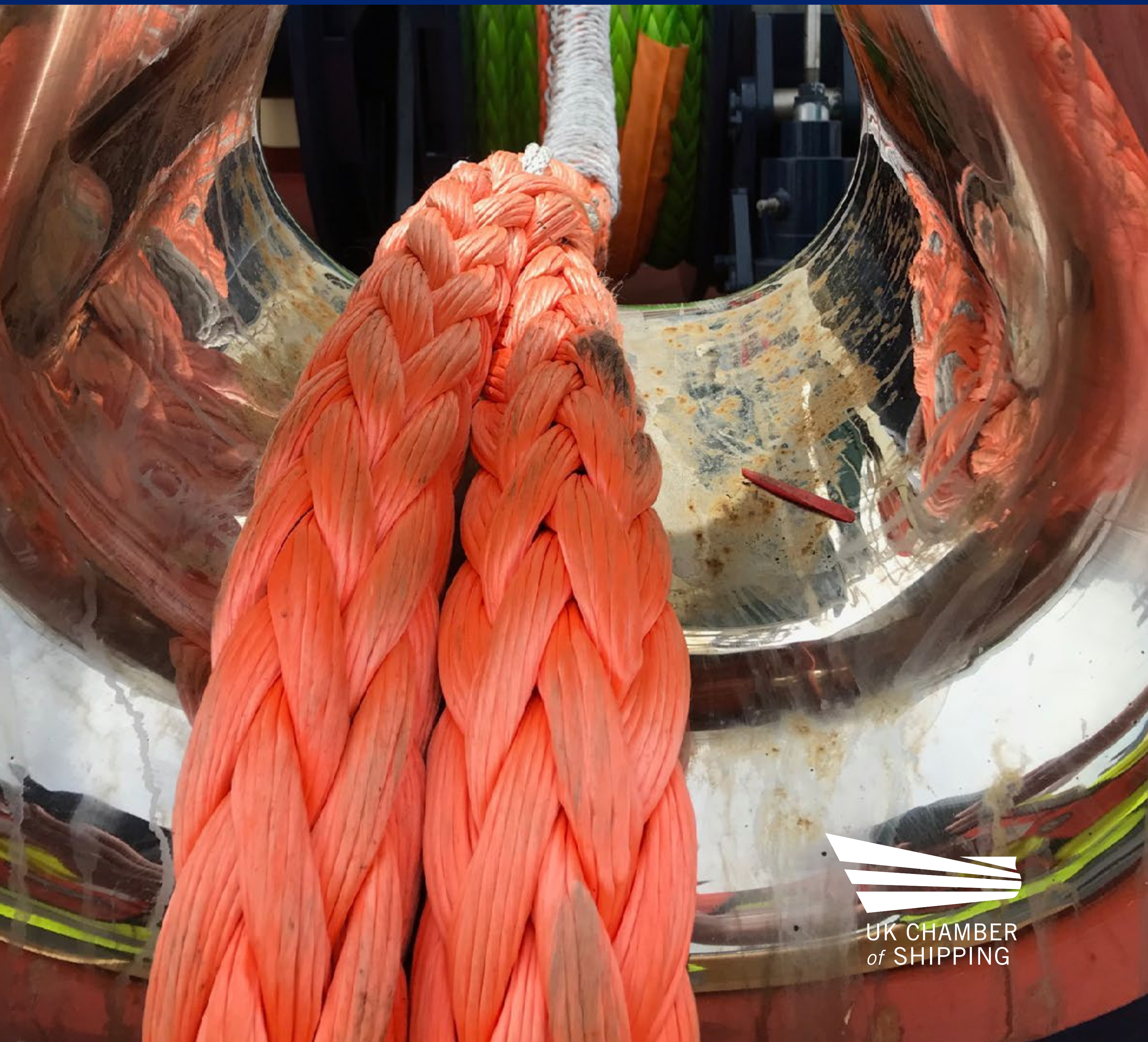
A BTA Guide

Rope Selection, Procurement & Usage (Second Edition)

BTA



UK CHAMBER of SHIPPING

A BTA Guide

Rope Selection, Procurement & Usage (Second Edition)

This product has been produced by members of the British Tugowners Association, as a part of the UK Chamber of Shipping.

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Foreword

The British Tugowners Association has developed the Second Edition of *Rope Selection, Procurement & Usage* to support tug owners, operators, masters, and technical personnel in the selection, procurement, use, and lifecycle management of towline and ropes.

The guidance expands on the procurement process, emphasising the importance of the Towline Operational Assessment, bringing together tug characteristics, operational considerations, and environmental conditions. This TOA supports informed dialogue between operators and vendors to identify suitable rope properties for intended operations.

Building on the highly respected First Edition, this edition provides updated structure and incorporates learnings around the proper selection and management of towlines used. It recommends operators to consider the towline as part of a system, rather than as an individual component, to better identify and manage the challenges that arise from the interaction between different elements of the towing arrangement.

The Second Edition expands coverage of through-life management, including installation, inspection, traceability, maintenance, testing, and retirement. Guidance on certification, record-keeping, and gog systems has been extended to promote consistency and support sound operational decision-making across differing towage practices.

The Guide should be applied with appropriate professional judgement alongside manufacturer guidance and company safety practices and policies.

The British Tugowners Association

BTA

1 Introduction

It can be argued that the towline is the single most important piece of equipment in the towage industry. It provides the essential connection between the assisting and assisted vessel, enabling safe operations.

The importance of proper rope selection, handling, inspection, and retirement cannot be overstated. Maximising the safety and service life of the rope begins with selection, followed by correct installation, through-life management and having a suitable retirement process.

Towlines have evolved beyond simple lines; they are more akin to a towing system. Selecting the right rope for each part of the towing system is not a one-size-fits-all proposition. Each component should be considered independently, accounting for its relationship to other parts of the system.

This guidance aims to assist in selecting an appropriate rope/towing system and provides details on the various aspects of the towing system lifecycle outlined below.

2

Purchasing

The specification of a towline for a vessel should be the culmination of the dialogue between operator and vendor. With this dialogue, the rope vendor should appraise all the relevant aspects of a tug's expected work and specify a rope that is fit for its purpose without overspecification.

MEASURING REAL VALUE

Direct costs – it is acknowledged that there are various direct costs associated with towlines, such as purchase costs, transport, crew time to fit and disposal, which are not relevant to this guide. However, an example cost-per-tow calculator is included in Annex C.

Indirect Costs – the importance of selecting the correct ropes and understanding the potential risks of failures is imperative to minimise indirect costs incurred if an operator needs to replace ropes early.

The aim is to ensure that the most suitable towline is selected for the operation, thereby reducing the likelihood of a failure and medium to long-term costs by increasing service life.

