.

6.1.3 Except as allowed by Sections 6.3 and 6.5 below, the transportation should generally be designed to the 10-year monthly extremes for the area and season, on the basis of a 30 day exposure.

6.2 OPERATIONAL REFERENCE PERIOD

6.2.1 Planning and design of marine transportations shall be based on an operational reference period equal to the planned duration of the operation plus a contingency period.

6.2.2 The planned duration for a transportation shall include, typically:

a. The time anticipated, after the departure decision, preparing for departure or waiting for the correct tidal conditions

b. The time anticipated for the voyage or towage itself

c. Time anticipated on arrival, waiting for the correct tidal conditions to enter harbour

d. If the operation following the transportation is a weather-dependent marine operation such as installation, the time required after arrival at the installation site to reach a safe condition.

6.2.3 The contingency period shall include, as appropriate, an allowance for:

a. slower than predicted voyage or towing speed, because of adverse weather conditions or vessel performance below specification

b. the time required to reach and enter the planned shelter point, in worsening weather conditions if the operation following the transportation is a weather-dependent marine operation such as installation, and the contingency action is to return to shelter.

6.3 WEATHER-RESTRICTED OPERATIONS

6.3.1 A transportation with a reference period generally less than 72 hours may be classed as a weather-restricted operation. The design environmental conditions for such an operation may be set independent of extreme statistical data, provided that:

a. The statistics indicate an adequate frequency and duration of the required weather windows

b. Dependable weather forecasts are available

c. The start of the operation is governed by an acceptable weather forecast, covering the reference period

d. A risk assessment has been carried out and the risks shown to be acceptable.

e. Adequate marine procedures are in place.

6.3.2 A transportation with a reference period greater than 72 hours may exceptionally be classed as a weather-restricted operation, provided that:

a. An adequate shelter point which can be entered in worsening weather is always available within 48 hours or the transport has sufficient speed to avoid the area of forecast severe weather

b. An acceptable weather routeing service is contracted and is available for advice at any time

c. Weather forecasts are received at appropriate intervals

d. The weather forecast service is contracted to issue a warning should the weather forecast deteriorate

e. Management resources of interested parties are always available with the right authority level to monitor any decision to proceed to shelter

f. A risk assessment has been carried out and the risks shown to be acceptable.

g. Adequate marine procedures and equipment are in place.

6.3.3 For weather-restricted operations, the maximum forecast operational criteria should be lower than the design criteria by a margin depending on the area and season, the delicacy of the operation, and the typical reliability of the forecast. The factor is dependent on the duration of the operation and the level of the design criteria set. Typically a factor of 0.7 times the design maxima may be used to determine the maximum forecast operational criteria.

6.4 UNRESTRICTED OPERATIONS

6.4.1 Except as allowed in Section 6.3.2, transportations with an operational reference period greater than 72 hours shall be defined as un-restricted operations.

6.5 CALCULATION OF "ADJUSTED" DESIGN EXTREMES, UNRESTRICTED OPERATIONS

6.5.1 The risk of encounter of extreme conditions by a particular transport is dependent on the length of time that it spends in those route sectors where extreme conditions are possible. If the length of time is reduced, then the probability of encountering extreme conditions is similarly reduced.

6.5.2 It is generally accepted that for a prolonged ocean transport the wind and wave design criteria should be those with a probability of exceedance per voyage of 0.1 or less. For an ocean transport of 30 days (or more), through meteorologically and oceanographically consistent areas, this corresponds to the 10 year monthly extreme.

6.5.3 Many transports last less than 30 days, or are potentially exposed to the most severe conditions for less than 30 days. Consequently, for shorter exposures, the 10 year monthly extreme may be adjusted for reduced exposure. This value is equivalent to the 10 voyage extreme and is also referred to as the 10% risk level extreme. This must not be confused with the 10% exceedance value for the transport, as discussed in Section 6.9.

6.5.4 When the 10% risk level extremes are less than the 1-year return monthly extremes, the 1-year monthly extremes are the minimum that shall be used for design. 4

6.5.5 If the 10 year extremes are due to a tropical cyclone it may not be appropriate to design to adjusted extremes. This is likely to be the case for barge or MODU towages that are not able to respond effectively to weather routeing.

6.6 CALCULATION OF EXPOSURE

6.6.1 For the purpose of the calculation of "adjusted" extremes the exposure time to potentially extreme or near extreme conditions is calculated taking consideration of the points discussed below.

a. The initial 48 hours of the transportation, is assumed to be covered by a reliable departure weather forecast and is excluded

b. The speed of the transport is reduced by taking the monthly mean wave heights along the route into consideration as described in Section 6.7.2.

c. The speed of the transport is adjusted to take into consideration the mean currents as described in Section 6.7.3.

d. A contingency time of 25 percent of the time is added. This allowance is to account for severe adverse weather, for tug breakdowns or other operational difficulties

e. A minimum exposure time of 3 days is considered.

6.7 CALCULATION OF VOYAGE SPEED

6.7.1 Voyage duration shall be calculated using the speed in the monthly mean sea state for each route sector and shall allow for adverse currents as described below.

6.7.2 The effect of the mean sea state on the transport speed in each route sector is calculated assuming that the wave height in which the transport will come to a dead stop is b (metres). This is typically 5m for barge towages, and 8m for ships. The calm weather speed is multiplied by a factor, F, defined by:

$$F = 1 - \left(H_m / b \right)^2$$

where H_m is the monthly mean wave height in that route sector.

6.7.3 The effect of the mean current on the transport speed in each route sector is calculated by adding the current vector (resolved with respect to the transport heading). For the calculation of exposure to the extreme conditions only negative currents which act to delay the transport shall be taken into account.

6.8 CALCULATION OF EXTREMES

6.8.1 The probability of non-exceedance of a value of wind speed or significant wave height in a particular route sector is expressed as a cumulative frequency distribution (e.g. a Weibull distribution).

6.8.2 The probability that during some 3 hour period for waves (or 1 hour for wind) the transport will experience a significant wave height (or wind speed) less than some value x is given by $F_X(x)$.

6.8.3 If it takes M hours to pass through the route sector and making the assumption that consecutive wave height and wind speed events are independent then the probability of not exceeding the value x is given by $[F_X(x)]^N$ where N=M/T where T=1 hour is applied for winds and T=3 hours for waves, which are a more persistent form of energy.

6.8.4 If it is reasonable to expect that extremes of wind speed or wave height could occur in more than one route sector then the probability of not exceeding the value x is given by the product

$$\prod_i F_{X_i}(x)^{N_i}$$

6.8.5 The probability of encountering an extreme value of wind speed or significant wave height, during a particular transport, that is reached or exceeded once on average for every 10 transports is 0.1. The value of x is varied until

$$1 - \prod_i F_{X_i}(x)^{N_i}$$ is equal to 0.1

to give the 10 transport extreme for the voyage or towage.

6.8.6 This value is also referred to as the "adjusted" extreme for the transport, or as having a risk level of 10%. The method may be adjusted to give other risk levels (e.g. 1% or 5%).

6.8.7 The extremes used for design shall not be less than the 1-year return monthly extremes. 4

6.9 COMPARISON WITH PERCENTAGE EXCEEDENCE

6.9.1 Given a series of values of wind speed or significant wave height, as may be observed during a complete transport, some value y will be exceeded at some times but not others and the percentage exceedance of value y is equal to:

$$\frac{100 \times (number\ of\ times\ y\ exceeded)}{total\ number\ of\ observations}$$

6.9.2 If each observed value of wind speed or significant wave height is assumed to last for some duration (typically 1 hour for winds and 3 hours for waves) then for example, during a transport lasting 10 days there will be 240 wind events and 80 wave events. On the transport, if a wind speed greater than 30 knots is observed during 24 separate, hourly occasions then the percentage exceedance of 30 knots is 10%.

6.9.3 The 10% risk level (as defined in Section 6.5.3) for a transport along a specific route, departing on a specific date is expected to occur only once, on average, in every 10 transports. However a value with a 10% exceedance level for the same route and departure date is likely to occur on average for 10% of the time on **every** transport.

6.9.4 Thus a 10% exceedance value is far more likely to occur than a 10% risk level value, or an adjusted, 10 year extreme value.

6.10 CRITERIA FROM TRANSPORT SIMULATIONS

6.10.1 If continuous time series of winds and waves are available along the entire transport route (e.g. from hindcast data or satellite observations), an alternative way to develop criteria with a specified risk of exceedance in a single transport is to perform tow simulations. A large number of simulations can be performed, with uniformly spaced (in time) departure times during the specified month of departure over the number of years in the database. For each simulated transport, the maximum wind speed and the maximum wave height experienced somewhere along the tow route are retained. Then the probability distribution of these transport-maxima can be used to determine the design value with a specified risk of exceedance. For example, the value exceeded once in every 20 transports, on average, can be determined by reading off the value of wave height from the distribution of transport-maximum wave heights at the 95th percentile level.

6.10.2 If fatigue during tow is an issue, the complete distributions of winds and waves experienced during the simulated transports (not just the transport-maximum values) can be retained. These can be used to give scatter diagrams of wave height against period and/or direction, and wind speed against direction.

6.10.3 The transport simulation method can be made to be very realistic and account for. variation of speed due to inclement weather or ocean currents, weather avoidance en route through forecasting/routeing services, or the use of safe havens, etc. If the transport simulator cannot accommodate all these features, a reasonably conservative estimate of criteria can be derived by using a conservative (slow) estimate of the average speed. Care should be taken when choosing the average speed estimate - a slow speed may not be conservative if it results in the vessel apparently arriving in a route sector late enough to miss severe weather, which might have been encountered if arrival had been earlier.

6.11 METOCEAN DATABASE BIAS

6.11.1 Regardless of whether the method described in Section 6.8 or the method described in Section 6.10 is used, it is important to know the accuracy of the metocean database being used. Specifically, if there is a known bias in the wind or wave statistics for any segment of a tow, it is essential to adjust the criteria accordingly.

6.12 DESIGN WAVE HEIGHT

6.12.1 The design wave height shall be the significant wave height (H_{sig}), where $H_{sig} = 4\sqrt{m_0}$ where m_0 is the sea surface variance. In sea states with only a narrow band of wave frequencies, H_{sig} is approximately equal to $H_{1/3}$ (the mean height of the largest third of the zero up-crossing waves). Advice should be provided as to the appropriate spectra.

6.13 DESIGN WIND SPEED

6.13.1 The design wind speed shall be the 1 minute mean velocity at a reference height of 10m above sea level. The 1 hour wind may also be needed in the calculation process.

6.14 METOCEAN DATA FOR BOLLARD PULL REQUIREMENTS

6.14.1 The design extremes are not normally used for calculation of bollard pull requirements, which are covered in Section 12.2.

7 MOTION RESPONSE

7.1 GENERAL

7.1.1 Design motions may be derived by means of motion response analyses, from model tank testing, or by using the default equivalent motion values shown in Section 7.9.

7.2 SEASTATE

7.2.1 For the motion analyses, seastates shall include all relevant spectra up to and including the design wave height for the most severe areas of the proposed voyage route. A wave height smaller than the design wave height, at the natural period of roll and/or pitch of the tow, should also be checked if necessary. "Long-crested" seas will be considered unless there is a justifiable basis for using "short-crested" seas. Consideration should be given to the choice of spectrum which should be applicable to the geographic area and H_{sig} of the design sea states.

7.2.2 The most probable maximum extreme (MPME) responses are to be based on a 3 hour exposure period and shall be used for design.

7.3 PERIODS

7.3.1 The range of periods associated with the extreme seastate may be calculated in two different ways, with due consideration given to the influence of swell.

7.3.2 In the simplest method the peak period (T_p) for all seastates considered, should be varied as:

$$\sqrt{(13.H_{sig})} < T_p < \sqrt{(30.H_{sig})}$$

where H_{sig} is in metres, T_p in seconds. The effects of swell should also be considered if not already covered in this peak period range.

However, this method incorrectly assumes that all periods are equally probable. As a result this 4
method should generally produce higher design accelerations than would be the case when using the more robust H_{sig}-T_p method described in the following section.

7.3.3 In the alternative method, a contour is constructed within the H_{sig}-T_p plane that identifies equally probable combinations of H_{sig} & T_p for the design return period subject to theoretical constraints on wave breaking. This contour should also cover swell. The combinations should be tested in motion response calculations to identify the worst case response.

7.3.4 The relationship between the peak period T_p and the zero-up crossing period T_z is dependent on the spectrum. For a mean JONSWAP spectrum (γ=3.3) T_p/T_z = 1.286; for a Pierson-Moskowitz spectrum (γ=1) T_p/T_z = 1.41.

7.3.5 The following Table 7-1 indicates how the characteristics of the JONSWAP wave energy spectrum vary over the range of recommended seastates. The constant, K, varies from 13 to 30 as shown in the equation in Section 7.3.1 above. T_1 is the mean period (also known as T_m).

Table 7-1 Value of JONSWAP γ, ratio of T_p:T_z and T_p:T_1 for each integer value of K

Constant K	γ	T_p/T_z	T_p/T_1		Constant K	γ	T_p/T_z	T_p/T_1
13	5.0	1.24	1.17		22	1.4	1.37	1.27
14	4.3	1.26	1.18		23	1.3	1.39	1.28
15	3.7	1.27	1.19		24	1.1	1.40	1.29
16	3.2	1.29	1.20		25	1.0	1.40	1.29
17	2.7	1.31	1.21		26	1.0	1.40	1.29
18	2.4	1.32	1.23		27	1.0	1.40	1.29
19	2.1	1.34	1.24		28	1.0	1.40	1.29
20	1.8	1.35	1.25		29	1.0	1.40	1.29
21	1.6	1.36	1.26		30	1.0	1.40	1.29

7.4 VESSEL HEADING AND SPEED

7.4.1 The analyses should be carried out for zero vessel speed for head, bow quartering, beam, stern quartering and stern seas.

7.4.2 In addition the analysis should be carried out for non-beam sea cases for the maximum service speed of the vessel or the maximum speed that can be maintained in the given seastate. The range of probable peak wave periods, Tp, should be adjusted for the speed of the vessel as follows:

$$\frac{\sqrt{13H_{sig}}}{1+\dfrac{V_{SHIP}\cos(\theta)}{1.56\sqrt{13H_{sig}}}} \le T_P \le \frac{\sqrt{30H_{sig}}}{1+\dfrac{V_{SHIP}\cos(\theta)}{1.56\sqrt{30H_{sig}}}}$$

where V_{SHIP} is the ship speed in m/s and θ is the ship's heading in degrees (0 = head seas, 180 = following seas).

7.5 THE EFFECTS OF FREE SURFACES

7.5.1 The application of free surface corrections to reduce metacentric height (GM) and hence to increase natural roll period will not generally be accepted. The effect of any reduction in GM must, however, be considered in intact and damage stability calculations.

7.6 THE EFFECTS OF CARGO IMMERSION

7.6.1 The effect of cargo immersion in increasing GM and hence reducing natural roll period as well as increasing damping should be considered in motion response analyses.

7.7 MOTION RESPONSE COMPUTER PROGRAMS

7.7.1 Computer programs shall be validated against a suitable range of model test results in irregular seas. The validation is to be made available to GL Noble Denton and is to contain appropriate analytical work which must be compared with applicable model tests.

7.7.2 When applying the results of a first-order motion response analysis program, heave shall be assumed to be parallel to the global vertical axis. Therefore the component of heave parallel to the deck at the computed roll or pitch angle (theta) is additive to the forces caused by the static gravity component and by the roll or pitch acceleration.

7.8 RESULTS OF MODEL TESTS

7.8.1 Model tests may be used to derive design motions, provided the tests pass the usual review of overall integrity. Generally, for transportation analyses, the model test results should present the standard deviation of the relevant responses. The standard deviation of the responses should then be multiplied by $\sqrt{(2.\log_n(N))}$, where N is the number of zero-upcrossings, to obtain the most probable maximum extreme (MPME) in 3 hours, which is required for design. The individual measured maxima from model tests should generally not be used in design as these vary between different realisations of the same sea conditions, and are therefore unreliable for use as design values. These recommendations apply to Gaussian responses, which is an appropriate assumption for most wave frequency motion responses. If in the unlikely event that the response is significantly non-Gaussian, then alternative methods should be used. 4

7.8.2 Maximum values of global loads, motions or accelerations from model test results can be used provided ten similar realisations, or greater, are carried out to ensure that variations between individual tests are accounted for. The mean and standard deviations of the maxima should be calculated. The design value should be the mean plus two standard deviations.

7.8.3 Scale effects should also be accounted for by increasing the design loads by a further 10% or a mutually agreed value.

7.9 DEFAULT MOTION CRITERIA

7.9.1 If neither a motions study nor model tests are performed, then for standard configurations and subject to satisfactory marine procedures, the following motion criteria may be acceptable.

Table 7-2 Default Motion Criteria

Nature of Transportation	Case	LOA (m)		B[1] (m)	L/B[1]	Block Coeff	Full cycle period (secs)	Single amplitude Roll	Single amplitude Pitch	Heave
Unrestricted	1	> 140	and	> 30	n/a	< 0.9	10	20°	10°	0.2 g
	2	> 76	and	> 23	n/a	any	10	20°	12.5°	0.2 g
	3	≤ 76	or	≤ 23	≥ 2.5	< 0.9	10	30°	15°	0.2 g
	4					≥ 0.9		25°		
	5	≤ 76	or	≤ 23	< 2.5	< 0.9	10	30°	30°	0.2 g
	6					≥ 0.9		25°	25°	
Weather restricted operations in non-benign areas for a duration <24 hours (see Section 7.9.2 d. For L/B < 1.4 use unrestricted case.	7	any			≥ 2.5	any	10	10°	5°	0.1 g
	8	any			< 2.5, ≥ 1.4	any	10	10°	10°	0.1 g
Weather restricted operations in benign areas (see Section 7.9.2.e). For L/B < 1.4 use unrestricted case.	9	any			≥ 2.5	any	10	5°	2.5°	0.1 g
	10	any			< 2.5, ≥ 1.4	any	10	5°	5°	0.1 g
Inland and sheltered water transportations (see Section 7.9.2.f). For L/B < 1.4 use unrestricted case.	11	any			≥ 1.4	any	Static	Equivalent to 0.1 g in both directions		0.0
Independent leg jack-ups, ocean tow on own hull.	12	n/a		> 23	< 1.4	n/a	10	20°	20°	0.0
Independent leg jack-ups, 24-hour or location move.	13	n/a		> 23	< 1.4	n/a	10	10°	10°	0.0
Mat-type jack-ups, ocean tow on own hull.	14	n/a		> 23	< 1.4	n/a	13	16°	16°	0.0
Mat-type jack-ups, 24-hour or location move.	15	n/a		> 23	< 1.4	n/a	13	8°	8°	0.0

[1] B = maximum moulded waterline breadth, L = waterline length. n/a = not applicable

Block coefficient = 0.9 is the cut-off between barge-shaped hulls (>0.9) and ship-shaped hulls. 4

7.9.2 The default motion criteria shown in Section 7.9.1, shall only be applied in accordance with the following:

a. Roll and pitch axes shall be assumed to pass through the centre of floatation.

b. Heave shall be assumed to be parallel to the global vertical axis. Therefore the component of heave parallel to the deck at the roll or pitch angles shown above is additive to the forces caused by the static gravity component and by the roll or pitch acceleration.

c. Phasing shall be assumed to combine, as separate loadcases, the most severe combinations of
- roll ± heave
- pitch ± heave

d. For Cases 7 and 8, the departure shall be limited to a maximum of Beaufort Force 5, with an improving forecast for the following 48 hours. The voyage duration including contingencies, should not be greater than 24 hours. 4

e. For Cases 9 and 10, the criteria stated is given as general guidance for short duration barge towages and vessel transports. The actual criteria should be agreed with the GL Noble Denton office concerned, taking into account the nature of the vessel or barge and cargo, the voyage route, the weather conditions which may be encountered, the shelter available and the weather forecasting services to be utilised.

f. For Case 11, the design loading in each direction shall be taken as the most onerous due to:
- a 0.1g static load parallel to the deck, or
- the static inclination caused by the design wind, or
- the most severe inclination in the one-compartment damage condition.

7.9.3 Alternative default motion criteria may be acceptable, as set out, for instance, in DNV Rules for the Classification of Ships, January 2003, Part 3, Chapter 1, Section 4 [Ref. 9], or IMO Code of Safe Practice for Cargo Stowage and Securing, 2003 Edition, Section 7 [Ref. 10]. Care should be taken to ensure that the criteria adopted are applicable to the actual case in question.

7.10 DIRECTIONALITY AND HEADING CONTROL

7.10.1 The incident weather shall be considered to be effectively omni-directional, as stated in Section 7.4. No relaxation in the design seastates from the bow-quartering, beam and stern-quartering directions shall be considered for:

a. Any transport where the default motion criteria are used, in accordance with Section 7.9, or similar

b. Single tug towages, or voyages by vessels with non-redundant propulsion systems (see Section 7.10.3 below).

c. Any transport where the design conditions on any route sector are effectively beam on or quartering, of constant direction, and of long duration, including, for example, crossing of the Indian Ocean or Arabian Sea in the south-west monsoon

d. Any towage in a Tropical Revolving Storm area and season

e. Any un-manned towage.

f. Any transport where the vessel does not have sufficient, redundant systems to maintain any desired heading in all conditions up to and including the design storm, taking account of the windage of the cargo.

7.10.2 Relaxation in the non-head sea cases may be considered for:

a. Manned, multiple tug towages, where after breakdown of any one tug or breakage of any one towline or towing connection, the remaining tug(s) still comply with the criteria of Section 12.2.

b. Voyages by self-propelled vessels with redundant propulsion systems. A vessel with a redundant propulsion system is defined as having, as a minimum:

- 2 or more independent main engines
- 2 or more independent fuel supplies
- 2 or more independent power transmission systems
- 2 or more independent switchboards
- 2 or more independent steering systems, or an alternative means of operation of a single steering system (but excluding emergency steering systems that cannot be operated from the bridge)
- the ability to maintain any desired heading in all conditions up to and including the design storm, taking account of the windage of the cargo.

7.10.3 Any vessel not complying with all the above shall be considered non-redundant.

7.10.4 An advance survey may be required, to establish whether or not a vessel can be considered to have a redundant propulsion system.

7.10.5 In general, where a relaxation is allowed in accordance with Section 7.10.2, the following is a guide to the acceptable sea state values. This should be confirmed as being suitable on a case-by-case basis.

Table 7-3 Reduced Seastate v Heading

Incident angle (Head Seas = 0°)	Applicable H_{sig}, as % of design sea state (adjusted as appropriate)
0° - ± 30°	100%
± (30° - 60°)	Linear interpolation between 100% and 80%
± 60°	80%
± (60° - 90°)	Linear interpolation between 80% and 60%
± 90°	60%
± (90° - 120°)	Linear interpolation between 60% and 80%
± 120°	80%
± (120° - 150°)	Linear interpolation between 80% and 100%
± (150° - 180°)	100%

7.10.6 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, a risk assessment shall be carried out and the risks shown to be acceptable.

7.10.7 Such relaxation shall only apply to considerations of accelerations, loads and stresses. It shall not be applied to considerations of stability.

7.10.8 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, the towage/voyage arrangements shall contain, in a format of use to the Master:

a. The limitations on critical parameters

b. Procedures for monitoring and recording of critical parameters

c. Procedures for heading control

d. Results of the risk assessment, and any recommendations arising

e. Contingency actions in the event of any breakdown.

7.10.9 Critical parameters should preferably be ones the Master can observe or measure. The Master should confirm that he can accept that the effects of these restrictions are practicable.

7.10.10 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, it is strongly recommended that an independent Company (Cargo Owner's) Representative is on board to witness events. He should be qualified to discuss with the Master weather conditions forecast and encountered, routeing advice received and avoidance techniques adopted.

8 LOADINGS

8.1 INTRODUCTION

8.1.1 The structure of the cargo or tow, including the legs, hull and jackhouses of self-elevating units, shall be shown to possess adequate strength to resist the loads imposed due to the specified or calculated motions and wind, combined with the additional loading caused by any overhang of the cargo over the side of the vessel or barge.

8.1.2 The cargo shall be shown to possess adequate strength to withstand the local cribbing and seafastening reactions.

8.2 LOADCASES

8.2.1 Loadcases for each heading shall be derived by the addition of fluctuating loads resulting from wind and wave action to static loads resulting from gravity and still water initial conditions.

8.2.2 The fluctuating components shall be the worst possible combination of the loads resulting from calculations or model tests carried out in accordance with Sections 7.1 through 7.8, with due account to be taken of the effects of phase. All influential loadings shall be considered: however the following static and environmental loadings are the most likely to be of importance:

S_1: Loadings caused by gravity including the effects of the most onerous ballast condition on the voyage.

F_1: Loadings caused by the wind heel and trim angle.

F_2: Loadings caused by surge and sway acceleration

F_3: Loadings caused by pitch and roll acceleration

F_4: Loadings caused by the gravity component of pitch and roll motion

F_5: Loadings caused by direct wind

F_6: Loadings caused by heave acceleration, including heave.sin(theta) terms

F_7: Loadings caused by wave induced bending

F_8: Loadings caused by slam and the effects of immersion.

8.2.3 One of the following three methods shall be used to determine the design loadings:

8.2.3.1 Except as noted in Section 7.9.2, the effects of phase differences between the various motions can be considered, if resulting from model test measurements, or if the method of calculation has been suitably validated.

8.2.3.2 In cases where it is not convenient or possible to determine the relative phasing of extreme wind loadings and heave accelerations with roll/sway or pitch/surge maxima, a reduction of 10 percent may be applied to fluctuating loadcases F_1 through F_8 which combine maximum wind and wave effects. However, if wind induced or wave induced loads individually exceed the reduced load, then the greatest single effect shall be considered.

8.2.3.3 Alternatively, the total loads may be calculated by combination of loads as follows:

$$S_1 + F_1(_{1hr}) + F_5(_{1hr}) + \sqrt{\{[F_2+F_3+F_4+F_6]^2 + [F_1(_{1min})+F5(_{1min})-F_1(_{1hr})-F_5(_{1hr})]^2\}}$$

Where:

$F_{(1hr)}$ = Loads based on 1 hour mean wind speed

$F_{(1min)}$ = Loads based on 1 minute mean wind speed.

8.3 DEFAULT MOTION CRITERIA

8.3.1 For loads computed in accordance with Section 7.9, the loads applied to the cargo shall be:

$$S_1 + F_1 + F_3 + F_4 + F_6$$

where: S_1, F_1, F_3, F_4 and F_6 are as defined in Section 8.2.2. The effects of buoyancy and wave slam loading shall also be considered if appropriate.

As stated in Section 7.9.2 c) roll and pitch cases are to be considered separately. Combined roll and pitch are not required.

8.4 LONGITUDINAL BENDING

8.4.1 The potential effects of longitudinal wave bending effects need to be considered if:

a. The towed hull is not a classed, seagoing vessel or barge, or

b. The cargo is longer than about $^1/_3$rd of the transport barge or vessel length, or

c. The cargo is supported longitudinally on more than 2 groups of supports, or

d. The relative stiffness of the hull and cargo could cause unacceptable stresses to be induced in either, or

e. The seafastening design allows little or no flexibility between cargo and barge.

8.4.2 Some cargoes, such as large steel jackets, may be inherently much stiffer than the barge, and will reduce barge deflections, at the expense of increased cargo stresses.

8.4.3 See also Sections 9.2.2 for friction, 9.3 for seafastening design and 19.4 for jack-ups.

8.5 CARGO BUOYANCY AND WAVE SLAM

8.5.1 Cargo overhangs which are occasionally immersed, and which may receive loadings due to wave slam and/or immersion, will require special consideration.

8.5.2 Buoyant cargoes, particularly where the buoyancy contributes to stability requirements, shall be adequately secured against lift-off unless it can be shown that lift-off will not occur.

9 DESIGN AND STRENGTH

9.1 COMPUTATION OF LOADS

9.1.1 The loads acting on grillages, cribbing, dunnage, seafastening and components of the cargo shall be derived from the loads acting on the cargo, according to Sections 6, 7 and 8, as applicable.

9.1.2 The loads shall include components due to the distribution of mass and rotational inertia of the cargo. This is of particular importance in the calculation of shear forces and bending moments in the legs of self-elevating units and similar tall structures.

9.1.3 If the computed loads are less than the “Minimum allowable seafastening force” shown in Table 9-1, then the values in the Table shall apply.

9.1.4 Care should be taken in cases where the cargo may be designed for service loads in the floating condition, but is being dry-transported. Its centre of gravity may be higher above the roll centre in the dry-transportation condition than in any of its floating service conditions. Even though the transportation motions may appear to be less than the service motions, the loads on cargo components and ship-loose items may be greater.

9.2 FRICTION

9.2.1 For certain cargo weights, cargo overhangs and arrangements of cribbing and seafastenings, the effects of friction may be used, as shown in the following Table 9-1 and subject to Section 9.2.2, to resist part of the computed loadings on the cribbing and seafastenings. This shows the maximum coefficient of friction which may be considered, and the minimum required seafastening force, expressed as a percentage of cargo weight, below which the actual seafastening design capability shall not be allowed to fall.

