



► **LOSS PREVENTION**

Tugs and Tows – A Practical Safety
and Operational Guide



SHIPOWNERS

SECURITY FOR SMALL & SPECIALIST VESSELS

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The information and recommendations in this booklet are given in good faith and are meant to highlight best practices, good seamanship and common sense to reduce incidents that result in related claims. However, Members must take into consideration the guidance and regulatory requirements given by flag states and other governing authorities when formulating policy in line with the contents of this publication.

NOT TO BE USED FOR NAVIGATION.

► Foreword

The Shipowners' Club provides P&I insurance for smaller and specialised vessels around the world, including those that engage in towage operations on a daily basis. It is while involved in this activity that incidents resulting in damage, injury or even death may occur. After an analysis of the claims notified to the Club over a two year period it was observed that 53% of all towage related claims were due to primary cause, 'human factor', with the initial claim being attributable to poor maintenance, crew negligence, sub-standard navigation, as well as inadequate operational and safety procedures. It is hoped, therefore, that training will assist in the avoidance or reduction of these incidents.

This booklet has been produced to assist in raising awareness of some of the practical aspects of a towage operation with a view to assisting mariners who may not be fully familiar with these processes.

▶ Contents

| | | |
|------------------|---|-----------|
| | Introduction | 5 |
| | Scope | 6 |
| Chapter 1 | P&I Cover Applicable to this Operation | 7 |
| | Customary and non-customary towage | 7 |
| | Towing surveys | 8 |
| Chapter 2 | Different Tug Types | 9 |
| | Conventional tugs | 9 |
| | Azimuth stern drive tugs (ASD) | 10 |
| | Tractor tugs | 10 |
| | The Rotor tug | 11 |
| Chapter 3 | Responsibilities | 12 |
| Chapter 4 | Manning and Training | 13 |
| Chapter 5 | Safety Management | 14 |
| Chapter 6 | Planning | 15 |
| | Tow plan | 15 |
| | Preparations on board the tug | 16 |
| | Checks on board the towed vessel or barge | 17 |
| | Planning for rough water | 18 |
| | Passage planning and bridge equipment | 19 |
| | Navigation | 20 |
| | Emergency planning | 21 |
| Chapter 7 | Stability | 22 |
| | Forces during towing in a horizontal plane | 23 |
| | Forces during towing in a vertical plane | 24 |
| | GZ stability lever | 26 |
| | Stability of towed unit | 29 |

| | | |
|------------------|---|-----------|
| Chapter 8 | Towing Operations | 30 |
| | Bollard pull (BP) | 30 |
| | BP calculation | 31 |
| | Pivot point | 32 |
| | Position of tug and interaction | 33 |
| | Girting, girding or tripping (GGT) | 36 |
| | Gob/Gog wire or rope | 40 |
| | Emergency quick release systems for towline | 42 |
| | The effect of wind | 42 |
| | The effect of current | 42 |
| | Other concerns effecting manoeuvrability | 46 |
| | Length of towing line | 46 |
| | Shortening the length of the tow | 47 |
| | Establishing the tow connection | 47 |
| | Position of barges | 48 |
| | Towing alongside | 49 |
| | Pushing ahead | 50 |
| | Double tows and tandem tows | 51 |
| | Single wire under rider tows | 53 |
| | Two wire tows | 54 |
| | During the tow | 54 |
| | Inspections during the towage | 55 |
| Chapter 9 | Loss of Tow Wire | 56 |
| | Emergency towline rigging | 57 |

| | | |
|-------------------|--|-----------|
| Chapter 10 | Towing Equipment | 60 |
| | General | 60 |
| | Planned maintenance system (PMS) | 60 |
| | Testing and certificates | 62 |
| | Towing winch | 62 |
| | Towing hook | 64 |
| | Bollards, fairleads and sheaves | 64 |
| | Towlines, wire and synthetic ropes | 64 |
| | Shackles | 66 |
| | Towing bridle | 67 |
| | Ancillary equipment | 68 |
| | Navigation lights and shapes | 68 |
| | Safety factors | 69 |
| | Strength of towline and towline connections (outside ice areas) | 69 |
| Chapter 11 | Personnel Injury Risk | 70 |
| Chapter 12 | Communication | 72 |
| Chapter 13 | Record Keeping | 73 |
| Chapter 14 | Other Risks – Piracy | 74 |
| Annex 1: | Case Studies | 75 |
| Annex 2 | Acknowledgements and References | 83 |

Introduction

This booklet has been produced by the Club in response to the increasing number of claims and incidents arising from towage operations which have resulted in injuries, groundings, collisions, pollution, property damage and loss of cargo.

From 20th February 2011 to 20th February 2013 all claims incidents notified to the Club were analysed for primary cause. Throughout the booklet we have included cases that were highlighted in this study with the aim to share the Club's experiences so that other Members may prevent a similar event from occurring.

Most tug and barge safety regulations focus on hardware and yet experience shows that a good safety record depends upon the safety culture of the entire company. The hardware issues are important, including the proper maintenance and inspection of equipment, but managing the human factor successfully would also lessen the number of accidents.

This guide is drawn from the accumulation of experience within the Club and from industry sources including IMO MSC/Circ 884¹ (Guidelines for Safe Ocean Towage). It highlights good towing practices and illustrates learning points from reported incidents. It is general in nature and is not intended to replace regulatory requirement, specific company procedures and guidelines, or what is learnt from simulator training and is intended to assist crews to perform a safe towing operation.

¹ For the purposes of this manual we use the definitions noted in the IMO MSC/Circ.884

Scope

The work that tugs and tow boats carry out is inherently risky. However, the risks can be managed and reduced with proper care and good practice.

This book is aimed at small tugs and work boats involved in towing and work boat operations which may not be required to be fully regulated. These tugs² may legitimately be less regulated, because of size, jurisdiction or operating area. The risks in their operations are similar to and in many cases exceed those of the more internationally regulated tugs.

This booklet does not address the working practices of pusher type tugs or integrated tug and barge units in detail. In addition, offshore, ocean towing or salvage industry operations and harbour tugs working in ports and terminals are not covered as it is likely they are governed by the IMO, flag states or by the port authorities.

The Club's towage claim statistics show that some 53% of incidents are caused directly by human error and 12% by inadequate navigational procedures. Whether the incident was caused by crew negligence, poor maintenance, poor navigation, inadequate operational/safety procedures, lack of knowledge or training, it is clear that if the human factor is addressed, incidents will decrease dramatically.

² Where a reference is made to tugs this also includes workboats where applicable.

Chapter 1

▶ P&I Cover Applicable to this Operation

Traditional P&I cover includes; collision claims, damage to third party property, injury or death to the crew, liability to passengers or cargo, liability for wreck removal and certain fines and penalties.

However, the liabilities covered when towing are often misunderstood and covered by three principal sub-sections to the Towage Rule.

- Customary towage of an insured vessel.
- Non-customary towage of an insured vessel.
- Towage by an insured vessel.

Tug masters should be aware that generally insurance cover provided by the P&I club traditionally excludes any loss including wreck removal or damage to the towed object and its cargo or property thereon. If the tug is not towing under an approved contract the Club may be able to provide cover for liabilities for loss of, damage to or wreck removal of the tow or cargo by special agreement.

It is within the Rules of the Club that as a third party liability insurer it requires notification when a non-customary towage is to be embarked upon. This is to ensure that certain aspects of the tow are checked and confirmed by an independent surveyor, providing the assurance that risks have been minimised. This will include the plan for a non-customary tow. When a customary towage operation is scheduled it is expected that appropriate planning steps have been taken by the Member.

Customary and non-customary towage

The Club Rules lay out its liabilities for customary and non-customary towage. The Rules should be referred to or the Club contacted if in any doubt about insurance cover for a towage operation.

Customary towage of an insured vessel refers to the liabilities arising under the terms of a contract for the purpose of entering/leaving port or manoeuvring within a port during the ordinary course of trading. It can refer to towage of an insured vessel as habitually towed in the ordinary course of trading from port to port or place to place.

Non-customary towage is all towage which is not customary. Liabilities arising from a non-customary towage under the terms of a contract for towage of an insured vessel other than the customary towage mean any other towage arrangement; so long as the cover has been agreed by the Club in writing. Therefore, if the towage to be undertaken is an unusual operation which the Club is unaware of, prior agreement needs to be sought from the Club to ensure continued insurance cover. The Club, on receipt of this information, may require that a fitness to tow survey is carried out by an approved surveyor so that all risks are evaluated.

Towing surveys

Different insurers will require an insurance towing survey, sometimes called a Towing Warranty survey or Fitness to Tow. These must be carried out by an experienced and independent surveyor. The scope of the survey will depend on the nature of the towing operation and often it may be combined with a Hull & Machinery (H&M) or the cargo insurer's survey. The survey is to establish if the towage arrangements for the tow, including the towing vessel or tug/s, the towed unit/s and cargo are fit for the intended voyage.

This includes:

- Satisfactory condition of the tug, barge and cargo stowage.
- Confirmation that the tug is manned with appropriate crew.
- Ensuring sufficient bollard pull and tug power to complete the operation.
- Satisfactory condition of the towing arrangements, equipment, gear and emergency arrangements.
- Satisfactory evaluation of the stability of tug and tow and lashing arrangements of any cargo on the towed vessel.
- Satisfactory towage plan, including intended passage.

Chapter 2

▶ Different Tug Types

It is important to understand, in the context of towing, that tugs with different design features have different handling characteristics. These could be, but are not limited to, a combination of hull profile, engine and/or rudder type and thruster's configuration and towing winch design, power and location.

Conventional tugs

These tugs are used worldwide and their characteristics vary. These tugs can be equipped with fixed propellers, single or twin screw (left or right-handed) and single rudders with fixed nozzles. New buildings may have steering or nozzles, controllable pitch propellers and nose rudders. Tugs may be fitted with tunnel or retractable azimuth thrusters. Work boats would usually fit into this category of craft and their general characteristics are:

- Manoeuvrable and effective for most work, but less manoeuvrable than Azimuth stern drive tugs (ASD) or tractor tugs.
- Good steering ability, especially as a forward pulling tug.
- Good sea-keeping ability.
- Good bollard pull to power output.
- Towing point is usually situated just aft of amidships.
- Astern bollard pull reduced by up to 50% of forward bollard pull.
- Increased risk of girting/girding when towing.

The position of the pivot point when no tow line is fast is similar to a conventional ship, about one quarter from the tug's bow. Once the towline is attached the pivot point moves astern to the towing point, usually the towing hook. This distance from the rudder has been reduced although the turning moment is still appreciable. If the tug is dragged astern there is an increased risk of girting. The use of a gob wire moves the towing point aft, allowing the tug to be dragged astern with a reduced risk of girting. This is an appreciable risk to conventional tugs and getting out of a girting situation by manoeuvring alone is often not possible. This subject will be addressed later (see page 36).

Azimuth stern drive tugs (ASD)

This tug type is fitted with two azimuth thrusters in nozzles at the stern and with bow tunnel thrusters. Some are fitted with controllable pitch propellers (CPP). General characteristics of ASD tugs are:

- Low relative draught.
- Good steering characteristics, except when going astern at higher speeds.
- Towing point is just forward or just aft of amidships.
- Underwater hull form improves the dynamic stability of the tug.
- Bollard pull going astern is reduced only by approximately 10%.
- Manoeuvrable and able to pull effectively over the stern or bow. Towing winches often fitted both fore and aft.
- Risk of girting/girding when towing over the stern.
- Enhanced training of tug masters required when operating the forward winch.

Tractor tugs

The design of tractor tugs is unlike that of conventional tugs. The propulsion units are fully turning controllable pitch blades, able to give thrust in any direction and act as steering units or azimuthing fixed or controllable pitched propellers. The propulsion units are placed far ahead of the towing point, close to the pivot point thereby producing a large turning momentum. This potentially gives a poor steering performance, which is overcome by fitting a large centreline skeg. Their general characteristics are:

- Full power available in all directions.
- Quick response to engine movements.
- Very manoeuvrable, especially in tight sea space.
- Reduced risk of girting/girding.
- Reduced manoeuvrability if towing from forward at higher speeds.
- Reduced directional stability, particularly in open waters.
- Reduced bollard pull per kilowatt output.
- Relatively deeper in draught therefore increased risk of bottom damage from grounding.
- Increased training required for tug masters.

The Rotor tug

The rotor tug is a patented tug design and is different to the others. It uses a propulsion configuration consisting of three azimuthing thrusters placed in a triangular configuration, sometimes called a triple Z drive. Two units are placed forward and one astern on the centreline of the tug. The manoeuvrability of this type of tug is reported to be better than other conventional designs. Many ports are adopting this type of design for ship assistance. Rotor tug characteristics include:

- Highly manoeuvrable, useful in confined spaces.
- Similar towing ability from forward or aft towing winch.
- Good towing performance over the stern and bow; 100% bollard pull ahead and astern; 65% of bollard pull athwartships.
- Good residual redundancy in engine failure.
- Additional tug master training required.

Whatever the tug type it is important that the tug master is fully familiar with his vessel; this includes how the tug manoeuvres in different circumstances. Experience shows that accidents happen when a person is new to a tug type, highlighting the need to train personnel on safe operational practices and safe use of the controls.

Chapter 3

► Responsibilities

Organisational command lines should be established and responsibilities and duties clearly defined before a new towage commences.

The tug master is at all times responsible for the vessel and crew and if acting as towing master also responsible for the towed unit. The tug master should always be satisfied before departing that his vessel is:

- Compliant with appropriate regulations and all machinery and equipment is in good order and fit for the intended tow.

In addition:

- Crew are correctly certified, trained and using correct and appropriate personal protection equipment (PPE).
- Communications are established with the tow and tow master.
- Towing gear is in good condition and prepared.
- Watertight doors, hatches and ports are closed prior to the tow commencing.
- The barge certification is in order and the stability of the barge has been verified where applicable.

It must be clear between the parties (other tugs etc.) who the towing master is and his responsibilities. Investigators often cite the failure of not having someone in overall control of the towing operation as a factor in incidents. All personnel should be aware of their own responsibilities and tasks.