- **Risk to crew safety** - both onboard the tug and towed vessel, fibres such as Polyesters and Polyamides have a high level of elongation/stretch and can recoil with extreme force and, due to the weight of these ropes, have the potential to cause damage or severe injury. Modern fibres such as High-Modulus Polyethene (HMPE, e.g., Dyneema®) exhibit minimal elongation but can still recoil under certain conditions. If the rope is damaged, in poor condition, or unsuitable for the tug or the operation the likelihood of a rope parting increases.
- **Repair and maintenance costs to the rope** – each time the rope is damaged or parts, it will incur costs to put it right. These expenses can include equipment, crew labour or management time to arrange a contractor to repair the rope.
- **Repair and maintenance costs to tug** – if a recoiling rope damages the tug or if a rope fouls a propeller, the costs can be considerable.
- **Tug down time** – if the rope requires repairing, re-splicing, or changing, the tug cannot work until the rope is ready to be used again. Depending on the operational set-up, it can take several hours to remove the old rope and land it ashore, to then load and fit the new rope. This procedure often requires multiple hands or machinery to complete safely.
- **Damage to company reputation and image** – having to report that a towline has parted or that a tug is out of service can cause reputational damage.
- **Management and administration time** –when a rope parts, it will take time to order a new rope and dispose of the parted one, as well as conduct thorough investigations.
- **Environmental impact** – every time a rope is replaced, the old rope must be disposed of. At the time of publication, there is limited recycling potential, with the majority of ropes being sent to landfill. However early-stage practices such as mechanical recycling and energy recovery suggest that alternatives to disposal are emerging.

TOWLINE OPERATIONAL ASSESSMENT

The following information should form the backbone of a Towline Operational Assessment (TAS) as part of the procurement process. An informed discussion of the key considerations should be undertaken with all stakeholders, including the rope manufacturer, to determine the most suitable towing system. The assessment should identify the tug's specific characteristics, intended towing operations and operational environment.

Further details are outlined below, and checklists, including guidance notes are included in **Annex A**, on page 25

Tug Specific Characteristics

- Tug type (ASD, ATD, Voith, and so on)
- Age and condition of tug
- Bollard pull
- Steering force
- Propulsion
- Drum specification and size
- Winch type
- Winch and staple location

Specific Towing Operation Considerations

- Nature of the tow
- Static load
- Company safety factor
- Expected use of winch if/when escorting
- Line buoyancy
- Expected types of assisted vessels
- Expected freeboard of assisted vessels
- Expected complications on mooring decks of assisted vessels
- Expected width of bitts on assisted vessels
- Lines expected to be connected to emergency towage bracket
- Expected safe working loads of bits and fairleads on assisted vessels
- Vessel crewing and manual handling potential
- Any other operation-specific factors

Operational Environment Considerations

- Nature of waters during operation
- Expected combined wave height
- Expected wind speeds
- Prevailing wind direction
- Expected tides/currents affecting towage
- Operational limits

When working in confined areas, high freeboards on assisted vessels can create a steep towing angle. This can lead to large increases in the load on the towline.

Tables outlining greater information on TOAs are included in **Annex A**

CONSTRUCTION

Rope construction is based on building strength in layers comprising:

- **Fibres** - the tiny building block of a rope. A fibre can be thought of as a single, hair-thin thread.
- **Yarns** - a small bundle of fibres that are twisted or grouped.
- **Strands** - bundles of yarns that are twisted or braided together.
- **Rope** - several strands combined.

Each level of this structure plays a role in how the rope performs, influencing its strength, flexibility, stretch, durability, and resistance to wear.

Different materials, such as polyester and HMPE, use the same basic construction principles but produce ropes with very different characteristics.

Ropes can be either jacketed or unjacketed, depending on whether they include an outer protective layer. A jacketed rope has a load-bearing core covered by a woven outer jacket that protects against abrasion, sunlight, dirt, and handling wear. An unjacketed rope is constructed from a single braided or laid structure with no outer cover, making it lighter, more flexible, and often stronger for its size, but more exposed to chafe and damage.

High Modulus Polyethylene (HMPE) Rope

HMPE ropes are often referred to by trade names (e.g. Dyneema) and are constructed using ultra-strong polyethylene fibres.

Characteristics

- High-strength (equivalent to wire, size for size)
- Lightweight
- Buoyant
- Low elongation
- Excellent resistance to alkalis, acids and petroleum-based products
- High melting point (140°C)

Polyester

A polyester rope is made by extruding polyester fibres.

Characteristics

- Medium-strength
- Heavier than HMPE
- Moderate elongation
- Non-floating
- Excellent resistance to UV, petroleum-based products

Mixed Fibres

A blend of two or more fibres, usually constructed from a mix of polyolefin and polyester – the ratio of the material mix can be varied.

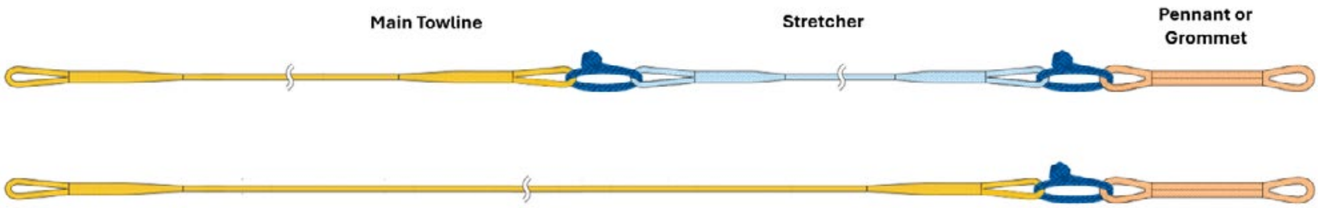
Characteristics

- Dependent of fibres used
- Moderate elongation
- Variable buoyancy
- Good resistance to UV, alkalis, acids and petroleum-based products
- Can have the benefits of lower cost while maintaining reasonable strengths and weights

The strengths and weights of ropes depend on the materials used and will vary from product to product.

THE TOWLINE SYSTEM

The main towline is the principal part of the towline system, which may also include pennants, stretchers, grommets and links, depending on the outcome of the Towline Operational Assessment. These components are used in towing systems, primarily to provide a safe and strong connection between vessels while managing the dynamic forces involved in the operation.



Source: Adapted from original courtesy of Samson Ropes ©

Pennants

A towline pennant is a shorter line attached to the end of a main towline. It is designed to protect the main line by taking the highest level of stress and abrasion. The pennant thereby extends the life of the main towline and improves safety and reliability during towing operations. At the same time, the pennant provides a replaceable connection point to the vessel being towed or assisted.

TURBO-75 Pennant with DC-GARD over splice protection
Source: Image courtesy of Samson Ropes ©

Grommets

A towline grommet is essentially a pennant with a robust, endless loop for strength, durability, and ease of handling. It is typically made of high-performance synthetic rope as a specific component within a larger towing assembly.

Unlike a standard rope with two ends, a grommet is a continuous loop of rope, often spliced together to create maximum strength and durability. This construction distributes the load evenly throughout the loop.

A grommet acts as a primary connection point, often serving as a sacrificial element that can be replaced more easily than the entire main towline.

By providing a specific point of contact that can be rotated or repositioned to distribute wear, the grommet helps prevent chafing and wear on the main line.

Amstel-Blue Grommet with full DC-GARD protection
Source: Image courtesy of Samson Ropes ©

Stretchers

A towline stretcher, or shock absorber, is a short, elastic section of rope (often polyester or nylon) used to absorb sudden shock loads caused by waves and vessel movement. Stretchers therefore prevent damage and fatigue to the main, less elastic towline by providing controlled stretch, ensuring safer, smoother operations and protecting equipment. It acts as a sacrificial, energy-absorbing link, typically stronger than the main line, protecting the costly primary rope and vessels.

