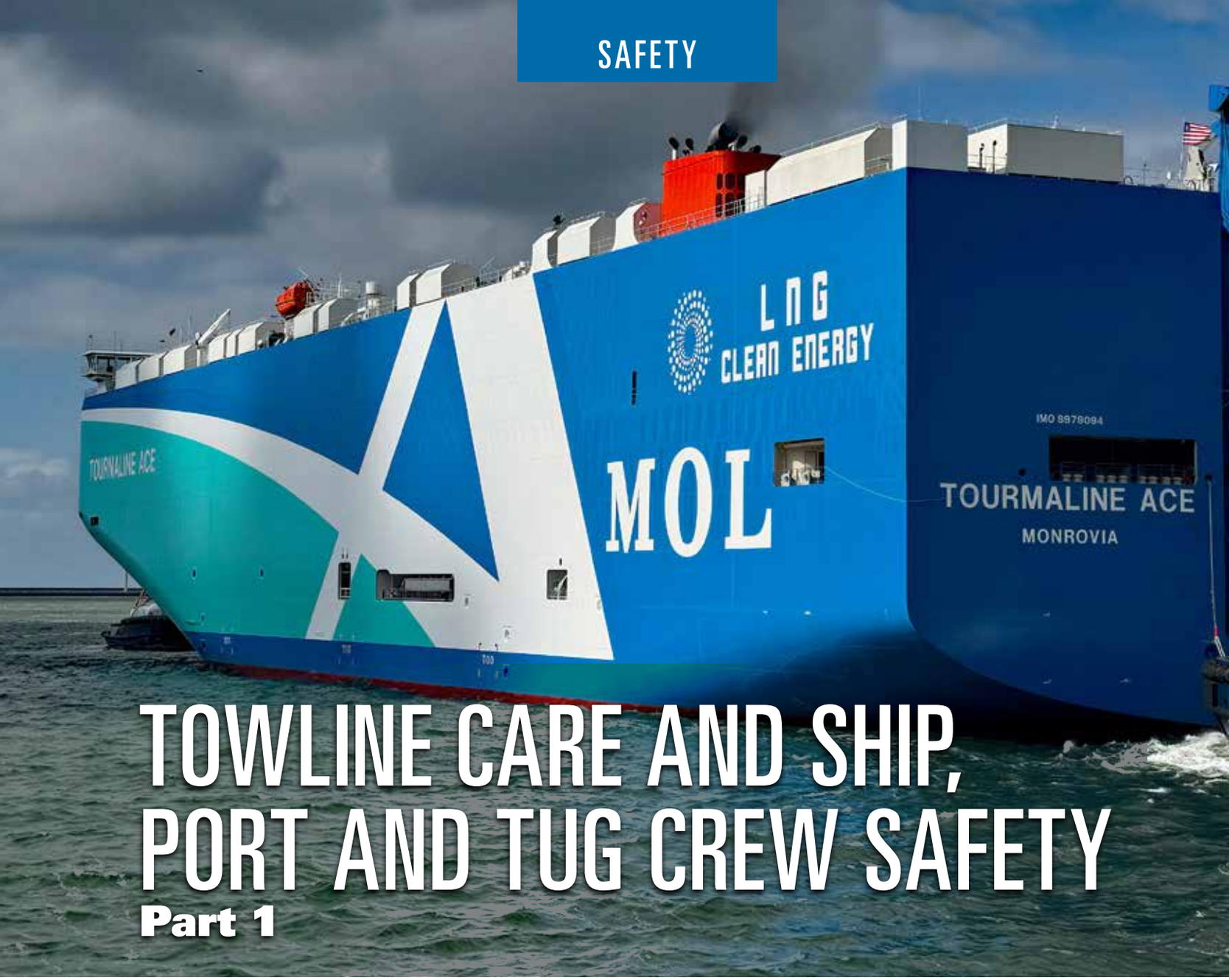


# TOWLINE CARE AND SHIP, PORT AND TUG CREW SAFETY

## Part 1



**The considerable increase in tug power also has certain consequences that are not always fully considered, such as the need for a suitable size and/or power of the tug in relation to the size of the ship to be handled, as has been explained in the article "Big is Better?" (see [1]). However, there are other consequences as well.**

The last decades have brought significant changes in tug designs and in tug power. Compared to conventional tugs, changes in tug design have resulted in a considerable improvement of safety of tug operations, as is the case with azimuth tractor drive (ATD)/azimuth stern drive (ASD) tugs, rotor tugs, and those with a carrousel system. However, the increase in power also has other consequences that will be addressed below.