Chapter 4

▶ Manning and Training

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Code) is often not applicable to towage operations carried out in some jurisdictions, particularly for non-international voyages, such as river passages. The manning of the towing vessel may be determined by an appropriate regulatory authority; however it is the responsibility of the owner/operator to ensure that the tug is manned with adequately certified and experienced personnel for the voyage. Following an accident it has sometimes been found that the cause was due to unqualified personnel, in which case P&I insurance cover could be compromised.

The towing master should be aware that inexperienced personnel must not be exposed without training and supervision to carry out high risk tasks, such as hooking up or releasing the tow. It is also the custom and practice in many areas that personnel supplied by barge operators are often part-time, contracted in and therefore possibly inexperienced and poorly trained. Their actions can therefore impact on the safety of a towing operation.

Training should be frequent and recorded in ship's log books. This should cover safety aspects such as lifesaving and fire-fighting, and:

- Dangers of and the safe practices for hooking up and releasing a tow.
- Capabilities and limitations of the towing equipment.
- Controls of the winches and use of the emergency quick release mechanism.
- Emergency contingency plans for if the wire/rope parts during a tow. Dangers associated with reconnecting the tow.
- Dangers associated with girting (girding) situations.
- Dangers associated with main engine or electrical failures.
- Risks associated with working in heavy weather and strong currents.
- Shortening the tow line.

An effective safety management system (SMS) allows these training requirements to be formalised and become second nature.

Chapter 5

▶ Safety Management

Although many towing companies are not required to comply with the ISM code, it is however recognised that implementing an SMS is consistent with good practice. A structured and recorded system of an appropriate size to the operation not only improves safety, and protects the employees but also protects the owner/operator. It is difficult to comply with accepted good practice if no SMS system is in place.

Experience shows that accidents often occur during routine operations and an SMS assists to identify the risks, allowing important lessons to be learnt so they will not be repeated.

Risks are increased with:

- Poor planning.
- Poor communication.
- Poor supervision.
- Failure to appreciate the dangers of a task or operation.
- Lack of experience or knowledge.
- Misuse of equipment.
- Taking of short cuts, possibly due to commercial pressure.
- Unpredictable environmental factors such as weather, tide or current.
- Changes or unappreciated factors of the tow, such as cargo shift.
- Unexpected events, such as equipment failure or unusual traffic movements.

Effectively managing the human factor can lessen the exposure to accidents. A safety management system allows a company to put into place the building blocks for reducing incidents of human error.

Chapter 6

▶ Planning

Incidents may occur because no pre-planning was carried out. Case Study One in Annex I highlights the type of incidents that can occur if the operations are not thought through prior to commencing the towage operations. In this case the local port authority was not informed of the proposed towage operation and therefore important impending traffic information was not received by the parties concerned. A further case of a similar nature, is highlighted in Case Study Three.

In all incidents pre-planning may not have been carried out for a variety of reasons; sometimes it is because the task is considered routine or there is no time available. Often, the argument is made that hands-on operational type work cannot be planned. However, in the form of a risk assessment it may effectively reduce the risk to personnel, damage to the environment and property.

Tow plan

Planning and preparation before a tow commences might include:

- Assessing the size and type of vessels or barges to be towed and any limitations of the tow.
- Confirmation that the tug is of suitable; size, manning, sea-keeping, horse power (HP) and bollard pull (BP).
- Tow wire and towing equipment is suitable for the planned tow.
- Route to be taken and passage planned, including safe transit times (day/night transits), times when passing through narrows, under bridges or areas of high traffic density, tight bends in rivers and adjacent river berths.
- Noting any areas of reduced depth, tidal limitations and currents expected during the voyage. A list of bridges with maximum and minimum height; tide height for each arch to be passed under showing the bridge's maximum air-drafts.
- Weather forecasts to include outlook for at least 48 hours.
- Confirmation of sufficient fuel, water, spares on board.
- Navigational information and warnings.
- Recommended speeds to comply with river regulations.
- Connection and disconnection arrangements.
- Stability of the tug and towed unit.
- Emergency contingency plans.

Preparations on board the tug

It is essential that checks should be completed on board the tug and vessel or barge to be towed, which should include:

- All water/weathertight openings are securely closed with signs indicating that they should remain closed for the duration of the voyage. It is a reality that tugs have capsized as a result of doors and ports being left open when in difficulty, e.g. girting. down flooding is a real danger to small tugs.
- Life-saving and fire-fighting appliances must always be operational.
- Navigational equipment, wheelhouse whistles, horns, shapes for day signals and communication gear are fully operational.
- All critical machinery prior to commencing a towing operation should be confirmed as operational – this would include; main engine, steering gear and towing equipment (winches, wires) etc.
- All personnel are fully familiar with the intended towage plan and their responsibilities.
- Any change of fuel and ballast to the tug and/or tow have been fully calculated and the crew are aware of any factors of concern.

Checks on board the towed vessel or barge

The tow should not proceed until a satisfactory inspection of the tow has been carried out by a competent party.

Checks should include:

- Condition of the towing arrangements.
- Condition of the anchoring equipment if fitted. If not fitted some authorities require a temporary anchor to be supplied of an adequate weight.
- Condition of tow including an inspection of the peaks and buoyancy spaces to check for water ingress.
- Watertight integrity of the unit to be towed; obvious signs of damage, especially in the hull and deck plating. Hatchways, ventilators, doors, scuttles, manholes and other openings are closed and sea valves shut.
- Fore and aft drafts, appropriate freeboard for the voyage and no evidence of a list. Generally a slight trim by the stern ensures that the tow is laterally stable when towed
- Air draft of the tow, appropriate for the voyage and bridge transits.
- Power is available for navigation lights.
- Safe method of boarding available (portable or fixed rungs).
- Emergency towline rigged.
- Life-saving and fire-fighting appliances are in good condition and in the regulatory number required.
- Cargo, whether it is bulk cargo (within the holds), containers or break bulk cargo can shift causing the barge to capsize and sink and therefore stowage and securing arrangements must be verified as adequate for the intended voyage prior to departure.
- Some bulk cargoes pose a serious hazard, including spoil and certain ore cargoes which are liable to liquefaction e.g. spoil cargoes can contain a high amount of moisture which can assume a liquid state in a seaway and can cause the barge to lose stability, list and even capsize. Reference should be made to the IMO International Maritime Solid Bulk Cargoes (IMSBC Code). When it is suspected that cargoes with high moisture content have been loaded onto a barge advice should be sought.
- If cargo is liable to move e.g. vehicles and timber, the lashing arrangements and sea fastenings should be inspected.

The tug master, shipper and/or P&I club may require an assessment to be made by a recognised organisation of the barge under tow and its cargo, including structural strength and cargo fastenings.

The British Tugowners Association has produced a comprehensive best practice guidance for tasks to be checked prior to performing a towage operation. This concentrates on the basic safety standards to be adhered to without taking into account local requirements. The guidance is available on: www.britishtug.com/extras/best_guidance_practice_01.pdf

Planning for rough water

Rough water in the context of a small tug or workboat is not restricted to being caused by strong winds. The Club has suffered many claims where the tug and tow unit have contacted a third party vessel, berth or other fixed floating object due to misjudging the prevailing weather conditions when manoeuvring. Adverse weather conditions can be caused by any of the following:

- The action of wind against tide.
- Tidal bores, rip tides or strong currents.
- Interaction of strong river currents and prevailing currents/winds e.g. at mouths of large rivers.
- Sudden changes in the current due to increased rains.
- Turbulence, undertows and/or wash reflected off river or channel banks.
- Wash from passing craft.
- Geographical/seasonal issues such as the freshet where operations on the Fraser River are affected by the seasonal ice flows.

The effects of rough water on a tug and tow can be appreciable and in extreme cases water over the bow of the tow can impact on barge stability. Extra strain on towing and mooring lines and potential damage to barges being towed alongside or in tandem can occur.

In order to reduce the potential of an incident due to rough weather the following should be considered:

- Delay departure and wait for an improvement in weather or tide.
- Anchor or tie up and wait for an improvement in weather or tide.
- Reduce speed of tow.
- Increase the length of the tow to compensate for power surge and wire tension due to tows movement in the seaway/swell.
- Consider towing astern if tow is arranged for towing alongside.
- Alter course.

Passage planning and bridge equipment

Reference material is available on passage planning, including IMO Res.893 - Guidelines for Voyage Planning, which states that the need for voyage and passage planning applies to all vessels. A large part of a towage risk assessment can be included in the appropriate passage plan. Even for experienced tug masters, plying familiar waters, the formal process of planning the voyage, however short, is a useful one.

A passage plan as a minimum should include and consider, but not necessarily be limited to the following:

- Plotting the intended route on appropriate, large scale and up to date chart.
- Reference to appropriate routing and passage information, publications, sailing directions and local information published by competent authorities.
- Towing draughts in relation to water depths and under keel clearances.
- Proximity of other shipping traffic and anticipated high traffic density areas.
- Manoeuvrability of tow in relation to the navigational channel constraints, including river and river bank operations e.g. construction or diving.
- Current and tidal information.
- Weather information and forecasts, in particular forecasted restricted visibility.
- Reporting positions and vessel traffic services information.
- Safe anchorages/places of shelter.
- Tow speed and adjustments to pass danger points.

- Consideration whether night-time transits should be restricted.
- Air-draft restrictions for passing under bridges.
- Navigational warnings, changes to navigational marks or lights.
- Available wheelhouse personnel, potential working hours and fatigue during the passage.

Current and tidal information may not be accurate even in well charted areas and therefore local knowledge may have to be relied on. Tugs work in all waters and at times extraordinary currents are a problem. In some rivers and inland waters where very high tides, heavy rains, or heavy ice melt has occurred, currents of 16 knots are not unusual (navigating through these areas, in and around slack water, is preferable if that option is available).

In addition it should be ensured that all critical bridge equipment must be in good working order prior to commencing any operation.

Navigation

The tug and tow should always comply with the local navigation rules and/or The International Regulations for Preventing Collisions at Sea 1972 (COLREGs) as appropriate, including displaying of the correct lights and shapes as required by the rules. The basics of navigating are the same for a tug as for other vessels and experience shows that keeping a look out at all times remains fundamental however sophisticated the electronic navigational equipment on board is.

Particular difficulties arise for tugs and tows when navigating through narrows or between bridges. Sea room becomes restricted, eddies and currents can be generated by the bridge structures. Tows should always be under control when approaching a bridge and the tow line can be shortened to assist with this (see page 47).

Emergency planning

A prudent towing plan includes 'what if' situations, unexpected events that could happen during the tow. This preparation could be a formal plan for specific contingencies and/or training.

Consideration should always be given on how to transfer personnel and equipment to the towed vessel or unit during an emergency. Personnel should always wear life-jackets and utilise communication equipment and portable lights during darkness. The safety of personnel is paramount and a transfer should not go ahead if considered too dangerous.

Contingency plans could include the following:

- Girting or girding situation (see page 36).
- Failure or parting of the tow wire.
- Failure of gob wire arrangements.
- Grounding of the tug or tow.
- Loss of hull integrity in either tug or towed vessel.
- Collision or contact with a fixed object or installation.
- Loss of main propulsion power or electrical power.
- Failure of steering and/or other critical control systems.
- Man overboard.
- Bridge, accommodation or engine room fire.
- Actions to take in the event of unexpected poor weather.

Chapter 7

▶ Stability

The Shipowners P&I Club booklet, 'Basic Stability for Small Vessels', is a useful reference for understanding basic stability concepts and is freely available to our Members on request or available to download on our website www.shipownersclub.com/lossprevention.

Conventional tugs in particular can experience very large tow line forces, sometimes in excess of the bollard pull. Good static and dynamic stability is required to accommodate the high forces likely to be experienced.

The IMO has established criteria, including static stability curve requirements applicable to vessels over 24 metres in length on international trades. Other administrations and classification societies have set their own standards for small tugs and workboats. The International Association of Classification Societies (IACS) in 1998 recommended additional stability criteria, but these are not mandatory. The stability requirements, especially for smaller tugs and work boats, are not internationally harmonised and do not always take account of high towline forces. Even though the amount of stability data available may be regulated by the flag state or classification society, it is possible that no specific data is available on board accounting for the high towline forces. The tug master should be aware of the safe stability requirements for his vessel.

The stability of a tug is determined by the heeling moment occurring during towing and what safety margin is applied. Authorities can judge safety margins differently.

The heeling moment is caused by:

- The tow, when the tug is dragged by the tow line.
- The tug, when the heeling moment is caused by the combined action of its rudders, propellers, towline or hydrodynamic lateral force on the hull.
- A combination of the above.
- Water ingress.

Forces during towing in a horizontal plane³

The towline force has to be counteracted by the tug and this is done by the thruster forces or by the drag forces or by a combination of both.

In the case of a tug with a forward towing point and aft positioned azimuthing thrusters, a thruster force in the direction of the towline is needed for horizontal equilibrium. In the case of a tug with an aft towing point, a thruster force in the opposite direction of the towline is needed.

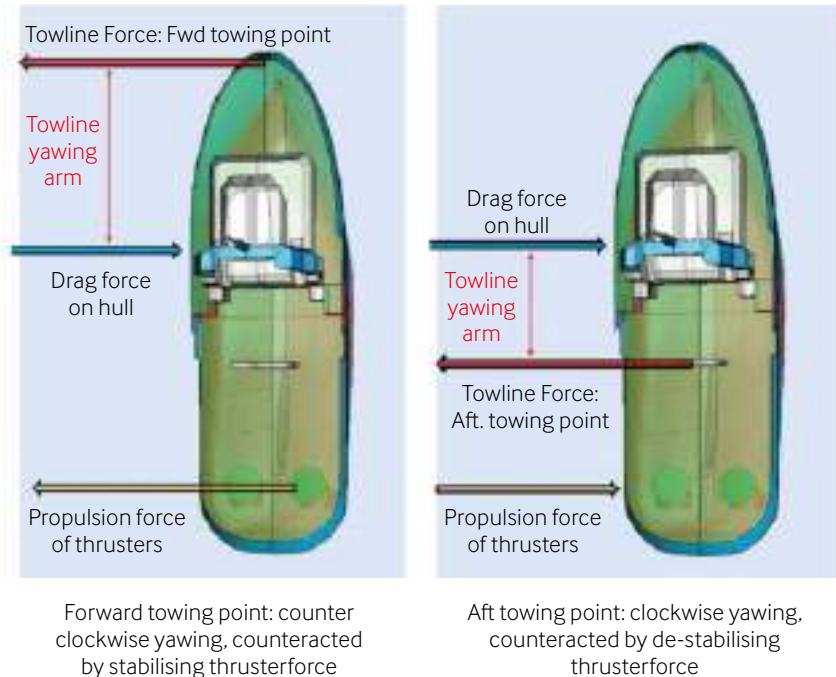


Figure 1
Forces during towing in a horizontal plane

³ The Dutch Safety Board report on the FAIRPLAY22, Report No. ASD 11-03 of February 2012

This means that with the towline force, two other forces are acting on the tug, the drag force and the thruster forces. The thruster forces can act in the same direction as the towline, counteracting the heeling moment, or in the opposite direction, thereby increasing the heeling moment.