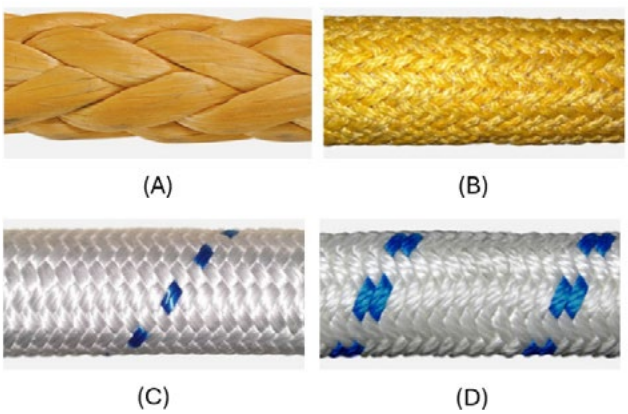
Additional Protection

The Towline Operational Assessment may require a towline to include additional protection, primarily to prevent abrasion, chafing against ship surfaces (e.g., fairleads, winch drums, bulwarks), and exposure to the operational environment, UV degradation, chemical and water damage, and debris penetration.

The example (**A**) is of LANKOFORCE, a 12-strand braided rope made of HMPE yarns. This towline provides an alternative to heavy steel wire ropes in modern towline systems.

The HMPE braid (**B**) is jacket-woven to provide the maximum protection against heavy abrasion.

Example (**C**) is another braided HMPE jacket, designed for applications where heat and heavy abrasion are expected. A polyester jacket (**D**) is also for applications where heat build-up and heavy abrasion are expected, but where non-floating properties are preferred or required.



Source: Image adapted from Lankhorst Ropes ©

Other examples of jacket protection include:

SATURN-12 with 8m DC-GARD

SATURN-12 with 8m DYNALENE protection

Source: Images courtesy of Samson Ropes ©

The Great Trade-off

As described, an additional jacket on a towline primarily provides abrasion and contamination protection and can extend the rope's lifespan. However, it comes with several important drawbacks:

- **Difficulty of inspection**: The jacket makes it nearly impossible to inspect the load-bearing core for internal damage or abrasion without removing the jacket. This can allow hidden damage to go unnoticed, leading to premature line failure, damage, or injury.

- **Reduced flexibility and handling**: Jacketed lines are generally less flexible and can be more difficult to handle and manage compared to non-jacketed lines.

- **More difficult to splice**: Splicing jacketed ropes is typically more complex than splicing single-braid, non-jacketed ropes. It often requires specialised techniques or services to perform properly.

- **Increased cost and weight**: The additional material and manufacturing process add to the initial cost and weight of the towline.

- **Potential for core slippage**: In some applications, especially on winches, there is a risk of the core and cover moving independently (slippage) unless the rope is specifically designed to prevent this (e.g. through coatings or specific braiding).

PROPERTIES AFFECTING ROPE USAGE

Elongation (Elasticity)

The elastic property of a rope is sometimes undervalued during the selection of a towing line configuration. The elastic elongation properties of ropes on board are extremely important to the durability of the towing line as well as vessel equipment (e.g. winches).

When a tug is connected to an assisted vessel, environmental factors (such as wind, waves and currents) will induce different movements in the two vessels. The changing distance between the two vessels is then absorbed by the towline system's elasticity. Some modern winches render and recover the towline to maintain a constant force on the line, thereby compensating for load fluctuations.

Elongation comes in three different forms:

1) Construction/structural Elongation

During rope manufacture, the tension on the rope is only a few percent of the Minimum Breaking Force (MBF). As a result, ‘air’ remains between the yarns and strands. During the first few times a rope is put to work (stretched), this 'air' is squeezed out and the yarns and strands set themselves. This is called structural elongation. Once this early stretch occurs, the rope is considered to have 'bedded in'.

2) Elastic Elongation

Elastic elongation is the flexibility of the yarns, which absorb the energy put into the rope. Once the load has been released, the rope returns to its original length.
If the rope is allowed to contract back to its original length in an uncontrolled manner, for example due to a failure, the stored elastic potential energy is converted into kinetic energy - often referred to as 'snap-back'. Under certain conditions, this can be very dangerous. High towline tension and high towline angles can result in higher snap-back speeds and an increased likelihood of the rope striking the tug. It is very difficult to predict how a rope will behave when it fails under high tension, but a decision should be made on whether a heavier/slower-moving impact (e.g., Polyester) is preferable to a lighter/faster one (e.g., HMPE).

This table shows the elongation characteristics and specific gravities of commonly used fibre types:

Generic Fibre type	Nylon	Polyester	Polypropylene	HMPE
Elongation (1)	15 – 28%	12 – 18%	18 – 22%	2.7 -3.6%
Specific Gravity (2)	1.14	1.38	0.91	0.98

1. Elongation refers to the percentage of fibre elongation at break.
2. Specific gravity is the mass density (g/cm3) and defines the buoyancy of the rope.
   Specific gravity < 1.0 = floating
   Specific gravity > 1.0 = non-floating
   (In salty water the transition from floating to non-floating is approximately 1.02)

3) Plastic Elongation

Plastic elongation is an irreversible, hazardous phenomenon. When yarns are overloaded (the elongation exceeding what the fibres can safely withstand), the structure of the yarns will change. Deformation occurs inside the yarns. As a result, the strength of the yarns will drop instantly, and the rope will not return to its original length.

Overstretching can occur either throughout a rope or at a single point. This shock loading results in plastic deformation/damage, weakening the rope and making it more likely to break in the near future, for example, at a sharp bend in a fairlead, bollard or other devices. The overstretched rope (or the part of the rope overstretched) must be rejected! Plastic elongation may be identified by a reduction in the rope diameter at this point.

Dynamic Loading / Shock Loading / Static Loading

Towlines are subject to dynamic loading during normal operations. The maximum loading on the towline should always remain below the designed maximum as outlined in the Towline Operational Assessment, which will define the required factor of safety.

Dynamic loading will cause fatigue in the yarns, eventually leading to a loss of strength. This is impossible to detect from outside the rope.
Insight into the fatigue performance of ropes may be provided by the Thousand Cycle Load Level (TCLL) value – an accelerated fatigue testing method developed by the Oil Companies International Marine Forum (OCIMF). TCLL expresses the maximum percentage of the nominal breaking strength that a rope can withstand when cycled loaded 1,000 times, tested under strict conditions. Put simply, the TCLL value expresses the rope's resistance to tension-tension fatigue. The higher the TCLL value, the greater the resistance to high loads or tension-tension fatigue.

Operators should be aware that TCLL is simply an indicator. The test is conducted under strict conditions and may not be representative of real-world use. For this reason, the TCLL value should not be relied upon to determine the life left in a rope.

Fatigue

Fatigue occurs when a material is repeatedly loaded and unloaded. A new synthetic rope has a specific Minimum Breaking Force (MBF). When first put to use, ropes tend to show a slight increase in strength. This is due to elongation during a towing operation, which can be compared to a stretching process. However, this increase is not substantial.

Once the rope has reached its full strength, it will work at this level. Over time, the yarns gradually lose their strength due to tension-tension fatigue. As this occurs, the Actual Breaking Force (ABF) of the rope will decline and, eventually, break under a 'normal' load.