### Risks for ship and port

Stronger tugs often result in fewer tugs used to handle a ship. Let us take a 200-metre-long car carrier with a height of 33 metres, without bow thruster. Wind velocity is 15 m/sec at 15 metres height, giving a required total tug force of about 120 tonnes.

Two tugs of 30 tonnes bollard pull could be used forward and two tugs aft. A safe system, because if something happens with one tug, for instance, parting of a towline, the ship still has tug assistance forward as well as aft. Depending on the situation or conditions, the ship may still be kept under control.

With a tug fleet of only high-power tugs, there is a good chance that the ship is assisted by two tugs of 60-100 tonnes bollard pull. This includes risks for the ship, because if with these windy conditions a towline were to part, the car carrier with its high windage may be in real trouble! And please note, the towline generally parts just when

*Photo: Car carrier assisted by two powerful tugs (photo Dirk Neyts, the Netherlands).*

## PART 1

This article consists of two parts. This is part 1. The second part, which goes into rope characteristics, mitigating measures taken and ways to deal with peak loads, will be published in SWZ|Maritime's May issue.

highest tug power is needed and given, so at a critical moment.
The question can be asked if this is an acceptable situation. The example above shows that safety in the port depends on the crucial link between tug and ship. One can argue it is an exceptional situation. Is that really the case? In the accident investigation report of the Svitzer Mercurius [3], it is stated that Svitzer recorded 87 towline failures within a period of two years. Seeing the number of jobs carried out during that time, it is not a high percentage; just a failure rate of only 0.05 per cent.
Nevertheless, there are still 87 cases in which ships lost the tug assistance they needed. As explained, this can be particularly problematic when a minimum number of high-power tugs are used.
Yes, a reserve towline can be passed quickly, if available. If not available or when the towline parts indeed at a crucial moment, it can still be risky. The broken towline may also foul the ship's or tug's propellers, making it even more problematic.
Therefore, from a ship handler's and ship safety point of view, parting of a towline should not be seen as a normal incident that can happen. As explained, particularly with high-power tugs, parting of a towline includes risk for the ship and port. Therefore, the question should be asked: Should parting of a towline not be prevented by all possible means?

### Danger of snap back

There are even more consequences if a towline of these high-power tugs parts. As already mentioned, tug power has increased considerably. As a consequence, towlines and pennants have become much stronger in order to cope with the larger forces that can be generated by present-day tugs. At the same time, there has been a continuous development in type and characteristics of towlines, from steel wire towlines to very strong towlines as well as pennants, made of high modulus polyethylene (HMPE) fibres. These towlines and pennants have to deal with high forces, which can even be much larger than the already significant bollard pull of the tug, such as when very high peak forces occur, which include risks even when the towline and/or pennant has an appropriate safety factor and/or seems to be in an optimal condition. It may nevertheless part. Note: In general, an appropriate safety factor is three times the tug's bollard pull.

Safety in the port depends on the crucial link between tug and ship

This may have serious consequences, apart from what has already been mentioned above. When the towline or pennant parts, there is a danger of snap back. The recoiling tow rope may hit the tug's superstructure with extreme force and may hurt exposed crew members. Several such accidents have happened. A few examples will be mentioned below.