Forces during towing in a vertical plane

The horizontal forces are projected in a vertical plane as shown in Figure 2. The towline force and the drag and thruster forces cause a heeling moment which has to be counteracted by the transverse stability moment of the tug.

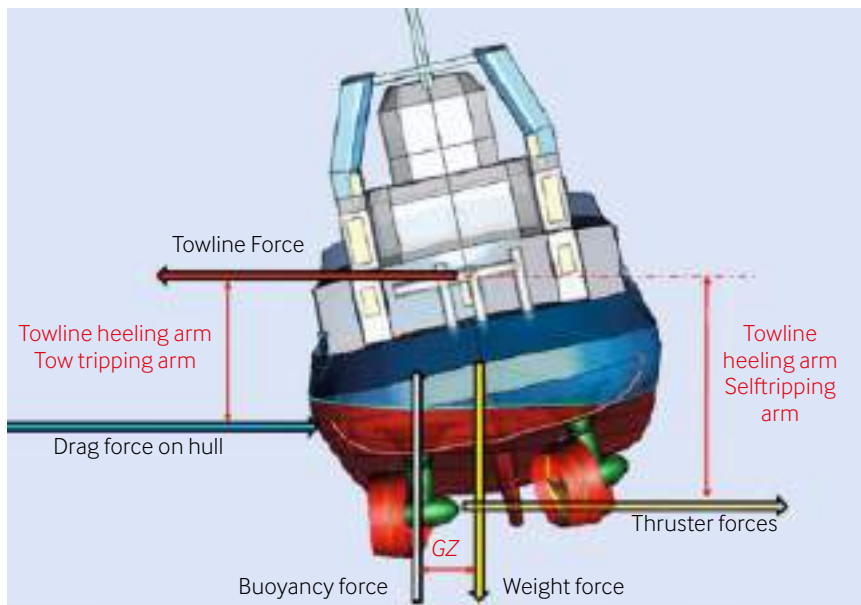


Figure 2
Forces during towing in a vertical plane

The transverse stability moment consists of two forces in opposite direction: the downward vertical acting weight force and the upward vertical acting buoyancy force. The lever of this moment is called GZ (Figure 3).

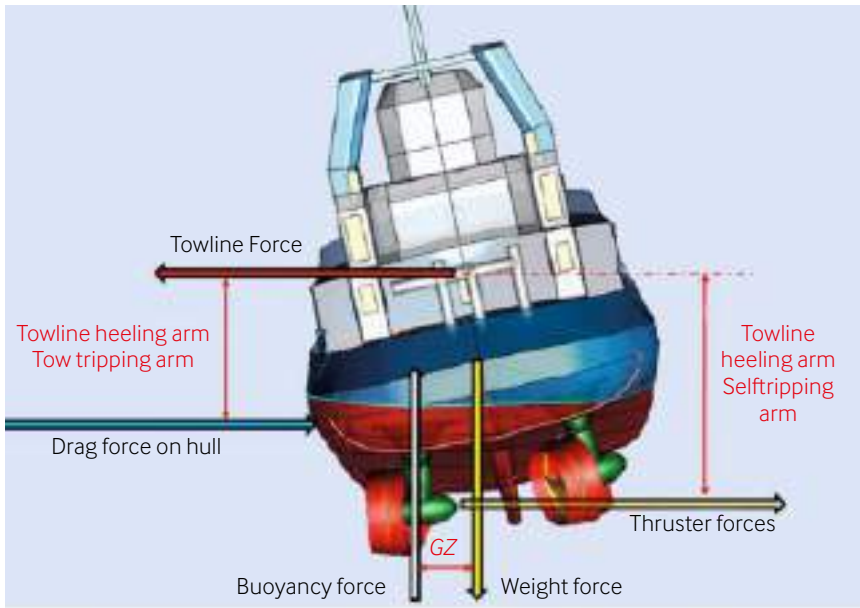


Figure 3
Forces during towing in a vertical plane

GZ stability lever

The stability of a tug is determined by the centre of gravity above the keel, KG (corrected for free surface effects with a distance GG', to the distance KG').

When given an inclination the weight of the tug acting through G', tends to further incline the tug.

In the case of positive stability this is counteracted by the buoyancy force acting in a vertical direction and is shifted from its location in the upright position B to its inclined position B ϕ . As long as the centre of buoyancy shifts more to the right than the centre of gravity, there is a positive moment (or lever) of stability to move the tug back to its original position. The stability of a tug is represented by the value G'Z, the righting lever of stability. The righting lever of stability $G'Z = KN \sin \phi - KG' \sin \phi$.

The value of $KN \sin \phi$ depends on the hull form, the inclination, the draught and the trim. The value of $KG' \sin \phi$ depends on the loaded condition of the tug.

For small angles the position of N approaches the position of M, the metacentre. Therefore, for small angles, the stability lever can be approximated by $G'Z = G'M \sin \phi$ and the upright heeling moment by $M^{st} = G'M \sin \phi \times \Delta$. (Where Δ = displacement of the vessel). The G'Z values as a function of the inclination angle are given in the curve of righting levers which should be on board the tug. Figure 4.

lever of stability moment:

$$G'Z = KN \sin \phi - KG' \sin \phi$$

for small angles : $N=M$

$$G'Z = G'M \sin \phi$$

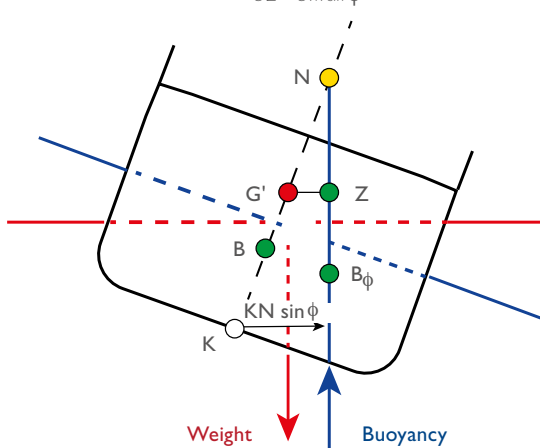


Figure 4
Levers of Stability – GZ

Traditional tug criteria should provide for sufficient stability to prevent capsize in case of girting when the towline exerts maximum pull perpendicularly to the vessel's centreline. Such a situation can develop rapidly, and tugs should be designed with sufficient stability to survive such events. Since the towline will in most cases act horizontally or upwards, a vertical component of the towline force is often disregarded. The tug's ability to withstand the forces on the towline in hazardous situations is enhanced by certain characteristics of the tug, which could include the location and height of the towing point and for example if the tug is fitted with a radial moving towing hook.

Tug masters must be alert to the danger of capsizing which can occur when the tow wire/rope reaches a large angle to the centre line of the tug and the quick release cannot be activated and girting occurs (see page 36). If girting is experienced tugs with towing hooks forward of the propeller system can find it difficult to recover. Contributory causes allowing a tug to capsize in a girting situation include:

- Small freeboard.
- Poor stability curve of righting levers.
- Weathertight and watertight openings not secured correctly.

To reduce the dangers associated with girting, particularly with small tugs, the following is recommended:

- The towing gear should minimise the overturning moment due to the lead of the towline, including the position of the tow hook and winch.
- The towing hook should have a positive, reliable means of quick release able to operate in all conditions.
- The release mechanism should be designed to be activated locally and from the wheelhouse. All crew members must be familiar with the characteristics of the system and it must be tested frequently.
- Maintenance of the towing gear must be carried out by competent persons.
- Openings such as watertight doors and ports must be kept closed during towing operations.
- Engine rooms should be fitted with high coaming ventilators; air pipes should be fitted with automatic means of closure.
- Utilisation of a gog/gob wire (see page 40).

Stability of towed unit

We have experienced numerous claims that have arisen from inadequate stability of the barge, in particular those used in the carriage of containers. How to calculate the stability of a barge with cargo stowed on deck is important. The stability of the barge or towed unit should be assessed by the tug master or recognised organisation. This would include checking if tanks are empty or full to reduce free surface effects (FSE), all openings are closed and appropriate freeing ports operational. Effects of any ballasting needed during the voyage should be taken into account.

Some organisations have produced guidelines on the intact stability of the towed object and Members should check and verify this with their overseeing authority.

Other considerations should include:

- The Metacentric height (GM) should be positive throughout the intact range. The GM should include a margin for calculation error. GM should never be less than 0.15 metres.
- FSE should be considered, including cargo and ballast free surface.
- Effects of potential icing evaluated.
- Dynamic stability requirements for the barge/barges are met.

Maritime New Zealand 'Barge Stability Guidelines' provides information on the subject of pontoon barge stability. In respect to barge stability the following information should be ascertained before towage commences:

- Know the lightship displacement of the barge before loading.
- Know the lightship centre of gravity (KG) for the barge.
- Know the weight and centre of gravity of the cargo.
- Be aware of the block co-efficient of the barge.
- Be aware of initial metacentric height (GM) and know how to calculate it for the loaded barge using the rectangular block formula.
- Know how to calculate the combined KG for the barge loaded with its cargo.
- Be aware of the limiting KG curve and have one available for guidance in loading your barge.

It is important to ascertain that the stability information set down for the vessel being towed is current.

Chapter 8

▶ Towing Operations

Bollard pull (BP)

When a tug is hired the chartering party requires knowledge of the BP of the tug i.e. the pulling capability of the tug. The charterer will know what the required BP is for the contract, either through experience or it will have been calculated. When newly built the pulling capability of the tug is measured using a load cell under certain conditions, including the main engines being at the manufacturers maximum recommended torque for a continuous period of 30 minutes. The classification societies have their guidelines on how the BP should be measured.

Problems can arise where the tug is chartered to carry out a task that requires a certain BP rating. The specification given to the charterer will usually be as per the BP certificate. The tug will have on board documentation, including a certificate issued by a competent authority proving the BP. It is not unexpected that as the tug gets older, the efficiency of the main engines and equipment will decrease the BP. It is generally accepted that if the BP certificate is less than 10 years old the BP rating is as stated on the certificate.

If the BP certificate is older than 10 years, the accepted BP rating should be reduced by 1% per year of age greater than 10 years i.e. a tug with a 20 year old BP certificate of 50 tonnes will effectively have a BP rating of 50 tonnes less $10 \times 1\% = 45$ tonnes.

Cases have been recorded where the calculated BP was not matched by the tug's actual operational BP and many of these have reportedly resulted in serious incidents. This is highlighted in Case Study 1, Annex I.

For tugs less than 10 years old with no valid BP certificate the BP can be estimated as $(1 \text{ tonne} / 100) \times \text{Brake Horse Power (BHP)}$ of the main engines. For tugs over 10 years old without a valid BP certificate the BP value can be estimated as $1 \text{ tonne} / 100 \times \text{BHP}$ reduced by 1% per year of age greater than 10 years⁴.

A tug master should always be aware of the commercial demands made of his tug and that the tug is able to comply with those demands.

⁴ This is an approximation and it always better to have BP measured by a competent

Surprisingly some older tugs have actually produced a higher bollard pull than that recorded when the tug was built and this is often thought to be due to unsuitable conditions at the testing site which may have included one or more of the following conditions: insufficient depth of water, insufficient length of towing gear, high wind speeds, poor tidal conditions or a damaged load cell.

Other factors may also affect the tugs efficiency, e.g. age, appreciable hull growth, propeller condition and high sea water temperatures. Another factor identified in fatal accidents is when a tug is using a shaft alternator during a tow. Therefore the main engine output will be reduced and consequently the BP is reduced. This fact should always be taken into consideration when in an operational mode.

BP calculation

In order to calculate what the bollard pull of the tug should be for a towed barge with a displacement Δ and dimensions stated the following formula has been issued by Transport Canada Publication (TP 11960 E of 1995) as a guide.

$$BP = \left\{ \frac{\Delta^{2/3} V^3}{120 \times 60} + (0.06 B \times D) \right\} \times K$$

BP = required bollard pull (tonnes)

Δ = full displacement of towed vessel (tonnes)

V = tow speed (knots)

B = breadth of towed vessel (metres)

D = depth of the exposed transverse section of the towed vessel including deck cargo, measured above the waterline (metres)

K = a factor that reflects potential weather and sea conditions;

- for exposed coastal tows K = 1.0 to 3.0
- for sheltered coastal tows K = 0.75 to 2.0
- for protected water tows K = 0.5 to 1.5

e.g.

Barge Displacement Δ including cargo on board; 15,000 tonnes

| | | |
|----------------------------|--------|-------------|
| Tow Speed | | 6 kts |
| B. Tow Breadth | | 20 metres |
| D. Transverse Ht above w/l | | 5 metres |
| Exposed Coastal Waters | BP Min | ~ 25 tonnes |
| | BP Max | ~ 73 tonnes |
| Sheltered Coastal waters | BP Min | ~ 18 tonnes |
| | BP Max | ~ 48 tonnes |

Obviously the factor K has a particular effect on the estimated BP. A higher figure should be used to allow for significant wave height and strong currents. It would always be prudent to err on the side of caution and introduce a safety factor of 25% - 50% or be fully aware of the BP limitations of the tug in the circumstances.