Environmental Temperatures

Generally, extremely cold temperatures will not have a negative impact on rope performance. However, moisture and subsequent freezing will impact a rope's handling and flexibility, although the long-term impact on the towline's lifecycle is unknown. High temperatures can reduce a rope's strength and fatigue resistance. If temperatures exceed certain limits, special care should be taken to ensure the rope is fit for purpose.

Friction

Friction can generate localised high temperatures when the towline moves through equipment in the system, such as when running over stuck sheaves or rollers.

Rope Strength

Rope tensile strength is one of the most commonly referenced characteristics when selecting rope products. Tensile strength may be defined as the maximum load or force a new rope can withstand under laboratory conditions before breaking, usually tested by tensioning it until failure. In general, it is important to match a rope's strength to the requirements of the application. Often, requirements are stipulated by regulatory and certification bodies or by safety standards.

While there is a tendency to select ropes with the highest possible tensile strength, care should be taken to ensure that other performance properties are not overlooked or that weak points are not inadvertently introduced.

Equally, selecting a rope with a higher tensile strength may be necessary to ensure sufficient material is available to resist chafing, friction, and other forms of damage, thereby maintaining sufficient strength throughout its operational life. For example, pennants and grommets may be oversized in terms of strength to account for contact with the assisted ship, whereas a main towline can be more optimised as the contact points are likely within the tug owner's control, allowing damage to be minimised.

Working Loads & Safety Factor

Working loads are the loads that a rope is subjected to under expected or typical working conditions. For rope in good condition, with appropriate splices, and under normal service conditions, working loads are based on a percentage of the breaking strength of new and unused rope.

Working loads, often called working load limits (WLL), are calculated by dividing the rope's Minimum Breaking Strain (MBS) by the required safety factor (sf).

WLL = MBS / sf

Safety Factor recommendations vary according to company safety practices and policies, and are determined by regulatory standards, best practices, or safety and design criteria.

A higher safety factor can be a trade-off between elasticity/strength and crew safety/snap-back risks. The higher a rope's MBL, the larger the amount of elastic potential energy a rope can store. Under normal towage, this is not necessarily problematic as the energy can only come from the tug's direct or indirect bollard pull. However, should a very high snatch load be introduced (for example, if a winch brake suddenly slips and allows the tug to drop back), a force much larger than the forecast towline tension may be encountered (potentially 10x Bollard-Pull on a large tug). If the rope is of a lower strength, it will part earlier than one of increased strength, therefore releasing less energy and potentially less impact damage.

Operators may set the strength (Minimum Breaking Load or MBL) of their towlines to 2.5 times the Bollard-Pull. However, it is recommended that the towline MBL be 3 times the Bollard-Pull (BP) or Maximum Achievable Towline Force (Escort notation tugs) of the tug, whichever is higher.

3

Installation

PREPARATIONS

Prior to the installation of any new towline, time should be allowed to remove the retired towline from the drum and inspect the exposed structure. Remedial action may be required in the form of light flattening/grinding of any rough or sharp surfaces of the drum, rust removal, and groove flattening caused by slippage of the rope on the drum.

It is imperative that staples, fairleads and any other running surfaces that the towline may come into contact with on the tug are clean and free of rust and sharp edges.

If the towing lead has not been in regular use, this may require polishing. When switching from wire to rope, an extended period to rectify grooves should be allowed and rough surfaces cut into the leads from the wire.

New ropes are generally supplied to the vessel either on a reel or as a coil. It is imperative that ropes are spooled on the drum of a winch without any twist in the rope. A twist in the rope, combined with a high load, may reduce service life once put to work.

A shoreside mobile delivery system that allows tensioning should be used as part of the installation process. Alternatively, the new towline should be uncoiled and laid out flat on a debris-free surface to avoid incorporating foreign objects in the outer surface.

ON THE WINCH

Bedding Rope

A bedding rope, i.e. a line secured on the winch to provide a friction layer to prevent the rope from slipping on the drum, can be used.

Bitter End and Emergency Release Mechanisms

The rope should be secured to the drum face plate using either a weak lashing or a compression plate, ensuring the rope can release in an emergency before running it onto the drum.

Source: courtesy of Maaskant Shipyards ©

Source: courtesy of Damen Shipyards ©

The previous images show one way to connect the bedding rope to the main towline/wire, using a hook on the winch drum that allows the tow wire to disconnect in an emergency.

Another method is shown in the following section, where the bedding rope is spliced to the end of the main towline and clamped to the winch drum at the other end. When spooling, the main rope on the bedding rope is clamped tight, and once the spooling operation is complete, steel washers are placed in between the clamp halves to allow the bedding rope to pull free of the winch drum under nominal load.

Source: Shetland Islands Council -Towage ©

Spooling On

The spooling process aims to avoid loose, or slack turns and to prevent the lead from being buried beneath subsequent layers, which can reduce compression and cause fibre damage.

In the absence of a mobile delivery system, appropriate back tension can be achieved by first running the rope in a figure-of-8 on two bollards, before feeding it onto the drum. It is important to inspect the figure-of-8 bollard to ensure it is free of grooves, rough surfaces, and sharp edges. Once loaded as shown in the previous image, the eye should be placed around a secure shore bollard and the rope run off the winch to the start of the last layer. The vessel should then winch towards the bollard at a low rate, building the layers back using the weight of the vessel to incorporate stretch and tension as it is reloaded prior to first use.

CONNECTIONS

If ropes need to be connected, several options are available.

a) Splicing

Splicing is the joining of two ends of yarn, strand or cordage by intertwining or inserting these ends into the body of the product.

Splicing can be a relatively simple task when the towline has a limited number of strands, but a competent person should always perform it. However, lines of a more complex construction may require an individual with specific qualifications.

In a conventional splice, one should reckon with a 10% loss of strength in the Minimum Breaking Force (MBF) of the rope (in accordance with ISO 2307: "Fibre ropes - Determination of certain physical and mechanical properties"). Despite careful splicing, the strands, and thus the fibres, are displaced throughout the splice area. At the end of the splice, the strands will return to their normal position. However, this transition will be the weakest point in the rope. If a rope is pulled to destruction in a straight line, it should break at this point.

Manufacturers recommend splicing as the preferred method of rope termination.

A spectacle splice (below) can be made by splicing one eye through another eye. This is a good connection, but any replacement ropes need to be spliced on board the vessel.

Source: Image courtesy of Samson Ropes ©

b) Knots

Knots (bends and hitches) reduce rope strength; they are also a convenient way to terminate a rope for attachment to other hardware/equipment. The strength loss is due to the tight bends in the knot. When using knots, it is vital to consider the reduction in strength when determining the size and strength of the rope to be used.

For example, a bowline can decrease a rope's strength by as much as 60%.

c) Through Footing (Cow Hitching)

A through foot can be considered if one length of the rope is short and easy to handle, like a pennant. As shown, in practice, the through foot can be difficult to get the knot out, and therefore suitable strops can be cow-hitched onto each eye and used to separate the hitch when necessary.