Table 9-1 Maximum allowable coefficients of friction & minimum seafastening forces

Overhang	**Cargo weight, W, tonnes**						
	<100	100 ≤W< 1,000	1,000 ≤W< 5,000	5,000 ≤W< 10,000	10,000≤ W< 20,000	20,000≤ W< 40,000	≥ 40,000
	Maximum allowable coefficient of friction						
None	0	0.10	0.20	0.20	0.20	0.20	0.20
< 15 m	0	0	0.10	0.20	0.20	0.20	0.20
15 – 25 m	0	0	0	0.10	0.20	0.20	0.20
25 – 35 m	0	0	0	0	0.10	0.20	0.20
35 - 45 m	0	0	0	0	0	0.10	0.10
> 45 m	0	0	0	0	0	0	0
Minimum required seafastening force, %W							
Transverse	10%	10%	10%	10%	10%	See Note 1	5%
Longitudinal	5%	5%	5%	5%	See Note 2	See Note 3	1.5%

Notes:

1. For 20,000 ≤ W < 40,000 tonnes, the minimum required seafastening force, transversely, shall be not less than 15 - W/4,000 (%W)
2. For 10,000 ≤ W < 20,000 tonnes, the minimum required seafastening force, longitudinally, shall be not less than 7.5 - W/4,000 (%W)
3. For 20,000 ≤ W < 40,000 tonnes, the minimum required seafastening force, longitudinally, shall be not less than 3.5 - W/20,000 (%W)
4. For transport of pipes and similar tubular goods, the above table does not apply. See Section 9.6.
5. The friction coefficient may be interpolated as a function of overhang using the maximum cargo overhang.

9.2.2 Friction is allowed as a contribution to seafastening restraint subject to the following:

a. Loadings are computed in accordance with Sections 7.2 though 7.8 and 8.2 above. Friction may not be used if the loadings are computed in accordance with the default criteria in Sections 7.9 and 8.3, except as allowed by Section 9.6.

b. Friction forces shall be computed using the normal reaction between the vessel and cargo compatible with the direction of the heave.sin(theta) term used in computing the forces parallel to the deck in Section 8.2.2. Thus, when heave.sin(theta) increases the force parallel to the deck, it also increases the normal reaction and vice-versa.

c. The cargo is supported by wood dunnage or cribbing – friction is not allowed for steel to steel interfaces.

d. The overhang is the distance from the side of the vessel to the extreme outer edge of the cargo.

e. For wood cribbing less than 600 mm high, with a width not less than 300 mm, the friction force due to the friction coefficient permitted in Table 9-1 may be assumed to act in any direction relative to the cribbing provided that:

(i) the cribbing is reasonably well balanced in terms of the proportion in the fore-aft and transverse directions, AND

(ii) each of these groups is reasonably well balanced about the cargo CoG in plan.

f. Provided that the conditions in (e) above are met, for cribbing heights between 600 and 900 mm, with a width not less than 300 mm, then the percentage computed friction force at right angles to the longitudinal axis of a cribbing beam shall not exceed (900 - H)/3 %, where H = the height of cribbing above deck, in mm. In the direction of the longitudinal axis of a cribbing beam, the full friction force can be used. 4

g. For wood cribbing over 900 mm high, or with a width less than 300 mm, no friction force is assumed to act in a direction at right angles to the longitudinal axis of a cribbing beam.

h. If greater cribbing friction is required than available according to (f) and (g) above, stanchions may be fitted to provide transverse cribbing restraint. Where such stanchions are fitted, they should be designed to carry loads due to a friction coefficient of 0.5 (to ensure they are able to carry loads due to upper-bound friction assumptions).

i. The underlying assumption in the approach given above is that the seafastenings have sufficient flexibility to deflect in the order of at least 2mm without failing. This will be reasonable in most cases, but when this is not the case the more detailed approach given in (j) below shall be used.

j. As an alternative to (e) through (h) above, a more detailed approach may be used. In such cases, the friction permitted in Table 9-1 can be doubled, but the relative flexibility of the cribbing and seafastenings shall be taken into account. The arrangements shall be such as to ensure that the required lateral load can be carried by the combination of friction & seafastening reactions BEFORE the seafastenings are overstressed. Where stanchions are used, they shall comply with (h) above.

k. The “Minimum allowable seafastening force” is the minimum allowable value of seafastening restraint, expressed as a percentage of cargo weight, in the event that the total required seafastening force, as computed, is less than this value.

l. For very short duration moves in sheltered water, such as turning a barge back alongside the quay after a loadout, then friction may be allowed to contribute. The entire load path, including the potential sliding surfaces, shall be demonstrated to be capable of withstanding the loading generated.

9.3 SEAFASTENING DESIGN

9.3.1 In this context, seafastenings include any grillage, dunnage, cribbing or other supporting structure, roll, pitch and uplift stops, and the connections to the barge or vessel.

9.3.2 Seafastenings shall be designed to withstand the global loadings as computed in Sections 7 and 8.

9.3.3 Seafastenings shall be designed to accept deflections of the barge or vessel in a seaway, principally due to longitudinal bending. In general, longitudinal bending should be considered for the cases described in Sections 8.4.1 and 8.4.2.

9.3.4 Where longitudinal bending is a consideration, suitable seafastening designs include:

a. Chocks which allow some movement between the barge and cargo

b. Pitch stops at one point only along the cargo, with other points free to slide or deflect longitudinally

c. Vertical supports at only 2 positions longitudinally

d. An integrated structure of barge-seafastenings-cargo, capable of resisting the loads induced by bending and shear.

9.3.5 Additionally, for towed objects such as FPSOs, which may have permanently installed modules with piping or other connections between them, there should be adequate flexibility in the connections to avoid overstress. It should be noted that the transport wave bending condition may be more severe than the operating condition. In long modules carried as cargo, internal pipework should be similarly considered.

9.3.6 In the absence of more detailed information, it should be assumed that the barge will incur bending and shear deflection as if unrestrained by the cargo. Quasi-static barge hogging and sagging should be considered in a wave of length L equal to the barge length, and height = $0.61\sqrt{L}$, metres.

9.3.7 Grillage and seafastening design is frequently influenced by the loadout method. Cargoes lifted onto the transport barge or vessel, or floated over a submersible barge or vessel, are frequently supported by timber cribbing or dunnage to distribute the loads and allow for minor undulations in the deck plating. Cargoes loaded by skidding normally remain on, and are seafastened to, the skidways. Cargoes loaded out by trailers normally need a grillage structure higher than the minimum trailer height. The grillage or cribbing height must allow for any projections below the cargo support line.

9.3.8 Welded steel seafastenings are preferred, but for smaller cargoes, typically of less than 100 tonnes, chain or wire lashings with suitable tensioning devices may be acceptable. Chain binders or turnbuckles shall be tensioned before departure to spread the load between the seafastenings and secured so that they cannot become slack. Lashings should be inspected regularly and after bad weather to ensure that tension is maintained. Wire lashings are not recommended for unmanned transportations unless such inspections can be made. Guidance on good practice for lashings and similar devices may be found in the IMO Code of Safe Practice for Cargo Securing and Stowing, 2003 Edition [Ref. 10].

9.3.9 The design load in any chain used for seafastening should not exceed the certified (lifting) WLL or SWL of the chain. When the WLL /SWL is not known, it shall be taken as no more than the certified BL / 2.25.

9.3.10 Connections to the deck of a barge or vessel should be carefully considered, particularly tension connections. Calculations should be presented to justify all connections. It should not be assumed, without inspection, that underdeck connections between deck plating and stiffeners or bulkheads are adequate. Seafastenings landing on doubler plates are not generally acceptable as tension connections.

9.3.11 Care should be taken to avoid welding onto fuel oil tanks or oil cargo tanks, unless the tanks are empty, and gas free certification has been obtained.

9.3.12 Final welded connections, particularly those which may be influenced by longitudinal deflections of the barge or vessel, should be carried out with the barge or vessel ballasted to the transportation condition, or as close as draught limitations permit.

9.3.13 Welding of seafastenings should not be carried out in wet conditions. Weather protection should be used to minimise the effects of wet conditions.

9.3.14 For cargoes that will be removed offshore, the seafastenings should be capable of being released in stages, such that the cargo is secure for a 10 degree static angle until the release of the final stage. The release of seafastenings, and the removal of any one item, should not disturb the seafastenings of any other item.

9.3.15 Where a lift is made onto a barge offshore, the seafastenings should be designed accordingly, normally by means of guides or a cradle, which will hold the cargo whilst it is being seafastened.

9.3.16 Items of the cargo which are vulnerable to wave action, wetting or weather damage shall be suitably protected. This may require provision of breakwaters or waterproofing of sensitive areas.

9.3.17 Internal seafastenings may be needed to prevent items moving inside structures or modules. See also the caution in Section 9.1.4 for dry transportations.

9.3.18 Guide posts should not be used for seafastenings unless specifically designed for that purpose.

9.4 CRIBBING

9.4.1 Where the cargo is supported on wooden cribbing or dunnage, rather than steel-to-steel supports, then sufficient material should be provided to ensure an adequate distribution of load to the underside of the cargo and to the deck of the transport vessel, under the static loadings and the design environmental loadings as shown in Sections 7 and 8.

9.4.2 Cribbing designed to pick up structural members in the underside of the cargo, the transport vessel deck, or both, and fixed to the deck of the vessel, should not normally be less than 200 mm high. See also the comments on cribbing width in Sections 9.2.2.f and 9.2.2.g.

9.4.3 A minimum clearance of 0.075 m should be provided between the lowest protrusion of the cargo and the deck of the barge or vessel.

9.4.4 The nominal bearing pressure on the cribbing should not normally exceed 4 N/mm^2 for softwood. Should it be demonstrated that the cargo, vessel and cribbing, without crushing, can withstand a higher pressure, then this may be acceptable. The cribbing pressure should be calculated taking into account the deadweight of the cargo plus the loads caused by the design environmental loadings.

9.4.5 Ideally the type of timber selected should withstand the computed cribbing pressures without crushing. Localised crushing to accommodate cargo and cribbing imperfections is permissible. A satisfactory arrangement may consist of hardwood for the main cribbing structure, topped by a soft packing layer, say 50 mm thick.

9.4.6 In the case of a random or herring-bone dunnage layout supporting a flat-bottomed cargo, without taking into account the strong points, then the maximum cribbing pressures should not exceed 1 N/mm^2, subject to consideration of the overall allowable loads on the deck of the vessel and the underside of the cargo.

9.4.7 For cargoes floated on and/or off a grounded or partially grounded transport barge or vessel, the cribbing should be designed to withstand loads caused by point loads and trim or heel angles during on-load and off-load. A minimum of 5° should be considered.

9.5 STRESS LEVELS IN CARGO, GRILLAGE & SEAFASTENINGS

9.5.1 The cargo, grillage and seafastenings shall be shown to possess adequate strength to resist the loads imposed during the voyage. Any additional loadings caused by any overhang of the cargo over the side of the transport vessel, buoyancy forces and wave slam loadings shall be included.

9.5.2 The cargo shall be shown to have adequate strength to withstand the local cribbing and seafastening loads.

9.5.3 Stress levels shall be within those permitted by the latest edition of a recognised and applicable offshore structures code.

9.5.4 The structural strength of high quality structural steelwork with full material certification and NDT inspection certificates showing appropriate levels of inspection (see Section 9.7) shall be assessed using the methodology of a recognised and applicable offshore code including the associated load and resistance factors for LRFD codes or safety factors for ASD/WSD codes. Traditionally AISC has also been considered a reference code. If the AISC 13th Edition is used, the allowables shall be compared against member stresses determined using a load factor on both dead and live loads of no less than:

	WSD option	LRFD Option
SLS:	1.0	1.60
ULS:	0.75	1.20

9.5.5 Stress in fillet fillet welds for brackets loaded by a force acting in a direction parallel to the weld bead shall be assessed using the method presented in Appendix F. The allowables shall be compared against member stresses determined using a load factor on both dead and live loads of no less than

SLS:	1.40
ULS:	1.05

9.5.6 Any load case may be treated as a normal serviceability limit state (SLS) / Normal operating case.

9.5.7 Most probable maximum extreme (MPME) load cases, (which typically occur at the same frequency as the maximum wave associated with the design seastate) may be treated as an ultimate limit state (ULS) / Survival storm case provided that they are dominated by environmental forces. This does not apply to: 4

- Steelwork subject to deterioration and/or limited initial NDT unless the condition of the entire loadpath has been verified, for example the underdeck members of a barge or vessel.
- Steelwork subject to NDT prior to elapse of the recommended cooling and waiting time as defined by the Welding Procedure Specification (WPS) and NDT procedures. In cases where this cannot be avoided by means of a suitable WPS, it may be necessary to increase the strength or impose a reduction on the design/permissible seastate.

9.6 SECURING OF PIPE AND OTHER TUBULAR GOODS

9.6.1 This section refers to the transport of tubulars, including line pipe, casing, drill pipe, collars, piles, conductors marine risers and similar, hereafter called "pipes", on vessels and barges. Transport of drill pipe, collars etc on jack-ups is covered in Section 19.11. The degree and design of securing required will depend on the type of vessel, the nature of the cargo, the duration of the towage or voyage, and the weather conditions expected.

9.6.2 For these types of cargoes, friction may be assumed to resist longitudinal seafastening loads, and Sections 9.2.1 and 9.2.2.a do not apply. The following friction coefficients may be used, as examples:

Table 9-2 Typical Friction Coefficients

Materials in contact	Friction coefficient
Concrete coated pipe - concrete coated pipe	0.5
Concrete coated pipe - timber	0.4
Timber - timber	0.4
Uncoated steel - timber	0.3
Uncoated steel - uncoated steel	0.15
Epoxy coated pipe - timber	0.1
Epoxy coated pipe - epoxy coated pipe	0.05

9.6.3 Caution should be exercised where sand may be present between the friction surfaces as this may considerably reduce the friction coefficient.

9.6.4 Generally speaking, pipes should be stowed in the fore and aft direction.

9.6.5 Where pipes are stacked in several layers, the maximum permissible stacking height shall be established, in order to avoid overstress of the lower layers. Reference may be made to API RP 5LW "Recommended practice for transportation of line pipe on barges and marine vessels" [Ref. 14].

9.6.6 Smaller diameter pipes such as drill pipe may be stacked without individual chocking arrangements and restrained transversely by means of vertical stanchions. Timber dunnage or wedges shall be used to chock off any clearance between the pipes and the stanchions. The stanchions, taken collectively, shall be capable of resisting the total transverse force computed.

a. For weather-restricted operations, and 24-hour or location moves of jack-ups, the stack may be secured by means of transverse chain or wire lashings over the top, adequately tensioned. Provided it can be demonstrated that sufficient friction exists to prevent longitudinal movement, no end stops need be provided.

b. For unrestricted operations, including ocean transportations of jack-ups, steel strongbacks should be fitted over the top layer, and each stow (group of pipes) set up hard by driving wooden wedges between the strongbacks and the top layer of pipe. End stops or bulkheads shall be provided.

9.6.7 Line pipe on pipe carrier vessels may be stacked between the existing stanchions/crash barriers, on the wooden sheathed deck. Timber dunnage or wedges should be used to chock off any clearance between the pipes and the stanchions.

a. For weather restricted operations, provided it can be demonstrated that adequate friction exists to prevent longitudinal movement, no end stops need be provided. This is likely to apply to concrete coated pipe, but uncoated or epoxy coated pipe should be treated with caution.

b. For unrestricted operations, steel strongbacks should be fitted over the top layer, and each stow set up hard by driving wooden wedges between the strongbacks and the top layer of pipe. End stops or bulkheads shall be provided.

9.6.8 Larger diameter pipes such as piles are often individually chocked, and end stops provided, often at one end only. Unless it can be demonstrated that the piles cannot roll out of the chocks further restraints may be necessary, such as individual wire or chain lashings, stanchions or strongbacks.

9.6.9 In all cases of transportation of coated line pipe, the transportation and securing arrangements must be designed so that the coating will be protected from damage. The manufacturer's and/or shipper's recommendations should be sought.

9.6.10 Where end stops are provided for pipes with prepared ends, the end preparation should be protected, either with protectors on the pipe, or by wood sheathing on the end stops.

9.6.11 When open ended pipes are carried as deck cargo and the pipes could become partially filled with water, care should be taken to ensure that:

a. the vessel's stability meets the requirements of Section 10, with particular reference to the effects of entrapped water, and

b. the deck and pipe layers are not overstressed.

Otherwise, it may be necessary to seal the ends of at least the lowest level of the stack.

9.6.12 **Note**: the trim and stability booklet of some vessels may include suitable example loading conditions and should be considered.

9.7 INSPECTION OF WELDING AND SEAFASTENINGS

9.7.1 For newly-constructed cargoes, an adequate system of construction supervision, weld inspection and testing shall be demonstrated. For other cargoes, the extent of inspection and testing shall be agreed.

9.7.2 Principal seafastening welds shall be visually checked and the weld sizes confirmed against the agreed design.

9.7.3 Non-destructive testing (NDT), by a suitable and agreed method, shall be carried out on the structural members of the seafastenings. NDT acceptance criteria should be to EEMUA 158 "Construction specification for fixed offshore structures in the North Sea" [Ref. 15], AWS D1.1 "Structural welding code – steel" [Ref .16] or equivalent. The following is a guide to the minimum recommended extent of NDT:

a. 100% visual

b. Penetration welds - 40% UT and 20% MPI

c. Fillet welds - 20% MPI

d. All welds to barge/vessel deck - 100% MPI with additional 40% UT for penetration welds

e. In any case, the extent of NDT should be not less than the Project specification requirements

f. For critical areas or where poor welding quality is suspected, then 100% inspection may be required.

9.7.4 Care should be taken where the seafastening load path depends on the tension connection of the deck plating of a barge or vessel to underdeck stiffeners or bulkheads. In cases of any doubt about the condition, an initial visual inspection should be undertaken, to establish that fully welded connections exist, and that the general condition is fit for purpose. Further inspection may be required, depending on the stress levels imposed and the condition found.

9.7.5 Any faulty welds discovered shall be repaired and re-tested.

9.8 FATIGUE

9.8.1 Notwithstanding the exclusion in Section 4.6.7, clients may wish the effects of fatigue on the towed object, cargo and/or seafastenings to be considered, in which case they should instruct GL Noble Denton accordingly.

9.9 USE OF SECOND HAND STEEL SEAFASTENINGS

9.9.1 When second hand steel seafastenings are used, any wastage caused during previous removal(s) or use should not affect its fitness for purpose, and there should be sufficient documentation to ensure the traceability of the steel and in particular documentation relating to the grade of steel.

9.9.2 There should be NDT inspection reports for areas of previous fabrication, old welds, burnt off attachments etc, to demonstrate no cracking or lamellar tearing in critical areas.

9.9.3 Should sufficient documentation of the type of steel (e.g. EN10025) be unavailable, coupon testing is acceptable to determine the steel type. The guaranteed minimum properties of this type of steel are to be used, not the tested values which may not be representative of the rest of the steel. 4

10 STABILITY

10.1 INTACT STABILITY

10.1.1 The intact range of stability, defined as the range between 0º degrees heel or trim and the angle at which the righting arm (GZ) becomes negative, shall not be less than the values shown in the following Table 10-1. Objects which do not fall into the categories shown in the Table, which are non-symmetrical, or which have an initial heel or trim which is not close to 0º, may require special consideration. Where there is a significant difference between the departure, arrival or any intermediate condition, then the most severe should be considered, including the effects of any ballast water changes during the voyage.

Table 10-1 Intact Stability Range

Vessel or towed object, type and size		Intact range
Large and medium vessels,	LOA ≥ 76 m and B[1] ≥ 23 m	36°
Large cargo barges,	LOA ≥ 76 m and B[1] ≥ 23 m	36°
Small cargo barges,	LOA <76 m or B[1] < 23 m	40°
Small vessels,	LOA <76 m or B[1] < 23 m	44°
Jack-ups with B[1], [2] ≥ 23 m for ocean towages		36°
Jack-ups with B[1], [2] ≥ 23 m for 24-hour or location moves		28°
Inland and sheltered water (in ice areas)		36°
Inland and sheltered water (out of ice areas)		24°

Notes:

1. B = maximum moulded waterline beam
2. Jack-ups with B < 23 m and without radiused bilges shall be considered as small barges. Those with radiused bilges shall be considered as small vessels.

10.1.2 Alternatively, if maximum amplitudes of motion for a specific towage or voyage can be derived from model tests or motion response calculations, the intact range of stability shall be not less than:

$$(20 + 0.8\theta)$$

where θ = the maximum amplitude of roll or pitch caused by the design seastate as defined in Section 6.1.3, plus the static wind heel or trim caused by the design wind, in degrees.

10.1.3 Metacentric height (GM) shall be positive throughout the range shown in Section 10.1.1 or 10.1.2. The initial metacentric height, GM_0, should include an adequate margin for computational and other inaccuracies. A GM_0 of around 1.0 m will normally be required, and in any case shall not be less than 0.15 m.

10.1.4 Cargo overhangs shall generally not immerse as a result of heel from a 15 m/s wind in still water conditions.

10.1.5 Subject to Sections 8.5 and 10.1.4, buoyant cargo overhangs may be assumed to contribute to the range of stability requirement of Section 10.1.1.

10.1.6 The effects of free surface shall be considered in the stability calculations. The effects of free surface liquids in the cargo must also be taken into account, as must residual free surface due to incomplete venting, such as may occur if ballasting when trimmed.

10.1.7 Vessels shall comply with the mandatory parts of the International Maritime Organisation (IMO) Resolution A.749 (18) as amended by Resolution MSC.75 (69) - “Code on Intact Stability” [Ref. 17], and the IMO International Convention on Load Lines, Consolidated Edition 2002 [Ref 18].

10.1.8 In areas and seasons prone to icing of superstructures, the effects of icing on stability should be considered as described in Section 22.11.

10.2 DAMAGE STABILITY

10.2.1 Except as described in Sections 10.2.4 and 10.2.5 below, towed objects, including cargo barges, MODUs and structures towed on their own buoyancy, shall have positive stability with any one compartment flooded or broached. Minimum penetration shall be considered to be 1.5 metres. Two adjacent compartments on the periphery of the unit shall be considered as one compartment if separated by a horizontal watertight flat within 5 m of the towage waterline.

10.2.2 The emptying of a full compartment to the damaged waterline shall be considered if it gives a more severe result than the flooding of an empty compartment.

10.2.3 If buoyancy of the cargo has been included to meet intact stability requirements, then loss of cargo buoyancy or flooding of cargo compartments, shall be considered as a damage case, as appropriate.

10.2.4 One-compartment damage stability is not always achievable without impractical design changes, for the following and similar structures:

a. Concrete gravity structures, particularly when towing on the columns

b. Submerged tube tunnel sections

c. Bridge pier caissons

d. Outfall or water intake caissons.

10.2.5 For those structures listed in Section 10.2.4, or similar, damage stability requirements may be relaxed, provided the towage is a one-off towage of short duration, carried out under controlled conditions, and suitable precautions are taken, which may include:

a. Areas vulnerable to collision should be reinforced or fendered to withstand collision from the largest towing or attending vessel, at a speed of 2 metres/second, and:

b. Projecting hatches, pipework and valves are protected against collision or damage from towing and handling lines.

c. Emergency towlines are provided, with trailing pick-up lines, to minimise the need for vessels to approach the structure closely during the tow.

d. Emergency pumping equipment is provided.

e. Potential leaks via ballast or other systems are minimised.

f. Ballast intakes and discharges, and any other penetrations through the skin of the vessel or object, shall be protected by a double barrier system, or blanked off.

g. Vulnerable areas are conspicuously marked.

h. Masters of all towing or attending vessels are aware of the vulnerable areas.

i. A guard vessel is available to warn off other approaching vessels.

j. A risk assessment is carried out **and the risks shown to be acceptable**.

10.2.6 The extent and adequacy of the precautions necessary for a particular towage will be assessed on a case-by-case basis.

10.2.7 The relaxations allowed by Sections 10.2.4 and 10.2.5 do not apply in ice-affected areas, where the vessel or structure should comply with Section 22.11.

10.2.8 The damage stability recommendations of this Section do not apply to transport of cargoes on flagged trading vessels, sailing at the assigned ‘B’ freeboard or greater. The ‘B’ freeboard is the minimum freeboard assigned to a Type B vessel, which is generally defined as any vessel not carrying a bulk liquid cargo. Reduced freeboards may be assigned to a Type B vessel over 100 m in length, depending on the arrangements for protection of crew, freeing arrangements, strength, sealing and security of hatch covers, and damage stability characteristics. See the IMO International Convention on Load Lines, Consolidated Edition 2002, [Ref. 15] for further details.

10.3 WIND OVERTURNING

10.3.1 For the intact condition, the area under the righting moment curve shall be not less than 40% in excess of the area under the wind overturning arm curve. The areas shall be bounded by 0º heel or trim, and the second intercept of the righting and wind overturning arm curves, or the downflooding angle, whichever is less.

10.3.2 The wind velocity used for intact wind overturning calculations shall be the 1-minute design wind speed, as described in Section 6.13. In the absence of other data, 50 metres /second shall be used.

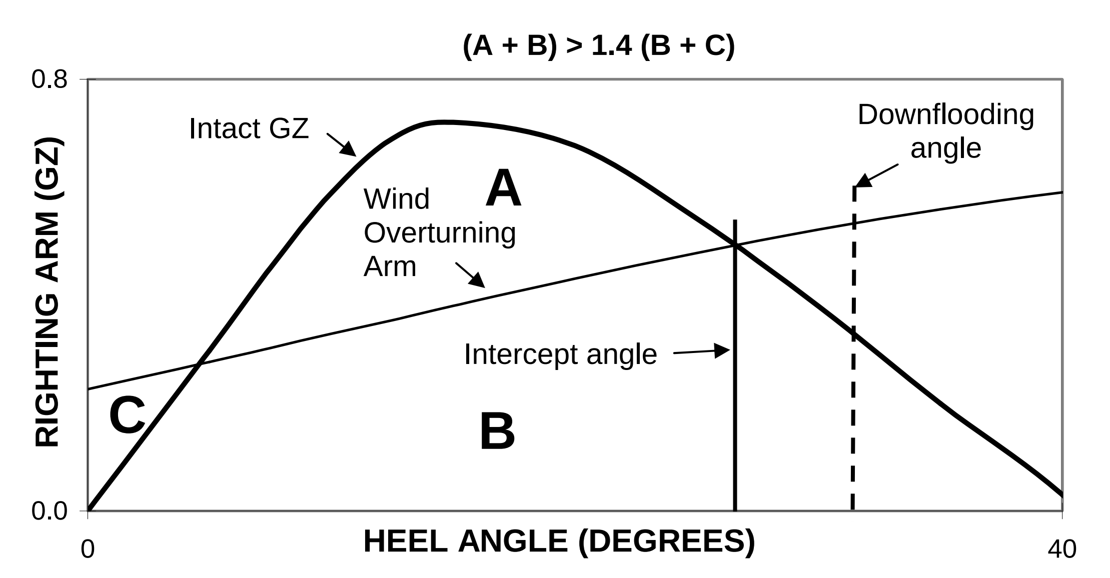


Figure 10-1 Wind Overturning Criteria (Intact Case)

10.3.3 For the damage condition, the area under the righting moment curve shall be not less than 40% in excess of the area under the wind overturning arm curve. The areas shall be bounded by the angle of loll, and the second intercept of the righting and wind overturning arm curves, or the downflooding angle, whichever is less.

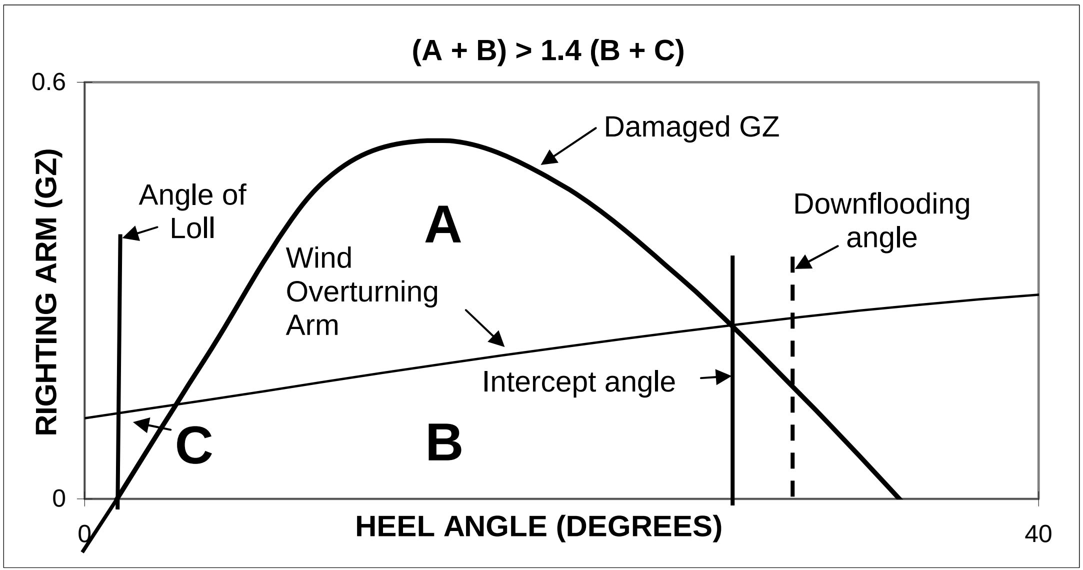


Figure 10-2 Wind Overturning Criteria (Damaged Case)

10.3.4 The wind velocity used for overturning moment calculations in the damage condition shall be 25 metres /second, or the wind used for the intact calculation if less.

10.4 DRAUGHT AND TRIM

10.4.1 For vessels and barges with a load-line certificate, the draught shall never exceed the appropriate load-line draught, except for temporary on-load and off-load operations under controlled conditions.

10.4.2 The draught should be small enough to give adequate freeboard and stability, and large enough to reduce motions and slamming. Typically, for barge towages, it will be between 35% and 60% of hull depth, which is usually significantly less than the load-line draught.

10.4.3 For barges and large towed objects, such as FPSOs, the draught and trim should be selected to minimise slamming under the forefoot, to give good directional control, and to allow for the forward trim caused by towline pull.

10.4.4 For guidance, and for discussion with the Master of the tug, the tow should be ballasted to the following minimum draughts and trims:

Table 10-2 Minimum draught & trim

Length of Towed Vessel	Minimum Draught Forward	Minimum Trim by Stern
30 metres	1.0 metre	0.3 metre
60 metres	1.7 metres	0.6 metre
90 metres	2.4 metres	0.8 metre
120 metres	3.1 metres	1.0 metre
150 metres	3.7 metres	1.2 metres
200 metres	4.0 metres	1.5 metres

10.4.5 Where barges with faired sterns are fitted with directional stabilising skegs, it may be preferable to have no trim. This should normally be documented in the Trim and Stability booklet. However allowance should be made for trim caused by the towline force and there should be adequate freeboard at the bow (and possibly a breakwater) to minimise damage from "green water" coming over the bow.