Pivot point

It is important to understand the effect of the pivot point on any vessel but particularly with tugs when towing. Knowledge of the pivot point assists the tug master to understand how the unit being towed will steer in different situations. A floating unit rotates about a point situated along its length called the pivot point and when a force is applied, it will turn about this point. These forces could be rudder movements, the tug pulling in one direction, wind or current. The position of the pivot point will change due to speed, draught, under keel clearance, rudder size/type, tug construction and hull form.

It is also important to understand how the pivot point of the towed unit changes. A ship or barge stopped in the water, with no external forces applied, will have a pivot point coinciding with the centre of flotation which is approximately amidships. When a vessel is making headway the pivot point will move forward. Generally it will move about 25% of the towed unit's length towards the bow when moving ahead and vice versa if moving astern.

For example if a barge is moving forward towards a berth being assisted by a tug 'breasting' the barge alongside and the tug is positioned at the barge's pivot point there will be no turning of the barge. If the tug is positioned away from the pivot point there would be a turning motion on the barge; the further away from the pivot point the greater the turning momentum.

A moving barge or ship will travel laterally or drift across the water when turning because the pivot point is not located at the craft's centre when moving forward. It is useful to be aware where the pivot point lies on the assisted vessel and how lateral movement can cause sideways drift. This awareness is crucial when manoeuvring close to hazards.

Position of tug and interaction

The position of the tug is always important especially when assisting a barge or vessel. The safe position of the tug relative to the assisted unit depends on many factors which include the size and pivot point of the unit, the number of tugs assisting, the speed of the unit being assisted, the depth of water, and amount of manoeuvrable room, currents and winds. Often when assisting a barge or vessel the tug will have to make fast with a towline. If the tug is to make fast to the barge with its own crew the risks are obviously increased, more so in poor weather.

The phenomenon of interaction is well known to mariners and it is particularly dangerous in situations where there is a larger vessel or barge moving at speed in close proximity to another smaller vessel, such as a tug. The effect is increased further in confined and shallow waters. Tugs and smaller vessels have capsized as a result of this, particularly when being overtaken by a larger, faster vessel in a confined waterway, such as a river or channel.

When a tug approaches a vessel or barge that is going at a moderately fast speed through the water there are various suction and pressure forces around the vessels hull – the greater the speed, the greater the effect.

Approaching the forward end of a ship or barge

If a tug approaches a vessel going ahead at speed forward of the pivot point it will be pushed away and if approaching from aft of the pivot point there will be little or no suction effect. This suction effect will increase as the tug approaches the vessel's stern or quarters, as the water flow increases due to the hull shape or increased water flow from the ship's propellers. The amount of force felt is related to the distance from the hull of the vessel. The force can also be increased by reduced water depths or confined water areas such as narrow channels.

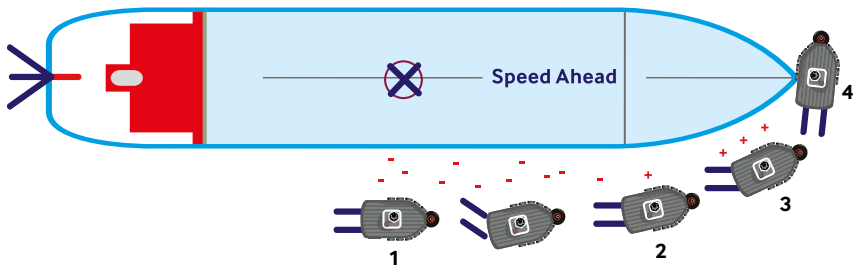


Figure 5
Approaching the forward end of a ship or barge

In Figure 5 the tug approaches the side of the vessel. This manoeuvre can be dangerous when the speeds are high. At position (2), close to the vessel's pivot point, the water pressure pushes away the tug's bow and the suction pulls in the tug's stern. This sudden effect requires quick reactions and use of rudder and engine to maintain position. At position (3) there is a general push away from the vessel, particularly at the tug's stern. This effect can result in a sudden shear across the bow of the ship and in position (4). The rapidity of this effect has caused a number of tugs to be run down with severe consequences. These accidents have been reduced with the use of tractor and ASD tugs.

Approaching the aft end of a ship or barge

When a tug approaches the aft end of a ship or barge there is considerable suction effect. This effect is dependent on how close the tug is to the barge or ship, speed and the shape of hull form around the stern. The suction effect can be huge and the tug is unable to manoeuvre away. This can result in damage to the tug as it is dragged beneath the ship's counter (when the ship is in ballast) or towards the ship's propellers.

Another effect of interaction is water flow around larger moving vessels acting on the under hull of the tug. This can cause a decrease in effective stability and increases the possibility of the tug capsizing if the two vessels come into contact.

Accidents occur if the tug and unit being assisted are not similar in size and the speeds are relatively high, in one case a tug with a 2 metres draught was making fast to the starboard bow of a ship with a draught of 3 metres. The tug was proceeding at about 4 knots parallel to the ship, gradually pulling ahead until about 6 metres abeam of the ship's forecandle. As the tow line was being passed the tug took a sudden shear to port and the two vessels touched before the tug master reacted. The impact was minimal in this case however, in seconds, the tug took a starboard list and capsized resulting in a fatality. Research confirms that the following consequences happen with hydrodynamic interaction:

- Interaction effects are increased in shallow water.
- Rudder effectiveness can be reduced in shallow water.
- Squat effects are increased in shallow water and the risk of grounding is enhanced.
- Transverse thrust of the propeller changes in shallow water.
- Changes in manoeuvring characteristics are experienced in shallow water.
- A large vessel or barge with small under keel clearance which is stopped in an enclosed basin can experience strong turning forces.

Girting, girding or tripping (GGT)

The terms mean the same thing and refer to the situation when a vessel, usually a tug, is towed broadside by a towline and is unable to manoeuvre out of this position.

This phenomenon is known to all tug masters. It is the most prevalent reason for tugs to capsize and can cause fatalities. This occurs at either end of the tow and can happen very quickly. Rarely does it happen slowly enough to allow all of the crew to leave the tug before it capsizes. Tug masters must be aware of the phenomenon and understanding the quick release to the tow wire is essential if disaster is to be averted. A case concerning this matter is included in the Annex I, Case Study 4.

GGT is particularly relevant to conventional single screw tugs. Tractor and ASD (Azimuthing stern drive) tugs are less likely to girt because their tow is self-aligning and the tug master is able to produce significant thrust in all directions. It is clearly understood that towing from a point near amidships on a conventional tug is inherently unstable and can result in situations where the load on the tow rope can heel the tug over to a large and dangerous angle.

Various organisations have issued advice, recommendations and investigation reports into girting incidents. For example Transport Canada has issued a safety bulletin (No. 13/1994) on the dangers of girting. The following is a précis of that and highlights the dangers:

- A recurring feature of these accidents has been that, once girded, the towboat capsized so rapidly that crew members were unable to operate the tow, abort control or make use of lifesaving equipment.
- The use of well-established towing arrangements to prevent girting may not always be effective in certain confined areas involving smaller towboats. In such cases potential dangers can best be avoided through careful planning and by each crew member being vigilant. A back-up strategy should always be considered in advance if, because of unusual or unforeseen conditions, a particular manoeuvre or action is not having the desired effect.
- A review of girting incidents has shown that a towboat carrying out routine tasks in close proximity to the forward end of a barge under way is particularly at risk. At such times it is essential to ensure that the manoeuvrability of the towboat is not compromised by the weight and motion of the tow.
- Tug masters should consider practical measures which might be adopted to avoid being placed in a girting situation (see page 28).

Girting can occur for a number of reasons including:

- The ship or barge being assisted turns or shears abruptly away from the tug.
- The speed of the vessel or barge being towed is too high, either intentionally or due to external forces such as increased currents or windage on a towed unit.
- The tug is too far astern of its intended position compared to the speed of the vessel if the tow is moving ahead, or too far astern if the tow is moving astern.

Girting when made fast forward

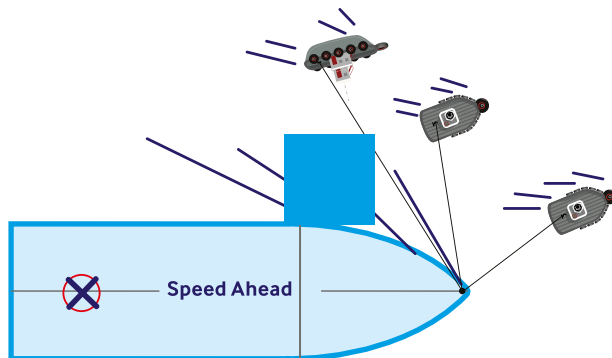


Figure 6
Girting of a Tug when made Fast Forward

In Figure 6, position 1 the tug is pulling safely, maintaining speed with the towed vessel or barge. In position 2, coming off the centre line of the tow, the tug is now coming into a potentially dangerous situation. If the vessel or barge speeds up, or the tug slows or the vessel/barge turns to starboard suddenly, the tug could end up in position 3. In this position the tug's line is perpendicular to the towed unit and unless the towline is released the tug will be pulled over and capsize. The time from being in a stable position 1 to the unstable position 3 can be a matter of seconds.

You can see from the diagram that the location of the tow wire attached to the tug is fixed near the pivot point. The use of a gob wire moves the towing point aft reducing risk of girting.

The design of the tug, hull form and propulsion arrangements can affect performance in a girting situation. It should be noted that in some ports the ship's speed is restricted to as low as 5 knots whilst making the tow connection.

If an approach is made to a fast moving unit there is the danger from the hull interaction which can cause the tug to be sucked to the towed hull. As a rule the interaction force increases by the square root of the towed unit's speed.

The conventional tug is particularly vulnerable to girting when acting as the stern tug or as a brake at speeds above approximately 3 knots in a towed situation. To minimise the risk of girting a gob wire or similar arrangement can be used. When the tug is fast aft and used as a brake the tug master should concentrate on the following:

- Risk of girting increased due to changes in the speed and/or course of the towed unit.
- The tug is often out of sight of the lead tug or bridge of the assisted vessel and therefore good communication is essential.
- On a conventional tug a gob wire is recommended, pulled down as far aft as possible.

The Club and the industry as a whole have suffered several recent incidents concerning girting of tugs. This is a major concern and to assist with understanding how these events can unfold Case Studies Three and Four have been included within Annex I.

Studies show that the elements acting on the tug are the force couple created from the towline and the resisting hydrodynamic forces as the tug moves laterally through the water. Often the heeling angle produced is not so large but sufficient to cause deck edge immersion. Frequently the tug capsizes so quickly due to down flooding because vents, ports, doors and hatches are open. In a number of recorded cases it is thought that the tug would have survived if these were closed. It has also been noted after some incidents procedure manuals state that all vents/openings etc must be closed during operations, but the reality is that closure of vents restricts air supply to the engine room and prevents the power plant functioning correctly. Companies must address these situations and present tugs with workable advice.

Gob/Gog wire or rope

By shifting the tow point aft or by using a gob rope or wire tow stability can be improved on conventional tugs. A gob wire or rope, sometimes referred to as a guest rope or bridle is a short wire or rope made fast to the towline at the after end of a tug. In this way the use of the gob wire effectively moves the towing point aft, closer to the tug's stern. This gives the tug master greater control and allows more manoeuvrability to prevent girting when the tug is acting as a stern tug. Some port authorities make it a requirement that a gob rope is used by all conventional stern-drive tugs.

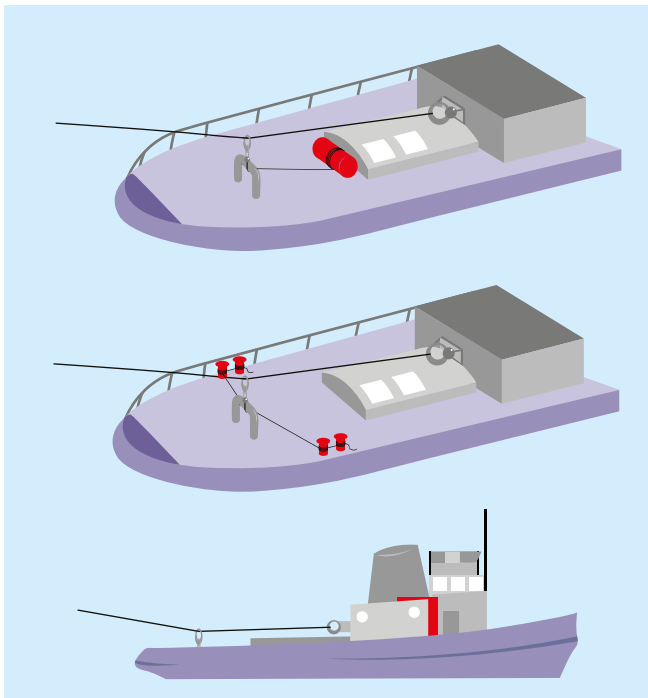


Figure 7
Rigging a gob wire

A gob wire can be rigged in a number of ways including the two ways noted in Figure 7 which use a length of wire secured to the tug that passes through a fairlead or appropriate bollard on the centre line of the work deck. The end of the wire holds a large shackle which is attached around the towline. The large shackle is free to slide along the towline. When the towline moves towards the tug's beam, the bridle wire comes tight and keeps the towing point aft and close to amidships. Another method of rigging a gob wire is to have a separate gob wire winch with the gob wire leading through a swivel positioned at the centreline at the aft end of the tug. A shackle is used to slide along the towline and the winch is used to vary the length of the gob wire. Obviously this cannot be varied when the gob rope is under tension.

If a single wire or chain gob wire system is used the connection point should be on the centreline of the tug and the length of the gob wire should not exceed half the distance to the protection rails or side bulwark.

If a fixed towing pod is used it should also be on the centreline, in line with the towing winch drum and have a bend radius at least ten times the diameter of the tow wire.

It is important that the shackles and wires used are appropriate for the operator, certified and in good condition. Some small tugs or work boats may be fitted with centreline rings fitted into the aft part of the main deck from which the gob wire can be attached. These should be certified for use to take the weights applied and regularly checked to be in a good condition.

Other methods can be used to prevent a towing wire moving onto the tug's beam. For example, the fitting of stop or tow pins positioned on each quarter.