Source: Images courtesy of Samson Ropes ©

Source: Images courtesy of Samson Ropes ©

Source: Images courtesy of Samson Ropes ©

Soft Shackles

A soft shackle with a matched MBL can be employed to join two ropes. This is a light option but needs to be fitted with protective eyes to minimise the chance of cutting into the joined ropes due to dissimilar diameters.

Source: Image courtesy of Samson Ropes ©

4

Operation

TOWLINE SAFETY

A clear deck policy should be actively enforced.

In any application, persons should be warned against the serious dangers of standing near a rope under tension. Should the rope part, it may recoil (snap back) with considerable force and speed. There have been several incidents in which a towline has parted and struck the tug, causing damage to the vessel and, in some cases, injury to the crew.

All rope handling should be done in accordance with the **Code of Safe Working Practices, in particular Section 26.6 on Towing.**

The maritime industry has experienced several serious accidents and near misses with tugs' towlines and associated equipment. Even an experienced tug crew can be caught out during towing, as it is not uncommon for a towline to suddenly become taut, surge, or jump without warning. A messenger line can also cause serious injury when under tension.

Once it has been confirmed that the rope has been made fast to the assisted vessel, crew members must vacate the deck prior to the load being taken on the tow. The crew members should report to the bridge when they are inside the accommodation, and the external doors are secure.

GOG SYSTEMS

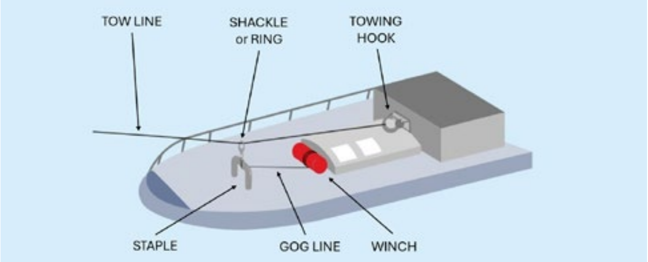
The introduction to this publication argued that the towline is the single most important piece of equipment in the towage industry. This is true, with one exception – the introduction of a gog line.

Gog arrangements are generally the preserve of conventional towage operations where lines, or wires, are used on tugs to control the towline's movement during ship assist and deep-sea towing.

On conventional tugs, the gog rope holds the towline near the stern, shifting the towing point aft and reducing the risk of the towline crossing the beam, which can rapidly create dangerous heeling forces, girting and potentially capsizing the tug.

Girting (often referred to as 'Girding') occurs when a tug is pulled sideways by a towline force. It can develop rapidly, often leaving insufficient time or capacity to introduce slack into the towline or release the tow before the heeling force becomes excessive and surpasses the vessel's righting ability.

A gog rope is essential for tug safety during towage operations. As such, the gog rope must be considered a gog system, not just a line or rope. All the components of that system must be arranged so that any potential point of failure is fully understood and managed.



A gog rope should be treated like a towing rope and ought to be a dedicated rope, used only for the purpose of providing a gog.

All the factors of construction and operational usage mirror those of the main towline. Therefore, the management of the gog line lifecycle should be similar. Type, size and strength of the line, the inspection routine and retirement criteria should be considered in relation to the type of work undertaken and the other components of the gog system.

British Tugowners Association (BTA), UK Maritime Pilots' Association (UKMPA) and the Workboat Association (WA) jointly published "Gog Ropes: Industry Advice", in November 2025 aimed at improving safety in conventional towage operations.

This resource provides practical recommendations for the safe and effective use of gog ropes on conventional tugs, incorporating lessons learned from MAIB recommendations and industry expertise generated in response to previous incidents.

TOWLINE MANAGEMENT

Traceability and Records

It is not uncommon for crews to move between vessels, so the master must understand the towline's history since its installation and its inspection records. This information will help inform their understanding when undertaking inspections related to the towline's age and the number of tasks completed.

This information should be readily available and easily linked to the rope it describes. There are many methodologies for maintaining this information. Some operators mark their certificates, some keep an online log, and some maintain a rope register.

Production batches of rope will have the same certificate number, which is printed on a tracer inside the rope. Individual ropes/stretchers have unique certificate numbers that trace back to their original production batch. However, some ropes have been found to have the same ID number, which, if distributed to different tugs, can result in multiple tugs possessing the same certificate number and loss of traceability.

Rigid identification tags may be used to identify a towline. However, they pose the risk of damaging the towline if they become caught on the assisted vessel or tug. They are also susceptible to damage and loss.

Some manufacturers' ropes carry a unique Product Information Code (PIC), which is printed on an internal tape within the rope and on the protective barrier in the eye. It corresponds to the factory certificate number, providing an effective way of tracking rope use and condition.

More recently, some manufacturers have introduced Radio Frequency Identification (RFID) tags. These tags can be embedded within the rope and eliminate the hazards of rigid identification tags.

Whichever method of identifying ropes is put into practice, the ropes in use and in storage should be clearly identifiable by their characteristics, with their history easily traceable.

Management of Change

Where tugs are moved to a new port or the type of operation changes, it is important to review the Towline Operational Assessment to ensure it remains valid. Alternatively, a new towline may need to be installed.

End-to-Ending

Most manufacturers recommend removing every line halfway through its planned lifecycle, based on the Towline Operational Assessment, and swapping the inactive end with the active end (also called end-to-ending). This will vary high stress and wear points and extend its useful life. Operators should have their own policy on 'end-to-ending' which will be dependent on the nature of service, frequency or use, ability to perform the end-to-end process, and other factors. Regardless of end-to-end timing, a visual inspection should also be performed during rope reinstallation.

Residual Strength Test

It can be beneficial to conduct residual-strength tests. This normally takes place at the end of a towline's working life. However, it is good practice, when end-to-ending your main towline, to cut the spliced eye off of the worked section of approximately 7.5m and submit it to the manufacturer for destructive testing. If this is performed, a notation should be made on the certificate for the rope in use, stating the reduction in overall length.

The manufacturer will then complete a visual inspection of the sample and fit the sample to a test rig to test the residual strength left in the 'worked section' of the towline. An example of the rig and endpoint state is shown below.

BEFORE PULL TO BREAKING FORCE

AFTER TESTING

Source: Images courtesy of Lankhorst Ropes ©

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Maintenance

TOWLINE CERTIFICATION

Towline certificates vary considerably between manufacturers and suppliers. Such variety can lead to confusion about the different ropes being considered, making a like-for-like comparison challenging.

The following information should be requested from the towline manufacturer to be included in the towline certificate.