10.4.6 It may be preferable to tow structures such as floating docks, at minimum draught with zero trim, in order to minimise longitudinal bending moments.

10.4.7 Draught marks forward and aft shall be easily readable and, if necessary, re-painted in the area above the waterline.

10.4.8 Where the tow is unmanned, and in order that the tug may monitor any increased draught during the towage, it may be advantageous to paint a broad distinctive line of contrasting colour around the bow approximately 0.5 metre above the waterline.

10.5 COMPARTMENTATION AND WATERTIGHT INTEGRITY

10.5.1 Where the watertight integrity of any tow is in question, particularly for demolition tows, part built ships and MODUs, it shall be checked by visual inspection, chalk test, ultrasonic test, hose test or air test as considered appropriate by the attending surveyor.

10.5.2 Any opening giving an angle of downflooding less than 20 degrees, or (θ + 5) degrees if less than 20 degrees, where θ is the angle as defined in Section 10.1.2, shall be closed and watertight, or protected by automatic closures in operable condition.

10.5.3 Hatches, ventilators, gooseneck air pipes and sounding pipes shall be carefully checked for proper closure and their watertight integrity confirmed. Where such equipment could be damaged by sea action or movement of loose equipment, then additional precautions should be considered.

10.5.4 Outboard accommodation doors shall be carefully checked for proper closure and their weathertight integrity confirmed. All dogs shall be in good operating condition and seals shall be functioning correctly.

10.5.5 Watertight doors in holds, tween decks and engine room bulkheads, including shaft alleyway and boiler room spaces, shall be checked for condition and securely closed.

10.5.6 Any watertight doors required to be opened for access during the transportation, shall be marked, on both sides, "To be kept closed except for access" or words to that effect. In some cases a length of bar or pipe may be required to assist opening and closing.

10.5.7 Portholes shall be checked watertight. Porthole deadlights shall be closed where fitted. Any opening without deadlights that may suffer damage in a seaway shall be plated over.

10.5.8 Windows which could be exposed to wave action shall be plated over, or similarly protected.

10.5.9 All tank top and deck manhole covers and their gaskets shall be in place, checked in good condition, and securely bolted down.

10.5.10 All overboard valves shall be closed and locked with wire or chain. Where secondary or back-up valves are fitted for double protection, they shall also be closed.

10.5.11 Closure devices fitted to sanitary discharge pipes, particularly near the waterline, shall be closed. Any discharge pipe close to the waterline not fitted with a closure device, may need such a facility incorporated, or be plated over.

10.5.12 All holds, void spaces and engine room bilges shall be checked before departure and should be pumped dry.

10.5.13 All other spaces shall be sounded prior to departure. It is recommended that all spaces should be either pressed up or empty. Slack tanks should be kept to a minimum.

11 TRANSPORT VESSEL SELECTION

11.1 GENERAL

11.1.1 The following points should be considered in the selection of a suitable transport barge or vessel:

a. Is there adequate deck space for all the cargo items planned, including room for seafastenings, access between cargo items, access to towing and emergency equipment, access to tank manholes, installation of cargo protection breakwaters if needed, and for lifting offshore if required?

b. Has the barge or vessel adequate intact and damage stability with the cargo and ballast as planned, including any requirement for ballast water exchange?

c. Does the barge or vessel as loaded have sufficient freeboard to give reasonable protection to the cargo?

d. If a floating loadout is planned, is there sufficient water depth to access and leave the loadout berth? Can the loadout be carried out in accordance with GL Noble Denton document 0013/ND - Guidelines for Loadouts [Ref. 2]

e. If a submerged loadout is planned, can the barge or vessel be submerged, within its Class limitation, so as to give adequate clearance over the deck, and adequate stability at all stages, within the water depth limitations of the loadout location?

f. Is the deck strength adequate, including stiffener, frame and bulkhead spacing and capacity, for loadout and transportation loads?

g. For a vessel, does securing of seafastenings require welding in way of fuel tanks?

h. For a barge, is it properly equipped with main and emergency towing connections, recovery gear, pumping equipment, mooring equipment, anchors, lighting and access ladders?

i. Will the motion responses as calculated cause overstress of the cargo?

j. Is all required equipment and machinery in sound condition and operating correctly?

k. Does the barge or vessel possess the relevant, in date, documentation as set out in Section 5?

11.2 SUITABILITY AND ON-HIRE SURVEYS

11.2.1 In his interest, the charterer is advised to have a suitability survey and an on-hire survey of the barge or vessel carried out prior to acceptance of the charter.

12 TOWING VESSEL SELECTION AND APPROVAL

12.1 GENERAL

12.1.1 The tug(s) selected should comply with the minimum bollard pull requirements shown in Section 12.2 below, and should also comply with the appropriate Category in Section 3 of GL Noble Denton document 0021/ND - Guidelines for the Approvability of Towing Vessels [Ref. 5]. The categories are summarised in the following table. The appropriate category should be agreed with the GL Noble Denton office concerned.

Table 12-1 Towing Vessel Categories

Category	Used for
ST – Salvage Tug	Single tug towages in benign or non-benign weather areas
U - Unrestricted	
C - Coastal	Towages in benign weather areas or weather routed
R1 - Restricted	Assisting in multi-tug towages
R2 - Restricted	Benign weather area towages
R3 - Restricted	Assisting in multi-tug towages in benign weather areas

12.1.2 The tug(s) used for any towage to be approved by GL Noble Denton should be inspected by a surveyor nominated by GL Noble Denton before the start of the towage. The survey will cover the suitability of the vessel for the proposed operation, its seakeeping capability, general condition, documentation, towing equipment, manning and fuel requirements.

12.1.3 For tugs entered in the GL Noble Denton Towing Vessel Approvability Scheme (TVAS), it will generally be possible to issue a statement of acceptability in principle, prior to departure. The extent and frequency of surveys as required by the TVAS is defined in Ref. [5]. A survey on departure will still be required, to ensure that the vessel still complies with the rules of the scheme.

12.1.4 Vessels not entered into the scheme will require to be surveyed before any formal opinion on acceptability or approvability can be issued. For vessels not known to GL Noble Denton, a survey well in advance of departure is recommended.

12.1.5 An additional tug may be recommended for high value tows or towages through areas with limited searoom, to carry out the following duties:

a. Act as a Guardship, to protect the tow, and advise approaching vessels they may be running into danger 4

b. In the event of mechanical failure or towline breakage, assist in removing the failed tug from the towing spread

c. Take over the duties of the failed tug

e. Provide any other required assistance in an emergency.

12.2 BOLLARD PULL REQUIREMENTS

12.2.1 The following Table summarises the different conditions to be considered. The most severe conditions that apply to a particular towage should be used. The conditions are described in more detail in the indicated sections.

Table 12-2 Meteorological Criteria for Calculating TPR (Towline Pull Required)

Section	Condition	H_{sig} (m)	Wind (m/sec)	Current (m/sec)
12.2.2	Limited searoom	Design	Design (1 hour mean)	0.5 or predicted current if greater
12.2.3	Continuous adverse current or weather	As agreed with the GL Noble Denton office concerned to ensure a reasonable speed in moderate weather.		
12.2.4	Standard	5	20	0.5
12.2.5	24-hour jack-up move	3	15	0.5 or predicted current if greater
12.2.6	Benign weather areas	As agreed with the GL Noble Denton office concerned but not less than: 2	15	0.5
12.2.7	Sheltered from waves	As agreed with the GL Noble Denton office concerned.		

12.2.2 For towages which pass through an area of restricted navigation or manoeuvrability, outside the validity of the departure weather forecast and which cannot be considered a weather-restricted operation, the minimum Towline Pull Required (TPR) should be computed for zero forward speed against the following acting simultaneously:

- the design wave height (see Section 6), and
- 1 hour design wind speed (see Section 6), and
- 0.5 metres/second current, or the maximum predicted surface current if greater.

12.2.3 If the tow route passes through an area of continuous adverse current or weather, or if a particular towing speed is required in calm or moderate weather, a greater TPR may be appropriate and agreed with the GL Noble Denton office concerned. In any event, an assessment should be made that a reasonable speed can be achieved in moderate weather.

12.2.4 For towages where adequate searoom can be achieved within the departure weather forecast and maintained thereafter, the TPR shall be computed for zero forward speed against the following acting simultaneously:

- 5.0 metre significant seastate, and
- 20 metres/second wind, and
- 0.5 metres/second current, or the maximum predicted surface current if greater.

12.2.5 For 24-hour moves of jack-ups the following reduced criteria, acting simultaneously, may be used for the calculation of TPR:

- 3.0 metres significant seastate, and
- 15 metres/second wind, and
- 0.5 metres/second current, or the maximum predicted surface current if greater.

12.2.6 For benign weather areas, the criteria for calculation of TPR shall be agreed with the GL Noble Denton office concerned. Generally these should not be reduced below:

- 2.0 metres significant seastate, and
- 15 metres/second wind, and
- 0.5 metres/second current.

12.2.7 For towages partly sheltered from wave action, but exposed to strong winds, the criteria shall be agreed with the GL Noble Denton office concerned.

12.2.8 TPR shall be related to the continuous static bollard pull of the tug(s) proposed (BP) by:

$$TPR = \sum(BP \times T_e/100)$$

where: T_e = the tug efficiency in the sea conditions considered, %
$(BP \times T_e/100)$ is the contribution to TPR of each tug
$\sum$ means the aggregate of all tugs assumed to contribute.

12.2.9 Tug efficiency, T_e, depends on the size and configuration of the tug, the seastate considered and the towing speed achieved. In the absence of alternative information, T_e may be estimated for good ocean-going tugs according to the following Table 12-3. However tugs with less sea-kindly characteristics will have significantly lower values of T_e in higher sea states.

Table 12-3 Values of Tug Efficiency, T_e

Continuous Bollard Pull (BP), tonnes	Tug Efficiency, Te %			
	Calm	H_{sig} = 2 m	H_{sig} = 3 m	H_{sig} = 5 m
BP $\leq$ 30	80	50 + BP	30 + BP	BP
30 < BP < 90	80	80	52.5 + BP/4	7.5 + 0.75 x BP
BP $\geq$ 90	80	80	75	75

12.2.10 These efficiencies are shown graphically in the following Figure.

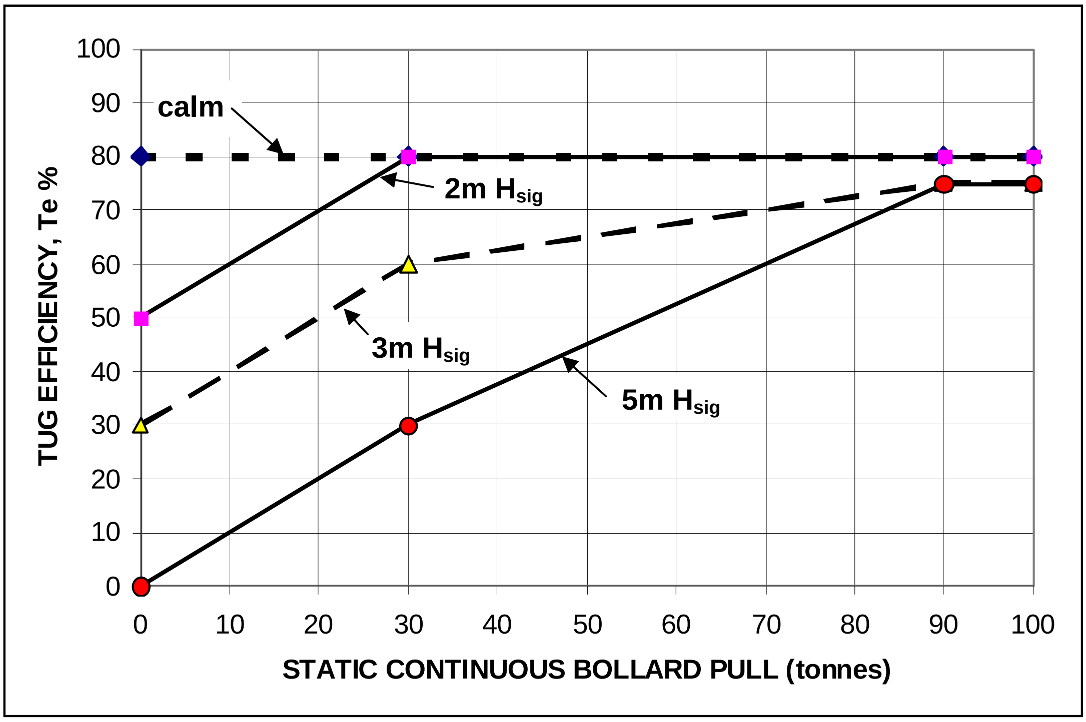


Figure 12-1 Tug efficiencies in different sea states

12.2.11 The resulting effective bollard pull in the different sea states is shown in the following Figure:

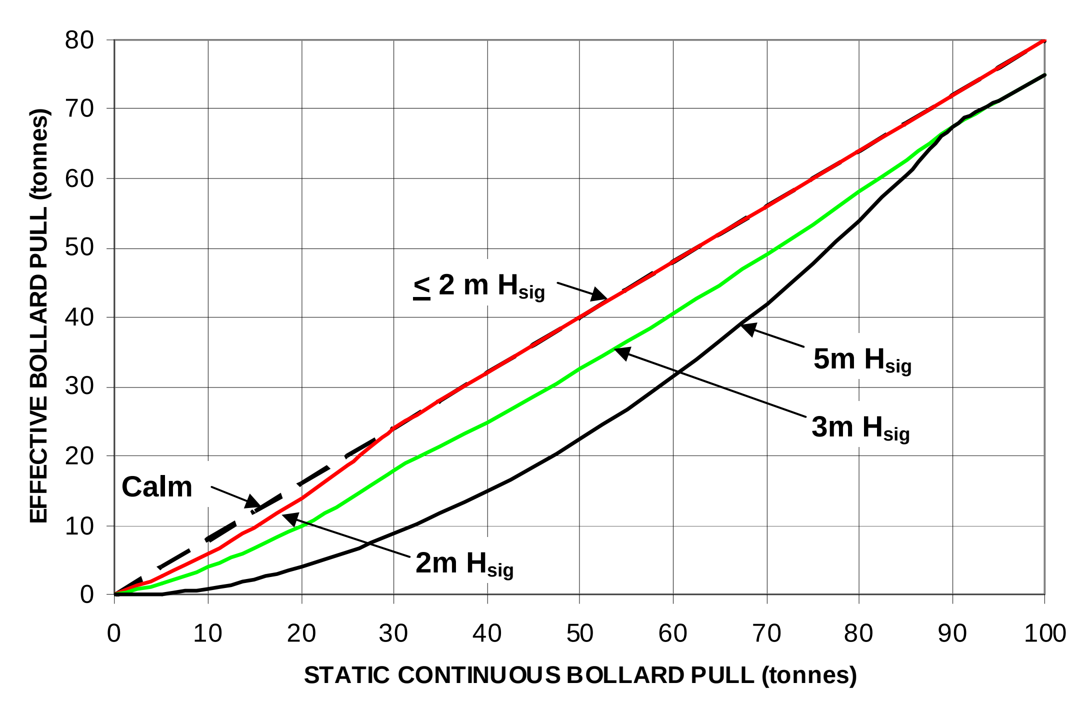


Figure 12-2 Effective Bollard Pull in Different Sea States

12.2.12 Alternatively, for the H_{sig} = 5.0 m case, BP can be related to TPR by:

Table 12-4 Selecting Bollard Pull from TPR for H_{sig} = 5 m

Towline Pull Required (TPR), tonnes	Continuous Bollard Pull (BP), tonnes
TPR $\leq$ 9	√(100 x TPR)
9 < TPR < 67.5	√[25 + (300 x TPR) /2.25] - 5
TPR $\geq$ 67.5	TPR /0.75

12.2.13 Only those tugs connected so they are capable of pulling effectively in the forward direction shall be assumed to contribute. Stern tugs shall be discounted in the above calculation.

12.3 MAIN & SPARE TOWING WIRES & TOWING CONNECTIONS

12.3.1 The main and spare towing wires, pennants and connections shall be in accordance with Section 13.

12.4 TAILGATES / STERN RAILS

12.4.1 Where a towing tailgate or stern rail is fitted, the radius of the upper rail shall be at least 10 times the diameter of the tug's main towline, and adequately faired to prevent snagging.

12.5 TOWLINE CONTROL

12.5.1 Where a towing pod is fitted, its strength shall be shown to be adequate for the forces it is likely to encounter. It should be well faired and the inside and ends must have a minimum radius of 10 times the towline diameter.

12.5.2 Where no pod is fitted, the after deck should be fitted with a gog rope, mechanically operated and capable of being adjusted from a remote station. If a gog rope arrangement is fitted then a spare shall be carried. Where neither a towing pod nor gog rope is fitted, then an alternative means of centring the tow line should be provided.

12.5.3 On square-sterned towing vessels, it is preferred that mechanically or hydraulically operated stops be fitted near the aft end of the bulwarks, to prevent the towline slipping around the tug's quarter in heavy weather.

12.6 WORKBOAT

12.6.1 A powered workboat must be provided for emergency communication with the tow, and must have adequate means for launching safely in a seastate associated with Beaufort Force 4 to 5. An inflatable or RIB may be acceptable provided it has flooring suitable for carriage of emergency equipment to the tow.

12.7 COMMUNICATION EQUIPMENT

12.7.1 In addition to normal Authorities' requirements, the tug shall carry portable marine VHF and/or UHF radios, for communication with the tow when tug personnel are placed on board for inspections or during an emergency. Spare batteries and a means of recharging them shall be provided.

12.8 NAVIGATIONAL EQUIPMENT

12.8.1 Towing vessels shall be provided with all necessary navigational instruments, charts and publications that may be required on the particular towage, including information for possible diversion ports and their approaches.

12.9 SEARCHLIGHT

12.9.1 The tug shall be fitted with a searchlight to aid night operations and for use in illuminating the tow during periods of emergency or malfunction of the prescribed navigation lights. The searchlight(s) should provide illumination both forward and aft, thereby allowing the tug to approach the tow either bow or stern on.

12.10 PUMP

12.10.1 On any tow outside coastal limits, the tug shall carry at least one portable pump, equipped with means of suction and delivery and having a self contained power unit with sufficient fuel for 12 hours usage at the pump's maximum rating. The pump shall be suitable for the requirements outlined in Section 15.2.1.e through 15.2.1.h, but may not be considered to be a substitute for the pump(s) required by Section 15. The methods and feasibility of deployment should be considered.

12.11 ADDITIONAL EQUIPMENT

12.11.1 Anti-chafe gear should be fitted as necessary. Particular attention should be paid to contact between the towline and towing pods, tow bars and stern rail.

12.11.2 All tugs should be equipped with burning and welding gear for use in emergency.

12.12 BUNKERS & OTHER CONSUMABLES

12.12.1 The tug should carry fuel and other consumables including potable water, lubricating oil and stores, for the anticipated duration of the towage, taking into account the area and season, plus a reserve of at least 5 days supply. If refuelling en route is proposed, then suitable arrangements must be made before the towage starts, and included in the towing procedures.

12.13 TUG MANNING

12.13.1 Notwithstanding minimum manning levels for tugs as described in Ref. [5], or those required by State or Port Authorities, consideration shall be given to the fact that in an emergency situation, two or more of the tug crew may need to board and remain on the tow for an extended period. This should be taken into account when approving the manning level of a towing vessel.

13 TOWING & MISCELLANEOUS EQUIPMENT ON TOW

13.1 TOWING EQUIPMENT & ARRANGEMENTS - GENERAL

13.1.1 Towage should normally be from the forward end of the barge or tow via a suitable bridle as shown in Appendix A. The components of the system are:

a. Towline connections, including towline connection points, fairleads, bridle legs and bridle apex

b. Intermediate pennant

c. Bridle recovery system

d. Emergency towing gear.

13.1.2 There may be a case for towing some structures by the stern. These could include:

a. Part-built or damaged ships, or any structure when the bow sections could be vulnerable to wave damage.

b. Part-built ships, converted ships or FPSOs without a rudder or skeg, or with a turret or spider fitted forward, where better directional stability may be obtained if towed by the stern.

c. Any structure with overhanging or vulnerable equipment near the bow, which could be vulnerable to wave damage, or could interfere with the main and emergency towing connections.

13.1.3 A decision whether to tow by the stern should be based on the results of a risk assessment which shall be presented to GL Noble Denton for review.

13.1.4 If two tugs are to be used for towing, then in general the larger tug should be connected to the bridle, and the smaller tug to a chain or chain/wire pennant set to one side of the main bridle. Alternatively two bridles may be made up, one for each tug. For two balanced tugs, the bridle may be split and the tugs should tow off separate bridle legs, via intermediate pennants. This is not generally preferred for tows with rectangular bows. Whichever system is used, a recovery system should be provided for the connection point for each tug.

13.1.5 For tows where a bridle is not appropriate, such as multiple tug towages, then normally each tug should tow off a chain pennant and an intermediate wire pennant.

13.1.6 It is normal that the towline and the intermediate pennant are supplied by the tug. However, the strength requirements are presented here, to bring together the requirements for towlines and towing connections.

13.2 STRENGTH OF TOWLINE & TOWLINE CONNECTIONS

13.2.1 The Minimum Breaking Loads (MBL) of the main and spare towlines, and the ultimate load capacity of the towline connections to the tow including each bridle leg, shall be related to the actual continuous static bollard pull (BP) of the tug as follows, (BP, MBL and ULC are in tonnes):

a. Towline breaking load MBL shall be computed as follows:

Table 13-1 Minimum Towline Breaking Loads (MBL)

Bollard Pull (BP)	Benign Areas	Other Areas
BP $\leq$ 40 tonnes	2.0 x BP	3.0 x BP
40 < BP $\leq$ 90 tonnes	2.0 x BP	(3.8 - BP/50) x BP
BP > 90 tonnes	2.0 x BP	2.0 x BP

b. The Ultimate Load Capacity (ULC), in tonnes, of towline connections to the tow, including bridle legs, chain pennants, and fairleads, where fitted, shall be not less than:

ULC = 1.25 x MBL (for MBL $\leq$ 160 tonnes) or

ULC = MBL + 40 (for MBL $\geq$160 tonnes)

See Section 13.5.2 for bridle apex angle >120^{o}.

13.2.2 A certificate to demonstrate the MBL of each towline shall be available. MBL may be obtained by testing, or by showing the aggregate breaking load of its component wires, with a spinning reduction factor. This certificate shall be issued or endorsed by a body approved by an IACS member or other recognised certification body accepted by GL Noble Denton. 4

13.2.3 Each bridle leg, and the connections to which it is attached, shall be designed to the full value of ULC, as shown in Section 13.2.1.b.

13.2.4 Fairleads, where fitted, shall be designed to take loadings as the tug deviates from the nominal towing direction, as follows, where:

α = a. the horizontal angle of towline pull from the nominal towing direction when a bridle is not used, as shown in Figure 13-1, or

b. the horizontal angle of the bridle leg from its normal direction (with bridle apex angles of less than 120^{o} - see Section 13.5.2).

ULC is as defined in Section 13.2.1.b.

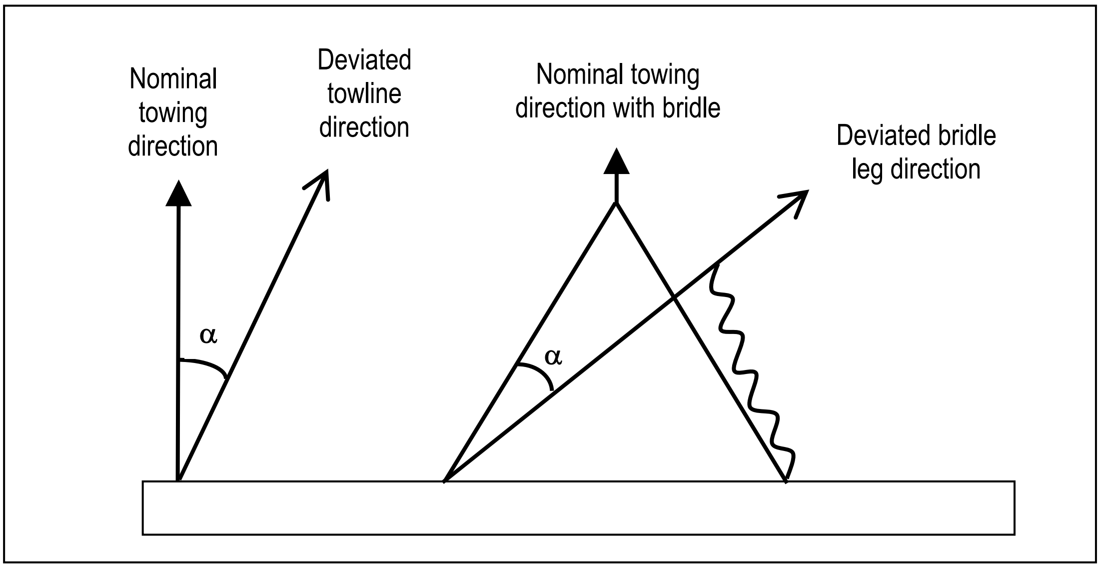


Figure 13-1 Definition of angle α with and without a bridle

Table 13-2 Fairlead Resolved ULC

Horizontal angle, α	Fairlead ultimate load capacity, resolved as appropriate
$0 \leq \alpha \leq 45°$	ULC
$45° < \alpha < 90°$	Linear interpolation with α between ULC and (0.5 x ULC)
$\alpha \geq 90°$	0.5 x ULC

13.2.5 Where no fairleads are fitted, the towing connections shall be similarly designed.

13.2.6 If a fairlead or towing connection is to be used either with or without a bridle, it should be designed for both cases.

13.2.7 For tows where it may be operationally necessary to apply the full value of towline pull at any angle, the connections and fairleads may require special consideration, and the reduction shown in Section 13.2.4 may not be appropriate.

13.2.8 Where towing connections or fairleads may be subjected to a vertical load, the design shall take account of the connection or fairlead elevation, the proportion of bridle and towline weight taken at the connection or fairlead, and the towline pull, at the maximum pitch angle computed.

13.2.9 It should be noted that the above requirement represents the minimum values for towline connection strength. It may be prudent to design the main towline connections to allow for the use of tugs larger than the minimum required.

13.2.10 In particular circumstances, where the available towing vessel is oversized with regard to TPR (see Section 12.2), and the towline connections are already fitted to the tow, then the towline connections (but not the towline itself) may be related to the required BP rather than the actual BP. Such relaxation shall be with the express agreement of the Master of the tug, and shall be noted in the towing arrangements. **It shall not apply for towages in ice areas.**

13.3 RELATIONSHIP BETWEEN TOWLINE LENGTH AND STRENGTH

13.3.1 Except in benign areas and sheltered water towages, the minimum length available of each of the main and spare towlines (L) shall be determined from the "European" formula:

$$L > (BP/MBL) \times 1800 \text{ metres}$$

except that in no case shall the available length be less than 650 metres, apart from coastal towages within a good weather forecast when this may be reduced to 500m.

13.3.2 For benign areas, the minimum length available shall be not less than:

$$L > (BP/MBL) \times 1200 \text{ metres}$$

except that in no case shall the available length be less than 500 metres.

13.3.3 The available length shall take into account the minimum remaining turns on the winch drum, and the distance from the drum to the stern rail or roller. One full strength wire rope pennant which is permanently included in the towing configuration may be considered when determining the available length.

13.3.4 MBL as shown in Section 13.2.1 shall be increased if required for L to comply with Section 13.3.1 or 13.3.2 as appropriate. ULC shall be correspondingly increased.

13.4 TOWLINE CONNECTION POINTS

13.4.1 Towline connections to the tow shall be of an approved type. Preferably they should be capable of quick release under adverse conditions, to allow a fouled bridle or towline to be cleared, but must also be secured against premature release. A typical bracket design is shown in Appendix C.

13.4.2 Towline connections and fairleads shall be designed to the requirements of Section 13.2.

13.4.3 Sufficient internal/underdeck strength must be provided for all towline connections and fairleads.

13.4.4 Where fitted, fairleads should be of an approved type, located close to the deck edge. They should be fitted with capping bars and sited in line with the towline connections, to prevent side load on the towing connections.

13.4.5 Where the bridle might bear on the deck edge, the deck edge should be suitably faired and reinforced to prevent chafe of the bridle.

13.4.6 Where towing connections are of a quick-release type, then the fairlead design shall allow all the released parts to pass easily through the fairlead.

13.5 BRIDLE LEGS

13.5.1 Each bridle leg should be of stud link chain or composite chain and wire rope. If composite, the chain should of sufficient length to extend beyond the deck edge and prevent chafing of the wire rope.

13.5.2 The angle at the apex of the bridle should normally be between 45 and 60 degrees. If it exceeds 120^o then the strength of the bridle legs, fittings and towing connections will need to be increased to allow for the increased resolved load in the bridle from the towline force.

13.5.3 The end link of all chains shall be a special enlarged link, not a normal link with the stud removed.

13.5.4 All wire ropes shall have hard eyes or sockets.

13.6 BRIDLE APEX

13.6.1 The bridle apex connection should be a towing ring or triangular plate, often called a Delta, Flounder or Monkey Plate, or an enlarged bow shackle.

13.7 SHACKLES

13.7.1 The breaking load of shackles forming part of the towline shall be at least 110% of the **actual** breaking load of the towline to be used.

13.7.2 The breaking load of shackles forming part of the bridle shall be not less than 110% of the **required** breaking load of the connected parts.