The use of the gob wire still requires the emergency quick release system to work correctly. The method of quick release must be known to those who are likely to be on the bridge. Small work boats towing without the facility of a quick release system should always have a cutting axe nearby should the tow line need to be parted quickly.

Bridles or gobs should only be adjusted or released under the direction of the tug master during towing operations.

Emergency quick release systems for towline

Most tugs are designed with emergency quick release systems which either trip the hook or release the brake on the towing winches so as to take the load off the towline and allow the tug some more time to regain control from a potential girting situation. These release systems are usually capable of being remotely activated from the bridge. There are also manual override arrangements available at the winch/hook in case of failure of the remote control. Crew members should familiarise themselves with these ship-specific arrangements, including limitations if any, as soon as they join the vessel. It must be borne in mind that these emergency quick release arrangements may not always release instantaneously due to various contributing factors such as the direction of pull, the heeling angle etc. and hence allowance must be made when contemplating its activation.

The effect of wind

Not appreciating the effects of the wind when towing can result in collisions, groundings, towlines parting, injury and girting. The wind causes headings to change, speeds to increase and a towed craft to drift.

Manoeuvring can become difficult if the wind increases or changes direction suddenly. Tug masters should always be aware of the potential effects of the wind before a tow commences or before commencing the next part of a towing operation. Knowing the forecast or local weather conditions is essential.

The effect of current

Mariners will be aware of the effects that currents have on a craft being manoeuvred in water. The effects of current in open waters are less important than the effects in confined waters which can be significant particularly when manoeuvring in busy waters or rivers. The speed and direction of currents are also unpredictable, reasons include; changes in tidal direction, sudden water flows at river mouths due to rains or ice melt, constraints such as narrows, reefs, breakwaters and harbour walls. The effect of squat in shallow water can be considerable, particularly for large barges with a flat hull form.

Current direction can be influenced by:

- Bends in rivers or configuration of channel or river entrances.
- Shallow water.
- Man-made constructions; piers, berths, breakwaters.
- Bridges with pillars.
- Industrial cooling water outlets.
- Geographical obstructions such as islands.

Currents can also help manoeuvring, for example:

- To control speed when approaching a berth.
- To assist a tug and tow to move sideways.
- To assist in a turn.

River tugs work where currents can be strong and changeable over short distances. Over the width of a river the current strength may vary. The outer parts of the river may be faster flowing than in the centre. Figure 8 shows how a vessel or tow is influenced when going downstream on a river bend. It should be noted that the diagrams in this section depict one vessel, however it should be considered that the same effect would be placed on the tug and towed unit. The more forceful current at the starboard bank impacts on the port quarter and as the vessel turns the bow is in a less strong current and so there is a turning moment to port. This effect can be sudden and the effect should not be underestimated. The Club has unfortunately suffered many incidents where this has been the case and contact has been made with installations on the river bank. Navigating in water where there is a constant current could be safer.

In a similar way a tow going upstream (Figure 9) can find that the bow or fore end is in the strong current and the stern in an area with less current. The bow of the towed unit could be forced to port quickly and bring a sudden unexpected strain on the tow wire.

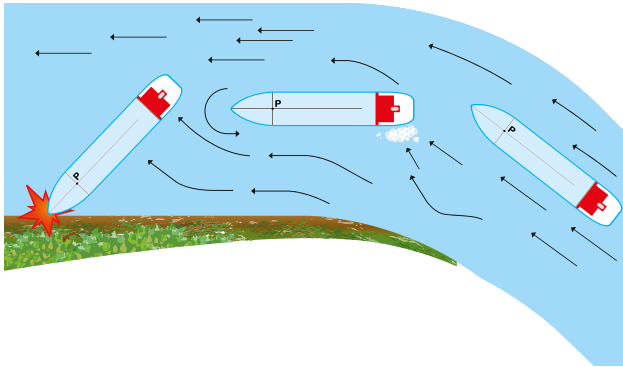


Figure 8

Influence on a vessel/tow when navigating down stream on a river bend

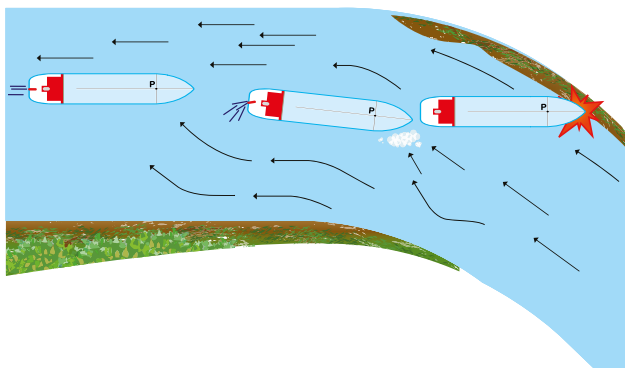


Figure 9

Influence on a vessel/tow when navigating upstream on a river bend

In Figure 10 the tow is moving downstream alongside a built-up area of the river where there is a berth or terminal jutting out from the bank. As the tow approaches the berth area the current changes direction and exerts a force on the after part of the tow. The pivot point is forward and a turning moment is applied and the barge moves to port suddenly, with a possibility of grounding or collision with the berth.

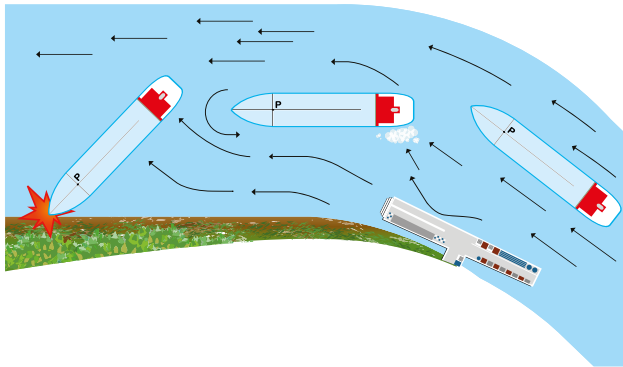


Figure 10
Vessel/tow navigating down stream in the vicinity of an infrastructure

The act of assisting a tow to berth or un-berth needs to take account of the current. It is usual for a river berth to lie in the same direction as the prevailing current so that the current can be used to assist with berthing.

A berth can be approached bow into the current to give a relatively high speed through the water with a reduced speed over the ground which will provide good steerage because of the good water flow over the rudders. The towed unit is also easier to stop and the current can be used to assist the tow alongside the berth. Currents in some locations can be complex and changeable so again local knowledge is essential.

Berthing in a following current is difficult and potentially dangerous since the tug and tow must develop sternway through the water in order to be stopped over the ground. In these circumstances, control of a conventional tug will not be easy and an approach into the current is possibly the best method of nearing the berth.

Other concerns effecting manoeuvrability

Wash effect: this is when the wash's contact with the towed object/barge reduces the pulling effectiveness of the unit. Factors that can contribute to this are:

- Small under keel clearance of the assisted unit.
- Hull form of the assisted unit.
- Length of tow line.
- Area of operation – confined areas will increase the wash effect.

Under keel clearance: if the under keel clearance is small the propeller wash effect is increased reducing the tug's pulling effectiveness. Obviously pulling a barge or a vessel that is effectively aground or stuck in mud will increase the tension in the tow line. The suction effect can cause unexpected dangers as the barge can come clear of the suction effect of the mud and become free suddenly. Tugs' crews should be aware of this possibility and stand in a place of safety.

Squat effect: is often applied to ships, but any moving craft through the water can be affected by squat. The effects of squat are greatly increased by speed and if operating in waters of a confined width and may result in the change to the vessel's headings and the possibility of the towline shearing.

Length of towing line

The less water under the keel the more power the tug will need to apply. This will increase the wash effect and a longer towline can reduce or avoid the wash effect.

A short tow line in a confined area can produce a significant wash effect. Tractor tugs pulling over the stern and ASD tugs pulling over the bow can reduce the wash effect since the propellers are further away from the towed unit's hull.

Shortening the length of the tow

Very often, the tug and barge transit through waters where the sea room is restricted. The master then must consider shortening the tow wire to ensure better control of the barge. The length of the tow wire is at the master's discretion depending on the prevalent situation. The shortening of the tow should be carried out preferably in deep water, weather permitting, and most certainly well before entering congested waters. The shortening in deep water reduces a lot of wear and tear in the wire which it would have endured with dragging on the seabed. However, if the weather is severe, then there will be no choice but to defer it to as late as possible.

It is recommended that the length of the tow should not be too short as if anything were to go wrong, the tug will not be able to manoeuvre out of the barge's path and can result in her coming into contact with by her own tow. If the tug has a wild tow on a short wire, the master should call for assistance without further delay to bring the barge under control. When on a short wire, utmost caution must be taken to avoid sharp alterations or else the chances are that the barge may violently swing out of control. If this happens then the master should immediately consider paying out some length of tow wire to dampen the violent movement.

Shortening of the tow is also recommended before transiting pirate infested waters. This will allow the tug's crew to keep a closer watch on the barge and raise the alarm in case any intrusion is observed.

Establishing the tow connection

There are no strict rules to making fast the tow. Each tow will be different; the barge size, shape, draught, weather, current strength, light or location will vary. Prior planning will make the operation safer. A briefing between the tug master and his crew on how the job is to be approached is vital. Before arrival at the connecting location effective communications should be established between the tug and towed unit if manned. Ideally, a risk assessment would be in place. Tug speed should be adjusted for a safe rendezvous and connection.

The nature of the towed voyage will dictate what equipment and configuration the tow will take. All need to be discussed beforehand and the towing equipment made ready and inspected before arriving at the tow.

If the tugs crew are required to access the towed unit plans must be made so that it can be carried out safely in the prevailing circumstances.

Position of barges

If the tow consists of a number of barges with different loads, sizes and shapes, the barges should preferably be arranged by similar size and design, with similar sized barges as the lead. If possible, loaded barges should be placed first with empty barges astern.

Tow ropes should be similar sized and of the same material, secured to the barges in equal lengths, with the same number of turns so that the tow ropes can be equally rendered if necessary and the stretch is similar. Where more than one barge is towed the remaining barges can be bundled into ranks using rope breast or stern lines.

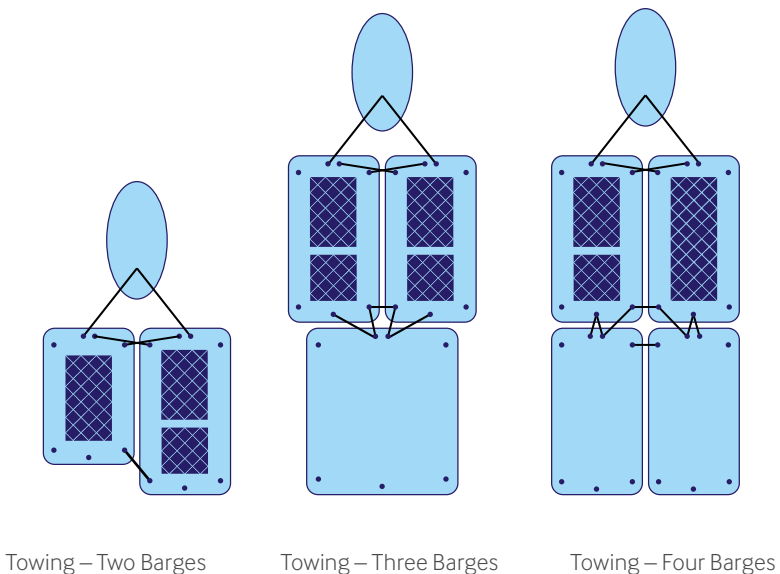
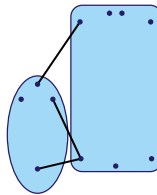


Figure 11
Barge towing arrangements

Towing alongside

When a barge is to be towed alongside the tug, the connection should be made with a suitable heavy spring and a stern rope. The tug should be positioned close to the stern of the barge so that the tug's stern overhangs the stern of the barge. The further forward the tug is positioned the more difficult it is for the tug to steer the combined unit.



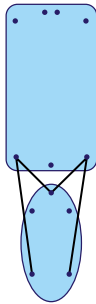
Towing – Alongside

Figure 12
Broken tow arrangement

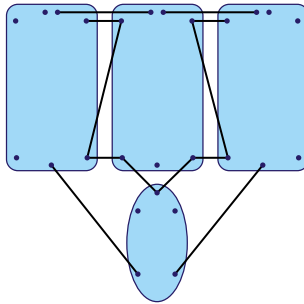
Barges should be made fast to each other with the use of non-jamming turns so that they can be released if necessary. Picking the best leads is also important, particularly when the barges are of a different size or height.

Pushing ahead

Tugs will regularly have to push barges ahead even though they may not be specifically designed to do so. It is recommended that the barge is secured to the tug using winch wires attached to corner bollards of the barge/s so that the whole unit can be operated as a single unit. There should also be two substantial ropes made fast to the tug's centre bollard and the barge's port and starboard quarter bollards.



Pushing Ahead – Single Barge



Pushing Ahead – Three Barges

Figure 13
Barge arrangements for pushing ahead

Double tows and tandem tows

In this booklet a double tow refers to the an operation that is undertaken with two wires from two towing drums, or in the case of a tug with a single drum winch using a Canadian link and an under rider to the rear barge. The term tandem tow is often taken to be referring to in-line or series tows where the rear barge is connected to a bridle on the aft end of the forward barge. This set-up is not suitable for ocean tows. The control of the barge's relative motions can be lost in a seaway and snatch loads can part tow wires, not to mention other problems with the tracking or over-running of the barges. This method of towing is regarded as suitable only for rivers and sheltered inland waterways. The term tandem towing has also been used for tows with two or more tugs attached to a single towed object. This terminology is commonly encountered when multiple tows are proposed.