# Number	Data Value	Guidance
1	Product/Brand Name	May differ from the original manufacturer's product name, i.e., sold by a third party (distributor, agent, fabricator) and renamed/rebranded. The issue, then, is that it may be difficult to establish the original data or specifications for the rope.
2	Original Product Name	To differentiate it from the brand or trade name.
3	Fibre Material	Polyester, Polyamide, HMPE, UHMPE, and so on. - Not trade or brand name Be aware that some manufacturers have been known to mix their fibres/materials.
4	Strength	Minimum Breaking Load (MBL) Measured in Metric Tonnes to ISO 2307, which is a common standard and measures unspliced strength.
5	Size (diameter in mm)	• Should be the finished diameter of the rope under no tension (includes jacket). • ISO 2307 states the diameter is measured under pre-tension (nominal value for open weave loose construction). • Includes jacket if part of the finished/manufactured rope, but not additional anti-chafe protection added to parts or all of the rope. • Regional variation in size units, e.g., inches in the US, mm in Europe. Circumference may also be used in some regions.
6	Construction	E.g., 8 strand, 12 strand, jacketed, unjacketed, and so on.
7	Colour	The product colour (base) and the marker yarn colour (fleck).
8	Length	Finish overall length (OAL) of the rope, yards in the US, metres in Europe.
9	Weight	1) Weight (weight per length, imperial or metric) of unjacketed finished product. 2) Weight of the finished product (OAL including jacket/splices/eyes, and so on, as sold).
10	Type of splice	E.g., Lankhorst A3, and so on.
11	Spliced Strength	ISO 2037 stipulates 90% of MBL.
12	General Description of Rope	Spliced Eyes included (Yes or No). Size of eyes. Description of additional protection, such as abrasion protection.
13	Buoyancy	Specific Gravity/Relative Density.
14	Date of Manufacture	E.g., DD/MM/YYYY.
15	Identification Number	Unique number specific to the finished rope.

Inspection

Towlines should be regularly inspected for damage or wear.

A towline that has been in use for any period will show wear and tear. Some characteristics of damage or wear and tear will not significantly reduce the strength of the towline, but should still be noted and recorded during inspections. Manufacturers issue their own guidance, inspection and retirement regimes which should be referenced and adhered to.

Towline Damage

All images are courtesy of Samson Ropes ©.

Pulled Strand

What	• Strand pulled away from the rest of the rope • Is not cut or otherwise damaged
Cause	• Snagging on equipment or surfaces
Corrective action	• Damage not permanent? → repair • Work back into the rope

Compression

Compressing the rope will damage the yarns, creating a weak point. Compression is caused by lateral pressure on the rope, for example, a vehicle running over the rope on the quay or rollers that are too small in combination with a high load on the rope. On a low ratio of the diameter of the rope to the diameter of the fairlead, the inside yarns are squeezed, and the outside yarns are overstretched.

What	• Visible sheen • Stiffness reduced by flexing the rope • Not to be confused with melting • Often seen on winch drums
Cause	• Fibre moulding itself to the contact surface under the radial load
Corrective action	• Damage not permanent? → repair • Flex the rope to remove compression

Melted or Glazed Fibre

Glossy or glazed areas are signs of heat damage with more strength loss than the amount of melted fibre indicates. Fibres adjacent to the melted areas are probably damaged from excessive heat, even though they appear normal. It is reasonable to assume that the melted fibre has damaged an equal amount of adjacent non-melted fibre.

What	• Fused fibres • Visibly charred and melted fibres, yarns, and/or strands • Extreme stiffness • Unchanged by flexing
Cause	• Exposure to excessive heat, shock load, or sustained high load
Corrective action	• Repair or retire • If possible, remove affected section and re-splice with a standard end-to-end splice. If re-splicing not possible, retire the rope.

Cut Strands

What	• 12-strands: two or more cut strands in proximity • 8-strands and 3-strands: one or more cut strands
Cause	• Abrasion • Shap edges and surfaces
Corrective action	• Repair or retire • If possible, remove the affected section and re-splice with a standard end-to-end splice. If re-splicing is not possible, retire the rope. • Check for areas where snagging may occur and remedy where possible

Discoloration

With use, all ropes get dirty. Look out for areas of discolouration that could be caused by chemical contamination. Determine the cause of the discolouration and replace the rope if brittle or stiff.

Prolonged exposure of synthetic ropes to ultraviolet (UV) radiation from sunlight and other sources may cause varying degrees of strength degradation. Many manufacturers offer products with coatings, fibres, and other attributes to combat UV degradation, but the best way to avoid it is to limit exposure.

What	• Fused fibres • Brittle fibres • Stiffness
Cause	• Chemical contamination • UV exposure
Corrective action	• Repair or retire • If possible, remove affected section and re-splice with a standard end-to-end splice. If re-splicing is not possible, retire the rope.

Inconsistent Diameter

Inspect for flat areas, bumps or lumps. This can indicate core or internal damage from overloading or shock loads and is usually a sufficient reason to replace the rope.

What	• Flat areas • Lumps and bumps
Cause	• Broken internal strands • Shock loading
Corrective action	• Repair or retire • If possible, remove the affected section and re-splice with a standard end-to-end splice. If re-splicing is not possible, retire the rope.

Abrasion

There are two types of abrasion:

- **Internal abrasion** occurs when the towline moves through a fairlead, bollard, sheave or when the towlines are cyclically tensioned. The repositioning of the towline in the curved section causes the strands to move against each other.
- **External abrasion** is where the towline has been in contact with other surfaces. When this occurs under high tension, the abrasion can severely damage a portion of the towline. If yarns or strands have been broken or worn away, an equal part of the strength of the towline has been lost.

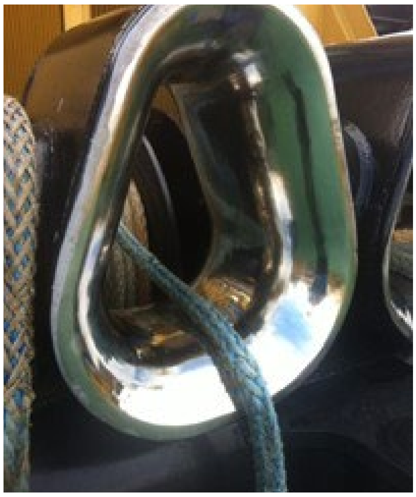
An unprotected rope moving over a rough surface, such as a poorly maintained chock, can be subjected to both internal and external abrasion. Upon inspection, it is easy to see that the external strands are abraded by a rough surface: often, fibres are left behind on the surface that caused the abrasion, and the surface of the rope readily shows abraded yarns.

What	• Broken filaments and yarns
Cause	• Abrasion • Sharp edges and surfaces • Broken internal strands

Corrective action	• Repair or retire
	• Evaluate the rope on its most damaged section
	  • Minimal strength loss (continue use)
	  • Significant strength loss (consult manufacturer)
	  • Severe strength loss (retire rope)

The same rough surfaces can also cause internal abrasion as the internal strands move relative to each other. When the rope's surface strands pass over rough surfaces, they are slowed relative to the strands next to them, causing friction which generates heat and damages the fibres.

As a general rule, for braided rope, when there is 25% or more wear from abrasion, or the fibre is broken or worn away, the rope should be retired from service. For double-braided ropes, 50% wear on the cover is the retirement point. For 3-strand ropes, 10% or more wear is accepted as the retirement point.

Source: Image courtesy of Samson Ropes ©

Source: Images courtesy of LankhorstRope ©

Sharp Cutting Edges and Abrasive Surfaces

Towlines should not be exposed to sharp edges and surfaces such as steel-wire gouge marks or metal burrs (on equipment such as winch drums, sheaves, shackles, thimbles, wire slings, and so on). When replacing winch lines, care must be taken to ensure the rope does not contact fixtures or fittings that have been scored or chewed by previously used wire lines.

When replacing steel-wire rope, in most cases, it will be necessary to repair the surfaces of sheaves, shackles, thimbles, and other equipment that may contact the rope. Other surfaces should be carefully examined and dressed as necessary.