1. In December 2021, while assisting the ship Anna into the port of La Coruña, the polyester towline of the tug Ibaizábal Doce parted and hit the front of the wheelhouse [2] with extreme force. As it recoiled, the broken rope broke the windows of the tug's wheelhouse, striking the captain in command. The broken line also injured the chief engineer and the sailor.
   The tug is a 24-metre-long, 65-tonne bollard pull ASD tug. It made fast to the stern of the incoming ship Anna. The conditions were far from optimal: NW wind force 5 Beaufort, northwesterly swell around 3 metres high; average period 9-10 seconds. Wind and swell came from astern and on starboard quarter. Due to the rough seas, tug and ship were pitching and heaving, but not simultaneously. A few minutes after the tug had made fast, the main towline broke due to shock loading.
   As no damage of the deck equipment of the attended ship occurred due to the high load in the towing line, it has been as-


*Tug Ibaizábel Doce with broken windows covered by plastic (courtesy Comisión Permanente de Investigación de Accidentes e Incidentes Marítimos, Madrid).*

sumed that the residual strength of the polyester main towline had decreased substantially.

The towrope had a 20-metre-long pennant made of HMPE. It had been in use for two years. The main towrope that parted had been in use for about three years with an "end-for-end" change (which means the towrope was turned so that the inner end of the rope, the winch-end, became the outer end, the part passing the tug's fairlead) carried out after about one year. There was no visible wear. The minimum breaking load (MBL) of the pendant was 3.4 times the bollard pull and of the mainline 2.7 times the bollard pull.

2. On 22 of December 2019, while assisting the container vessel CMA CGM Marco Polo as stern tug, the pennant of the tug Svitzer Mercurius parted [3]. The towline and pennant recoiled towards the tug's superstructure, breaking one of its forward wheelhouse windows and damaging several others. The investigation report says: 'Five of the seven-man crew, who were standing in the wheelhouse, were sprayed with glass fragments from the broken toughened glass window and suffered multiple minor lacerations. Fortunately, they were all wearing either glasses or sunglasses, and no eye injuries occurred.'
The tug Svitzer Mercurius is a 32.7-metre-long ASD tug with a bollard pull of 82.5 tonnes ahead and 76.1 tonnes astern. Mainline and pennant were made of polyester Strongline-Lankhorst. The MBL of both was 229.5 tonnes. The soft link between towline and pennant had a theoretical breaking force of 184 tonnes. The safety factor of the towline and pennant was 2.8 and of the soft link 2.2.
The towline had been in use for four months and had been used for 540 jobs. The pennant had been in use for nine months and when in use for six months, it was turned end-for-end after a suspected overload. It had been employed for 769 jobs. After testing, it was concluded that the pennant had broken when it had a 51.8 per cent residual strength.
The MAIB report of the Svitzer Mercurius states furthermore: 'Over a number of years, three other snap back accidents have been mentioned due to parting towlines: SD Shark in Southampton; towline made of polyester; no injuries; Smit Elbe in the Port of Rotterdam; Report Dutch Safety Board: towline made of Dyneema Kevlar; tug master and a pilot injured; and the tug Bülk in Kiel Canal; tug master injured.
3. On 25 November 2023, while assisting the container ship Teno in the Port of Hamburg, the towline of the tug VB Perfect parted and hit the tug's wheelhouse with force and broke the wheelhouse windows. The flying glass splinters seriously wounded the eyes of the tug master. The accident investigation report has not yet been published.
4. On 4 February 2025, while assisting the car carrier Auto Eco in the approach to Royal Portbury dock, Avonmouth, England, the towline of the tug Svitzer Avon parted. The resulting lashing back of the towline damaged the wheelhouse and injured two crew members. The accident investigation report has not yet been published.

## Particular risks for crew in the wheelhouse

Parting of towlines is not a rarity; the Spanish Permanent Commission for the Investigation of Maritime Accidents and Incidents (CIAIM) has also drawn attention for this problem. In the CIAIM report of the tug Ibaizábal Doce is stated: 'Furthermore, the breakage of these windows when struck by a hawser, as evidenced by nu-

merous similar incidents on tugboats in recent years, causes them to shatter into multiple small panes of glass that are projected at high speed, with a high potential for injury to bridge crew members. Given this situation, some tugboat companies have opted to install laminated glass in windows susceptible to this type of impact.'
Another reason why the snap back of a parting towline or pennant has such a large effect on the tug's wheelhouse and those inside it, is that the wheelhouse is often located lower above the main deck than on older tugs in order to increase the comfort for the crew in sea conditions. It has, however, the consequence that it is then positioned closer and more at the same level as the towing winch, with a towline at possibly high tension.
It can be concluded that parting of towlines or pennants includes high risks for the tug, ship, and the port. Wheelhouse, wheelhouse windows and crew members can be seriously hit. It should be carefully investigated how parting of towlines can be prevented or reduced.