Figure 14
A double tow operation

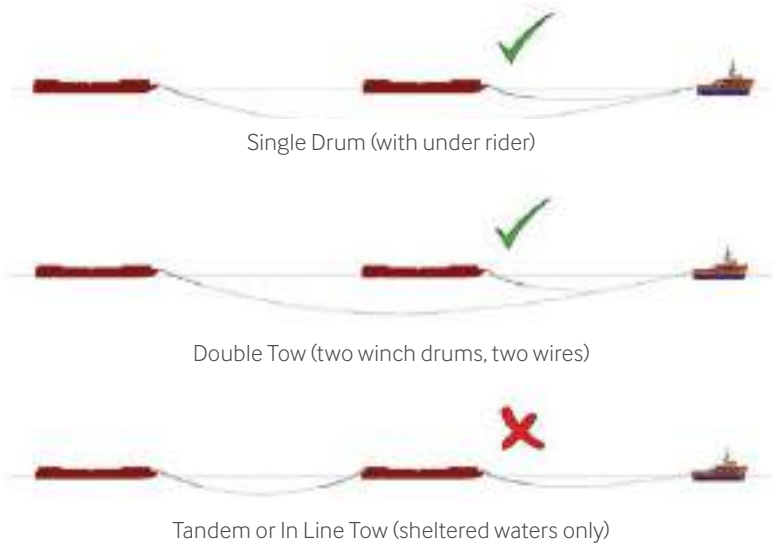


Figure 15
Different Double/Tandem tow operations

Having established a set of criteria for setting up double tows, i.e. either two wire set ups or under riders, the methodology of the tow becomes somewhat clearer. Obviously the making up and breaking up the tow at each end of the voyage is more complex than single tows. It involves factoring in the planning of the roles of the assist tugs, weather and sea conditions, setting up the gob arrangement, water depths and crew skills as well as equipment selection for the tug and the barges including the barge's main and emergency gear. Procedures during the passage such as catenary management, freshening the nip, control of the gob arrangement and tracking of the barges are all skills which require experience and intuition rather than ones that can be set out in formal text.

Single wire under rider tows

The single wire/under rider tows (often referred to as Honolulu or Christmas tree rigs in some areas) have several benefits when compared with tows from two separate towing drums. The make up and break up of single wire tows can often be less complicated than a two wire tow. The gob arrangements, chafe protection and freshening of the nip are simplified and some masters maintain barges track better with an under rider to the second barge compared to a two wire tow.



Figure 16
Canadian Link

This type of tow does require some specific features on the tug, being the Canadian Link permanently fitted in the tow wire and the winch spooling gear designed to allow the link to pass through the rollers and wind onto the winch drum. The main drawback to this system lies in the vulnerability of the tow if the tow wire parts, leaving two barges adrift and still connected to each other.

Two wire tows

With a two wire tow the exposure from a wire parting is reduced to one barge adrift while the second barge remains under tow. However, the make up and discharge of the tow can be more complex and wire management on deck requires more planning with two gobs, two chafing sleeves and routine freshing of the nip. The daily work load on deck increases with the efficient monitoring and managing of the tracking of the tows and the position of the wires. This requires skill and experience from the tug master, crew and officers.



Figure 17
The use of two tow wires

During the tow

In addition to the normal navigational and collision avoidance duties, the watch keeper has to ensure that the tow wire and tow are positioned correctly. The tug master should ensure that those carrying out wheel- house duties are aware of the requirements of the towing operation. This should be written down in the tug master's order book or as part of the standing orders. The tug master should always be satisfied that his watch keepers are aware of how to use the towing winch and its quick release system correctly.

These instructions may also include:

- In what circumstances the tug master wants to be alerted.
- In what circumstances the watch keeper should shorten or lengthen the tow line.
- Appropriate engine revolutions.
- In what circumstances and how often the watch keeper should freshen the tow line particularly in heavy weather.
- What length of tow wire and catenary should be maintained.
- Precautions to take in different water depth and weather conditions.
- Attention paid to chafing or friction in the towline; position of protectors or regularly adjustment tow wire length.
- Towing speed and headings to be maintained.
- Vessel Traffic Service and security communication if appropriate.

During the voyage the duty officer on the tug must also keep watch on the barge. One easy way to determine that the barge integrity has not been compromised and is not taking in water would be to paint the barge with a strip of high visibility paint at the waterline on the bow before commencement of the voyage. This would be a good benchmark for the duty officer to observe during the sea passage and so long as he can observe this line above the water, it can be safely concluded that the barge's draughts have remained the same.

Inspections during the towage

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. This should be done only when the prevailing weather allows such an operation and when on board the crew must verify that all the towing arrangements, condition of the cargo sea fastenings and watertight integrity of the tow are satisfactory. Suitable access must be provided which may include at least one permanent steel ladder on each side from main deck to below waterline.

Chapter 9

▶ Loss of Tow Wire

Planning for an emergency should include:

- Actions in bad weather
- Hove to arrangements
- Available anchorages and safe ports for shelter
- Emergency towline rigging or bridle recovery.

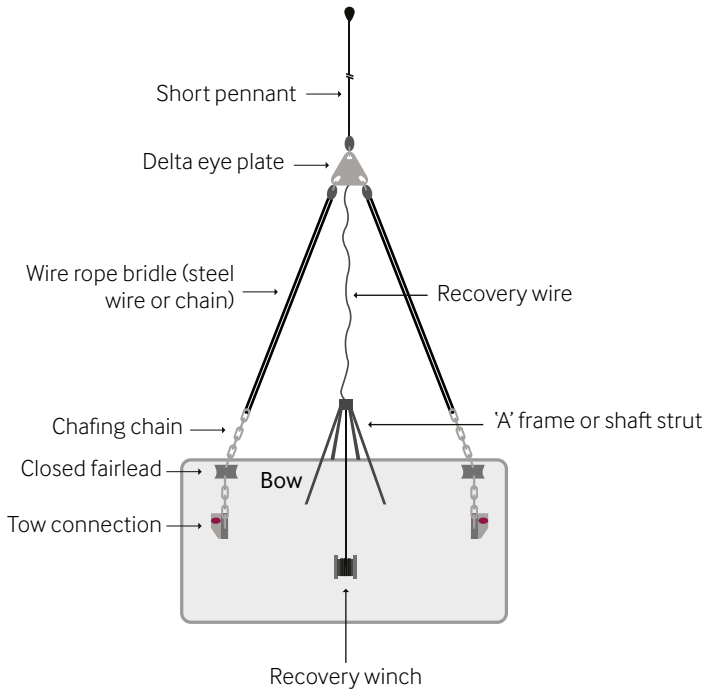


Figure 18
Example of a recovery bridle arrangement

In order to allow an effective and safe recovery, a bridle recovery system should be rigged. The most effective method is using a winch and recovery line as above. The winch should be able to lift 100% of the weight of the bridle, wire and attachments. For large barges the power for the winch should be available on the barge. For smaller barges alternative arrangements will have to be made, including manually operated recovery systems. It is recommended that the breaking load of the recovery wire be at least six times the weight of the recovery gear.

Emergency towline rigging

In the event of a towline or bridle failure, or the inability to recover a bridle, an emergency tow wire should be rigged. This is usually fitted to the bow and a suggested arrangement is as in the Figure 19.

Prior to departing on a voyage the emergency arrangement may include:

- Towing connection through a centre closed fairlead
- Length of wire, with similar breaking strength as main tow wire, at least the length of the barge, plus an extension wire long enough to allow the float line to extend over 75 metres astern of the barge
- A high visibility pick-up buoy, with reflective tape attached with a self-activating light to the end of the float line
- The emergency towline should be led over the main tow bridle and secured to the barge side with soft lashings
- Precautions taken to prevent chafe of the wire ropes
- Spare re-connection gear should be available on the barge.






















In the event of any failure of the main towing arrangement, the tug must first retrieve the balance of the broken towing wire on board so that it does not foul the tug's propulsion systems. If it is possible for the tug's crew to board the barge, then they must attempt to retrieve the towing bridle on board. However, if this is not possible, then they must consider disconnecting it and slipping it to the seabed. Having the main bridle trailing over the side can cause it to foul with underwater obstructions or simply dredge the seabed and act as an anchor thereby making emergency towing difficult. The tug must then approach the stern of the barge at a safe distance and retrieve the float line. The use of a boat hook can also be made to assist in the retrieval of the float line. Once the float line has made its way on board, it can be further hauled in with the use of the winch. This will help it break the soft clips which secure the towing pennant (spare towing wire) on the barge's deck. Once the eye of the pennant comes on board the tug, it must be made fast to the towing hook. The tug must then gradually take weight on the towing pennant and commence towing the barge with her emergency towing system.

It must be borne in mind that the emergency towing systems are not designed to continue towing the barge on her ocean passage but only to tow the barge to nearby safety such as a holding area or a port of refuge.

As a result of the failures they have seen regarding the correct arrangement of the equipment used, the Club has produced a poster on the rigging of emergency tow wires. This is freely available to the Club's Members and can be downloaded from the website www.shipownersclub.com/loss-prevention

EMERGENCY TOWING

Arrangement for barges

| | | | | | | | | | | | | | | | | |
|--|---|---|---------------------|---|--------------------------|---|--------------------|---|--------------|---|--|---|---------------------------|---|--------------------------------|-------------------------|
| Legends: | <table border="1"> <tr> <td></td> <td>Towing bridle chain</td> </tr> <tr> <td></td> <td>Emergency towing pennant</td> </tr> <tr> <td></td> <td>Buoyant float line</td> </tr> <tr> <td></td> <td>Strong point</td> </tr> <tr> <td></td> <td>Emergency towing pennant leading over main bridle, connected to strong point</td> </tr> <tr> <td></td> <td>Soft lashings/metal clips</td> </tr> <tr> <td></td> <td>Float with self-igniting light</td> </tr> </table> |  | Towing bridle chain |  | Emergency towing pennant |  | Buoyant float line |  | Strong point |  | Emergency towing pennant leading over main bridle, connected to strong point |  | Soft lashings/metal clips |  | Float with self-igniting light | Normal towing condition |
|  | Towing bridle chain | | | | | | | | | | | | | | | |
|  | Emergency towing pennant | | | | | | | | | | | | | | | |
|  | Buoyant float line | | | | | | | | | | | | | | | |
|  | Strong point | | | | | | | | | | | | | | | |
|  | Emergency towing pennant leading over main bridle, connected to strong point | | | | | | | | | | | | | | | |
|  | Soft lashings/metal clips | | | | | | | | | | | | | | | |
|  | Float with self-igniting light | | | | | | | | | | | | | | | |
| <p>Emergency towing gear consists of:</p> <ol style="list-style-type: none"> 1. Emergency towing pennant connected to a strong point on the bow (or stern) and clear of the main bridle and other obstructions. 2. A float line connected to the emergency towing pennant and a conspicuous floating buoy with a self-igniting light at the free end. The buoy is rigged at the stern so that it can easily be recovered by the tug. This must be of sufficient length to enable the buoy to float clear of the barge. 3. The pennant and the float line must be secured to the barge with soft lashings or metal clips which break free when pulled. | Deployment of emergency towing gear | | | | | | | | | | | | | | | |
| <p>Emergency towing procedures:</p> <ol style="list-style-type: none"> 1. Disconnect main towing bridle from tug. 2. Manoeuvre tug to stern of barge. 3. Retrieve float line until the eye of the emergency towing pennant is onboard the tug. 4. Make fast the pennant eye to the tug towing hook. 5. Manoeuvre the tug slowly to the bow, gradually taking the weight of the tow. 6. Proceed to tow the barge to a safe location. 7. Emergency towing arrangements can also be replicated on the stern of the barge if the barge layout is suitable. | Emergency towing | | | | | | | | | | | | | | | |

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Figure 19

Emergency towline arrangements for barges

Chapter 10

▶ Towing Equipment

Towing equipment generally includes the equipment on the towing vessel and towed object which may include: towing winch, hook, drum, fairleads, towing pins or hydraulic jaws (if fitted) and towing gear. Towing gear includes tow lines, wire ropes, gob wire, bridles, chains, pennants, eye plates, towing rings and shackles.

General

Again, before every towing operation the towing gear should be visually inspected and tested.

Towing arrangements and equipment should conform to the following:

- All the towing equipment and gear, towing hook and fittings should be strong enough to withstand all loads imposed during the tow and fully certified with up to date tests in place.
- Ideally the towing hook or towline should have a means of release which can operate in all conditions. The release mechanism should include both remote and local controls. The operation of this equipment is to be fully understood by the crew.
- Navigation lights are rigged and are capable of remaining alight during the hours of darkness for the duration of the voyage. Navigational shapes are to be made available for daylight navigation as appropriate.

To reiterate, for the equipment to be in good order there has to be a regime of inspection and maintenance on board the tug as part of a company planned maintenance system (PMS). It is not possible to operate a tug safely without an effectively operating PMS. The PMS should include other critical systems on board, such as the main engine and electrical power systems.

Planned maintenance system (PMS)

Planned maintenance systems can be sophisticated computer based, giving real-time data back to the technical office and sometimes these systems are approved by a classification society. Or, they can be simpler paper based systems, but no less effective. Whichever PMS is in place, it is important that maintenance of critical equipment is monitored and recorded and this includes the towing gear. If no records are kept and there is no reliable knowledge on what has been inspected or overhauled, in good or poor order.

The PMS should include:

- Towing hooks and arrangements.
- Towing hook quick release systems.
- Hydraulic systems, pins, sharks jaws or equivalent.
- Towing winches.
- Bollards, fairleads and sheaves.
- Ropes and wires.
- Ancillary equipment, i.e. shackles, thimbles, eyes, rings, plates.

All PMSs require a structure to ensure equipment inspections on a regular basis, weekly, monthly or annually – whatever is considered suitable by the company or by legislation. The time between inspections of equipment will depend on their criticality and their amount of usage. The PMS should also include the maintenance, testing and keeping of test certificates for the different equipment.

New lifting and towing equipment and wires should always be received on board with approved test certificates. It is important to maintain an ordered system for all test certificates including wires, pennants, stretchers, ropes, towing plates, shackles, rings, bridles and other towing or lifting equipment.

It should be noted that whenever accidents have occurred as a result of equipment failure it has been found that the equipment was not maintained correctly and/or was repaired incorrectly by an unauthorised or inexperienced person. The use and failure of welded fittings where the welding was carried out by unqualified staff or the welds were not inspected or tested by an appropriate person has often been the cause of personal injuries.

Many port and river authorities will require that inspections and testing of towing equipment should be regularly carried out and appropriate records maintained.