The surface condition of the fairleads and deck fittings on assisted vessels can significantly impact the towline and its lifespan. Corrosion or abrasive surfaces will degrade the towline, and protective sheathing could be considered. On completion of the inspection, if any damage is found, it is necessary to consider the damage in the context of the particular towline and its remaining life. Factors include:

- Type of damage
- Extent of damage
- Location of damage along the length of the towline

These should be considered in relation to:

- The length of the rope
- The time it has been in service
- The Towline Operational Assessment

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Retirement

Determining Lifespan

The average lifespan of a main towline is difficult to estimate. It is dependent on all the variables identified in the Towline Operational Assessment, including the unquantifiable history of dynamic loading throughout its life.

Some operations regularly report lifespans exceeding 2,000 tasks. Some operators extend this to 4,000 tasks when the practice of end-to-ending is used. Conversely, in operations involving regular high dynamic loading, the life expectancy of a towline could be as little as 500 tasks.

Other components of the towline, such as continual loop grommets, should have their working section (used on the ship bollards) rotated approximately 1m in every 100 tasks. Therefore, a 20m grommet with a 10m length loop would have a working life of approximately 2,000 tasks before retirement.

Rope Repackaging & Reselling

Operators and procurement personnel should be aware that repacked towlines are available in the industry. Towlines of the same size and MBL can have vastly differing characteristics. It is important to understand these characteristics. Purchasers are strongly recommended to ask for the original certificate with the original trade name. Operators should consider the risks involved in reusing towlines for their primary purpose.

Repurposing

Due to the durable nature of the materials used in the construction of towlines, there are many options for repurposing for both functional and decorative uses, such as marine-themed accessories, garden and landscaping and even functional pet supplies.

Rope Recycling

The majority of towlines will be manufactured from some form of plastic. Marine plastic is a significant threat to life in the ocean and the planet as a whole. The shipping and maritime industries have a responsibility to be proactive in reducing their environmental footprint.

The safe disposal of ropes at the appropriate Port Reception Facilities is imperative. Under no circumstances should ropes be disposed of at sea, as this would be an illegal discharge in contravention of MARPOL.

Where possible, the recycling of rope into other polymer-based products should be encouraged. It is recognised across the shipping industry that much more research is required, and that meaningful solutions for unusable ropes should be developed. At the time of publication, few active towline recycling facilities are available.

Disposal

With the current absence of any feasible recycling process in most parts of the world, unfortunately, disposal to landfill remains the end-of-life fate for most towlines.

Operators should ensure that towlines are disposed of in accordance with the relevant local legislation and as responsibly as possible.

Final Residual Strength Test

This test is commonly known as a 'Final Residual Strength' test. The procedure is similar to the residual-strength test, but the visual inspection is cursory. A key figure on this test will be the Actual Breaking Strain. Along with the towline these tests can also be applied to grommets (continual loop), pennants and stretchers in a similar manner.

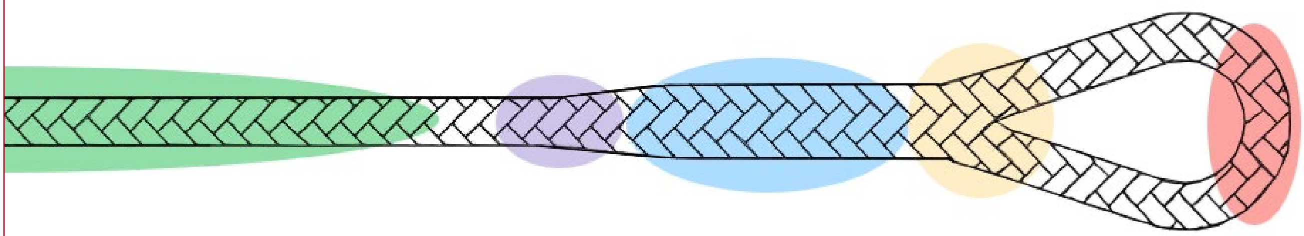
Knowing this figure for the retired rope, along with the number of tasks, operating history, repairs, and any previous residual-strength test results, will be key to the technical and operational departments. It can then be used to assess the validity of the current practice that governs the replacement of their towlines under their guidelines.

An unplanned residual-strength test usually follows a failure in service, along with any corresponding investigation. In this event, it is common for either the complete line to be tested/ inspected, or at least a substantial section incorporating any failed area within the rope. A test sling preparation will be used and tested to break load.

The manufacturer or test facility will then produce a report containing the results of the break test, the visual inspection, the interpretation guidelines of their report and supporting technical information and experience.

Example of Residual Test Report:
Test report(s) must show the relationship with the specific sample tested. The location of the failure must be determined. Based on a proper visual inspection, the main deterioration mode or failure mode in case of an investigation may be determined.

TYPICAL FAILURE ZONES OF RESIDUAL STRENGTH TEST SLINGS:



(pink)	Apex of Eye	• damaged apex of eye due to the original connection method used, e.g., cow-hitch/ shackle, and so on. • D/d impact
(yellow)	Base of Splice	• unbalanced splice • included angle eye too large (eye length to test-bed pin diameter combination to be checked)
(blue)	Splice	• unbalanced splice • poor rope condition used to form the splice
(purple)	End of Splice	• typical failure area in a used fibre rope test sling
(green)	Clear Rope	• between the splices is the ideal failure area, indicating perfectly balanced splices not affecting the result.

Source: Lankhorst Ropes Inspection and Retirement guide ©

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Annex A: Forms for Completion

TUG VESSEL CONSIDERATIONS

Characteristics	For completion	Guidance notes
Bollard Pull		Number in tonnes
Steering Force		Number in tonnes
Company Safety Factor		Quantitative ratio
Propulsion		ASD, Voith-Schneider, Rotor, Tractor, Conventional, and so on
Drum Specification		Size of drum (diameter & depth of cheek plates)
Winch Type		Rend & Recover, other, and so on
Winch & Staple Location		Location of winch & staple relative to tug (fore/aft)
Tug Age		In years (sub 5, 5-15, 15+)
Tug Condition		Qualitative view

OPERATIONAL CONSIDERATIONS

Characteristics	For completion	Guidance notes (select all that apply)
Nature of the tow		Stern, CLF, bow/bow, escort, barge, push/pull, and so on Indicate all that apply
Static Load		For escort towing, either passive or active Quantitative in tonnes
Company Safety Factor		Quantitative ratio
Expected use of winch if/ when escorting		Auto tension or 'on the brake' Indicate which applies (will be specific to operator/class rules)
Line buoyancy		Sinking or floating line desired
Expected types of assisted vessels		Cargo ships, naval ships, barges, rigs, plants, and so on Indicate all that apply
Expected freeboard of assisted vessels		• High (10m+) • Medium (5-10m) • Low (sub 5m) Indicate all that apply
Expected complications on mooring decks of assisted vessels		Qualitative free text to include: • Known awkward arrangements • Average condition of fairleads on assisted vessels
Expected width of bitts on assisted vessels		Quantitative in metres. Note: some larger vessel bitts are too large for the standard 2m eye.
Lines expected to be connected to emergency towage bracket		Indicate which is most likely to apply.
Expected Safe Working Loads of bitts and fairleads on assisted vessels		Quantitative in tonnes
Any other operational abnormalities		Free text qualitative (operation, environment, assisted vessels deck complications, expected hazards, criteria required by port, and so on)

ENVIRONMENTAL CONSIDERATIONS

Characteristics	For completion	Guidance notes
Nature of waters during operation		E.g., river, harbour, sheltered, coastal, sea
Expected combined wave height		Quantitative height in metres
Expected wind speeds		Quantitative speed in kts or mph
Prevailing wind direction		
Expected tides/ currents affecting towage		Strength in kts or mph and direction
Operational limits		Do stop work orders exist above certain wind speeds?