13.7.3 If the breaking load of a shackle cannot be identified then the minimum Safe Working Load (SWL) may be related to the continuous static bollard pull (BP) of the largest tug proposed, as follows:

Table 13-3 Default Shackle SWL

Continuous bollard pull, BP, tonnes	Minimum Safe Working Load, SWL, tonnes
BP < 40	1.0 x BP
BP $\geq$ 40	(0.5 x BP) + 20

13.8 INTERMEDIATE PENNANT OR SURGE CHAINS

13.8.1 An intermediate wire rope pennant should be fitted between the main towline and the bridle or chain pennant. Its main use is for ease of connection and reconnection. All wire rope pennants shall have hard eyes or sockets, and be of the same lay (i.e. left or right hand) as the main towline.

13.8.2 A synthetic spring, if used, should not normally replace the intermediate wire rope pennant.

13.8.3 The length of the wire pennant for barge tows is normally 10-15 metres since this can be handled on the stern of most tugs without the connecting shackle reaching the winch. Longer pennants may be needed in particular cases.

13.8.4 The breaking strength of the wire rope pennant shall not be less than that of the main towline with the possible exceptions in Section 13.8.6.

13.8.5 A surge chain may be used, especially in shallow water when a long towline catenary cannot be used, to provide shock absorption. If a surge chain is supplied then the MBL shall not be less than that of the main towing wire. The surge chain shall be a continuous length of welded studlink chain with an enlarged open link at each end (see Section 13.5.3). A method of recovery of the chain shall be provided in case a tow wire breaks.

13.8.6 GL Noble Denton may approve a “fuse” or “weak link” pennant provided that:

a. The strength reduction is not more than 10% of the actual strength of the main towline, and

b. The resulting strength of the pennant is at least equal to that required for the towline.

13.9 SYNTHETIC SPRINGS

13.9.1 Where a synthetic spring is used, its breaking load shall be at least 1.5 times that required for the main towline. As synthetic springs have a limited life due to embrittlement and ageing, they must be in good condition, and have been stored to protect them from wear, solvents and sunlight. See Section 22.7.7 for towages when icing can occur.

13.9.2 If used, a synthetic spring should normally be connected between the main towing wire and the intermediate pennant, rather than connected directly into the bridle apex.

13.9.3 All synthetic springs shall have hard eyes. A synthetic spring made up as a continuous loop with a hard eye each end is generally preferable to a single line with an eye splice each end.

13.10 BRIDLE RECOVERY SYSTEM

13.10.1 A system shall be fitted to recover the bridle or chain pennant, to allow reconnection in the event of towline breakage. The preferred type of bridle recovery system is shown in Appendix A. It consists of a winch and a recovery line connected to the bridle apex, via a suitable lead, preferably an A-frame.

13.10.2 The recovery winch shall be capable of handling at least 100% of the weight of the bridle, plus attachments including the apex and the intermediate pennant. It shall be suitably secured to the structure of the tow. Except for very small barges, the winch should have its own power source. It should be noted that an adequate winch will be useful for initial connection of the towline. Adequate fuel should be carried.

13.10.3 If the winch is manually operated, it should be fitted with ratchet gear and brake, and should be geared so that the tow bridle apex can be recovered by 2 persons.

13.10.4 Should no power source be available, and manual operation is deemed impractical, then arrangements shall be made, utilising additional pennant wires as necessary, which will allow the tug to reconnect.

13.10.5 The breaking load of the recovery wire, shackles, leads etc shall be at least 6 times the weight of the bridle, apex and intermediate pennant. The winch barrel should be adequate for the length and size of the wire required.

13.11 EMERGENCY TOWING GEAR

13.11.1 Emergency towing gear shall be provided in case of towline failure, bridle failure or inability to recover the bridle. Preferably it should be fitted at the bow of the tow. It may consist of a separate bridle and pennant or a system as shown in Appendix B. Precautions should be taken to minimise chafe of all wire ropes.

13.11.2 The emergency system will typically consist of the following:

a. Towing connection on or near the centreline of the tow, over a bulkhead or other suitable strong point

b. Closed fairlead

c. Emergency pennant, minimum length 80 metres, with hard eyes or sockets, preferably in one length. This length may be reduced for small barges and in benign areas

d. Extension wire, if required, long enough to prevent the float line chafing on the stern of the tow

e. Float line, to extend 75-90 metres abaft the stern of the tow

f. Conspicuous pick-up buoy, with reflective tape, on the end of the float line.

13.11.3 The strength of items a, b and c above should be as for the main towline connections, as shown in Section 13.2.1. The breaking load of the handling system, items d and e above should be not less than 25 tonnes, and must be sufficient to break the securing devices.

13.11.4 If the emergency towline is attached forward, it must be led over the main tow bridle. It should be secured to the outer edge of the tow, outside all obstructions, with soft lashings, or metal clips opening outwards, approximately every 3 metres.

13.11.5 If the emergency towing gear is attached aft, the wire rope should be coiled or flaked near the stern, so that it can be pulled clear. The outboard eye should be led over the deck edge to prevent chafe of the float line.

13.11.6 For towage of very long vessels, alternative emergency arrangements may be approvable but any arrangement shall be agreed with the Master of the tug to ensure that reconnection is possible in an emergency.

13.11.7 Whatever the arrangement agreed, care shall be taken that no chafe can occur to the floating line when deployed.

13.11.8 It is good practice to have swivels at the connection of the float line to the pennant line or extension wire, and at the connection of the float line to the buoy.

13.11.9 The following reconnection equipment should also be considered, and placed on board if the duration and area of the towage demand it:

a. Heaving lines

b. Line throwing equipment

c. Spare shackles.

13.12 CERTIFICATION

13.12.1 Valid certificates shall be available for all chains, wires and shackles utilised in the towing arrangement. Where certification is not available or attainable for minor items the surveyor may recommend that oversized equipment shall be fitted. Certificates shall be issued or endorsed by bodies approved by an IACS member or other recognised certification bodies accepted by GL Noble Denton. 4

13.12.2 The GL Noble Denton surveyor may reject any items that appear to be unfit for purpose, or are lacking valid certification.

13.13 NAVIGATION LIGHTS & SHAPES

13.13.1 The tow shall carry the lights and shapes required by the International Regulations for Preventing Collisions at Sea, 1972 amended 1996 (COLREGS [Ref. 19]) and any local regulations.

13.13.2 Navigation lights shall be independently powered (e.g. from an independent electric power sources or from gas containers). Fuel or power sources shall be adequate for the maximum duration of the towage, plus a reserve. Spare mantles or bulbs should be carried, even if the tow is unmanned.

13.13.3 It is desirable that a duplicate system of lights be provided.

13.13.4 Towed objects which may offer a small response to radar, such as barges or concrete caissons with low freeboard, should be fitted with a radar reflector. The reflector should be mounted as high as practical. Octahedral reflectors should be mounted in the “catch-rain” orientation.

13.14 ACCESS TO TOWS

13.14.1 Whether a tow is manned or not, suitable access must be provided. This may include at least one permanent steel ladder on each side, from main deck to below the waterline.

13.14.2 Where practical, ladders should be recessed, back painted for ease of identification, be clear of overhanging cargo, and faired off to permit access by the tug’s workboat.

13.14.3 Alternatives may be accepted if it can be demonstrated that they will provide a safe and reliable means of access during the towage. For example, a pilot ladder on each side or over the stern, secured to prevent it being washed up on deck, may be accepted for short tows or where it can be deployed from a manned tow.

13.14.4 Objects with high freeboard (e.g. over about 10 m) may need special consideration. Ladders should be enclosed, except within 5 m of the towage waterline, with resting platforms every 10 metres. Where practical, stairways are preferable to ladders.

13.14.5 Where practical, a clear space should be provided and appropriately marked, with access ladders if necessary so that, in an emergency, men may landed or recovered by helicopter. If it is required to land a crew on board prior to entering port, for instance to start pumps and reduce draught, then a properly marked and certified helideck or landing area would be an advantage.

13.14.6 A boarding party should be appropriately equipped with survival suits, lifejackets and communication equipment.

13.14.7 Even if the tow is not manned, consideration should be given to placing life saving appliances on board, appropriate to the hazards a boarding party may face once aboard.

13.14.8 Not withstanding the potential for piracy in some areas, means of boarding shall still be available.

13.15 ANCHORING & MOORING EQUIPMENT

13.15.1 See Section 16.

13.16 DAMAGE CONTROL & EMERGENCY EQUIPMENT

13.16.1 When the length and area of the towage demand it, the following equipment should be carried on the tow in suitable packages or in a waterproof container secured to the deck:

a. Burning gear
b. Welding equipment
c. Steel plate - various thicknesses
d. Steel angle section - various sizes and lengths
e. Plywood sheets - 25 mm thick
f. Lengths of 3” x 3” (75mm x 75mm) timber
g. Caulking material
h. Sand and cement (suitably packaged)
i. Nails - various sizes
j. Wooden plugs – various sizes
k. Wooden wedges – various sizes
l. A selection of tools, including a hydraulic jack, hammers, saws, crowbars, Tirfors.
m. Portable coamings 60 cm minimum height, with a flange and boltholes to suit the manhole design. The top should be constructed to avoid damage to hoses and cables
n. A sounding tube extension, of 60 cm minimum height, threaded so that it can be screwed into all sounding plug holes
o. Sounding tapes
p. Fire fighting equipment as appropriate
q. Personal protection equipment - gloves, goggles, hard hats, survival suits etc
r. Emergency lighting.

14 VOYAGE PLANNING

14.1 GENERAL

14.1.1 The following recommendations apply with respect to the way in which the towage or voyage is conducted. The Certificate of Approval is based on agreed towage or voyage arrangements, which shall not be deviated from without good cause, and where practical with the prior agreement of GL Noble Denton.

14.2 PLANNING

14.2.1 Planning of the voyage or towage shall be carried out in accordance with the requirements of the IMO International Safety Management Code [Ref. 8].

14.3 ROUTEING

14.3.1 Routeing procedures shall be agreed with the Master prior to commencement of the towage or voyage, taking into account the transport vessel or tug's capacity and fuel consumption, the weather and current conditions and normal good navigation and seamanship.

14.3.2 Piracy in some areas, for instance South East Asia, is prevalent, and slow moving vessels or tows are particularly at risk. Maintaining sufficient distance from land throughout the tow will reduce this risk and also ensure there is sufficient sea room in case of emergency. Guidance on prevention of piracy may be found in IMO MSC/Circ.623 - Piracy and armed robbery against ships [Ref. 20].

14.4 WEATHER ROUTEING & FORECASTING

14.4.1 Weather forecasts for the departure area should be commenced at least 48 hours before the anticipated departure date. Whenever possible a second weather forecast should be obtained from a different independent source prior to departure.

14.4.2 For any towage, the weather conditions for departure from the departure port or any intermediate port or shelter area shall take into account the capabilities of the towing vessel, the marine characteristics of the tow, the forecast wind direction, any hazards close to the departure port or shelter area and the distance to the next port or shelter area. A suitable weather forecast may be one that predicts a minimum 48 hour period with winds not in excess of Beaufort Force 5 and a favourable outlook for a further 24 hours.

14.4.3 If appropriate, a weather routeing service, provided by a reputable company, should be arranged prior to the start of the towage or voyage. The utilisation of a weather routeing service may be a requirement of the approval. See also Section 6.3.2. In any event, every effort shall be made by the Master to obtain regular and suitable weather forecasts from a reputable source during the towage.

14.5 DEPARTURE

14.5.1 Prior to departure, a departure condition report for the tow or vessel shall be provided by the owners or their agents, for the Master and the GL Noble Denton surveyor. This report should contain as a minimum:

a. The documentation referred to in Section 5 as appropriate

b. Lightship weight

c. Tabulation and distribution of ballast, consumables, and cargo, including any hazardous materials

d. Calculated displacement and draughts

e. Actual draughts and displacement

f. For ships, a statement that the longitudinal bending and shear force are within the allowable seagoing limits

g. Calculated VCG

h. Calculated GM and confirmation that it is within allowable limits

i. GZ Curve and confirmation that it is within allowable limits.

14.5.2 Departure condition shall be verified to be satisfactory regarding the stability of the tow with proper allowance made for any slack tanks.

14.5.3 If no stability documentation is available then it may be necessary to perform an inclining experiment to check that the GM is satisfactory. Calculations may be needed to establish righting and overturning lever curves.

14.5.4 It shall be verified that the tow floats in a proper upright attitude and at a draught and trim appropriate to the calculated weight and centre of gravity.

14.5.5 The Certificate of Approval shall be issued on agreed readiness for departure and on receipt of a suitable weather forecast.

14.6 PORTS OF SHELTER, SHELTER AREAS, HOLDING AREAS

14.6.1 Ports of shelter, or shelter areas on or adjacent to the route, with available safe berths, mooring or holding areas, shall be agreed before departure and all necessary permissions obtained.

14.6.2 Where such shelter points are required as part of a weather-restricted operation, as described in Section 6.3, they shall be capable of entry in worsening weather.

14.7 BUNKERING

14.7.1 Bunkering ports, if required, shall be agreed before departure. If it is not practical to take the tow into port, then alternative arrangements must be agreed which may include:

a. Where the towage is by more than one tug, each tug in turn may be released to proceed to a nearby port for bunkers, subject to a favourable weather forecast. The remaining tug(s) should meet the requirements of Section 12.2, or some other agreed criterion.

b. Relief of the towing tug by another suitable tug, which itself is considered suitable to undertake the towage, so that the towing tug may proceed to a nearby port for bunkers.

c. Bunkering at sea from a visiting vessel, subject to suitable procedures and calm weather conditions.

14.7.2 Such procedures shall form part of the approved towage or voyage arrangements.

14.8 ASSISTING TUGS

14.8.1 Assisting tugs shall be engaged at commencement of the towage, at any intermediate bunkering port and at the arrival destination, as appropriate.

14.9 PILOTAGE

14.9.1 The Master shall engage local pilotage assistance during the towage or voyage, as appropriate.

14.10 LOG

14.10.1 A detailed log of events shall be maintained during the towage or voyage.

14.11 INSPECTIONS DURING THE TOWAGE OR VOYAGE

14.11.1 Unless the tow is manned, it should be boarded on a regular basis by the crew of the tug, particularly after a period of bad weather, in order to verify that all the towing arrangements, condition of the cargo, seafastenings and watertight integrity of the tow are satisfactory. Suitable access shall be provided - see Section 13.14.

14.11.2 For manned tows, and self propelled vessels, the above inspections should be carried out on a daily basis as relevant - see also Section 17.5.

14.11.3 Any adjustable seafastenings or lashings should be re-tensioned as necessary.

14.12 REDUCING EXCESSIVE MOVEMENT & THE SHIPPING OF WATER

14.12.1 The Master should take any necessary measures to reduce excessive movement or the shipping of water which may damage the cargo, cribbing or seafastenings. This may entail changes of course, or speed, or both.

14.13 NOTIFICATION

14.13.1 After departure of an approved towage or voyage, regular notification shall be sent to GL Noble Denton regarding progress, the reporting of any unusual or abnormal events, or necessary deviation from the agreed towing arrangements.

14.14 DIVERSIONS

14.14.1 Should any emergency situation arise during the towage or voyage which necessitates diversion to a port of refuge, then GL Noble Denton shall be advised. GL Noble Denton will review and advise on the validity of the existing Certificate of Approval for continuing the towage or voyage depending on the circumstances of the case. A further attendance at the port of refuge may be required in order to re-validate the Certificate of Approval.

14.15 RESPONSIBILITY

14.15.1 The Towmaster is responsible for the overall conduct of a tow, and towing arrangements during the towage.

14.15.2 If any special situations arise during the towage or voyage and it is not possible to comply with any specific recommendations, agreed procedures or International Regulations, then such measures as appropriate for the safety of life and property shall be taken. GL Noble Denton shall be informed as soon as practical of any such circumstances.

14.15.3 Nothing in this document shall set aside or limit the authority of the Master who remains solely responsible for his vessel during the voyage in accordance with maritime laws.

14.16 TUG CHANGE

14.16.1 The tug(s) approved for any towage, as noted on the Certificate of Approval, shall be the only tug(s) approved for that specific towage and should remain with the tow throughout the towage. Should it be required to change the tug(s) for any reason, except in emergency or where special arrangements have been agreed for bunkering, the replacement tug must be approved by GL Noble Denton and a new Certificate of Approval issued.

14.17 HAZARDOUS MATERIALS

14.17.1 Hazardous substances may be considered as materials which, when released in sufficient quantities or improperly handled, have the potential to cause damage to the asset, personnel or the environment through chemical means or combustion. Unless it is necessary the carriage of such materials should be avoided, unless it can be shown that the substances are effectively controlled. Stowage of such materials should take into account that the transportation may be unmanned and therefore remedial action in the case of inadvertent release will be limited.

14.17.2 The properties of such material should be contained in the COSHH (Control of Substances Hazardous to Health) data sheets and the recommended method of stowage and handling is found in the IMDG (International Maritime Dangerous Goods) Code.

14.17.3 Where identifiable hazardous material is found on board prior to a tow / transportation taking place, it should be controlled either through isolation or removal ashore.

14.18 BALLAST WATER

14.18.1 The IMO Ballast Water Convention of 2004 (Resolution A.868(20)) requires the monitoring and recording of ballasting and de-ballasting operations. Vessels flagged in signatory states are required to have on board and to implement a Ballast Water Management Plan. This plan is specific to each vessel and the record of ballast operations may be examined by the Port State Authorities.

14.18.2 Vessels may need to change ballast water before or at their arrival port for operational reasons (loading /discharging). There may be local laws that will have an impact on these activities. In the U.S.A. there are numerous state laws that cover these operations. Compliance with these rules may need to become part of the voyage planning.

14.18.3 The necessary ballast plan and records should be available for any attending surveyor.

14.19 RESTRICTED DEPTHS, HEIGHTS & MANOEUVRABILITY

14.19.1 The following recommended clearances are general, and each towage should be assessed on its own, taking into account

a. environmental conditions,

b. length of areas of restricted manoeuvrability,

c. any course changes within the areas of restricted manoeuvrability,

d. cross section of areas of restricted manoeuvrability in relation to underwater area/shape of the base structure, and

e. capability of the tugs.

14.19.2 The recommended values give guidance. If it can be proved that smaller values give the same or even better level of confidence these values should be taken.

14.19.3 For areas where the under-keel or side clearance is critical, a survey report that is not older than 3 months shall be available. If not, the tow route should be surveyed with a width of 5 times the beam, with a minimum of 500 metres. Side-scan sonar and bathymetric data should be provided. The equipment used should be of a recognized industry standard. The spacing between depth contour lines should be appropriate for the purpose. Current surveys should be made in restricted parts of the tow route.

14.19.4 The survey requirements can be relaxed if it can be shown that the on-board bathymetry measurement systems and position management systems have sufficiently high precision.

14.19.5 Ideally passages through areas of restricted manoeuvrability and passing under bridges and power cables should not take place in darkness.

14.20 UNDER-KEEL CLEARANCES

14.20.1 The under-keel clearance allowing for protrusions below the hull shall account for the effects of

a. Roll, pitch and initial heel and trim,

b. heave,

c. tow-line pull,

d. inclination due to wind,

e. tolerance on bathymetry,

f. changes in draught of the transport or towed object,

g. differences in water density,

h. low water tidal height variations,

i. squat effects,

j. deflections of the structure

k. errors in measurement, and 4

l. negative surge.

and shall include a margin of not less than the greater of one metre or ten percent of the maximum draught. The 10% may be reduced in very benign conditions after agreement with the GL Noble Denton office concerned.

14.20.2 Under-keel clearances for departure from dry-docks or building basins are covered in 0015/ND [Ref 3].

14.20.3 If sections of the passage are tidally dependent, safe holding areas should be identified in the vicinity with adequate sea room and water depth to keep the structure afloat at low tide, while maintaining the minimum under-keel clearance. Any delay time waiting for the tide must be included in the overall planning.

14.20.4 Immediately before critical sections of the passage the tidal level shall be confirmed by measurement.

14.20.5 Use of an air cushion to reduce draft to assist in crossing localised areas of restricted water depth may be considered subject to:

a. Any conceivable loss of air not increasing the draft by more than the reserve on underkeel clearance, and

b. The recommendations contained in 0015/ND [Ref 3] on air cushions.

14.21 AIR DRAUGHT

14.21.1 When passing under bridges and power cables, the overhead clearance shall be calculated allowing a margin of not less than one metre plus dimensional tolerances on the items listed in Section 14.20.1 excluding squat. Where clearance is limited then a dimensional survey of the barge/vessel and structure shall take place just prior to sailaway in order to ensure that the required clearance exists.

14.21.2 Power cables need a 'spark gap', as well as a physical clearance; the transmission company will have their own criteria on the minimum allowable clearance. It should be noted that the catenary of the power cable will change depending on the load being carried in the cable; the lowest position should be used.

14.21.3 The actual clearance shall be confirmed with all appropriate authorities including those responsible for the obstruction.

14.21.4 Immediately before the passage the tidal level shall be confirmed by measurement.

14.22 CHANNEL WIDTH & RESTRICTED MANOEUVRABILITY

14.22.1 The minimum channel width along any inshore legs of the tow route with the underkeel clearance and air draught required in Sections 14.20 and 14.21 should be three times the maximum width of the towed object after allowances for yaw. Additional channel width may be required in exposed areas, if there are significant cross currents or if needed for the tugs to manoeuvre safely.

14.22.2 Side clearances for departure from dry-docks or building basins are covered in 0015/ND [Ref 3].

15 PUMPING AND SOUNDING

15.1 GENERAL

15.1.1 Emergency-pumping arrangements should be available for any tow.

15.1.2 Pumps in accordance with this section are primarily required for barges. The need for, and specification of, pumps for other tows, including self-floating objects, MODUs, FPSOs and ships, will be assessed on a case-by-case basis, depending on the nature of the towage and the extent and availability of any installed system.

15.1.3 Some relaxation may be possible, agreed on a case-by-case basis, for a towage considered as a weather-restricted operation.

15.1.4 Whatever pumping system is agreed, and whether or not a tow is manned, the pumping system shall be available at short notice. Any time required for connection or warm-up should be included in the pumping times and capacities shown in Section 15.5.

15.1.5 Where a tow is not manned, then the tug master and chief engineer shall be aware of the available pumping system. Members of the tug crew shall be familiar with the systems, and be able to board the tow and run the pumps at short notice. Procedures for pumping shall be known and available, including any restrictions arising from considerations of stability or hull stresses, and any vents, which must be opened before pumping starts.

15.2 PURPOSE OF PUMPS

15.2.1 Pumps may be required for the following:

a. Ballasting before, during and after loadouts
b. Ballasting to the agreed departure condition
c. Restoration of draught and trim after discharge (especially at sea)
d. Deballasting to reduce draught to enter port
e. Damage control, including counterflooding
f. Deballasting after accidental grounding
g. Trimming to allow inspection and repair below normal waterline
h. Access to a flooded compartment (e.g. pump room, anchor winch room).

15.2.2 The use of a barge compressed air system may not be practicable for all these cases, especially if manhole covers have been removed, or the barge is holed above the waterline. A compressed air system should have a compressor on board and available, connected into the permanent lines.

15.2.3 It should be possible to sound and pump into or from critical compartments (defined in Section 15.3.2) in severe weather. The following shall be provided:

a. Pumping system
b. Watertight manholes
c. Portable coamings
d. Sounding plugs, extensions and tapes or rods. An additional remote sounding system may be needed for compressed air ballasting systems
e. Vents to all compartments.

15.3 PUMPING SYSTEM

15.3.1 It is recommended that barges have one of the following systems, able to pump into and from all critical spaces, in order of preference:

a. Two independent pumprooms or one protected pumproom, as described below

b. An unprotected pumproom with an independent emergency system that can pump out the pumproom

c. A system of portable pumps.

15.3.2 **A critical space** is defined as any tank or compartment which:

1. when flooded or emptied, at any stage of the voyage, may lead to:
   a. non compliance of intact or damage stability criteria, or
   b. non compliance of structural load limits, or
   c. heeling or trimming that may prevent the tow from continuing its passage safely and free from obstructions in shallow water, or
   d. maximum allowable transit draught being exceeded.
2. may be required for ballasting / de-ballasting so that the barge or vessel can safely continue her passage after any single compartment is damaged. 4

15.3.3 Independent pumprooms should have separate power supply, pumps, control and access. Each pumproom should be able to work into all spaces.

15.3.4 To be considered protected, a pumproom, and any compartment required for access, should be separated from the bottom plating by a watertight double bottom not less than 0.60 m deep and from the outer shell by other compartments or cofferdams not less than 1.5 metres wide.

15.4 PUMP TYPE

15.4.1 If portable pumps are used then either they should be portable enough to be moved around the barge (and cargo) by two men, or enough pumping equipment should be carried so that any critical compartment can be reached.

15.4.2 Each portable pump should be able to pump out from the deepest space (with portable coaming installed). This requires submersible pumps for barges over about 6 metres depth, due to suction head. Portable submersible pumps must be able to fit through tank manholes.

15.5 PUMP CAPACITY

15.5.1 The total capacity of the fixed or portable pumps should be such that any one wing space (or other critical tank or pumproom) can be emptied or filled in 4 hours for an unmanned tow, or 12 hours for a manned tow. At least two pumps shall be provided, except where there is a protected pump room.

15.5.2 Whatever type of pumps are fitted or supplied, sufficient fuel shall be carried for at least 72 hours continuous operation.

15.6 WATERTIGHT MANHOLES

15.6.1 If manholes to critical compartments are covered by cargo then either alternative manholes should be fitted, or cutting gear should be installed and positions marked for making access. Welding gear and materials shall be carried to restore watertight integrity.

15.6.2 Where the barge is classed, the owner should inform the classification society in good time of any holes to be cut or any structural alterations to be made.

15.6.3 Access shall always be available to pumprooms and other work areas.

15.6.4 Ladders to the tank bottom are required from each manhole position.

15.6.5 Suitable tools shall be provided for removal and refastening of manhole covers and sounding plugs. All manhole covers should be properly secured with bolts and gaskets, renewed as necessary.

15.6.6 Portable coamings to suit the manhole design should be carried, if required by Section 13.16.1.m.

15.7 SOUNDING PLUGS AND TAPES

15.7.1 For vessels or barges with compressed air ballast systems, gauges should be provided in lieu of sounding pipes.

15.7.2 A sounding plug shall be installed in each compartment (in manhole covers if necessary) to avoid removing manhole covers. Sounding tapes and chalk shall be carried on board the tow.

15.7.3 For spaces that will be sounded regularly, a tube and striker plate are recommended.

15.8 VENTS

15.8.1 All compartments connected to a pumping system should have vents fitted, preferably of an approved, automatic, self-closing type. If not automatic, then the vents should be sealed for towage with wooden bungs or steel blanks, but with a 6 mm diameter breather hole fitted. This will give audible warning or reduce pressure differentials in event of mishap, and compensate for temperature changes. The breather hole can be drilled into the gooseneck of the vent or through the wooden bung used to close the vent.

16 ANCHORS AND MOORING ARRANGEMENTS

16.1 EMERGENCY ANCHORS

16.1.1 Emergency anchors have traditionally been required to reduce the risk of a tow running aground if a towing vessel is disabled or a towline broken. However in many cases the disadvantages (described in Section E.4 of Appendix E) associated with using such anchors may outweigh the advantages.

16.1.2 If a tow passes through an area of restricted sea room, a comparative risk assessment should be performed to determine the preferred arrangements. Appendix E sets out topics to be taken into account in this risk assessment. One possible outcome may be the provision of suitably sized extra tugs in some sectors of the tow.

16.1.3 The same requirements apply for towed ships, including demolition towages. See Section 20.6. Where such towages may need to wait for a few days on arrival at the end of a voyage before documentation is completed then, if this is in a high-current area, anchoring or mooring arrangements may be required.

16.1.4 For self-elevating platforms, see also Section 19.16.

16.2 SIZE AND TYPE OF ANCHOR

16.2.1 For classed vessels and barges, the anchor(s) fitted in accordance with Class requirements will generally be acceptable unless there is deck cargo.

16.2.2 In other cases the minimum weight of the emergency anchor should be 1/10 of the towline pull required (TPR) for the tow, as defined in Section 12.2. A high holding power anchor with anti-roll stabilisation is preferred.

16.3 ANCHOR CABLE LENGTH

16.3.1 The normal minimum effective length of anchor cable required is 180 metres, preferably mounted on a winch. If the cable runs through a spurling pipe, or other access, to storage below decks, then the pipe or access should be capable of being made watertight.

16.4 ANCHOR CABLE STRENGTH

16.4.1 For cable on a winch, or capstan, which can be paid out under control, the minimum breaking load of the cable should be 15 times the weight of the anchor, or 1.5 times the holding power of the anchor if greater.

16.4.2 For cable flaked out on deck, the minimum breaking load of the cable should be 20 times the weight of the anchor, or twice the holding power if greater, to allow for the extra shock load.

16.4.3 The last few flakes of cable on deck should have lashings that will break and slow down the cable before it is fully paid out.

16.5 ATTACHMENT OF CABLE

16.5.1 The inboard end of the cable should be led through a capped fairlead near the barge centre line and be securely fixed to the barge. Precautions should be taken to minimise chafe of the cable.

16.5.2 The breaking load of the connections of the cable to padeye or winch, and padeye or winch to the barge structure should be greater than that of the cable.

16.5.3 For towed ships, and tows with similar arrangements, the anchor cable(s) shall be properly secured, with the windlass brake(s) applied. Any additional chain stopper arrangements that are fitted shall be utilised, or alternatively, removable preventer wires should be deployed.

16.5.4 Spurling pipes into chain lockers should be made watertight with cement plugs, or another satisfactory method.

16.6 ANCHOR MOUNTING AND RELEASE

16.6.1 If there is no suitable permanent anchor housing the anchor should be mounted on a billboard, as shown in Appendix D, at about 60 degrees to the horizontal.

16.6.2 The anchor should be held on the billboard in stops to prevent lateral and upwards movement. It should be secured by wire rope and/or chain strops that can be easily released manually without endangering the operator.