Testing and certificates

It is important that the company and tug master are aware of the regulations required for the testing and inspection of the towing gear and equipment. Regulations may differ depending on location and the following is usually an accepted guideline if no other guidance is available.

All towing gear, hooks, shackles, winches and wire ropes should always be provided with test certificates when new and kept as a record. All gear should be tested and re-certificated by an approved contractor every five years or after any significant repairs have been carried out. Mooring ropes also should be issued with certificates when they are new.

Keeping track of wires and shackles (with their certificates) is important and the PMS should allow for this. Apart from the visual inspection of all gear before a towing operation commences, all gear should be formally inspected annually by a competent person. This could include the tug master or experienced crew person.

In the event of an accident the ability to prove that the gear was in a good condition with all the certification and tests in order is a strong indication that the tug was operating to the correct standards and in addition assists the Club with the defence of any related claim.

All damaged equipment should be isolated and removed from operation. If it cannot be repaired properly by a competent person it should be condemned and discarded. Damaged equipment should never be used.

Towing winch

Towing winches come in different designs and sizes and the workings of winches should be understood by those using them. The manufacturer's manual should always be available on board to refer to. If the tug is provided with additional secondary winches these should also be included in the PMS.

Clear operating instructions in the appropriate language should be available near all the manual and emergency controls. The working of the winch emergency release system (ERS), if fitted, should always be understood by those operating the winch.

Checks on the towing winch should include:

- Effective operation of the braking system.
- Winch power and hydraulic systems.
- Signs of corrosion or fractures on the holding bolts, welds and supporting deck.
- Effectiveness of the emergency release from the wheelhouse and/or the local activation point.
- Effectiveness of the spooling mechanisms.
- Connection end of the towline should always be fixed but with a force of less than 15% of the breaking load of the towline.

The towing winch brakes should provide a static holding capacity of at least 1.1 times the breaking load of the tow line.

There are no accepted international standards for tug tow line ERS. Following many accidents, particularly those that have been caused by girting, it has been found that the ERS for the towing winch or the towing hook failed or did not operate quickly enough to prevent the tug from capsizing.

It is important for the crew to be aware of the operating limitations of the ERSs on board their vessel. There have been cases where some older types of manual ERSs have not released when there was an excessive load on the tow wire/hook. These should be tested at the earliest opportunity to ascertain the operating parameters and if necessary then prominent notices must be put up at the winch/towing hook and on the bridge that some weight must be taken off the tow line before the emergency release can be activated.

Towing hook

The maintenance of the towing hook should be included in the PMS and thus inspected regularly and visually before each tow. The towing hook release mechanisms should be tested and recorded to ensure that the hook releases properly.

Damage to the towing hook (or other essential equipment) must be reported and not used until the damage is rectified.

Generally it is not regarded as good practice to utilise towing hooks for ocean passages.

Bollards, fairleads and sheaves

Checks should include:

- Regular inspection for wear, excessive corrosion and wastage.
- Inspection for fractures to welds and supporting structures.
- Ensuring that all rotating sheaves are properly greased and free.

Towlines, wire and synthetic ropes

The care of wire and synthetic ropes, including stretchers, is an important part of the PMS. Formal guidance on how to inspect, stow and maintain ropes and wires should be provided.

A major issue is trying to maximise the service life of rope and still maintain safety. All tug's deck crew should be trained in rope inspection and gauging when a rope is damaged and is no longer fit for purpose and safe for use.

Maintenance guidance and checks on ropes should include:

- Pennants inspected prior to every use, annually and tested after a suitable period or five years.
- Main tow wire 'end for end' every year, and replaced when appropriate.
- Main tow wire physically inspected every month and/or before each tow.
- Main tow wire physically inspected after every deployment for damage and abrasions such as:
 - Ultra violet (sunlight), heat or chemical degradation.
 - Wear, broken, cut or fused strands.
 - Overstretched rope (can reduce the effective diameter of the rope).
- Distortion and kinking of the rope, particularly wire rope indicating that the wire has been severely stressed.
- Rope not properly stowed can degrade, for example synthetic rope can deteriorate, become mouldy if stowed wet with no proper air flow.

The importance of routine checks and maintenance of the towing lines should not be underestimated. The Club has seen many claims that have been due to the tow lines failing and the towed object then contacting other vessels and shore infrastructures. On occasions this may be due to incorrect handling in the prevailing weather conditions but also may be due to ineffective maintenance and testing.

Ideally there should be a spare tow wire on board, although for tugs operating in benign areas a single tow wire maybe acceptable. The length of the tow wire should also be commensurate with the towing area of operation. Generally no tow wire should be less than 800 metres for an ocean tow (some advise 1,000 metres) and never less than 500 metres for a benign towing area.

All towing wires should have hard eyes formed by a heavy duty gusseted thimble with a closed spelter socket fitted at the outer end.

All towing pennants should have the same lay as the tow wire with a Minimum Breaking Load (MBL) of not less than the tow wire.

The tow wire minimum breaking load should never exceed the breaking loads of the connecting points or equipment. A suggested general rule is that the tow wire and springs and towing hooks should have a Safe Working Load (SWL) of at least 2.5 times (some suggest 3 times) the bollard pull of the tug.

Shackles

The failure of shackles is often a cause of accidents and personal injury. They should be included in the PMS to ensure that they are safe to use. A system for example of colour coding shackles is a good way to track and monitor this equipment.



Figures 20 and 21
SWL system for shackles utilising colour coding

Before using a shackle it should be visually inspected. Damaged shackles or shackles which are not correctly supplied with certificates should not be used.

Tugs should be equipped with sufficient towing shackles and connecting links. As a guide at least six towing shackles should be on board. The towing shackle should have a MBL of at least 110% of the MBL of the tow wire; some administrations require this to be at least 1.5 times the MBL of the tow wire. If the MBL of the shackle cannot be identified then the minimum safe working load (SWL) can be related approximately to the BP of the tug by the formula $1 \times BP$ (if the tug is less than BP of 40 tonnes) and if over 40 tonnes $BP (0.5 \times BP) + 20$ tonnes.

Towing bridle

The towing bridle should consist of two legs having an angle at the apex of approximately 45° to 60°. If the bridle legs are chain it should be composed of stud link chain with enlarged open links at each end to facilitate connections.

If a composite bridle is used it should comprise two lengths of studded link chain, extending beyond the deck edge and to prevent chafing wire-pendants must be fitted with hard eye thimbles. The bridle legs shall terminate in a shackled connection at a towing ring or triangular plate.



Figure 22
Emergency towline rigged for a barge

If the tow is carried out with a single tow lead the bridle leg shall terminate in a shackled connection at a towing ring, triangular plate (Figure 22) or other approved device.

The breaking strength of each bridle leg and bridle terminator shall generally be at least three times the static bollard pull of the tug. Under no circumstances should the breaking strength of each leg of the towing bridle be less than the MBL of the towing wire.

Ancillary equipment

Ancillary towage equipment, such as wire towage protectors and thimbles should be regularly inspected and form a part of the PMS.

Sufficient tow wire protectors should be on board to prevent the tow wire from excessive chafe. These can be in the form of custom-made polyurethane sleeves which are exceptionally durable/resilient and are usually employed as a protection on tow wires. The simpler method for short towing voyages is just by wrapping the chaffing part of the tow rope with a piece of hawser or gantline and coating it with a bit of grease. Care must be taken to not to overdo the grease in case it causes an oil sheen in water during adverse weather including rain.

A powered workboat which the administration may accept as being a part of the life saving equipment should be available for use as an inspection boat when towing a barge. The tug should be fitted with adequate launching devices to lower the boat in open sea conditions. All personnel should be wearing appropriate PPE at all times and be trained in the launching of the boat.

An operational searchlight should be available to illuminate the tow at night.

Navigation lights and shapes

The tow shall carry the lights and shapes required by the International Regulation for Preventing Collisions at Sea, 1972 amended 1996 and any local regulations.

Navigation lights should be independently powered and the fuel or power source should be adequate for the maximum duration of the towage with reserve. It is also advisable for a searchlight to illuminate the tow to be available.

Towed objects where necessary should be fitted with a radar reflector mounted as high as practical.

Safety factors

There are no statutory international guidelines.

A tug master should always be aware of the condition of his tug and its equipment. As a guideline, steel and fibre tow wires/ropes should have a Safe Working Load (SWL) of at least two to three times the BP of the tug. This safety factor can also be used when considering the towing hooks and fittings.

Some approval organisations have issued guidelines for tow line MBL for different sizes of tug (measured in BP) and location of operation. GL Nobel Denton Guidelines for Marine Transportation 0030/ND (Revision 5 - Table 13-1) provides the following matrix for calculating the MBL.

Strength of towline and towline connections (outside ice areas)

| Continuous bollard pull (BP) | Benign areas | Other areas |
|------------------------------|--------------|--------------------|
| BP ≤ 40 tonnes | 2.0 x BP | 3.0 x BP |
| 40 < BP ≤ 90 tonnes | 2.0 x BP | (3.8 - BP/50) x BP |
| BP > 90 tonnes | 2.0 x BP | 2.0 x BP |

The Transport Canada publication (TP 11960 E, Appendix A of 1995) for oil tank barges however have provided the following guidelines.

| Voyage description | bollard pull of tug (BP) in tonnes | Breaking strength of towline in tonnes |
|------------------------|------------------------------------|--|
| Exposed coastal tows | ≤ 32 | 4.5 x BP |
| | > 32 | 144 + 0.7 (BP - 32) |
| Sheltered coastal tows | ≤ 35 | 4 x BP |
| | > 35 | 140 + 0.75 (BP - 35) |
| Protected water tows | ≤ 35 | 3 x BP |
| | > 35 | 105 + 1.15 (BP - 35) |

The breaking strength (BS) of chains, bridles, shackles and other gear should be consistent with the BS of the towline.

Chapter 11

▶ Personnel Injury Risk

Risk of personal injury is high. Recent studies in the USA⁵ indicate that the one of the largest risks to personnel is falling over the side into the water.

Owners and tug masters should have a Clear Deck policy that does not allow personnel onto the towing area when the unit is being towed.

Personnel working on tugs have a responsibility for their own and their colleagues' safety. They should:

- Wear approved personal protective equipment (PPE) (hard hat, safety footwear, high visibility clothing etc). Personnel not wearing the correct PPE are exposed to increased risk. Tug masters should demand that their crews wear the appropriate PPE.
- Wear approved and appropriate in-date self-inflating lifejackets whenever on deck. Not using a lifejacket when working on deck, boarding, tying up or connecting up a barge can be hazardous.
- Ensure that working areas are safe and free from trip or slip hazards, particularly around bollards.
- Remain alert to the ongoing operations.
- Listen to orders from the tug master.
- Hold a line by the side of the eye or the standing part.
- Be aware of lines (towing or mooring) suddenly coming under tension.
- Stay clear of snap back zones.

⁵ Reference should be made to the studies carried out by the American Waterways

<http://www.americanwaterways.com/sites/default/files/legacy/commitment-safety/AnnualTowingIndustrySafetyStatistics31JUL2013.pdf>

Other factors that can impact on the safety of crew during a towing operation include:

- Fatigue should not be underestimated and it is now acknowledged that many incidents occur where fatigue is a factor. Local and international regulations may apply to the working hours of the crew. The international rules for working hours are regulated by the IMO Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), amended in 2012. These require a minimum of ten hours of rest in any 24 hour period; hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length. These regulations may not apply to non-international trading tugs, but in the absence of other guidelines could be used.
- Poor weather increases the risk to a towing operation and has to be properly assessed by the tug master. It is better to abort an operation than risk life.
- Night working requires additional vigilance and good lighting.
- Danger from damaged tow lines or equipment.
- Working in rivers or tidal areas is particularly hazardous due to strong currents and unexpected change of current direction.
- Working alone.
- Failures to communicate effectively.

Tug working decks should be non-slip in the working areas, well lit with obstructions, trip hazards and snap back zones highlighted. Steps and ladders should be in a good condition with non-slip steps painted in a light colour to be easily visible at night.

The tug shall have means of recovering a man overboard (MOB) either by a rescue boat or a MOB device such as a Jason's Cradle when the tug can actually pick up the casualty alongside.

Chapter 12

▶ Communication

The communication equipment on board both the tug and the towed unit must comply with the requirements of the administration.

Attention should be given to the communication equipment on board a manned towed unit. This should include at least two portable VHF radio telephones and a daylight signalling lamp. If the towed unit is boarded at least two VHF radios should be available.

Lack of effective communication is often a factor in the cause of accidents. Effective communication must include:

- Good communication between the wheelhouse, working deck and engine room. The use of pre-towing briefings (tool box talks) is essential
- Good communication from the tug to the port/river authorities to keep the tug updated on hazards and traffic movements
- Good communication with the tow master and the towed unit
- All personnel must understand any agreed hand signals.

Chapter 13

▶ Record Keeping

As a minimum the tug should keep a towing log as well as other logs and records required by the flag state. It is important that good records are maintained. In the event of an incident these are referred to in detail and are important in supporting the tug master's description of events and defending a Member's position in the event of a related claim.

Chapter 14

▶ Other Risks – Piracy

The Malacca Straits, Bay of Bengal, West Africa (in particular the area bounded by the countries in the Gulf of Guinea), the Indian Ocean, Somali Basin and Red Sea are areas where extensive towing operations are undertaken and piracy is a threat. Tugs are particularly vulnerable due to their slow speed and low freeboard. Tug masters and companies should take additional anti-piracy precautions, including compliance with the latest version of the 'Best Management Practices' and local flag state guidance available on:

www.ics-shipping.org/piracy

Annex 1: Case Studies

▶ Case Study 1

The incident

This incident occurred when two tugs were employed in shifting a floating dry dock of approximately 3,400 tonnes into deep water so that she could be ballasted down to sail out a vessel within. The operation required the dock to be manoeuvred across the port approach channel, down which a supply vessel was navigating. In order to give this vessel more sea room, the tug's towing the dock eased off. The dock then started to drift towards vessels moored at a nearby berth and despite the best efforts of the tugs, the dock continued towards the moored vessels, eventually making contact with one.