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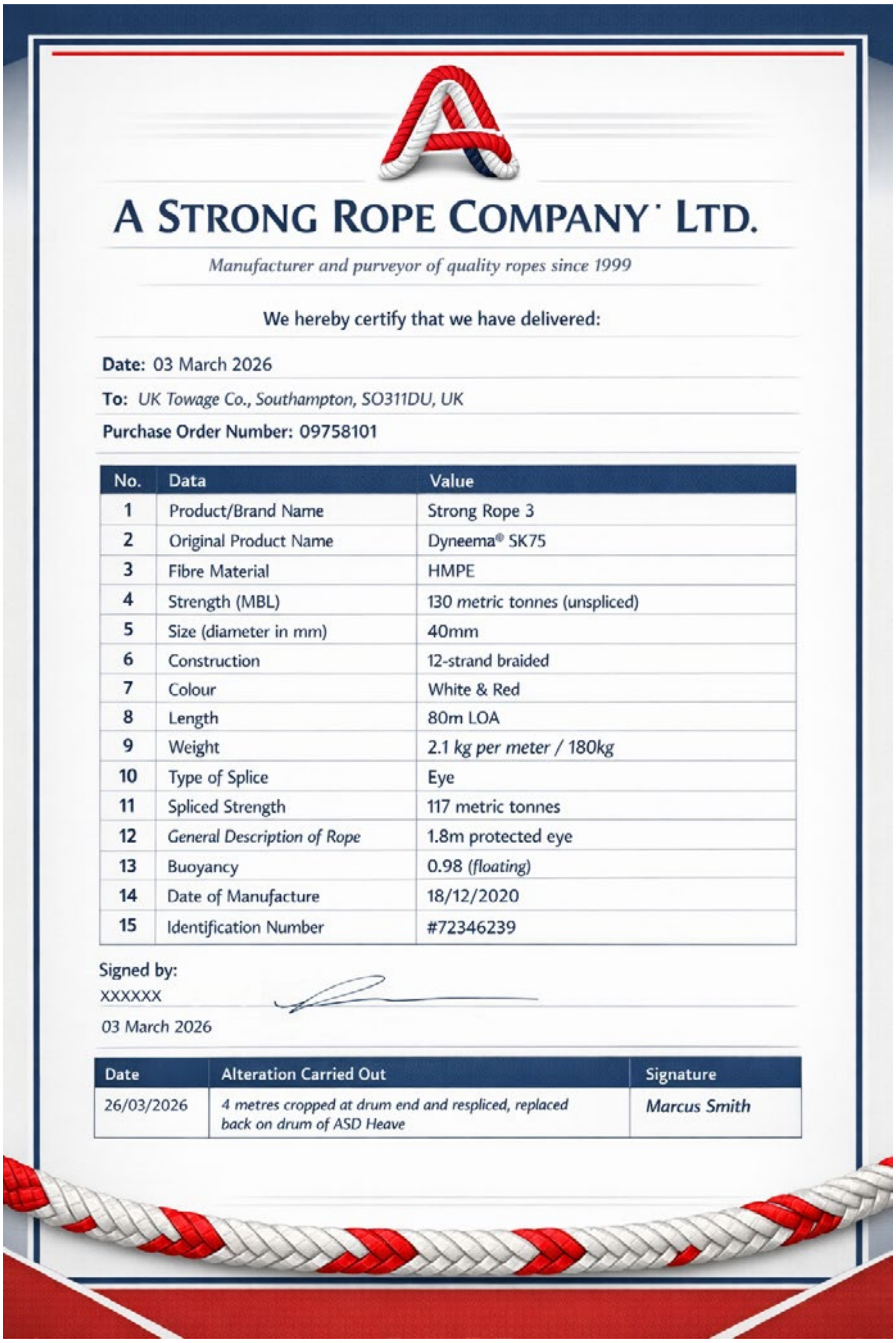
Annex B: Example Certificate



A STRONG ROPE COMPANY LTD.

Manufacturer and purveyor of quality ropes since 1999

We hereby certify that we have delivered:

Date: 03 March 2026

To: *UK Towage Co., Southampton, SO311DU, UK*

Purchase Order Number: 09758101

No.	Data	Value
1	Product/Brand Name	Strong Rope 3
2	Original Product Name	Dyneema® SK75
3	Fibre Material	HMPE
4	Strength (MBL)	130 metric tonnes (unspliced)
5	Size (diameter in mm)	40mm
6	Construction	12-strand braided
7	Colour	White & Red
8	Length	80m LOA
9	Weight	2.1 kg per meter / 180kg
10	Type of Splice	Eye
11	Spliced Strength	117 metric tonnes
12	General Description of Rope	1.8m protected eye
13	Buoyancy	0.98 (floating)
14	Date of Manufacture	18/12/2020
15	Identification Number	#72346239

Signed by:
XXXXXX

03 March 2026

Date	Alteration Carried Out	Signature
26/03/2026	*4 metres cropped at drum end and respliced, replaced back on drum of ASD Heave*	Marcus Smith

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Annex C: Estimating Cost per Tow

One method for estimating real value is to use the cost per tow. Calculating the cost per tow can serve as an indicator for operators and rope manufacturers to estimate a rope's service life and assist in determining the best line for specific types of operation.

The cost per tow can be applied to all parts of the towing system, not just the mainline. Cost per tow will not be consistent across vessels and should not be assumed.

Simple CPT Calculator

This can be calculated by dividing the original purchase price of the towline by the number of tows before the line was retired or failed.

CPT = Original Price / Number of jobs completed

For example, £40,000 / 2,000 jobs = £20 per towing operation.

Detailed CPT Calculator

The BTA has devised an example cost per tow, illustrated below.

This technique requires the following data:

- Average tonnes pull during job
- Time used in minutes
- Number of jobs per year expected/historic
- Expected life cycle of the rope (e.g., 4,000)
- Expected cost of the rope (e.g. £50,000)

	A	B	A x B	C	D	C x D
Job Type	Average Tonnes	Time (mins)	Multiplier	% rope life	No. of jobs per year	% rope life x no. of jobs per year
Standard job	70	20	1400	0.00025	70	0.0175
1st alternative	70	20	1400	0.00025	70	0.0175
2nd alternative	35	90	3150	0.0005625	225	0.1265625
3rd alternative	35	30	1050	0.0001875	225	0.0421875
		Totals		0.00125	590	0.20375

Base number of jobs per rope = 4,000

(CxD) / D	E	((CxD) / D) x E
Multiplier	Rope Cost (£)	Cost per Job/Tow (£)
0.00034534	50,000	17.27

Feedback on the BTA Guide
'*Rope Selection, Procurement Usage (Second Edition)*'

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PUBLISHING