16.6.3 The billboard should normally be mounted on the stern. It should be positioned such that on release the anchor will drop clear of the barge and the cable will pay out without fouling.

16.6.4 For any system, it shall be possible to release the anchor safely, without the use of power to release pawls or dog securing devices. If the anchor is held only on a brake, an additional manual quick release fastening should be fitted.

16.6.5 The anchor arrangement should be capable of release by one person. Adequate access shall be made available.

16.7 MOORING ARRANGEMENTS

16.7.1 All vessels and floating objects should be provided with at least four mooring positions (bollards / staghorns etc.) on each side of the barge unless it is impracticable to moor them, e.g. because of draught limitations.

16.7.2 If fairleads to the bollards are not installed then the bollards should preferably be provided with capping bars, horns, or head plate to retain the mooring lines at high angles of pull. Suitable chafe protection should be fitted as required e.g. to the deck edge for low angles of pull.

16.7.3 At least four mooring ropes in good condition of adequate strength and length, typically about 50-75 mm diameter polyprop or nylon, and each 60-90 metres long, should be provided.

16.7.4 Mooring ropes should be stowed in a protected but accessible position.

16.7.5 Objects with very large freeboard such as FPSOs may advantageously be fitted with mooring and towing connection points along the side, at a convenient height above the towage waterline. These may provide a more convenient connection for mooring lines and harbour tugs than bollards at deck level. Care should be taken that the connection points cannot damage, or be damaged by, attending vessels.

17 MANNED TOWS AND TRANSPORTATIONS

17.1 GENERAL

17.1.1 Manning of tows should generally be limited to those where early intervention by a riding crew can be shown to reduce the risks to the tow, for example tows of MODUs, passenger ships and Ro-Ro vessels.

17.1.2 Where a riding crew is carried on a tow for commissioning and/or maintenance, sufficient marine personnel shall be included to operate the equipment listed in Section 17.4 and to carry out the duties in Section 17.5. A riding crew may be carried on an FPSO for similar reasons.

17.1.3 There is sometimes a requirement for a riding crew on a dry transportation to maintain or commission systems or to carry out general maintenance. Riding crew carried on any dry transportation must be within the carrying vessel's Flag State limits for life saving appliances; any exceedance of the Flag State limit must be approved by the Flag State in advance.

17.1.4 GL Noble Denton will only be able to approve the transport with respect to the riding crew when the documented flag state approval for the proposed number of riding crew has been seen. The transportation contractor is therefore advised to obtain this Flag State approval in good time. The underwriters should also be informed if a large riding crew is proposed.

17.1.5 The health and safety of the riding crew shall be assured at all times.

17.1.6 A risk assessment shall be carried out to demonstrate the acceptability of the proposed arrangements.

17.2 INTERNATIONAL REGULATIONS

17.2.1 Accommodation, consumables, lifesaving appliances, pumping arrangements and communication facilities with the tug shall comply with International Regulations.

17.3 RIDING CREW CARRIED ON THE CARGO

17.3.1 Where a riding crew is carried on the cargo, for instance a maintenance crew on a dry-transported jack-up rig, the total number of persons on board may exceed the capacity of the vessel or barge. Subject to Flag State approval (see Section 17.1.3) this may be permissible. Additional precautions which may be necessary include:

a. Access to/from the cargo /rig forward and aft, and to the liferaft launching area

b. The cargo /rig's liferafts and lifeboats should be relocated and the falls lengthened, if necessary, so that on launching they will land in the water.

c. A firewater supply should be made available to the cargo /rig.

d. The cargo /rig's and vessel's alarm systems should be linked, so that an alarm on the cargo /rig is repeated on the vessel, and vice versa.

17.4 SAFETY AND EMERGENCY EQUIPMENT

17.4.1 Notwithstanding the requirements of SOLAS and any or all international regulations for Life Saving Appliances and Fire Fighting Equipment, the minimum complement of safety and emergency equipment carried aboard the tow shall be as follows:

a. Certified liferafts located on each side of the tow, clear of any possible wave action, provided with means of launching and fitted with hydrostatic releases. The liferaft or liferafts on each side of the tow shall be capable of taking the full crew complement. Adequate means of access to the water shall be provided

b. 4 lifebuoys, two located on each side of the tow and including two fitted with self igniting lights and two with a buoyant line

c. Approved life jackets to be provided for each crew member plus 25% reserve

d. If appropriate, a survival suit to be provided for each crew member

e. First aid kit

f. Fire fighting equipment, which may consist of an independently powered fire pump with adequate hoses, and portable fire extinguishers as appropriate.

g. 6 parachute distress rockets and 6 hand held flares

h. A daylight signalling lamp and battery

i. 2 portable VHF radios, fitted with all marine VHF channels, with appropriate battery charging equipment

j. Hand held GPS (Global Positioning System) receiver

k. GMDSS radio (Global Maritime Distress and Safety System)

l. Charts covering the route

m. An EPIRB (Emergency Position Indicating Radio Beacon) emergency transmitter

n. 2 SARTs (Search and Rescue Radar Transponder)

o. Heaving line(s) and/or line throwing apparatus if appropriate.

17.4.2 All members of the riding crew shall be adequately trained in the use of the safety equipment. At least 1 crew member shall possess the appropriate radio operator's licences.

17.5 MANNED ROUTINE

17.5.1 The riding crew shall take the following actions during the towage:

a. Maintain a daily log and include all significant events

b. Inspect towing arrangements and navigation lights

c. Inspect all seafastenings and any other accessible, critical structures

d. Tension any adjustable seafastenings or lashings as necessary

e. Check soundings of all bilges and spaces

f. Monitor any unexpected or unexplained ingress of water

g. Pump out any ingress of water

h. Maintain regular contact by radio with the tug, reporting any abnormalities.

18 MULTIPLE TOWAGES

18.1 DEFINITIONS

18.1.1 This section expands on the definitions in Section 3 for **multiple towages**:

18.1.2 **Double tow** – 2 tows each connected to the same tug with separate towlines. One towline is of sufficient length that the catenary to the second vessel is below that of the first.

18.1.3 **Tandem tow** – 2 (or more) tows in series behind 1 tug, i.e. the second and following tows connected to the stern of the previous one.

18.1.4 **Parallel tow** – the method of towing 2 (or more) tows, using one tow wire, where the second (or subsequent) tow(s) is connected to a point on the tow wire ahead of the preceding tow, and with each subsequent towing pennant passing beneath the preceding tow.

18.1.5 **Two tugs (in series) towing one tow** – where there is only 1 towline connected to the tow and the leading tug is connected to the bow of the second tug.

18.1.6 **More than 1 tug (in parallel) towing one tow** – each tug connected by its own towline, pennant or bridle to the tow.

18.2 GENERAL

18.2.1 Compared with single towages, multiple towages have additional associated problems including those of:

a. Manoeuvring in close quarter situations

b. Reconnecting the towlines after a breakage

c. Maintaining sufficient water depth for the longer and deeper catenaries required.

18.2.2 With the exception of the cases described in Section 18.1.6, multiple towages may only be approvable in certain configurations, areas and seasons, and subject to a risk assessment.

18.2.3 When approval is sought, then full details of the operation, including detailed drawings, procedures and equipment specifications shall be submitted to GL Noble Denton for review and comment. An initial assessment of the method will then be made, and if the basic philosophy is sound, recommendations may be made for the approval process to continue.

18.2.4 Approval may be rejected if any doubt exists as to the viability of the operation proposed.

18.2.5 For those multiple towages that are approvable, each tow shall be prepared as described in these Guidelines.

18.2.6 Additional factors may be applied to the towing arrangements, so that the probability of breakage is further reduced.

18.2.7 The bollard pull requirement of the tug shall be according to the number and configuration of the tows connected. The Towline Pull Required (TPR) should be the sum of those required for each tow. The towing arrangements on each tow shall have sufficient capacity for the Bollard Pull (BP) of the tug(s).

18.2.8 The tug shall be equipped as in Ref. [5], although additional or stronger equipment and longer towlines may be necessary. Where longer towlines are required, these may be formed by the utilisation of pennant wires of no less Ultimate Load Capacity than the main tow wires.

18.2.9 Where the towing configuration requires the use of 2 towlines from 1 tug, a third tow wire shall be carried on board the tug, stowed in a protected position, whence it can be **safely** transferred at sea to either towing winch.

18.2.10 It may be necessary to include (surge) chain or a stretcher to improve the spring, or to provide the required catenary in any towing arrangement.

18.2.11 If a synthetic stretcher is included in any towing arrangement, it shall comply with Section 13.9. A spare stretcher shall be carried aboard the tug for each stretcher utilised in the towing arrangement.

18.2.12 Multiple tows being towed behind a single tug may yaw in different directions. Special arrangements shall be made on the deck of the tug to separate the towlines.

18.2.13 It is particularly difficult to reconnect to a tow that has broken loose when another tow or tows are connected to the same tug. Special procedures must be agreed for reconnection.

18.2.14 Due to the difficulties that will be encountered if a towline breakage should occur, GL Noble Denton may recommend a higher total number of crew on the tug.

18.3 DOUBLE TOWS

18.3.1 These are usually only considered as acceptable:

a. In benign areas

b. For short duration towages covered by good weather forecasts

c. Where there is sufficient water depth along the tow route to allow for the catenary required for the second tow.

18.3.2 The tug should be connected to each tow with a separate towline on a separate winch drum. It shall also carry a spare towline, stowed on a winch, or capable of being spooled onto a winch at sea.

18.4 TANDEM TOWS

18.4.1 These are normally only acceptable in very benign areas or in ice conditions where the towed barges will follow each other.

18.4.2 In ice conditions the towlines between tug and lead tow and between tows will normally be short enough for the line to be clear of the water. Care must be taken to avoid tows over-running each other, or the tug.

18.5 PARALLEL TOWS

18.5.1 This method is generally only approvable in extremely benign areas, and may be subject to additional safety factors with respect to the capacity of the towing arrangements.

18.6 TWO TUGS (IN SERIES) TOWING ONE TOW

18.6.1 This is usually only feasible when a small tug is connected to the bow of a larger, less manoeuvrable tug to improve steering.

18.6.2 This configuration is generally only acceptable if:

a. All the towing gear (towline/pennants/bridles/connections etc.) between the second tug and the tow is strong enough for the total combined bollard pull

b. The second tug is significantly heavier than the leading tug (to avoid girding the second tug).

18.7 MULTIPLE TUGS TO ONE TOW

18.7.1 This is generally considered acceptable, provided that each tug has a separate towline to the vessel (via bridles or pennants as required). Care must be taken that the tugs do not foul each other or their towing equipment.

18.7.2 Consideration should be given to matching the size and power of the tugs.

18.7.3 The use of eccentric bridles may be advantageous but care must be taken to avoid chafe.

18.7.4 Normally there will not be more than 3 tugs, except for the towage of very large objects, such as FPSOs and concrete gravity structures.

19 SPECIAL CONSIDERATIONS FOR THE TRANSPORT OF JACK-UPS

19.1 GENERAL

19.1.1 This Section is intended to cover the special requirements of jack-up platforms, not covered by other sections. The terms 24-hour move, location move, ocean towage and ocean transportation have the meanings shown in Section 3.

19.1.2 Reference [24] – "UKOOA Guidelines for Safe Movement of Self-Elevating Offshore Installations" and Reference [25] "The Safe Approach, Set-Up And Departure of Jack-Up Rigs to Fixed Installations" describe good practice for jack-up moves within the North Sea and many of these practices can be usefully followed in other areas.

19.2 MOTION RESPONSES

19.2.1 The motion responses for towage of a jack-up on its own hull, or for transport on a barge or vessel, may be derived from Section 7, either by calculation, from the standard motion criteria in Section 7.9, or by model tests.

19.3 LOADINGS

19.3.1 Loads in legs, guides, jack-houses and jack-house connections into the hull, as appropriate, shall be derived in accordance with one of the methods set out in Section 8.

19.3.2 For jack-ups transported on a barge or vessel, the loads in cribbing and seafastenings shall be similarly derived in accordance with Section 8.

19.4 HULL STRENGTH

19.4.1 For units transported on their own buoyancy, either the hull shall be built to the requirements of a recognised Classification Society, and be in Class or verified to comply with Class building and inspection requirements. Otherwise the requirements of Section 19.4.2 through 19.4.5 shall apply.

19.4.2 If not in Class, the hull shall be demonstrated to be capable of withstanding the following loadings:

a. Static loading, afloat in still water, with all equipment, variable load and legs in towage position, plus either:

b. Longitudinal or transverse bending, as derived from Section 19.4.3, or

c. Loads imposed on the hull and guide support structures by the legs, when subjected to the agreed motion criteria.

19.4.3 Longitudinal and transverse bending may be derived by quasi-static methods, assuming a wave length, L_w, equal to the unit's length or beam, and height:

$$H_w = 0.61\sqrt{L_w},$$

where L_w is in metres.

19.4.4 External plating shall be demonstrated to have adequate strength to withstand the hydrostatic loads due to the immersion of the section of shell plating considered, to a depth equivalent to that which would be caused by inclining the hull, in towage condition, to the static angle equal to the amplitude of motion as considered in Section 7.9.1.

19.4.5 Hull and superstructure construction, details, materials and workmanship shall be shown to be in accordance with sound marine practice, and shall be in sound condition.

19.5 STRESS LEVELS

19.5.1 Stress levels in legs, guides, jack-houses, hull and all temporary securing arrangements shall comply with Section 9.5. The hull in way of seafastenings to a barge or transportation vessel shall also be checked to comply with Section 9.5. See also the caution for dry transportations in Section 9.1.4.

19.5.2 A critical motion curve may be drawn up, or provided in the Operations Manual, reflecting the motion limits for the legs or any other component. This may be used as a guide during the towage or voyage, indicating whether course or speed should be changed, or the legs lowered, as appropriate.

19.5.3 Prior to an ocean transportation of a jack-up, an inspection programme, including non-destructive testing, for critical structural areas shall be implemented. Typically, this should include, as appropriate, the areas of legs from just below the lower guides to 2 bays above the upper guides, with the legs in any proposed transport condition. It should also include the guide connections, the jack-house connections to the deck and connections of the spudcans to the leg chords.

19.5.4 The exclusion stated in Section 4.6.7 regarding fatigue damage should be noted. Local areas of jack-up platforms may be particularly prone to fatigue damage. The effects of fatigue damage will be excluded from any Certificate of Approval issued by GL Noble Denton unless specific instructions are received from the client.

19.6 STABILITY AND WATERTIGHT INTEGRITY

19.6.1 For units transported on their own buoyancy, the following shall apply:

a. The intact stability requirements set out in Sections 10.1 and 10.3.

b. The damage stability requirements of Sections 10.2 and 10.3.

19.6.2 For ocean towages, the compartmentation and watertight integrity requirements of Section 10.5 shall be particularly addressed. Engine room intake vents and exhausts, shall comply with Section 10.5.2. Other special considerations for jack-ups include:

a. All compartments and their vents, intakes, exhausts and any other appurtenances or openings shall be effectively watertight up to the waterline associated with the minimum required downflooding angle (see Section 10.5.2), or 3 m above main deck level, whichever is the higher.

b. All compartments and their vents, intakes, exhausts and any other appurtenances or openings shall be structurally capable of withstanding hydrostatic pressure due to inclination to the minimum required downflooding angle, and direct loadings from green water.

c. All air intakes and exhausts for equipment that must be kept running and/or which must be available for emergency use must extend above the waterline associated with the minimum required downflooding angle, or 3 m above main deck level, whichever is the higher.

d. Any jetting lines and pumping nipples in lines shall be checked closed and watertight before departure.

e. All pre-load dump valves shall be closed and secured.

f. Mud return lines from shale shaker pumps etc, leading below main deck, shall be blanked off.

g. Dump valves in mud pits shall be checked closed secured.

h. Overboard discharges shall be blanked off, or fitted with non-return valves.

19.6.3 For all towages, liquid variable loads shall be minimised and shall be in pressed up tanks where possible.

19.6.4 Free surface in the mud pits is not generally acceptable, except for very short 24-hour moves in controlled conditions.

19.6.5 Free surface effects of all remaining liquid variables, except those in pressed up tanks, shall be taken into account in the stability calculations.

19.6.6 Stability calculations shall accurately reflect the position and buoyancy of the spud cans. Spud can water shall be taken into account in weight and centre of gravity calculations, where appropriate.

19.7 TUGS, TOWLINES AND TOWING CONNECTIONS

19.7.1 Tugs shall be selected in general accordance with Section 12, using the categories required in Section 4 of 0021/ND - Ref [5] as applicable to:

a. ocean towages

b. 24-hour or location moves.

19.7.2 The particular requirements for manoeuvring on and off location may be taken into account when selecting the towing fleet, unless additional tugs are used for manoeuvring. Similarly additional tugs may be required when in congested waters or when approaching a lee shore when there may not be sufficient time to reconnect a tug after a broken towline or breakdown in the forecast weather conditions.

19.7.3 Towlines and towing connections shall, as a minimum, be in accordance with Section 13. The cautions in Section 13.2.8 (for vertical loads) and 13.2.9 (for larger tugs) should be noted.

19.8 SECURING OF LEGS

19.8.1 For ocean transportations, legs shall be properly secured against excessive horizontal movement by means of shimming in the upper and lower guides, or by means of an approved locking device. Shim material specification should take into account the pressures expected, particularly for units with guides having a small contact area.

19.8.2 For 24-hour and location moves, leg position and securing arrangements shall be agreed, and shall comply with designers' recommendations.

19.8.3 For electric jacking systems, all motors should be checked for torque and equalised in accordance with manufacturers' instructions.

19.8.4 Hydraulic and pneumatic jacking systems shall be secured in accordance with manufacturers' recommendations.

19.8.5 For jacking systems fitted with elastomeric pads, clearances should be shimmed or preload applied in accordance with the manufacturer's specifications.

19.8.6 For tilt-leg jacking systems, tie bars shall be fitted to by-pass the tilt mechanism.

19.8.7 Where lowering of legs or jacking on a standby location is envisaged during the towage, then any leg securing arrangements shall be quickly removable.

19.8.8 Where a critical motion curve, or equivalent limitation, is provided for the legs, it may be necessary to lower the legs in order to comply. Instructions and limitations for this operation shall be clearly defined in the Operations Manual, taking into account any lesser motion limitation during the lowering operation. The lowering operation shall be carried out well before the onset of forecast bad weather.

19.9 DRILLING DERRICK, SUBSTRUCTURE AND CANTILEVER

19.9.1 The drilling derrick, substructure and cantilever shall be shown to be capable of withstanding the motions as derived from Sections 7 and 19.2. For 24-hour and location moves the crown block may be left in place. For ocean transportations the derrick shall be considered in the condition proposed for transportation, with the crown block lowered if required. Other machinery and equipment are to be similarly considered.

19.9.2 For ocean transportations and location moves, no setback shall be carried.

19.9.3 For 24-hour moves, towage with setback in the derrick may be considered, provided it can be demonstrated that all of the following apply:

a. The derrick, with the setback proposed and after suitable allowance for wear, corrosion or fatigue, can withstand the motion criteria derived from Section 19.2.

b. All pipe, collars and other equipment racked in the derrick are secured to meet the same criteria.

c. The seabed conditions at the arrival location are confirmed as presenting virtually zero risk of a punch-through.

d. The stability of the unit can meet the requirements of Section 19.6.

e. The carriage of setback in the derrick is clearly documented. The limitations thereof, the securing method, and any special precautions shall be clearly stated.

19.9.4 For ocean transportations the travelling block and/or topdrive should be lowered and secured. The drill line should be tightened, and secured against movement.

19.9.5 The cantilever and substructure shall be skidded to their approved positions for tow, and secured in accordance with manufacturers' recommendations.

19.10 HELIDECK

19.10.1 For ocean towages, it shall be shown that at an inclination in still water of 20 degrees about any horizontal axis, no part of the helideck plating or framing is immersed.

19.10.2 Alternatively, model tests may be used to demonstrate that the helideck remains at least 1.5 m clear of wave action, in any seastate up to the design seastate as defined in Section 6.

19.10.3 If neither Section 19.10.1 nor 19.10.2 can be satisfied, then all or part of the helideck shall be removed for the towage.

19.11 SECURING OF EQUIPMENT AND SOLID VARIABLE LOAD

19.11.1 Weight of equipment variable load carried on board shall not exceed the maximum variable load allowed for jacking.

19.11.2 All items of equipment above and below decks shall be secured to resist the motions indicated in Sections 7 and 19.2.

19.11.3 For 24-hour and location moves, drill pipe, collars and other tubulars shall be properly stowed on the pipe deck and in the bays provided with stanchions erected. Chain lashings over each stack shall be used. See also Section 9.6.

19.11.4 For ocean transportations, drill pipe, collars and other tubulars shall be stowed in the piperacks, to a height above the rack beams of no more than 1.8 metres. Drill pipes should normally be stowed on top of collars. Timber battens should be placed between each layer of pipe. See also Section 9.6.

19.11.5 For ocean transportations, the well logging unit shall be secured in position and stops fitted to prevent rotation.

19.11.6 All crane and lifting derrick booms shall be laid in secure boom rests. For ocean transportations, the booms should be shimmed or wedged against transverse and vertical movements, but left free to move axially. Fitted brake systems for prevention of crane rotation shall be implemented. Electric power shall be isolated at the main switchboard. Cranes shall not be used at sea except in an emergency.

19.11.7 Deepwell and leg well pumps shall be fully raised and secured.

19.12 SPUD CANS

19.12.1 For 24-hour and location moves, the spud cans should normally be full. See also Section 19.6.6 for stability calculations.

19.12.2 For ocean towages, the spud cans may be full or empty. See also Section 19.6.6. If empty, and if the towage procedures call for lowering of legs (see Section 19.8.7), then the lowering procedures must include procedures for filling the spud cans.

19.12.3 For dry transports, the spud cans should be empty and vented. Safety notices should be posted at each spudcan, and at the control panel.

19.13 PUMPING ARRANGEMENTS

19.13.1 For units transported on their own buoyancy, the general pumping requirements of Section 15 shall apply. The requirements of Sections 19.13.2 and 19.13.3 shall also apply.

19.13.2 All spaces should be capable of being pumped by the unit's own pumping systems. Sufficient generator capacity should be available to operate bilge and ballast systems simultaneously.

19.13.3 Additionally for ocean towages, 2 no x 3 inch portable, self-contained, self-priming salvage pumps shall be on board, with not less than 30 metres each of suction and delivery hose.

19.14 MANNING

19.14.1 Units transported on their own buoyancy should usually be manned, and the general manning requirements of Section 17 shall apply.

19.14.2 Units transported on a barge or vessel need not be manned. However, it may be advantageous for person(s) familiar with the unit's structure, machinery and systems to be on board the tug or the transport vessel, and to inspect the unit periodically.

19.15 PROTECTION OF MACHINERY

19.15.1 Where practical, and where the unit is manned, main and auxiliary machinery should be run periodically during the transportation.

19.15.2 For ocean transportation, electrical equipment which cannot be run, including motors, switchgear and junction boxes, should have dehumidifying chemicals placed inside, and then be wrapped against wetting damage. Heaters, where fitted, should be run periodically.

19.16 ANCHORS

19.16.1 The general emergency anchor /risk assessment requirements of Section 16 shall apply.

19.16.2 For ocean towages where anchors are fitted, the forward anchors should normally be removed, and secured on deck. The aft anchors should be left in place and stopped on the racks to prevent lateral movement. A retaining wire tightened by a turnbuckle and incorporating a quick-release system should be passed through the anchor shackle and secured on deck. The turnbuckle and quick-release system shall be on deck and accessible.

19.17 SAFETY EQUIPMENT

19.17.1 For towages on a unit's own buoyancy, safety equipment in accordance with SOLAS and any or all regulations for Life Saving Appliances and Fire Fighting Equipment shall be carried. Consideration should be given to any additional safety and emergency equipment listed in Section 17.4.1.

19.17.2 For ocean towages, it may be necessary to relocate liferafts stowed forward or overboard to a secure area protected from wave action. Securing arrangements for liferafts stowed aft should be checked.

19.18 CONTINGENCY STAND-BY LOCATIONS

19.18.1 Where the towing arrangements envisage jacking up at any intermediate location, suitable procedures shall be written to cover location feasibility, preloading requirements, airgap requirements, local clearances and Customs formalities etc.

20 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF SHIPS

20.1 GENERAL CONSIDERATIONS

20.1.1 This Section sets out the technical and marine aspects, which would be considered by GL Noble Denton for approval of the towage of ships, including demolition towages and as appropriate, towages of FPSOs.

20.1.2 It is recognised that all ships are different and these guidelines are therefore general in nature. Each specific approval depends on a survey to identify any particular problems which may exist for the vessel(s) in question.

20.1.3 It is preferred that any towed vessel should be in Class with a recognised Classification Society, and possess a current Load Line or Load Line Exemption Certificate. It is recognised that for demolition towages, the Class and other documentation may have expired, and renewal may be impractical. Minimum certification and documentation requirements are shown in Section 5.

20.1.4 The existence of current classification and certification will be taken into account when determining the extent of survey required.

20.1.5 After carrying out an inspection, and in order to verify that the structural strength and watertight integrity of the tow is approvable for the intended voyage, the attending surveyor may require one or more of the following:

a. An extended, in depth, survey of the vessel structure involving one or more specialist surveyor(s). Facilities for close-up survey of inaccessible parts of the hull structure may be required.

b. Thickness determination (gauging) of specified areas of the vessel structure. This survey may be in limited areas or extend over large parts of the hull structure. Such surveys shall be carried out by a reputable independent company. An existing survey report may be acceptable provided that it is not more than 1 year old, and there is no evidence of damage or significant deterioration since that date.

c. A GL Noble Denton review of classification society approved scantling drawings.

d. Calculations to show that the structural strength of particular local areas of the vessel is adequate. The extent of the calculation required to be determined by the results of the surveys.

20.1.6 Should any doubt exist as to the ability of the vessel to complete the proposed towage, after all the necessary surveys and calculations have been undertaken, a dry dock survey of the vessel may be necessary.

20.1.7 After complying with the requirements of Sections 20.1.2 through 20.1.6 above, GL Noble Denton may deem that the vessel is unfit for tow and decline to issue a Certificate of Approval. Alternatively the vessel may only be considered fit for tow after specified repairs or temporary strengthening have been carried out.

20.1.8 The towage of any vessel which is damaged below the waterline, is suspected of being damaged below the waterline or has suffered other damage or deterioration which could affect the structural strength will not normally be approved except where it is clearly shown by survey and calculation that the strength of the vessel and its watertight integrity is satisfactory for the intended towage.

20.1.9 Passenger ships and warships, because of the complex nature of their systems, pose particular problems with respect to their compartmentation, and require special consideration. Ro-Ro ships may also pose particular problems, on account of the potentially large free surface in the event of flooding. Passenger ships and Ro-Ro ships will generally only be approved for towage if the tow is manned, to permit early intervention in the event of any problems.

20.1.10 Any heavy fuel oil within the tanks of the vessel must be identified, and shall be minimised where possible. In the event of heavy fuel oil being carried, possible limitations on entry to ports of refuge and ports of shelter shall be noted and taken into account in the towage procedures. To minimise the risk of pollution, the requirements of the IMO "Guidelines for Safe Ocean Towing" [Ref. 21], paragraph 13.19, shall be taken into account so far as is practical.

20.1.11 These guidelines assume that the tow will be towed from its forward end or bow. If a stern-first towage is required (see Section 13.1.2) then approval may be given and the basic guidance contained in this report is valid. In this case, and depending on the circumstances, special care shall be taken regarding towing connections, draught, trim and the control and protection of the tow during the towage.

20.2 TUG SELECTION

20.2.1 Tug selection, including specification and bollard pull, shall be in accordance with Section 12.

20.3 TOWLINES AND TOWING CONNECTIONS

20.3.1 Each ship or vessel towage is unique and it is therefore not possible to specify the connection equipment to be used and how it is to be attached for every case. The guidelines hereunder are therefore general in nature. In any event, any equipment used for the towage must be fit for purpose and must be agreed between the Owner of the tow, the tug master and the GL Noble Denton surveyor.

20.3.2 Towlines, towline connections, recovery systems and emergency towing gear shall be in general accordance with Sections 13.1 through 13.12.

20.3.3 Unless the tow has been fitted with proper towing brackets, or the anchor chain and windlass are used, it may be necessary to utilise attachments such as mooring bitts to connect to the tow. In such cases it shall be shown that the mooring equipment has sufficient ultimate strength, above and below deck, to comply with Section 13.2.1. If necessary, reinforcements shall be fitted to achieve the required capacity, otherwise alternative arrangements must be made.

20.3.4 The configuration of the attachments to the tow may be one of the following depending on the circumstances and equipment available:

a. Chain bridle with bridle leg from each side of the bow

b. Single chain from centre line location or forward fairlead

c. Anchor chain(s) from vessel's hawse pipe(s)

d. Single continuous chain with the ends extending out from each bow

e. Single continuous chain, or chain and wire combination, around a part of, or the whole superstructure of the vessel.

20.3.5 Chain may be substituted by wire rope of the required ultimate load capacity, but only where chafe cannot occur.

20.3.6 Chafe of chain or wire may occur when unsuitable fairleads have to be used, or the tow yaws significantly. In these cases, consideration should be given to providing oversize chain or wire.

20.3.7 A bridle is most suitable for tows which have a wide bow. In any event the angle at the apex of the bridle should not exceed 60º. A triangle plate, delta plate or towing ring shall be fitted at the apex of the bridle.

20.3.8 For tows which have a sharp bow configuration a single chain pennant passing through a bow centre line or forward fairlead may be preferred.

20.3.9 If deemed appropriate an anchor chain from the tow may be used after removal of the associated anchor. The condition and capacity of the chain shall be assessed with reference to Section 13.2. If such a method is utilised then appropriate safety measures shall be applied as follows:

a. Windlass in gear

b. Windlass brake applied

c. Chain claw or stopper deployed

d. Back-up wire to connect chain to base of windlass or other suitable securing point.