Observations

Two factors played a part in the cause of this incident. The bollard pull of the tugs was considered insufficient for the size of the dock. A strong current was flowing at the time of the operation and the tugs were not of sufficient power to regain control. Secondly, neither the dry dock operations department nor the tug masters took it upon themselves to inform the port control of the operation. Had this been done, the manoeuvre would have probably been delayed until the channel was clear or the inbound vessel prevented from entering the channel. All in all, the operation was very poorly planned.



The financial cost

Whilst damage claimed was extensive we eventually concluded settlement in the modest sum of US\$ 14,737.

Annex 1: Case Studies

▶ Case Study 2

This case study has been issued by Australian Transport Safety Bureau, Report MO-2011-009/Tuahine

Tuahine (MNZ No. 105436) is a conventional twin screw, twin rudder harbour tug which was built in 1965. (Figure 1). It has an overall length of 14.94 metres, a beam of 4.6 metres, a moulded depth of 2.56 metres and a 7 tonne bollard pull. At the time of the incident, Tuahine was owned and operated by Bay Underwater Services, New Zealand. It had a crew of three appropriately qualified and experienced New Zealand nationals.



Figure 1

Tuahine in the Brisbane Riverpositions



Figure 2

Navigational chart Aus 424 showing initial EPIRB location and mayday positions

The incident

On 3rd October 2011, Tuahine arrived in Tin Can Bay, Queensland. While berthed there, various tasks were undertaken by its crew to prepare the tug for its upcoming voyage to New Zealand. One of these tasks was the removal of the rubber tyres, which were in use as fenders, as these had been found to hinder the vessel when in a seaway. After their removal, the tyres and a 500 mm long x 100 mm thick piece of rubber fendering, were stowed and secured in the tug's steering compartment.

At 1000 on 30th October, Tuahine departed Tin Can Bay with the intention to sail to Brisbane and then onto New Zealand. The crew had also been told about a fishing spot by a local resident and planned to stop there to fish while en route to Brisbane. The weather was good and by late in the afternoon, the tug had reached a position well to the east-southeast of Double Island Point (Figure 2).

During the afternoon, the weather started to deteriorate and the tug's motion in the seaway increased. At about 1700, the master noted a loss of steering. On investigation, one of the crew discovered that the piece of rubber fendering had come loose in the steering compartment and had damaged a steering gear hydraulic hose. This had led to a loss of hydraulic oil from the steering system and the subsequent failure of the tug's steering.

The crew attempted to repair the damaged hydraulic hose but could not get it to seal properly. The oil supply on board was low and so the on-going leak proved to be unsustainable.

The weather continued to deteriorate and the master was having difficulty controlling the tug's heading using only the two propellers. One of the crew had become ill and the crew began to fear for their safety.

The master attempted to contact shore assistance by very high frequency (VHF) radio but was unsuccessful. At about 2316, he made the decision to activate the tug's Emergency Position Indicating Radio Beacon (EPIRB).

The Australian Maritime Safety Authority's (AMSA) Rescue Coordination Centre (RCC) in Canberra received notification that the EPIRB had been activated. At 0029 on 31st October, the EPIRB position was resolved to be 26° 41.88'S 154° 53.76'E (Figure 2), 79 miles east-northeast of Cape Moreton.

The EPIRB was registered in New Zealand and the RCC contacted New Zealand search and rescue authorities to establish the identity of the vessel. The RCC then contacted the owner in New Zealand, informing him that the EPIRB on board the tug had been activated.

Despite attempts, the RCC was unable to establish direct communications with Tuahine. The RCC then began to task air and sea assets to the area. At 0243, a passing aircraft established VHF radio contact with Tuahine and determined the condition of the tug and crew.

At first light on 31st October, AMSA's Brisbane based search and rescue aircraft dropped a satellite telephone to Tuahine's crew and communications with the RCC were established. The master reported that all crew were safe and the tug was adrift, beam on, heading southeast at about 1 knot and requiring a tow. AMSA then provided assistance to the tug's owner and local marine authorities in Brisbane to arrange a tow for the disabled tug.

At 1310, Tuahine's master made the decision to abandon the vessel rather than remain on board overnight with the weather continuing to worsen, a sick crew member and the tug unable to be manoeuvred. He declared a mayday and the RCC tasked a rescue helicopter to proceed to the tug's position of 26° 50.02'S 154° 59.28'E.

To assist with the rescue, Tuahine's crew streamed an empty 1,000 litre plastic container, attached to the tug's tow line, to act as a drogue. They also deployed the tug's life raft as instructed.

At 1610, the tug Rodds Bay departed Brisbane to rendezvous with Tuahine and take it in tow.

Just before 1700, a rescue helicopter arrived overhead Tuahine and by 1708, the three crew members had been winched on board the helicopter. They were flown to the Sunshine Coast, north of Brisbane.

At the RCC's request, the crew had left Tuahine's engines running to provide power to light the tug as it drifted through the night and the EPIRB was left activated.

At 1120 on 1st November, Rodds Bay arrived at Tuahine's position and connected a tow line to it. At about 1030 on 2nd November, both tugs arrived in Brisbane.

Safety message

Regardless of the length of a voyage, or their experience, the crew should always adequately prepare their vessel before departing port. The proper stowage and securing of equipment to prevent movement in a seaway and the carriage of spare parts to repair critical equipment are essential parts of a thorough voyage preparation. The dangers of being ill-prepared for a voyage have been illustrated in previous ATSB investigations.

Annex 1: Case Studies

▶ Case Study 3

This case study has been issued by the MAIB Report concerning the Ijsselstroom

The tug Ijsselstroom had been working on the construction of a new berth and breakwater in the Port of Peterhead. On the morning of 14th June 2009 she was tasked to act as a stern tug for the barge Tak Boa 1, which was arriving off the port with a cargo of 5,000 tonnes of large rocks from Sweden.

Ijsselstroom's master chose to deploy her topline over her stern and intended to maintain position and heading relative to the barge by using differential ahead power on her two engines. A bridle wire was not rigged. As the lead tug increased speed, the master found that he was unable to control Ijsselstroom's yawing motion effectively and five minutes after connecting to the barge the vessel took a large sheer to starboard, girted and capsized.

The investigation identified a number of factors that contributed to the accident, including:

- Van Wijngaarden Marine Services relied too heavily on the individual knowledge and experience of its masters to carry out a safe operation and did not have a formal staff training programme. However, the masters' knowledge and experience were never assessed.
- For a conventional tug, towing over the stern, while running astern, is an inherently unstable mode of operation.
- The tow speed was too high to replicate earlier, successful entries using Ijsselstroom as the stern tug.
- The lack of a bridle wire or gob rope meant there was no physical safety device to prevent Ijsselstroom from girting when directional control of the tug was lost.
- Ijsselstroom's master had not been trained in the use of the emergency brake lift control, had not tested it or witnessed its effect, and did not operate it when the tug got into difficulties.
- The pilot had not adhered to the port's procedures regarding risk assessments prior to the arrival of Tak Boa. 1. Specifically, he had not discussed the barge entry with the master of Ijsselstroom and had no knowledge of the master's intended towing method or operational limitations.
- The Peterhead Port Authority's Safety Management System (SMS) had some inaccuracies that were not identified in the annual review and which could have prompted the pilot to select a more suitable tug for the task.



Recommendations have been made to the operator following this investigation. As a result, the operator has been advised to introduce a master training programme, review the stability of its tugs for the tasks they have been used for and establish risk assessment and briefings as standard operations procedures. The Peterhead Port Authority has been recommended to audit actual working practices against those laid down in its SMS and to ensure that the operational limitations and working practices are understood when non Port Authority tugs are working in the harbour.

Annex 1: Case Studies

▶ Case Study 4

The incident

This incident occurred as a small passenger vessel was being towed from a river into a harbour basin. This dead tow was being performed by a harbour tug acting as lead tug and a tug/workboat which was made fast aft. The masters of the two tugs had agreed that the towlines would be shortened off the basin entrance and that the lead tug would then tow the vessel into the basin with the workboat holding the stern of the passenger vessel up into the ebb tide, which was running downriver at approximately 3 knots. As they commenced the final stage of the tow the tug/workboat was girted and capsized, drowning its master.



Observations

Once the towline had been shortened and the slack had been picked up the lead tug called the workboat to confirm that they were ready to proceed. On receiving the all-clear the lead tug progressively applied power, turning the tow into line with the approach. Power had been brought up to approximately half ahead when the tug received a VHF message asking it to stop. Almost simultaneously crew members on board the tow shouted to the lead tug that the workboat had capsized.

Based on information from the survivor and witnesses on the tow, it appears that the workboat master had intended to let his boat drift into line with the stern of the passenger vessel as the slack on the towline was taken up. It seems that the workboat did not turn as fast as expected for when the weight came on the workboat was still lying at an angle of about 140° to the fore and aft line of the tow. It appears that the master realising the danger abruptly put his engines full ahead intending to swing his vessel into line with the tow. Before the workboat could turn the tow started to pull the workboat along with it. The workboat listed to starboard and a combination of the workboat's engines, the river current and the forward motion of the tow dragged the starboard quarter under, with the result that the workboat capsized. The eye of the towline from the passenger vessel to the workboat had been placed over the bitts. There was no means of releasing the towline in an emergency.

Financial cost

The workboat, although eventually refloated, was a constructive total loss. The measures taken to prevent pollution together with the fees of lawyers and consultants exceeded US\$ 14,000. The master's family was compensated by the State Workers' Compensation scheme.

Annex 2

► Acknowledgements and References

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References

1. Transport Canada Guidelines for Tug and Barge Systems used for the Transportation of Oil in Bulk 2010-01-Transport Canada - Ship Safety Bulletins
2. Transportation Safety Board of Canada - Accident Investigations Tug Keta V (2003), Sea Cap XII (2000), Tug Miller Richmond (2000), Progress (2002), Workboat 36E33460 (2002), Tiger Shaman (2003), Workboat Elmer H (2004), Tug Salvor (2004), Tug Manson (2004), Ocean Warrior (2005), Workboat Bonnie Mouse (2008), North Arm Venture (2009), Seaspan Pacer/Escort Eagle (1999)
3. Dutch Marin Transport Investigation Report - Fairplay 22 (2011)
4. USCG - Investigation Rpt Tug Valour (2006)
 - The Marine Accident Investigation Branch MAIB
 - Tug Adherence (1996)
 - Tug Chiefton (2011)
 - Tug Flying Phantom (2007)
 - Workboat Forth Guardsman (2011)
 - Tug Ijsselstroom (2009)

5. Hong Kong Marine Accident Investigation Section
 - MOB dumb barge 18 (2005)
 - Millions Harvest 2 (2006)
 - Hua Chang Hai 3 (2006)
 - Smart Hill 1 (2007)
 - Shun Keung 8 (2007)
 - Chun Wah (2007)
6. BSU Investigation Report 381/2004 - Capsize of Tug Julius
7. BSU Investigation Report 607/2007 - Personnel Accident Bugsier 11
8. BSU Investigation Report 263/2003 - Towing Line Failure Tug Axel
9. Danish Maritime Authority - Stevns Power Casualty - report (2003)
10. ATSB investigation; New Zealand Tug Tuahine (2011), Seatow 61 (2007)
11. Maritime New Zealand - Barge Stability Guidelines
12. PLA Code of Practice for Ship Towing Operations on the Thames (2010)
13. PLA Code of Practice for Craft Towing Operations on the Thames (2011)
14. Sullom Voe Harbour Authority - Towing Operations (2008)
15. BTA'S Best Practice Guidance - Pre-Towing Tasks Checklist
16. Robert Allan Ltd. Naval Architects Escort Winch, Towline and Tether System Analysis PWSRCAC RFP No. 8570.12.01 Final Report Project 212-030 Revision 4 (August 24, 2012) - Prince William Sound
17. Close It Up! - Staying Watertight - paper by Chris Stockman

18. ITS papers:

- Tug Tow Rope Systems and Planned Maintenance Procedures R Underhill (2006)
- How Safe are Today's Tugs? - John Noble (2010)
- Ocean Towing and a Double Tow Dilemma - Kent Stewart (2012)
- Towing Liabilities - Am I Properly Covered? - Simon Swallow - Shipowners' Protection UK Ltd (2012)
- Girting/Tripping - Capt Grant Livingstone (2012)

19. China Classification Society - Guidelines for Towing at Sea (2012)

20. Korean Registry - Rules for the Towing Survey of Barges and Tugs (2010)

21. ABS Rules for Building and Classing Steel Vessels less than 90 metres (2012)

22. MCA MGN 280 (M) Small Vessels in Commercial Use for Sport or Pleasure, Workboats and Pilot Boats - Alternative Construction Standards

23. MCA MGN 199 (M) - Dangers of Interaction (2001)

24. IMO Res A.893 (21) (1999) Guidelines for Voyage Planning

25. IMO MSC/Circ 884 (1998) Guidelines for Ocean Towing

26. American Waterways Operators - Proposed Towing Vessel Inspection Programme fact sheet

27. U.S. Navy Towing Manual Rev 3 (2002)

28. IMCA - Guidance on Wire Rope Integrity Management for Vessels in the Offshore Industry (2008)

29. IMCA - Marine Inspection for Small Workboats (2012)

30. Dept Ecology - State of Washington - Tug and Tank Barge Operations (2010)

31. Noble Denton - Guidelines for Marine Transportations (2009)
32. American Waterways Operators (AWO) Responsible Carrier Program (2012)
33. Maritime Engineer Pty Ltd - Ocean Towing and the Double Tow Dilemma - A Solution at Last
34. Oilfield Seamanship - Towing - Michael Hancox
35. The IMO document - Guidelines for Safe Ocean Towage - MSC/Circ 884 provides general guidance for ocean towing that is applicable for many towing situations. There are also other guidelines used by various parts of the industry and the classification societies also produce useful advice and guidance.
36. In the absence of any acknowledged standard, the ABS 5-8-A1/5 Standard: Intact Stability Guidelines for Towing vessels (1998) can be used to ensure adequate intact stability for towing vessels. Other classification societies also have their own guidelines.
37. Maritime New Zealand - Barge Stability Guidelines
38. IMO MSC/ Circ 884 - Guidelines for Safe Ocean Towage
39. IMO Res.893 - Guidelines for Voyage Planning.



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