## Recording rope overload

Based on OCIMF recommendations (MEG4), the Lankhorst Mooring Rope Manual advises for ship mooring ropes: 'The working load limit (WLL) is the maximum load that a mooring line should be subjected to in operational service. If the maximum load exceeds the WLL, for synthetic ropes this is fifty per cent of the rope ship design MBL, we refer to this as an overload. Overloading a rope can cause significant loss of strength and reduce service life. It can be difficult to determine if there's been an overload. Next to visual inspection, checking the logbook will help, if the history of the rope has been recorded carefully.'
The above recommendations apply to tug towlines and pennants as well. It also shows how important an appropriate safety factor is. For instance, a safety factor significantly less than 3 easily leads to overloading the towline, with all the consequences of reducing the service life. If residual strength reduces during use, overloading and peak loads become even more risky.

## Towlines in use

Basically, there are two types of towlines: those made of conventional fibres, for instance, polyester, and those made of HMPE fibres, such as Dyneema and Spectra.
Towlines made of polyester have a stretch at break of seven to twelve per cent (for used polyester). With such high elongation, fibres can absorb energy by stretching elastically. This energy is temporarily stored as elastic potential energy. Upon rope parting, this stored energy is released, causing the fibre to return to its original shape, resulting in a violent snap back of the line, which can damage the tug's wheelhouse and/or hurt crew members. The higher the tug power, the higher the tension in the towline and the more violent the snap back can be. However, the longer the towline and the higher the elasticity, the better dynamic forces can be absorbed and the lower the peak values are.
Towlines or pennants made of HMPE have little stretch and absorb much less energy. Upon rope parting, this stored energy is released less violently. However, ropes with HMPE can still snap back. The most dangerous is when there is an angle involved.
On the other hand, because of the low energy absorption capacity of HMPE pennants and towlines, peak loads can be high and HMPE pennants are, therefore, often used in combination with main towlines made of polyester to reduce the peak loads in the system. However, towlines and pennants both made of HMPE can also be found, with the drawback of the mentioned high possible peak loads. Towlines as well as pennants, both made of polyester, are also used. Much depends on the sea conditions, tug equipment and ships to be assisted, what type of towline or combination of towline and pennant is used and what their lifespan will be. The latter also depends on the tug master's experience. Consequently, lifespan of towlines and pennants differ largely by port.
An indication of how long towlines and pennants are used:

- Samson Ropes says that pendants are retired after roughly 1.5 years and mainlines on average after three to 3.5 years in use.
- Rope manufacturer Lankhorst says that in general the mainline is used during 1800-3500 jobs and pennants 1200-2500 jobs.
- BTA (British Tugowners Association) mentions in its report [4]: 'If turned end-for-end and the main line is used in combination with a grommet or stretcher or both, lifespan can be approximately 4000 jobs.'

A tug carries out on average 865 jobs yearly, according to reference 5.

## REFERENCES & ACKNOWLEDGEMENT

1. Big is better, https://www.nautinst.org/resources-page/free-article-big-is-better.html
2. CIAIM Report-17/2023, Rotura de un cabo del remolcador Ibaizal Doce mientras se encontrabaayudando en la maniobra del buque Anne, con resultado de tresheridos, el 28 de noviembre de 2021
3. Report on the investigation of the failure of a towline pennant and injury to the crew on board the tug Svitzer Mercurius in Southampton, England, on 22 December 2019, Report No 15/2022, December 2022
4. Rope Selection, Procurement and Usage, BTA, 2021
5. Economic impact of the European Towage Sector, Ecorys, ETA, Rotterdam, 29 October 2019

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**Captain Henk Hensen**
Master Mariner, former pilot and marine consultant, author and Fellow of the Nautical Institute and member of the International Federation of Shipmasters, hhensen@kabelfoon.nl