20.3.10 A single chain passing through one side fairlead, around a strongpoint such as the windlass base and out of a fairlead on the other side may be approvable. An alternative arrangement may consist of a single chain passing up one hawse pipe and out of the other. In either case the outboard ends should be made up into a bridle. Each leg should have preventers on the inboard side to stop the chain sliding and it should not interfere with the vessel's emergency anchoring arrangements.

20.3.11 On a vessel which is not provided with suitable attachments, or where the anchoring arrangements do not permit the single chain method described above, a chain, or a combination of chain and wire may be positioned around a part of, or the whole superstructure of the vessel and made up into a bridle at the bow.

20.3.12 Where mooring bitts are utilised to secure chain to the tow, and in order to ensure that the towing arrangement is securely anchored on the vessel and does not slip on the bitts, the chain should be backed-up to further bitts abaft the main connection points using suitable wire pennants locked into position with clips. If such an arrangement is used then the first bitts used must have the required ultimate capacity, unless positive load-sharing can be achieved. Bitts and fairleads shall be capped with welded bars or plates of sufficient strength to prevent equipment jumping off or out of the arrangement.

20.4 STABILITY, DRAUGHT AND TRIM

20.4.1 Stability, draught and trim shall be in accordance with Sections 10.1 through 10.4.

20.5 COMPARTMENTATION AND WATERTIGHT INTEGRITY

20.5.1 Compartmentation and watertight integrity shall be in accordance with Section 10.5.

20.6 ANCHORS

20.6.1 An emergency anchor shall be provided if required as a result of the risk assessment described in Section 16.1 and appropriate access afforded for deployment by one person.

20.6.2 Port and starboard anchor cables shall be properly secured with the windlass brake applied. Any additional chain stopper arrangements that are fitted shall be utilised or, alternatively, removable preventer wires shall be deployed.

20.6.3 Spurling pipes into chain lockers shall be made watertight with cement plugs or other satisfactory method.

20.7 SECURING OF EQUIPMENT AND MOVEABLE ITEMS

20.7.1 In general, all equipment shall be secured to meet the appropriate motion requirements of Section 7, and seafastenings of loose items designed in accordance with Sections 8 and 9.

20.7.2 See Section 19.11.6 for securing and use of cranes and lifting derricks.

20.7.3 The rudder shall be positioned in the amidships position, or as agreed with the Tug Master, and immobilised.

20.7.4 The propeller shaft shall be immobilised, or disconnected, to prevent damage to machinery during the towage.

20.7.5 Every effort shall be made to limit the carriage of any loose deck equipment to an absolute minimum. Where equipment must be carried on an exposed deck then it shall be protected and secured against movement using welded brackets, chain or wire. Equipment in other areas shall also be secured.

20.7.6 For large equipment, engineering calculations shall be carried out in order to verify that the securing of items is satisfactory.

20.7.7 Additional protection or securing may be required for equipment exposed to wave slam.

20.8 EMERGENCY PUMPING

20.8.1 Emergency pumping arrangements shall be available on the tow, in general accordance with Section 15.

20.9 CARRIAGE OF CARGO

20.9.1 The carriage of manifested cargo on the tow shall not normally be approved unless the tow is manned and is fully classed by a Classification Society, including the possession of a current International Load Line Certificate.

20.9.2 International Load Line Regulations shall be strictly followed. Approval shall not be given to any towage where the prescribed Load Line draught is exceeded.

20.9.3 A cargo plan shall be provided for agreement by the attending surveyor.

20.9.4 The cargo shall be loaded in a seaman-like manner making proper allowances for load distribution both during loading and for the duration and route of the towage. Longitudinal strength requirements shall be complied with.

20.9.5 Bulk cargoes shall be properly trimmed to prevent shifting in a seaway. Shifting boards or other preventative methods shall be utilised where appropriate.

20.9.6 All other cargoes shall be secured in accordance with Sections 7, 8 and 9.

20.9.7 Particular attention shall be paid to the securing of scrap steel, which if carried shall be properly seafastened. If carried in a hold, it shall not be treated as a bulk cargo.

21 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF FPSOS

21.1 GENERAL AND BACKGROUND

21.1.1 Many of the foregoing guidelines apply equally to the towage of FPSOs, and similar large vessels. The aim of this Section is to address the specific marine-related issues associated with the towage of these units. Although it is recognized that there are many more marine activities in an FPSO development, towage to field is a critical and often long operation, which must be addressed by the project team early in the schedule.

21.1.2 Some FPSO developments are 'fast-track', resulting in construction and commissioning activities being completed during the tow.

21.1.3 New-build or converted FPSOs usually undertake a limited number of towages only, following construction or conversion. There may be a further towage at the end of their working life.

21.1.4 Frequently the design weather conditions for towage are more severe than the service conditions. There is a natural reluctance to build in additional strength or equipment which will have no practical value during the service life.

21.1.5 Project-specific fit-for-purpose guidelines must be agreed in each case.

21.2 THE ROUTE AND WEATHER CONDITIONS

21.2.1 Metocean design criteria should be carefully established early in the project, in accordance with Section 6. In many cases, the field's operational criteria may be less onerous than the tow-to-field criteria, so temporary-phase operational limits may define structural load cases and equipment motion criteria.

21.2.2 Mitigation of the design extremes may be achieved by the use of a staged towage, in accordance with Section 6.3.

21.2.3 In such cases the towage route must be planned to incorporate a series of safe-havens, meaning sheltered locations where the tow can safely ride out severe weather. It may also be necessary to identify suitable bunker ports. These requirements may conflict with the requirement for adequate searoom, and such conflicts should be resolved.

21.2.4 Passage through restricted or busy waters should be considered, and the need for appropriate additional tugs determined.

21.3 STRUCTURAL ISSUES

21.3.1 FPSOs are intended to remain at sea without dry-docking for their entire working life, usually in the order of 20 years. In this respect the integrity of the hull must be maintained and precautions taken to ensure no damage occurs during the tow. A commercial vessel is usually assumed, for design purposes, to spend about 20% of its life in port, and is periodically dry-docked. These differences place much greater emphasis on the reliability, integrity and quality of the hull including its coating. These qualities must not be compromised during the tow other than by reasonable wear and tear.

21.3.2 For long towages, fatigue damage may need to be considered.

21.3.3 The capability of the FPSO to withstand design towage conditions shall be demonstrated. Checks should include hull girder strength, local plating strength, operating limit states for process equipment including rotating machinery.

21.3.4 Equipment foundations shall be designed for the temporary phase operations. Fatigue damage to the connections between the topsides and hull should be considered.

21.3.5 Any temporary equipment aboard shall be secured to withstand the design conditions. If construction, completion, or commissioning work is performed during tow, then all the scaffolding, temporary power packs, work containers etc shall be installed to withstand the design criteria. Any scaffolding or other temporary works which cannot comply with the design criteria shall be dismantled or removed.

21.3.6 Green water damage or slamming damage on temporary equipment should be considered in the location of equipment.

21.4 TUG SELECTION

21.4.1 Tugs shall be selected, as a minimum, in accordance with Section 12, but with regard to the comments on redundancy below.

21.4.2 Redundancy in the towing fleet is recommended.

21.4.3 The use of additional tug(s) may be required in restricted waters.

21.4.4 Redundancy of towing vessels gives greater freedom for bunkering, where one tug may divert to bunker whilst the other(s) continue(s) with the towage.

21.4.5 A concern in multiple-tug towages relates to emergency procedures in the event of loss of a tug's power. If, for example, the lead tug in a three-tug spread blacks out, then it could be over-ridden by the FPSO, with catastrophic consequences. Suitable emergency procedures and tow equipment will be required to mitigate such a possibility.

21.4.6 Additional or larger tugs may be required if it is not possible or practical to provide an emergency anchor. See also Section 21.9.

21.5 BALLAST, TRIM AND DIRECTIONAL STABILITY

21.5.1 Directional stability under tow may be compromised resulting in the FPSO veering off the course line. This is due to various factors related to the design and construction of the FPSO, including but not limited to:

a. The presence of a mooring or riser turret, below the keel of the vessel, generally at the forward end or midlength.

b. The removal of the vessel's rudder, where the FPSO is a conversion

c. The hull design of purpose-built FPSOs

d. High windage structure at the fore end.

21.5.2 The lack of directional stability can be hazardous due to:

a. Lack of sea room in congested and/or confined waters, e.g. Dover Strait

b. Accelerated deterioration of the towing gear caused by excessive movement, especially wear of chains.

21.5.3 To limit the loss of directional stability the hull must be carefully ballasted, trimmed by the stern and in the case of a ship-shape hull with the forefoot well immersed. This will also reduce slamming in heavy weather. The ballast distribution must be checked to ensure that the shear and longitudinal bending moment are within acceptable limits.

21.5.4 Consideration may also be given to attaching a towing vessel at the stern of the FPSO (see also Section 21.5.5 below).

21.5.5 Careful design of the towing gear may mitigate the problem. Consideration may be given to towing by the stern. If this is proposed then any motions analysis or model testing shall recognise this configuration. The strength of the hull in way of the stern shall be checked to ensure that:

a. The stern can withstand the anticipated slamming loads

b. Suitably sized towing connections and fairleads are or can be attached.

21.6 TOWING EQUIPMENT

21.6.1 Requirements for assisting tugs to provide additional manoeuvring control, and to assist with berthing or connection to the permanent mooring system shall be assessed for:

a. Departure

b. Any intermediate ports

c. Any shelter areas

d. Bunkering

e. Arrival.

21.6.2 The towing equipment shall be configured to accommodate additional and assisting tugs and to allow connection and disconnection when required. These activities may dictate the equipment on board the unit. For example, tugger winches, davits or cranes could be needed.

21.6.3 As noted in Section 21.5, FPSOs may exhibit a lack of directional stability during towage. There are two key tow-gear-related issues to address this problem and minimise the risk of gear failure:

a. The towing brackets on the vessel need to be wide-spaced, preferably more than one-half of the beam

b. The chafe chains should be generously oversized (typically +50%) to allow for accelerated wear during the voyage.

21.6.4 At least one emergency towline is mandatory, and means to recover each bridle after any breakage shall be provided. The possible manning of the vessel will influence the type and location of any recovery gear.

21.7 SELF-PROPELLED OR THRUSTER-ASSISTED VESSELS

21.7.1 In some cases, the FPSO may have its own propulsion, which may be either the original ship's system or thruster units to be used in service. If these are to be used for the voyage to site, the vessel must comply fully with all regulatory requirements.

21.7.2 The specification of the thruster units, power supplies and manning should be reviewed, to ensure that they are compatible with the voyage requirements.

21.7.3 A risk assessment shall be undertaken to determine the need for assisting tugs.

21.8 MANNING AND CERTIFICATION

21.8.1 Most FPSOs are not classed as ships during their service life. The documentation set out in Section 5 shall be provided.

21.8.2 If the towage is to be manned, then the requirements of Section 17 shall be considered.

21.8.3 Regardless of the presence of construction or commissioning personnel, a dedicated marine riding crew is recommended, as shown in Section 17.1.4.

21.8.4 In all cases, whether manned or unmanned, the unit must be fitted with appropriate means of boarding, in accordance with Section 13.14.

21.9 EMERGENCY ANCHOR

21.9.1 The general emergency anchor requirements of Section 16 shall apply.

21.9.2 FPSO mooring systems (whether turret-type or spread), being only for in-place conditions, are not configured to act as emergency moorings during transit. On a conversion the permanent anchors will often be removed. For many designs the deck space where an emergency anchor might be sited is taken up with the permanent mooring equipment.

21.10 MOORINGS & UNDER KEEL CLEARANCE

21.10.1 The need for moorings before, during or immediately after the towage shall be considered. Design and layout of such quayside moorings should be incorporated into the overall arrangement of the vessel as described in Section 16.7.

21.10.2 Wherever an FPSO hull is moored in shallow water, a minimum of 1m underkeel clearance must be maintained at all levels of tide for the duration of the vessel's stay in a particular location. The clearance should be calculated after consideration of:

a. Lowest predicted astronomical tide,

b. Maximum negative surge

c. Other environmental factors,

d. Weight growth due to construction activities and loading of modules,

e. Ballast, trim and heel changes,

f. Bottom protrusions,

g. Hull girder bending,

h. Water density,

i. Squat (when moored in a river or tidal stream),

j. Seabed conditions.

22 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF VESSELS AND STRUCTURES IN ICE COVERED WATERS

22.1 GENERAL

22.1.1 This Section sets out the special technical and marine aspects and issues not covered elsewhere in these Guidelines, that will be considered by GL Noble Denton for the approval of the towage of ships, barges, MODU's and any other floating structure towed in ice-covered waters.

22.1.2 It is recognized that towing in ice-covered water is a unique marine operation and that all vessels and towages in ice are different - making these guidelines general in nature. Each approval will depend on the result of an in-depth review of the tow-plan as well as an equipment inspection/attendance by a surveyor to identify any particular problems that may exist for the specific vessel(s) and towage in question.

22.1.3 Structural safety and towing performance will require careful consideration of the size and shape of the vessel being towed, especially with respect to the beam of the towed vessel in comparison to the beam of the towing vessel and the shape of the bow of the towed unit. The beam difference will affect the level of ice protection provided by the tug to the tow, as well as the ice interaction and towing resistance caused when the beam of the tow is greater than that of the tug and/or of any independent icebreaker support. In addition, special towing techniques used in ice and manoeuvrability restrictions caused by the ice require that experienced personnel plan and execute the tow.

22.1.4 Except as allowed by Section 22.1.5, any vessel that is operated and/or towed in ice shall be in Class with a recognized Classification Society and have a current Load Line Certificate.

22.1.5 Special cases may be considered for the towage of vessels with a Load Line Exemption Certificate or for objects with no classification such as caissons and vessels with expired classification such as a demolition towage. In such special cases an inspection will be carried out and, in order to verify if the structural strength and watertight integrity of the tow is approvable for the intended voyage, the attending surveyor may require one or more of the following:

a. An extended, in depth, survey of the vessel structure involving one or more specialist surveyor(s). Facilities for a close-up survey of inaccessible parts of the hull structure may be required.

b. Thickness determination (gauging) of specified areas of the vessel structure. This survey may be in limited areas or extend over large parts of the hull structure. Such surveys shall be carried out by a reputable independent company. An existing survey report may be acceptable provided that it is not more than 1 year old, and there is no evidence of damage or significant deterioration since that date.

c. A GL Noble Denton review of classification society approved scantling drawings.

d. Calculations to show that the structural strength of particular local areas of the vessel is adequate. The extent of the calculation required to be determined by the results of the surveys and drawings review.

22.1.6 Should any doubt exist as to the ability of the vessel (object) to complete the proposed towage, after all the necessary surveys and calculations have been undertaken, a dry dock survey of the vessel may be necessary.

22.1.7 After complying with the requirements of Sections 22.1.2 to 22.1.4 listed above, GL Noble Denton may deem that the vessel/object is unfit for tow and decline to issue a Certificate of Approval. For example, the towage of any vessel or object which is damaged below the waterline, is suspected of being damaged below the waterline or has suffered other damage or deterioration which could affect the structural strength and/or watertight integrity will not be approved for towage in ice. Alternatively, the vessel/object may only be considered fit for tow after specified repairs and suitable ice strengthening has been carried out.

22.2 VESSEL ICE CLASSIFICATION

22.2.1 The tug(s) and towed vessel shall have an appropriate ice classification or equivalent for transit through the anticipated ice conditions identified in the Tow Plan and verified by GL Noble Denton.

22.2.2 The International Association of Classification Societies (IACS) introduced “Requirements concerning Polar Class” in 2007 [Ref 23] which came into effect on ships contracted for construction on and after 1 March 2008. These are described in the following Table:

Table 22-1 Polar Class Descriptions

Polar Class	Ice Description (based on WMO Sea Ice Nomenclature)
PC 1	Year-round operation in all Polar waters
PC 2	Year-round operation in moderate multi-year ice conditions
PC 3	Year-round operation in second-year ice which may include multiyear ice inclusions
PC 4	Year-round operation in thick first-year ice which may include old ice inclusions
PC 5	Year-round operation in medium first-year ice which may include old ice inclusions
PC 6	Summer/autumn operation in medium first-year ice which may include old ice inclusions
PC 7	Summer/autumn operation in thin first-year ice which may include old ice inclusions

22.2.3 The following tables summarize the previous nominal ice classification equivalencies for some classification societies and regulators.

22.2.4 It is important to note that the structural requirements of various classification societies are different and that many requirements have changed substantially over the years so that the ‘equivalencies’ shown in the tables should only be used for general guidance. This may result in a vessel’s ice capability being interpreted by GL Noble Denton to be different to that indicated by the table.

22.2.5 Vessels classed as Ice breakers:

Table 22-2 Previous Icebreaker Classifications

<table>
<tr><th rowspan="2">Polar Classes</th><th rowspan="2">Russian</th><th rowspan="2">LRS</th><th rowspan="2">Canadian Arctic Class CASPRR</th><th rowspan="2">DNV</th><th colspan="2">Operating Criteria</th></tr>
<tr><th>Typical WMO ice type & thickness capability</th><th>Ice thickness</th></tr>
<tr><td>PC 5</td><td rowspan="2">(LL4)
LU6</td><td rowspan="2">C1</td><td rowspan="2">CAC4</td><td>Ice 05</td><td>Winter ice with pressure ridges</td><td>0.5 m</td></tr>
<tr><td>PC 4</td><td>Ice 10</td><td rowspan="2">Thick first year ice with old ice inclusions</td><td>1.0 m</td></tr>
<tr><td rowspan="2">PC 3</td><td rowspan="2">(LL3)
LU7</td><td rowspan="2">AC1.5</td><td rowspan="2">CAC3</td><td>Ice 15</td><td>1.5 m</td></tr>
<tr><td>Polar 10</td><td rowspan="3">Multi-year ice floes and glacial ice inclusions</td><td rowspan="2">2.0 m</td></tr>
<tr><td>PC 2</td><td>(LL2)
LU8</td><td>AC2</td><td>CAC2</td><td>Polar 20</td></tr>
<tr><td>PC 1</td><td>(LL1)
LU9</td><td>AC3</td><td>CAC1</td><td>Polar 30</td><td>3.0 m</td></tr>
</table>

22.2.6 Vessels classed For Ice Navigation:

Table 22-3 Previous Vessel Ice Classifications

Canada (ASPPR)	GL	Russian	ABS	BV	DNV	LRS	Typical WMO ice type and thickness capability
E	E	(L4) LU	D0	1D	Ice C	1D	Grey (0.0 m - 0.15 m)
D	E1	(L3) LU2	1C	1C	1C	1C (Ice 3)	Grey white (0.15 m - 0.3 m)
C	E2	(L2) LU3	1B	1B	1B	1B (Ice 2)	Thin first year (1st stage - 0.3 m - 0.5 m)
B	E3	(L1) LU4	1A	1A	1A	1A (Ice 1)	Thin first year (2nd stage - 0.5 m - 0.7 m)
A	E4	(UL/ULA) LU5	1AA	1A Super	1A*	1A Super	Medium first year (0.7 m - 1.2 m)

For Russian Classes L-ICE U-REINFORCED A-ARCTIC

22.3 TOWAGE WITHOUT INDEPENDENT ICEBREAKER ESCORT

22.3.1 Where no independent icebreaker escort is identified in the tow-plan for the intended voyage, the tug and tow must be of appropriate ice classification and power to maintain continuous headway in the anticipated ice conditions. When a tow is anticipated to take more than three (3) days (the maximum for a reasonably accurate weather/ice forecast) or longer in ice conditions that includes a concentration of five (5) tenths or more of limiting ice types, the tow-plan must indicate the location of the nearest icebreaker support and the anticipated time before independent icebreaker assistance (Coast Guard or Commercial) can be provided.

22.3.2 With the exception of a vessel pushed ahead (push-towed), the ice classification requirement for the towed object may be considered for reduction if it is determined that the tug has a higher than necessary level of ice classification and can protect the tow from potentially damaging ice interaction.

22.3.3 CONVENTIONAL TOW OPERATIONS:

a. the tug must have sufficient power and hull strength (ice classification) to be capable of safely maintaining continuous towing headway through the worst anticipated ice conditions including, if necessary, the breaking of large diameter floes and deformed ice with no requirement for ramming and:

b. the tow-plan must show that the towage should not be subjected to ice pressure.

22.3.4 CLOSE-COUPLE TOWING OPERATIONS

22.3.4.1 Close-couple towing is an operation that allows a specially designed icebreaker to combine towing and icebreaking assistance. The stern of the icebreaker has a heavily fendered ‘notch’ into which the bow of a ship is pulled by the icebreaker’s towline. The towline remains attached and the icebreaker steams ahead, usually with additional power provided by the towed vessel in the notch. In this way an icebreaker can tow a low-powered and low ice classed ship quickly (up to 3 times faster than conventional towing in ice) and safely (better protection of the towed vessel and less risk of collision due to over-running) through high concentrations of difficult ice. For close-couple towages:

a. The beam of the icebreaker must be more than that of the towed ship in order to avoid shoulder damage to the towed vessel and excessive towline stress and:

b. The icebreaker is fitted with a constant tension winch or equipment that will reduce the effects of shock-loading:

c. The bow of the towed ship must be compatible with the notch design of the icebreaker. Preferably the entrance of the towed ship is not so sharp as to apply excessive force on the stem when going straight ahead. Freedom of movement of the towed ships bow can cause manoeuvring difficulties as well as applying heavy side forces on the towed ships bow when turning. The bow should not be so bluff that all the force is concentrated in localized areas. In addition the towed ship cannot have a bulbous bow because the underwater protrusion could damage the icebreakers propellers and:

d. The displacement and freeboard of the towed vessel should not be so disproportionate with that of the icebreaker that the manoeuvring characteristics of the icebreaker are seriously compromised:

e. The anticipated ice conditions should not require ramming or passage through areas where high levels of ice pressure may be experienced without independent icebreaker assistance.

22.3.5 PUSH-TOW OPERATIONS

22.3.5.1 Push-Tow operations can be carried out using rigid connection (composite unit) or flexible connections (a push-knee erected at the stern of the pushed vessel). In some cases where the design and ice strength of the tug and tow is appropriate a tug may opt to push rather than tow in ice, especially when experiencing ice pressure, so that headway can be maintained and to remove the stress from the towline.

22.3.5.2 In some cases a push-tow is a more efficient and a more desirable method of ice transit to conventional towing, however, in all circumstances where the push-towing technique may be used, it is important that the pushed vessel has appropriate ice strengthening, particularly in the bow and shoulder areas.

22.3.5.3 The ice classification of a tug that is engaged in a ‘push-tow’ operation with no independent icebreaker support can be reduced if:

a. the vessel being pushed has appropriate ice classification and strength for unescorted transit in the anticipated ice conditions and:

b. the beam of the pushed vessel is greater than that of the tug. The beam of the pushed vessel should be at least one third greater than that of the tug to allow suitable manoeuvring for a flexible connection and:

c. the connection between tug and tow is of suitable strength for emergency stops and:

d. the tow-plan shows that the ‘push-tow’ will not enter, or be exposed to, an area where ice pressure may be encountered of sufficient severity to stop the continuous forward progress of the push-tow without independent icebreaker assistance.

22.4 TOWAGE OPERATIONS WITH INDEPENDENT ICEBREAKER ESCORT

22.4.1 The ice classification requirements indicated in Section 22.2.2 for the tug(s) and towed vessel(s) may be considered for reduction if it is determined that appropriate icebreaker escort assistance is provided for the duration of the tow in ice and that:

a. The icebreaker(s) has sufficient capability to allow the towage to maintain continuous headway through all of the anticipated ice conditions and,

b. The icebreaker(s) has a beam equal to, or greater than, the tug and tow combination or:

c. The icebreaker(s) is fitted with suitable and operational equipment such as azimuthing main propulsion units or compressed air systems that are capable of opening the track wider than the beam of the escorted towage in the anticipated ice conditions or:

d. More than one icebreaker will be used to provide a broken track equal to, or wider than, the beam of the tug and tow combination.

22.5 MANNING

22.5.1 In addition to Section 12.13 concerning manning, special consideration should be given to the number, qualification and experience of personnel required on the navigating bridge to ensure safe navigation including steering and engine control, lookout, operation of searchlights and, emergency operation of the towing winch abort system.

22.5.2 The master in charge of a tow (tow-master) should typically have at least 3 years experience of towing in ice conditions similar to those anticipated for the proposed towage. Other navigating officers on tugs involved in a towage in ice should also have previous experience of towages in ice.

22.6 MULTIPLE TOWS AND MULTI-TUG TOWS

22.6.1 Multiple Towages in ice are subject to the appropriate provisions set out in this section regarding ice classification, equipment and suitable propulsion power as well as the general provisions (particularly those presented in Section 18). However, only in exceptional circumstances of very light ice and/or very low ice concentration (trace) will a Double Tow (Section 18.1.1) or a Parallel Tow (Section 18.1.4) be considered for approval. An in-depth risk assessment would be required and the risks shown to be acceptable.

22.6.2 In addition to the provisions presented in Section 18 concerning towing operations that use more than one tug or multiple tows:

a. To avoid collision or over-running each tug shall have a quick release and re-set system as described in Sections 22.7.2.1 and 22.7.2.2.

b. The most experienced tug Master shall be designated as the tow-master and give directions to the other vessels. All other tug Masters and senior navigating officers involved in the multi-tug towage should have an appropriate level of experience of towing in ice and be familiar with the associated difficulties and hazards.

c. A multi-tug tow-plan that is presented to GL Noble Denton for approval that does not include independent icebreaker escort assistance shall demonstrate clearly why it is not considered necessary. As an acceptable example, the tow could be configured such that one or more tugs with the capability to perform ice management (escort duties) can be released, and the remaining tug(s) have sufficient BP to continue making towing progress. In some circumstances a tow-plan can include the contingency of releasing one or more tugs that are towing in the conventional manner to push-tow provided that:

- the towed vessel is appropriately ice strengthened:
- the towed vessel is appropriately designed and strengthened in the pushing location(s):
- the tugs are designed and adequately fendered for pushing:
- such action would only be considered in a high ice concentration where there is no influence by sea or swell.

d. When two tugs are towing in series as described in Section 18.6 in an ice infested area, special attention shall be given to the strength of the towing connections on the foredeck of the second tug in case it is necessary for the lead tug to break through ice floes of varying thickness that may cause shock-loading.

e. A tandem tow of barges as described in Section 18.4.2 is sometimes referred to as ice-coupled. Where the presence of ice increases the potential for rapid changes to the towing speed, this type of close connection necessitates good fenders to be in place between each unit in the tow.

22.7 TOWING EQUIPMENT

22.7.1 GENERAL

22.7.1.1 The towing techniques that are used in ice typically require a short distance between the tug and tow to increase manoeuvrability and so that the propeller wash from the towing vessel can assist in clearing ice accumulation around the bow of the towed vessel. Because of the short towing distance and reduction of towline catenary it is necessary for the towing arrangement to be suitable for the additional stress that can be experienced. The stress on the towing arrangement can vary considerably with:

a. the thickness and concentration of ice as well as ice pressure,

b. the difference in beam between the tug and tow resulting in ice interaction on the shoulders of the towed vessel and ice accumulation in front of the tow as well as the use and effectiveness of independent icebreaker escort and

c. large heading deviations due to manoeuvring through and around ice and

d. unintentional tug interaction with heavy ice floes which can result in shock-loading to towing components due to whiplash and the tow taking charge.

It is for these reasons that additional provisions concerning towing equipment strength, type and configuration are necessary.

22.7.2 ADDITIONAL EQUIPMENT REQUIREMENTS FOR TOWING IN ICE

22.7.2.1 In addition to Section 12.5 (Tow-line Control), a tug involved in towing in ice infested waters must be fitted with an operational towline quick release/reset system (tow-wire abort system):

a. when towing in ice that could rapidly reduce towing speed or

b. when a tug is involved in a multiple tow or

c. when a tug is involved with a multi-tug tow.

22.7.2.2 The towline quick release system should be capable of immediate winch brake release for pay out of tow-wire as well as winch brake re-set from the navigation bridge and the winch control station (if different).

22.7.2.3 With reference to Section 12.9, a tug involved in a towage in ice should be fitted with at least two searchlights that can be directed from the navigation bridge.

22.7.2.4 As recommended in Sections 12.11.2 and 13.16, every tug that is towing in ice shall be equipped with burning and welding gear for ice damage control and repair.

22.7.3 STRENGTH OF TOWLINE

With reference to Section 13.2.1 (a):

22.7.3.1 For a tug that is planning a conventional single towline towage in ice the Minimum Towline Breaking Load (MBL) should be computed as follows:

Table 22-4 Minimum Towline MBL in Ice

Bollard Pull (BP)	MBL (tonnes)
BP ≤ 40 tonnes	3.7 x BP + 12
40 < BP ≤ 90 tonnes	(4.2 – BP/50) x BP + 24
BP > 90 tonnes	2 x BP + 60

22.7.3.2 An exception can be made for short tows in very thin 'new' ice or in very low concentrations (<3/10ths) of medium or thick 'rotten' ice. In these circumstances the Minimum Towline Breaking Load (MBL) should be computed as shown for a 'non-benign' tow in Section 13.2.

22.7.3.3 The strength of all other towing connections and associated equipment should be appropriately calculated as required by the provisions of Section 13.2.

22.7.3.4 Further, ALL tugs involved in a towage in ice must carry a spare tow-wire of the same length and strength as the main tow-wire that is immediately available on a reel to replace the main tow-wire. In addition, there must be enough competent personnel, equipment and spares on board to crop and re-socket the main tow-wire at least once.

22.7.4 SPECIAL CASES OF REDUCED TOW-WIRE STRENGTH

22.7.4.1 The minimum size of tow-wire that is typically used by icebreaking tugs of 160te BP for close-couple towing is for example, 64mm EIPS rove through a multiple sheave floating 'Nicoliev Block' system. In this system a single bridle wire, usually of the same size and strength as tug's main tow-wire, is made fast to each bow of the vessel being towed.. The tow-wire goes from the towing winch to the floating block on the bridle and back via a fairlead to a towing damper on the tug. For larger powered tugs, the tow-wire may be doubled up again by passing the wire through a standing block on the tug's deck and around a second sheave on the floating block before it is made fast to the towing damper. This makes the bridle wire the 'weak link' in the system and because of this an icebreaking tug shall carry sufficient spare bridle wires, typically at least 6.

22.7.4.2 To meet the minimum towline strength criteria a tug that has an appropriate bollard pull may, in exceptional circumstances, be considered for approval of a conventional towage in calm waters containing ice using two towlines provided that:

a. Each of the two independent towlines is a minimum of 90% of the required strength and

b. Each tow-wire is on a separate towing winch that can be adjusted, quick released and reset independently from the other and

c. Each tow-wire meets the requirements of a single tow-wire in terms of minimum length, construction etc. and

d. Each tow-line has a monitoring system to enable load sharing.

22.7.5 TOWING WINCHES

22.7.5.1 Towing winches are required due to the typical manoeuvring restrictions and hazards that are inherent to towing in ice. Towing hooks do not allow for the rapid adjustment of towline length.

22.7.5.2 Each towing winch should have sufficient pull to allow the towline to be shortened under tension. When possible, the navigating bridge and winch operator should be provided with continuous readouts of towline length deployed and towline tension.

22.7.5.3 Winch controls and winch operating machinery should be suitably protected from environmental conditions, particularly low temperatures that can result in winch malfunction.

22.7.5.4 Towing winches shall have a quick release and re-set system as described in Sections 22.7.2.1 and 22.7.2.2.

22.7.6 CHAIN BRIDLES

22.7.6.1 A chain bridle is typically used for a towage in ice with a chain pigtail connected to a 'fuse wire' or directly to the towline. In some circumstances where high shock loads are anticipated, an extra long chain pigtail may be considered appropriate. Wire pennants and bridles are sometimes used for small barge and vessel tows, especially when the close-couple or ice-couple towing technique is anticipated.

22.7.7 SYNTHETIC ROPE

22.7.7.1 Synthetic rope is prone to rapid cutting both internally by ice crystals and externally by ice edges and therefore is not approved for use in a towing system for an in-ice towage. Sections 13.8.2 and all parts of Section 13.9 do not apply in ice transits or in very low temperatures where icing can occur.

22.7.8 BRIDLE RECOVERY SYSTEM

22.7.8.1 In addition to the requirements of Section 13.10:

a. To reduce direct ice interaction and disconnection of the bridle recovery wire, the wire should be lightly secured to one leg of the bridle and the end shackled onto the apex or a chain link close to the apex of the tri-plate.

b. The fuel mentioned in Section 13.10.2 for a motorized recovery winch shall be appropriate for the anticipated temperatures.

22.7.9 EMERGENCY TOWING GEAR

22.7.9.1 With reference to Section 13.11, special arrangements may be required for the emergency towing gear, especially on an unmanned tow proceeding in ice. For all towages in ice the emergency towing gear should be fitted and arranged to tow from the bow unless it can be shown that the object being towed is designed for multi-directional towing.

22.7.9.2 A floating line and pick-up buoy are susceptible to being cut and lost or snagged by ice and pulled clear of the soft lashings or metal clips. It is recommended that a different arrangement is employed in high concentrations of ice. For example, an intermediate wire may be attached to the end of the emergency tow-wire and lightly secured to a pole extended astern at least 5 metres. The eye of the intermediate wire is suspended above the surface of the ice approximately 1 metre above the aft working deck of the tug where it can be captured for connection to a tugger-winch wire. The float line and pick-up buoy are shackled to the emergency tow-wire in the same way as described in Section 13.11.2, but remain coiled on the deck of the tow for deployment once the towage arrives in open water.

22.7.10 ACCESS TO TOWS

22.7.10.1 With reference to Section 13.14, whether a tow is manned or not, suitable access must be provided. For towages in ice, a permanent steel ladder should be provided at the stern from the main deck to just above the waterline. As discussed in Section 13.14.2, ladders, particularly side ladders should be recessed to avoid ice damage. A tug workboat should carry suitable equipment to de-ice recessed access arrangements and ladders to tows. Pilot ladders used as a short term alternative should be closely inspected for ice damage before being used. Typically, a pilot ladder secured at the stern of the tow is subject to the least amount of ice interaction.

22.7.11 TOWING EQUIPMENT CERTIFICATION AND SPECIAL PRECAUTIONS

22.7.11.1 As described in Section 13.12, all equipment used in the main and emergency towing arrangements for a towage in ice shall have valid certificates. Special precautions are necessary for equipment that has been, or will be, used in extremely low temperatures. Regardless of anticipated temperatures during the proposed towage, a GL Noble Denton surveyor may request to have sockets, chains, flounder plates and shackles used in the towing process non-destructively tested (NDT). Based on the results of a visual inspection of the tow-wire, the surveyor may also require that the tow-wire is cropped and re-socketed prior to the towage.

22.7.12 RECOMMENDED SAFETY EQUIPMENT FOR THE WORKBOAT

22.7.12.1 In addition to Section 12.6, sufficient Arctic survival suits shall be carried on board the tug for all personnel that may be operating the workboat and personnel transferred to the tow by the work boat. These additional survival suits should be fitted with hard soled boots, belts and detachable gloves.

22.8 TUG SUITABILITY

22.8.1 The tug shall have a bollard pull appropriate for the anticipated ice and weather conditions. The calculated BP should never be less than that necessary for an open ocean towage, as shown in Section 12.2.

22.8.2 OVERSIZED TUG

22.8.2.1 For all towages in ice, Section 13.2.10 concerning towing connections does not apply. In the case of an oversized tug (in terms of TPR) all connections should be at least equal to the MBL of the tow-wire in use. The tow-master must be fully aware of any strength reduction to the connections, carry adequate replacement spares and the towing procedures should identify the maximum power setting that may be applied.

22.9 CARGO LOADINGS

22.9.1 Special attention should be given to cargo overhangs on a case-by-case basis.

22.9.2 In general, cargo overhang for a towage in ice will not be approved unless it can be shown that the cargo is adequately protected such that no ice interaction can occur.

22.9.3 To determine the potential for ice interaction, calculations must show that the cargo has at least three meters clearing height above the maximum height of ice deformity that can be experienced during the tow. In all ice concentrations this minimum clearing height will be maintained in all conditions of roll, pitch and heave (see Sections 7 and 8). Due to the potential for ice impact and resulting damage cargo overhang cannot be allowed to immerse under any circumstance, so that Sections 7.6, 8.5, 10.1.4 and 10.1.5 are not applicable.

22.10 SEA-FASTENING DESIGN AND STRENGTH

22.10.1 The motions of a vessel transiting through low concentrations of ice should be assumed to be as severe as those experienced in clear open water storm conditions. Swell waves can persist for many miles even into an ice edge of very high ice concentration. In high ice concentrations where no waves are evident, impact or over-running of thick ice floes can cause sudden deceleration, heading deflections, listing and rolling of the tow. For these reasons the strength of cargo and sea-fastenings for transportation in ice conditions should be of appropriate design and not less than that required for unrestricted transportations in non-benign areas - see Sections 7 and 8. The cargo mass shall include the effect of ice accretion calculated in accordance with the IMO Intact Stability Code [Ref. 17], Chapter 5.

22.10.2 INSPECTION OF WELDING AND SEAFASTENINGS

22.10.2.1 With reference to Section 9.7, consideration of special welding procedures and techniques may be necessary for sea-fastenings installed in very cold temperatures.

22.10.3 PIPES AND TUBULARS

22.10.3.1 With reference to Section 9.6.4 - stress on pipes in a stack, and Section 9.6.10 - open ended pipes, special consideration should be given to pipes filling with ice due to freezing spray and/or wave action in low temperatures and the potential to overstress lower levels of pipe, seafastenings and deck structures. The effect on the vessel stability should also be considered.

22.11 STABILITY

22.11.1 Stability calculations for vessels, including tugs and tows, operating in very cold temperatures and in ice conditions shall be submitted to GL Noble Denton for review against the IMO Intact Stability Code [Ref. 17], Chapter 5.

22.11.2 The intact range of stability of a towed vessel (see Section 10.1.1) shall never be less than 36 degrees, including inland and sheltered towages.

22.11.3 For transit in ice-infested waters, the statement in Section 10.1.4 of these guidelines shall be modified to read 'Cargo overhangs shall be such that no immersion is possible in the anticipated environmental conditions'.

22.11.4 Section 10.1.5 referring to buoyant cargo overhangs does not apply to transits in ice.

22.11.5 In addition to the requirements of Section 10.2.1, towed objects shall have positive stability with any two compartments flooded or broached.

22.11.6 The damaged stability relaxations for towed objects referenced in Sections 10.2.4 and 10.2.5 do not apply in any area where ice interaction can occur. See also Section 10.2.7.

22.11.7 The integrity of all underwater compartments of a tug and compartments subject to down-flooding must be safeguarded from flooding by watertight doors and hatches that access such compartments. This is a critical requirement for an approval to conduct a towage in ice. All compartment accesses must be checked for watertight integrity and kept closed at all times throughout the towage.

22.11.8 The draughts mentioned in Section 10.4.4 are the minimum for open water operations. In an ice environment, additional consideration must be given to the location of any specially strengthened 'ice belt' and to the exposure of areas vulnerable to ice damage such as propulsion and steering equipment that may require specific and/or deeper overall ice transit draughts.

22.11.9 A vessel being towed or pushed (regardless of being self propelled) shall not be excessively trimmed. On manned tows the trim should be appropriate to provide watch personnel with as much forward visibility as possible for observation of approaching ice conditions and the movements of other vessels involved in the towage to reduce the potential for ice impact and/or collision damage.

22.12 BALLASTING

22.12.1 Ballasting of the forepeak (to above the waterline) of a tug and towed vessel is done to assist with ice impact load dispersal. This also provides protection against developing excessive trim by the head in the event that a forward compartment is breached by ice and flooded. In addition, the emptying of a ballasted forward compartment can assist with exposing damage for emergency repair or to raise the damaged area clear to avoid continued ice interaction and escalation of damage.

22.12.2 Special precautions should be taken to avoid structural damage caused by pressurizing compartments when ballasting and deballasting due to water freezing in tanks or inside tank vent pipes. This is in addition to the freezing of tank vents from coating with freezing spray in very low temperatures.

22.13 VOYAGE PLANNING

22.13.1 In addition to the requirements listed in Section 14, a written voyage plan or tow-plan should be submitted for review and comment by GL Noble Denton in advance of a proposed towage in an ice-infested region.

22.13.2 The plan should include:

a. A general description of the proposed voyage (manned/unmanned towage etc)

b. Tug and tow particulars including ice classifications and certification

c. Research documentation indicating the anticipated ice/weather conditions

d. Routeing including shelter and holding locations

e. Navigation and communications equipment appropriate for the region

f. Summary of tow-master and senior officer experience

g. Arrangements for receiving weather and ice information and/or routeing

h. Voyage speed and fuel calculations including any bunkering requirements and procedures to comply with National regulations

i. Contingency fuel, hydraulic & lubricating oils of suitable viscosity for the low ambient temperatures

j. Main and emergency towing arrangements and certification

k. Stability calculations and location of all cargoes, consumables, ballast and pollutants for the tug and tow

l. Sea-fastening (cargo securing) arrangements

m. Arrangements for assist tugs for docking etc and for ice management as required

n. Damage and pollution control equipment as applicable

o. Contingency procedures for ice damage, tug breakdown, fire, broken tow, man overboard and the nearest icebreaker assistance.

22.13.3 In addition to the list in Section 14.5.1, prior to departure the tow-master of an unmanned towage should be supplied with the appropriate drawings that indicate the basic structure, watertight compartments, ballast system, cargo securing arrangements on the tow, and manuals that provide the tug crew with operating procedures for emergency equipment such as ballast pumps (see Section 15), the emergency generator, the emergency anchor system and the tow bridle retrieval system.

22.13.4 RE-FUELLING THE TUG

22.13.4.1 The tow-plan should indicate the calculated fuel usage during the tow for the required power in the anticipated ice conditions.

22.13.4.2 For the portion of the voyage that will be carried out in ice conditions, in addition to the times listed in Section 6.2.2 - the operational reference period, and Section 6.7 – calculation of voyage speed, the planned duration will include:

a. typical towing speeds of not more than 2 knots in ice covered areas as a conservative estimate where the actual towing distance is unlikely to be direct. A towing speed of 5 knots may be used where it can be shown that the tow will only encounter very thin new ice or alternatively very low concentrations (<3/10^{ths}) of thick rotting ice and:

b. waiting for appropriate ice conditions for departure, transit and arrival and:

c. up to 25% additional fuel (and other consumables) may be required (see Sections 6.2 and 12.12).

22.13.4.3 The tow-plan must indicate compliance with the International, National and Local regulations and guidelines concerning the carriage of oil cargoes, the allowable quantity and distribution of fuel oil or any other pollutant or dangerous cargo. In addition, where a tow-plan indicates the requirement to re-fuel the tug from the tow or from another vessel this will normally require special approval from a National authority and also require that the tug carries appropriate pollution containment and clean-up equipment. The re-fuelling approval from the appropriate jurisdiction, as well as the re-fuelling procedure and equipment, shall be provided in the tow-plan for review.

22.14 WEATHER /ICE RESTRICTED OPERATIONS

22.14.1 In addition to the requirements of Section 6.3, for a towage in an ice infested area, dependable ice forecasts must be available and the tug must have appropriate equipment on board to receive ice information including ice maps, bulletins, advisories and forecasts.

22.15 DAMAGE CONTROL AND EMERGENCY EQUIPMENT

22.15.1 Special consideration should be given to the remoteness of the area and the anticipated ice conditions where a towage will take place to determine the availability of emergency response, assistance and equipment. In addition to the damage control equipment listed in Section 13.16, additional equipment is recommended for a towage in ice:

a. Portable generator

b. Portable compressor

c. Portable salvage pump(s)

d. Bracing shores

e. Portable de-icing equipment

f. Space heaters

g. Extension ladders

h. Chain falls

i. Collision mat materials.

23 SPECIAL CONSIDERATIONS FOR CASPIAN SEA TOWAGES

23.1 BACKGROUND

23.1.1 For the purposes of these guidelines the Caspian Sea has been divided into the shallow Northern area (North of 45°N latitude as shown in Figure 23.1), an Intermediate area between 45°N and Kuryk (approximately 43°N), and the Southern area. The Intermediate area has been introduced for vessels travelling between the Northern and the Southern areas with relaxations subject to suitable weather routeing.

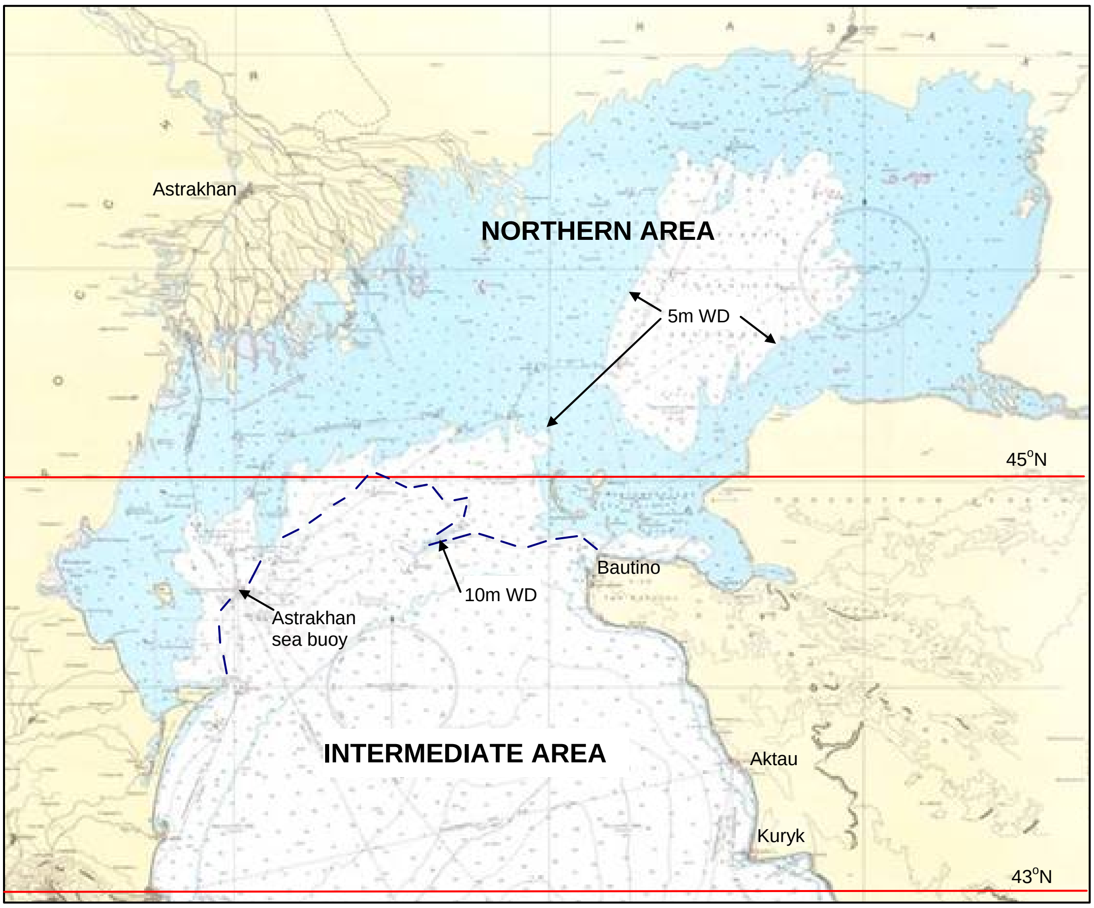


Figure 23-1 Northern Caspian Sea areas

23.1.2 The Northern area contains 25% of the total Caspian Sea area but only 5% of the water volume. The shallow water (typically 3 to 5 m deep, and very rarely more than 10 m) is a feature of the area which leads to the ready formation of ice in the winter months. Although winds can be very strong, the limited fetches and shallow water do not allow significant wave heights above about 3.5 to 4 metres.

23.1.3 Because the water level depends on river inflows balancing the evaporation, there are long term and seasonal rises and falls in the mean sea level and seawater density. As at 2005, the mean sea level (MSL) was 27 metres below Baltic Datum (equivalent to global mean sea level) and 1.0m above Caspian Datum.

4

23.1.4 The whole Caspian Sea suffers from a large number of unmarked fishing nets which provide a serious hazard to tugs which can be immobilised by these nets fouling their propellers. Therefore single propeller tugs are not recommended, unless there are suitable additional (redundant) tugs in attendance to replace them.

23.1.5 Many of the tugs found in this region are pusher tugs which should not be used for pushing in open waters.

23.2 REQUIREMENTS WITHIN NORTHERN CASPIAN SEA

23.2.1 **GENERAL** The following departures from the requirements shown in Sections 5 to 22 of these guidelines may be accepted for tows that take place totally within the Northern area (North of 45°N latitude).

23.2.2 **BOLLARD PULL REQUIREMENTS** Because of the limited wave heights (due to the shallow water) the meteorological criteria for calculating the Towline Pull Required (TPR) referred to in Section 12.2.7, when there is no ice, may be taken as:

H_{sig} = 2.5 m

Wind = 20 m/sec

Current = 0.5 m/sec

provided that the tow will have adequate sea room after the initial departure. If there will not be adequate searoom, then Section 12.2.2 will apply. 4

23.2.3 **TOWLINE LENGTHS** Because of the very shallow water depths and limited wave heights the minimum towline lengths required in Section 13.3.1 may be reduced within this area as follows. The minimum length available for each of the main and spare towlines (L) shall be determined from the "European" formula:

$$L > (BP/MBL) \times 1{,}200 \text{ metres}$$

except that in no case shall the available length be less than 200 metres.

23.2.4 **TOWLINE STRENGTH** Because of the short towlines there will be little catenary to absorb shock loads in bad weather. Unless other methods of reducing the shock loads are used, the towline MBL shall be increased in line with Section 13.3.2. As an example, a deployed towline length of 200m will require a towline MBL of 6 (=1,200/200) times the continuous static bollard pull. The towing connection capacities in Section 13.2.1 b shall be related to the increased required towline MBL.

23.2.5 **TOWING CONNECTIONS** Suitably positioned, purpose-built quick-release towing connections are preferred. Where bollards have to be used as the towline connection:

- The capacity of the bollards and their foundations must comply with the requirements of Section 13.4.
- Suitable fairleads and anti-chafe arrangements must be used.
- A keeper plate, capping bar or other means of keeping the towing bridle connected to the bollards must be provided and this must be suitable for any vertical loads likely to be encountered.
- The design must also allow for quick release of the keeper plate, capping bar or another proven method to rapidly clear a fouled bridle.

23.2.7 **WORKBOAT** A twin screw tug fitted with a bow thruster and two anchors in accordance with Class requirements may be exempt from the requirement for a workboat in Section 12.6 provided the voyage can be completed within a favourable weather forecast. The tug must also be able to come alongside the barge at sea so that crew can board with any necessary equipment for pumping, repairs, dropping the barge's anchor or reconnecting a towline.

23.2.8 **BUNKERS** The requirement for 5 days reserve in Section 12.12 may be reduced to 3 days (pumpable reserve) provided that:

- the towage can be completed within a good weather forecast period, and
- there are suitable bunkering ports within 3 days sailing at all times, and
- there are suitable tugs available to take over the tow if required during a diversion for refuelling.

23.2.9 **TOWAGES IN ICE** Section 22 applies.

23.3 REQUIREMENTS FOR REMAINING CASPIAN SEA AREAS

23.3.1 All tows in this area should follow the requirements in Sections 5 to 22 of these guidelines for unrestricted ocean tows outside benign weather areas, as applicable.

23.3.2 In addition, tugs with a single propeller are not recommended, unless there are suitable additional (redundant) tugs in attendance to replace them.

23.4 REQUIREMENTS FOR TOWAGES BETWEEEN CASPIAN SEA AREAS 4

23.4.1 Many shallow draft tugs that are designed for working in the shallow Northern area will be unable to carry towing gear suitable for towing in the Southern area. When it is not practicable for towages to change tugs when travelling between these areas whilst within the intermediate area defined in Section 23.1.1, and subject to suitable weather routeing, the following relaxations may be accepted:

- Deployable towline length to be at least 400 m, and
- Towline and towing connection strength requirements of Sections 22.3.4 and 23.2.5 will apply, and
- Minimum bollard pull requirements as in Section 23.2.2.

23.4.2 Weather routeing will include:

- Voyage planning to avoid travelling too close to a lee shore and to identify sufficient suitable safe places of shelter for different weather directions, and
- Receipt of regular marine weather forecasts and a commitment to go to a suitable safe place of shelter on receipt of a bad weather forecast.

REFERENCES

[1] GL Noble Denton document 0009/ND - Self-Elevating Platforms - Guidelines for Elevated Operations

[2] GL Noble Denton document 0013/ND - Guidelines for Loadouts

[3] GL Noble Denton document 0015/ND - Concrete Offshore Gravity Structures - Guidelines for Approval of Construction and Installation

[4] GL Noble Denton document 0016/ND - Seabed and Sub-Seabed data required for Approvals of Mobile Offshore Units (MOU)

[5] GL Noble Denton document 0021/ND - Guidelines for the Approval of Towing Vessels

[6] GL Noble Denton document 0027/ND - Guidelines for Marine Lifting Operations

[7] GL Noble Denton document 0028/ND - Guidelines for the Transportation and Installation of Steel Jackets

[8] IMO International Safety Management Code - ISM Code - and Revised Guidelines on Implementation of the ISM Code by Administrations - 2002 Edition

[9] DNV Rules for the Classification of Ships, January 2003, Part 3, Chapter 1, Section 4

[10] IMO Code of Safe Practice for Cargo Securing and Stowing - 2003 Edition

[11] API Recommended Practice 2A-WSD (RP 2A-WSD), Twenty First Edition, December 2000, Errata and Supplement 1, December 2002.

[12] API Recommended Practice 2A-LRFD (RP 2A-LRFD), First Edition, July 1, 1993

[13] AISC Allowable Stress Design and Plastic Design, July 1, 1989, with Supplement 1

[14] API RP 5LW - Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels

[15] EEMUA 158 - Construction Specification for Fixed Offshore Structures in the North Sea,

[16] AWS D1.1 - Structural Welding Code - steel

[17] IMO Resolution A.749 (18) as amended by Resolution MSC.75(69) - Code on Intact Stability

[18] International Convention on Load Lines, Consolidated Edition 2002

[19] International Regulations for Preventing Collisions at Sea, 1972 (amended 1996) (COLREGS)

[20] IMO MSC/Circ.623 - Piracy and armed robbery against ships - guidance to ship-owners and ship operators, shipmasters and crews on preventing and suppressing acts of piracy and armed robbery against ships

[21] IMO Document Ref. T1/3.02, MSC/Circ.884 - Guidelines for Safe Ocean Towing

[22] IMO BWM/CONF/36 - International Convention for the Control & Management of Ships' Ballast Water & Sediments, 2004

[23] IACS Requirements concerning Polar Class Oct 2007

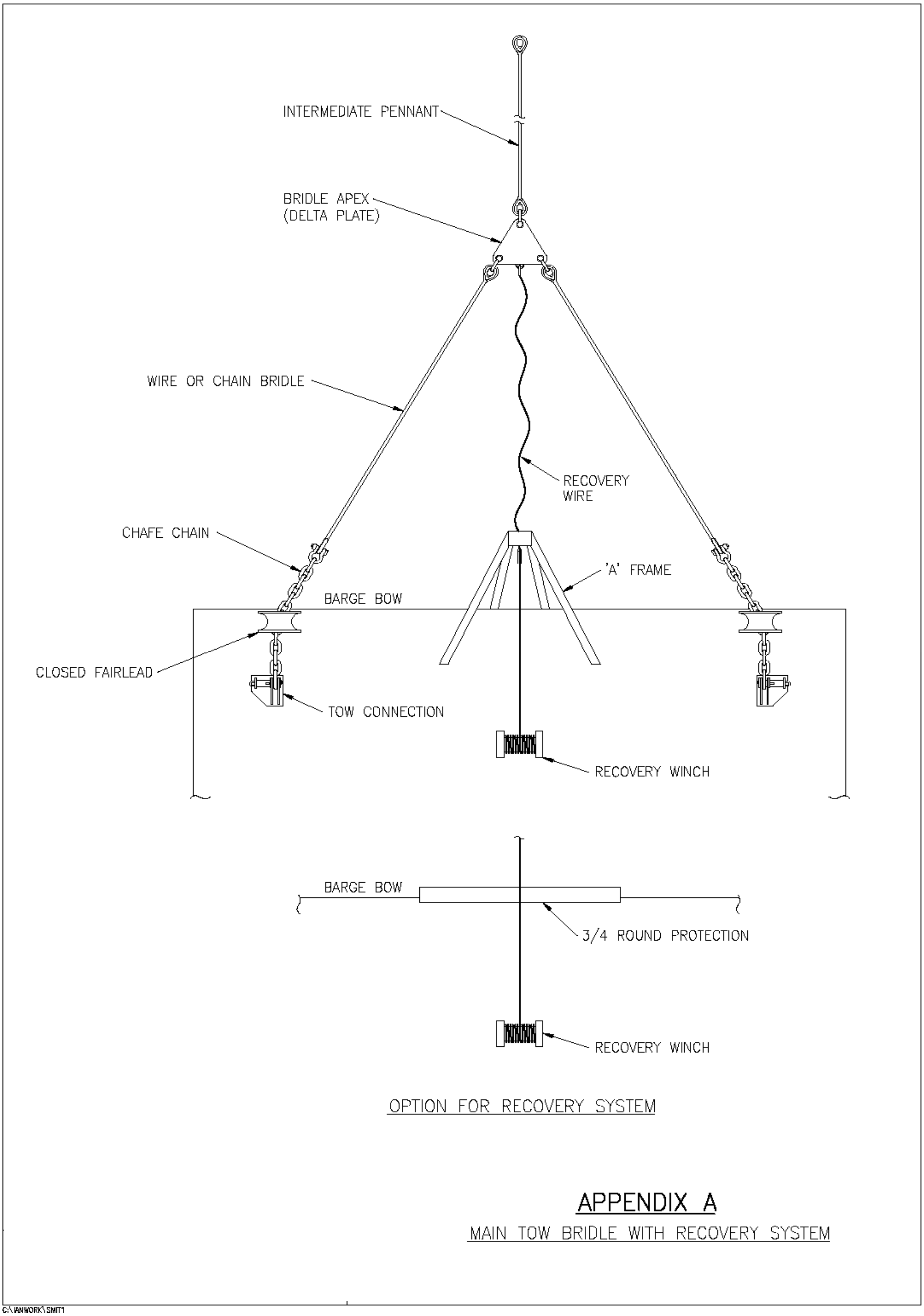
[24] UKOOA Guidelines for Safe Movement of Self-Elevating Offshore Installations (Jack-ups) April 1995

[25] UK HSE circular "The Safe Approach, Set-Up And Departure of Jack-Up Rigs to Fixed Installations" Sept 03 from www.hse.gov.uk/foi/internalops/hid/spc/spctosd21.pdf

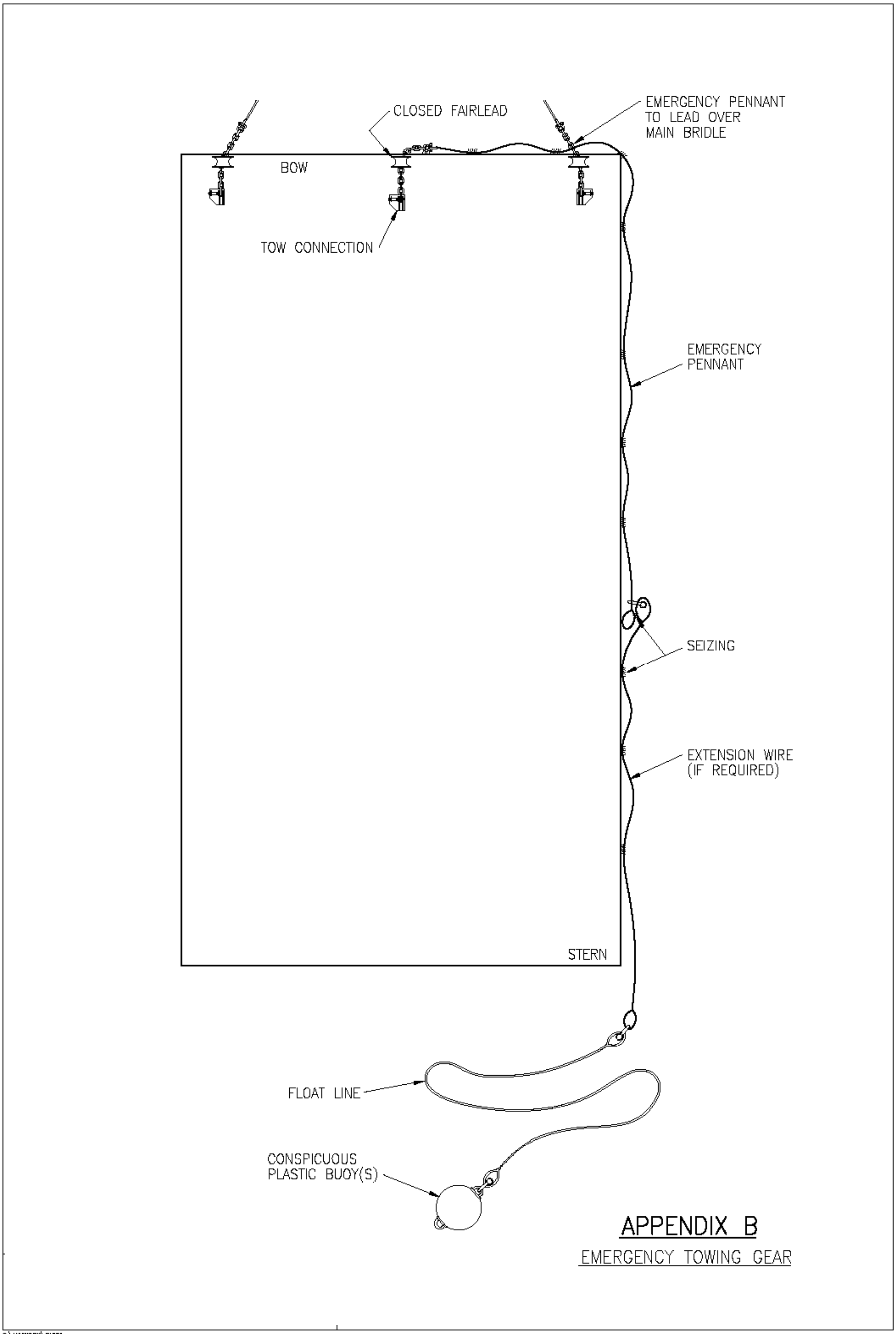
[26] Eurocode 3: Design of steel structures - Part 1-8: Design of Joints (BS EN 11993-1-8:2005)

All GL Noble Denton Guidelines can be downloaded from www.gl-nobledenton.com

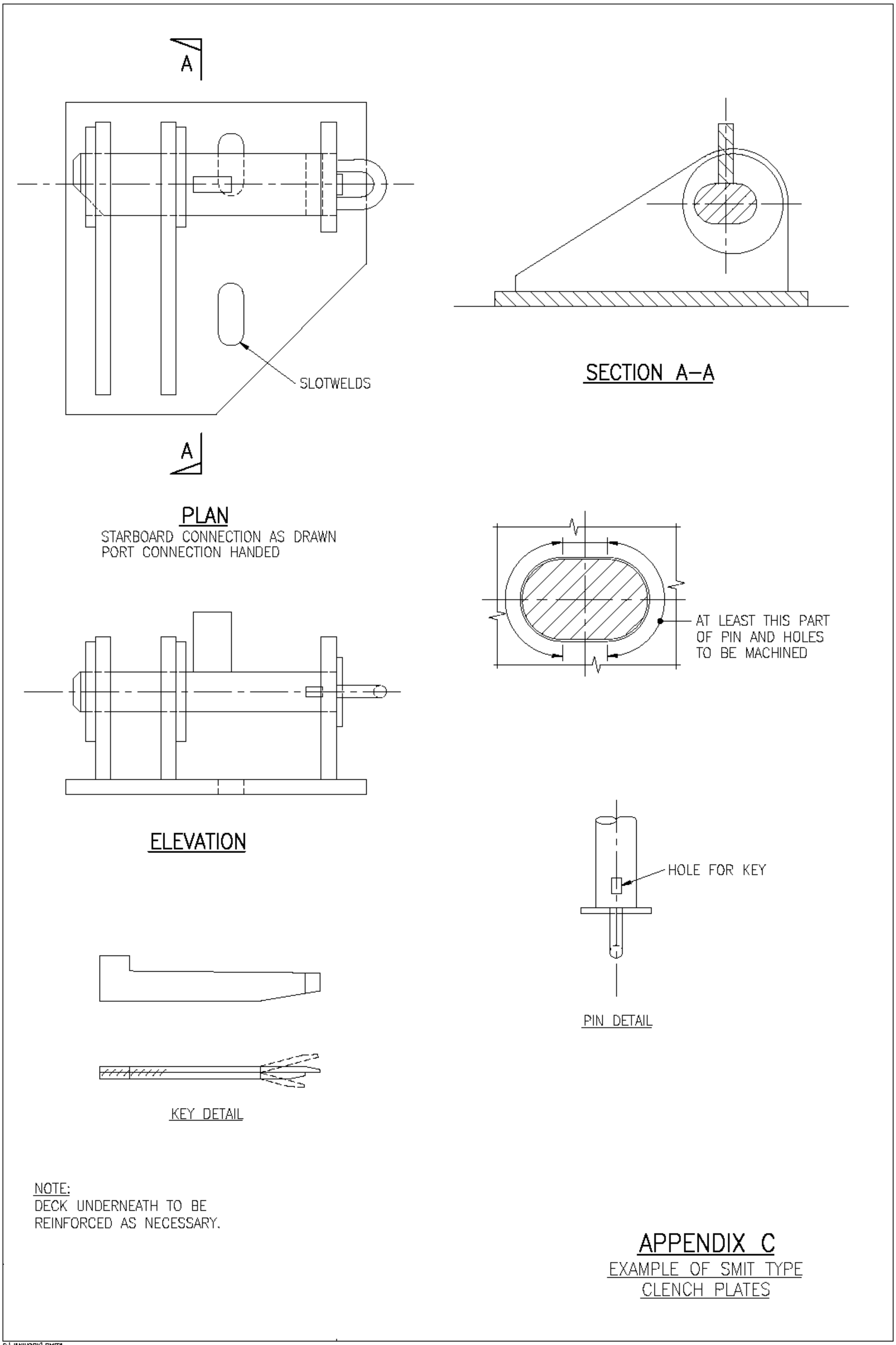
APPENDIX A - EXAMPLE OF MAIN TOW BRIDLE WITH RECOVERY SYSTEM



APPENDIX B - EXAMPLE OF EMERGENCY TOWING GEAR



APPENDIX C - EXAMPLE OF SMIT-TYPE CLENCH PLATE



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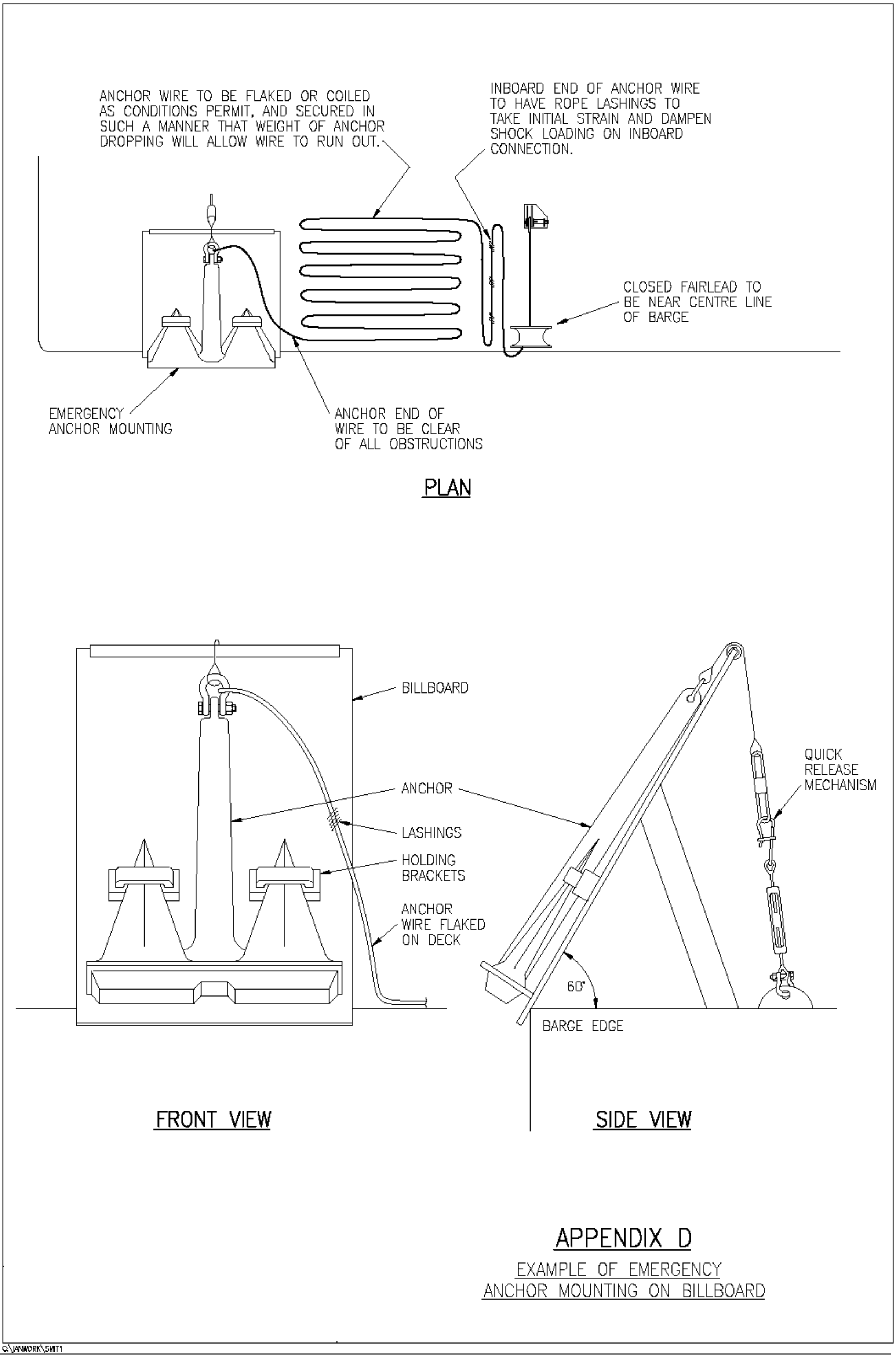
APPENDIX D - EMERGENCY ANCHOR MOUNTING ON A BILLBOARD



APPENDIX E - ALTERNATIVES TO THE PROVISION & USE OF AN EMERGENCY ANCHOR

E.1 An anchor may be required in an emergency situation, for instance in the event of a broken towline, or tug failure due to breakdown or fire. The requirement for an emergency anchor in areas of restricted searoom may be determined as a result of a risk assessment as set out in Section 16.1.2 and which should satisfy all parties that the precautions proposed are adequate.

E.2 For very large tows, such as GBS's, TLP's and FPSO's, an emergency anchor may be impractical, and alternative means of achieving an equivalent level of safety should be sought.

E.3 FPSO mooring systems (whether turret-type or spread), being only for in-place conditions, are not normally configured to act as emergency moorings during transit. On a conversion the permanent gear is usually removed. For many designs the deck space where an emergency anchor might be sited is taken up with the permanent mooring equipment.

E.4 For any tow, there are arguments for and against the provision of anchors:

For:

a. Conventional marine and insurance industry practice is that an anchor is provided, and any alternative arrangement must be justified.

b. Once access is gained to the tow, or if the tow is manned, an anchor may provide a "last resort" method of controlling the tow.

Against:

a. A chain locker must be provided together with an anchor windlass, chain stoppers etc. and these will be for one use only. A billboard arrangement, as shown in Section 16.6 and Appendix D would almost certainly be ineffective for large tows.

b. Whereas ships and ship-FPSO conversions may retain a hawse pipe, chain locker, anchor windlass, chain stoppers etc, most new build FPSO's are not fitted with these facilities.

c. For most of an ocean towage, and close to steep-to coastlines, the depth of water will be too great for an anchor to be effective.

d. If the tow is not manned, then boarding it in bad weather could pose an unacceptable hazard to the boarding crew, and deploying the anchor may prove to be impossible. In this respect a spare tug rather than an anchor would be more useful.

e. In some restricted areas, especially with pipelines, cables or subsea equipment, anchoring is prohibited, even in emergency situations.

f. Unless the anchor can be paid out under control, the shock loads when the anchor beds in and the cable comes taut may be excessive, and could result in damage, loss of the anchor or unacceptable risk to the riding crew.

g. Under adverse conditions the anchor may drag, and the tow could still be lost.

h. If 2 or more tugs are towing, then it is unlikely that any attempt to deploy an anchor would be made until all tugs or towlines had failed. If, for instance, 2 tugs were towing, dropping an anchor after a single towline failure would seriously hamper the efforts of the remaining tug to control the situation. An anchor will probably only be dropped, therefore, if all towlines break.

i. After deployment of an anchor the towage must resume at some point. The anchor must either be retrieved or cut and abandoned for later retrieval. It is probable that the tow would then be lacking an anchor, at least for a time. It is suggested that any anchor used is fitted with a retrieval pennant and buoy.

E.5 If sufficient towing capacity and redundancy is provided, in the towing spread, tugs will provide a more flexible and manoeuvrable means of controlling the tow. Reaction time will be faster and control should be possible in all water depths.

E.6 Proposed criteria, if anchor(s) are not used, include:

a. Provision of at least N main towing tugs, any (N-1) of which comply with the requirements of Section 12.2, or:

b. Provision of at least 2 main towing tugs, which together comply with the requirements of Section 12.2, and:

c. If 1 or 2 main towing tugs are provided, an additional tug will be required to escort the tow, if the tow comes within an agreed distance of any coastline or offshore hazard. (48 nautical miles is suggested as a minimum, assuming the tow may drift uncontrollably at 2 knots for 24 hours).

d. The escort tug should be approximately equal in specification to the larger main towing tug.

e. The escort tug is not always required to hook up for escort duties, but contingency plans and equipment must allow for it to be connected rapidly, either in place of one of the other two tugs, or in addition, such that the configuration is still reasonably balanced.

f. In restricted waters, if one of the main towing tugs has a breakdown, it may be preferable to connect the escort tug to the bow of the broken-down tug, rather than to the tow

g. The towage route must be drawn up showing the proximity to coastlines or other hazards, and the route sectors where an escort tug is required. Planning should ensure that the escort tug has time to arrive and connect up before the searoom is below the agreed limits.

APPENDIX F - FILLET WELD STRESS CHECKING

F.1 The effective length of a fillet weld, ***l***, should be taken as the length over which the fillet is full-size. This may be taken as the overall length of the weld reduced by twice the effective throat thickness ***a***. Provided that the weld is full size throughout its length, including starts and terminations, no reduction in effective length need be made for either the start or the termination of the weld.

F.2 The effective throat thickness, ***a***, of a fillet weld should be taken as the height of the largest triangle (with equal or unequal leg) that can be inscribed within the fusion faces and the weld surface, measured perpendicular to the outer side of this triangle, see Figure F.1.

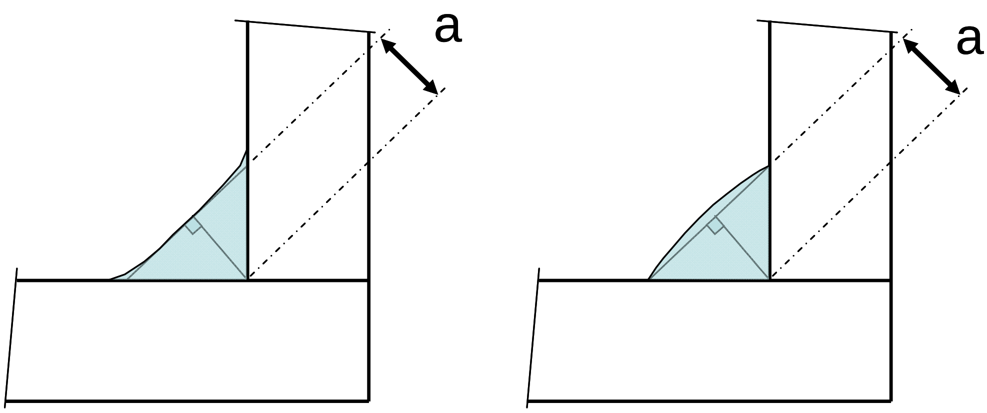


Figure F.1 Effective Throat Dimension **'a'** for concave and Convex Fillet Welds

F.3 A uniform distribution of stress is assumed on the throat section of the weld, leading to the normal and shear stresses shown in Figure F.2.

$\sigma_\perp$ = normal stress perpendicular to the throat

$\sigma_\parallel$ = normal stress parallel to the axis of the weld

$\tau_\perp$ = shear stress (in the plane of the throat) perpendicular to the axis of the weld

$\tau_\parallel$ = shear stress (in the plane of the throat) parallel to the axis of the weld

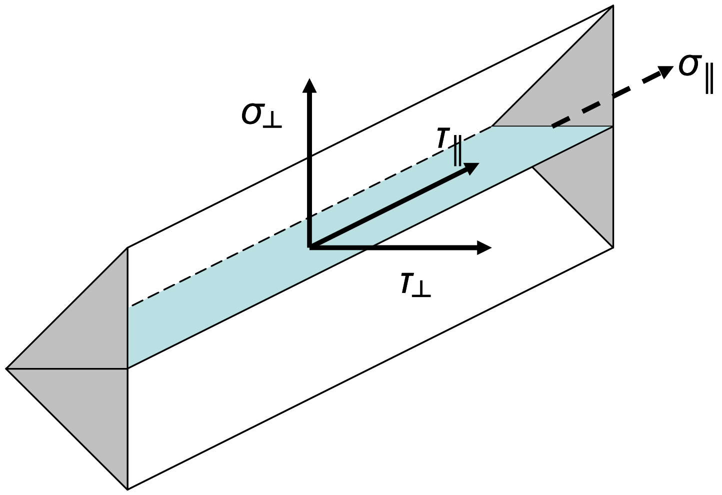


Figure F.2 Normal and Shear Stresses acting on the plane of Weld Throat

F.4 The normal stress **σ∥** parallel to the axis is not considered when verifying the design resistance of the weld.

F.5 The two stress conditions perpendicular to the axis of the weld, **σ⊥** and **τ⊥** may be considered to be equal in magnitude in the case where the load ***P*** acting on the bracket is applied parallel to the axis of the weld. This can be seen in the assumption in Figure F.2 that the load vectors should be drawn with the symmetry that is illustrated.

F.6 The design resistance of the fillet weld will be sufficient if the following is satisfied:

$$\left\{\sigma_{\perp}^{2} + 3\times\left(\tau_{\perp}^{2} + \tau_{11}^{2}\right)\right\}^{0.5} \leq \gamma_{m} \times \sigma_{yield} \qquad \text{Eqn 1}$$

Where:

σ_{yield} is the yield stress of the material

γ_m is the appropriate material factor selected

Fillet Welded Bracket

F.7 For a bracket subjected to a load ***P*** parallel to the weld line as shown in Figure F.3 and where the base structure to which the bracket is welded is adequately stiff the bending load applied to the weld line can be considered to vary linearly and the shearing load at the weld to be constant, as shown in the figure.

F.8 In this case the maximum perpendicular load per unit weld length, f_v, can be described as shown in Eqn 2.

$$f_v = 6 \times P \times h \times \frac{1}{l^2} \qquad \text{Eqn 2}$$

F.9 The uniform shear load per unit weld length, f_h, is given by

$$f_h = \frac{P}{l} \qquad \text{Eqn 3}$$

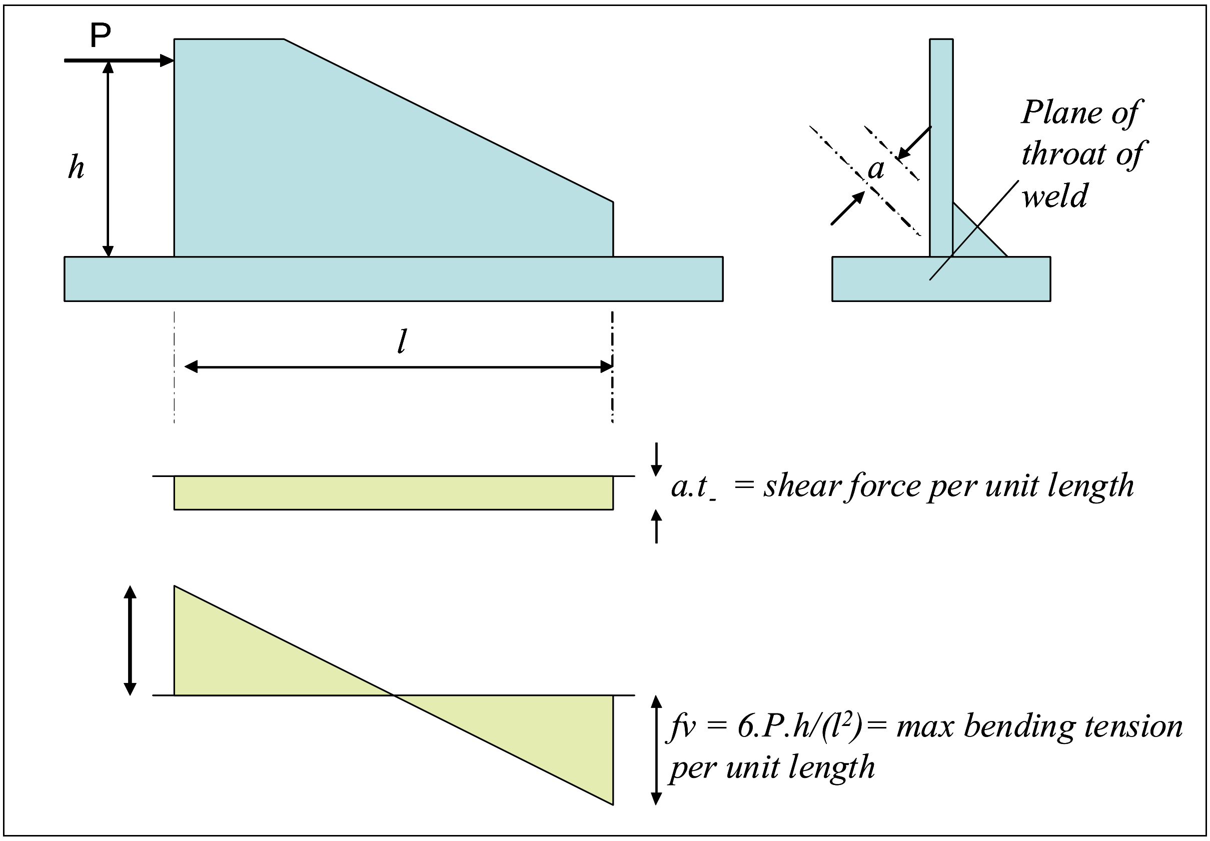


Figure F.3 Bracket connected by double Fillet Weld

Double Fillet

F.10 For a double fillet weld as shown in Figure F.4 the force ***f*v** may be considered as being resisted by a combination of normal and shear stresses acting on the throat of the weld as illustrated in the diagram. The applied load also produces a shear stress on the weld throat of $\tau_{\parallel}$ acting at right angles to the other shear stress $\tau_{\perp}$.

F.11 These stresses can be combined to form the von Misses equivalent stress (see Eqn 1). The equations for $\sigma_{\perp}$, $\tau_{\perp}$ and $\tau_{\parallel}$ are given in Eqn 4 and Eqn 5.

$$\sigma_{\perp} = \tau_{\perp} = \frac{3}{\sqrt{2}} \times \frac{P \times h}{a \times l^2}$$ Eqn 4

$$\tau_{\parallel} = \frac{P}{2 \times a \times l}$$ Eqn 5

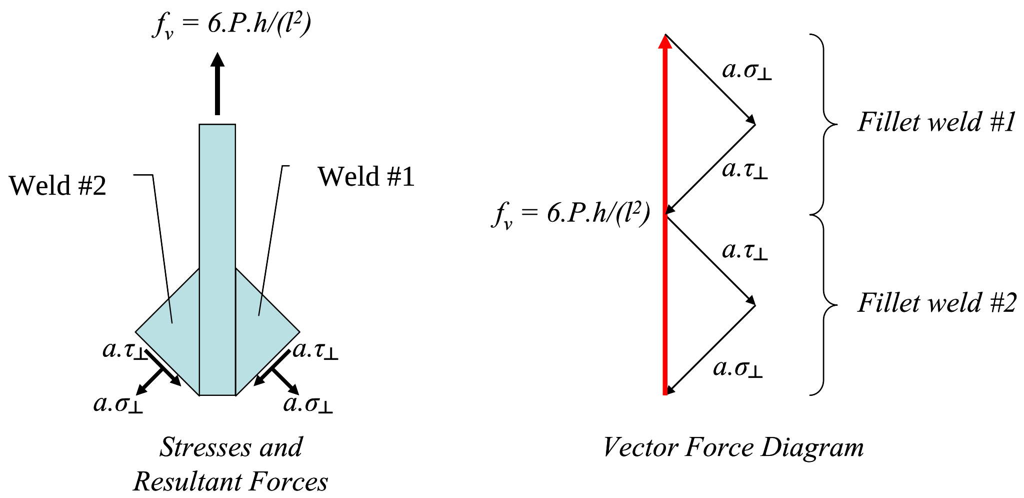


Figure F.4 Stresses and Forces acting on Fillet Weld

F.12 The resulting limiting value for the weld throat thickness, ***a***, is given in Eqn 6.

$$a \geq \left(\frac{P}{\gamma_m \times \sigma_{yield} \times l} \right) . \times \sqrt{\left(18 \times \left(\frac{h}{l} \right)^2 + \frac{3}{4} \right)} \qquad \text{Eqn 6}$$

Single Fillet

F.13 For a bracket with a single fillet weld of length ***l*** the resulting limiting value for the weld throat thickness, ***a***, is given in Eqn 6.

$$a \geq \left(\frac{P}{\gamma_m \times \sigma_{yield} \times l} \right) . \times \sqrt{\left(72 \times \left(\frac{h}{l} \right)^2 + 3 \right)} \qquad \text{Eqn 6}$$

Selection of Yield Stress and Material Factor

F.14 The yield stress used should be the lowest of the yield stress values of the weld itself and the two parts of metal welded together.

F.15 The material factor, γ_m, shall be taken as 1.0.

Note: The **applied loads** shall be increased by the following factors:

1.40 for serviceability limit state (SLS) checks and

1.05 for ultimate limit state (ULS) checks.

APPENDIX G - TRANSPORTATION OR TOWING MANUAL CONTENTS

G.1 The purpose of the transportation or towing manual described in Section 5.4 is to give to:

- the vessel or tug Master and
- Persons In Charge (PIC), or Responsible Persons ashore for emergency response planning in the event of an incident or accident,

information about:

1. The cargo,
2. Routeing, including possible deviations to shelter points if required,
3. What to do in an emergency,
4. Contact details (client, owner, local authorities, Marine Warranty Surveyor etc.),
5. Organogram showing the scope split between different contractors (if applicable). These must be clearly defined, to ensure that all parties are aware of their responsibilities, handover points and reporting lines.

G.2 The contents of the manual shall be in a form and language that can be clearly understood by the Master and senior officers undertaking the operations.. Revisions should be clearly marked and attached drawings, with their revision numbers noted in the main text. 4

G.3 Where a manual has been produced to satisfy local authority requirements then this should take precedence, providing it satisfies the main requirements detailed below.

G.4 The list below is what the Marine Warranty Surveyor would expect to see in the transportation or towage manual. The list also includes the essential details needed by the vessel's Master. Detailed calculations and other documents may be in separate manuals referenced in the transportation or towage manual.

1. Introduction. What is the cargo, where is it being transported or towed, who for and why.
2. Description of the vessel and cargo.
3. Proposed route (with plot or chart) including waypoints and any refuelling arrangements, anticipated departure date and speed.
4. Metocean conditions for the route for anticipated departure date.
5. Any limiting criteria and motions (roll, pitch and period etc) for the transport or tow, weather forecasting arrangements and weather routeing details if applicable.
6. Contact details and responsibilities.
7. Reporting details: who to, how often and content.
8. Summary of ballast conditions and stability (usually including anticipated departure and arrival loading conditions) with corresponding stability calculations and GZ curves. Calculations should also be provided for any ballasting required for loading or discharging where applicable.
9. Motions and strength - detailed supporting calculations for the motions and accelerations, longitudinal strength and strength of the seafastening and cribbing/grillage.
10. Arrival details, contacts, field plan etc.
11. Contingency arrangements.
12. Drawings to include, where applicable, cargo, GA and other key drawings of vessel and cargo, stowage plan, towing arrangement, cribbing /grillage arrangement, load-out /discharge plan, seafastening arrangement, guidepost details etc.
13. Reference documents.
14. Tug bollard pull calculation (if applicable).
15. Tug or transport vessel specification.