The Mersey Docks and Harbour Company Limited

TOWAGE INFORMATION

PORT OF LIVERPOOL

Tug Types

Conventional Screw Tug

Worldwide, the largest number of tugs belong to this type. The towing point (e.g. towing bits, hook or winch) is located approximately 0.45xLOA from aft. To improve their manoeuvrability, conventional screw tugs may be fitted with a steerable nozzle, a bow thruster or a retractable azimuthing bow thruster. Tugs fitted with the latter device are referred to as "Combi-Tugs".

Twin-screw conventional tugs offer increased manoeuvrability over a single-screw tug, as the two screws can be worked independently and in opposite directions, thus enabling the tug to pivot within its own length.

Azimuthing Stern Drive (ASD) (Z-peller)

This is a tug where normal propellers and shafts have been replaced by azimuthing propulsion units, which enables the propeller and its associated nozzle to rotate about its vertical axis (360^{o} rotation). The position of the propulsion units is identical to that of a conventional twin-screw tug. Just as with a twin-screw tug, these propulsion units can operate independently, making it possible for the tug to move forwards, backwards, sideways and turn around its own axis with great precision. The towing point on an ASD tug is located on the foredeck; however some ASD tugs may have additional towing points on their after decks, thus enabling them to function in a similar manner to a conventional twin-screw tug (but with increased manoeuvrability).

ASD tugs can be referred to as "reverse-tractor tugs". This definition is applied mainly to tugs with stern-mounted azimuthing propellers but with limited or no towing fixtures on their aft decks.

Voith-Schneider Tractor Tug (VST)

The term "Tractor Tug" is used where the propulsion units are located about 0.3xLOA from the bow with the towing point located at the opposite end of the tug, close to the stern. The main difference between the stern drive (ASD) and the tractor tug types is the location of the propulsion units.

The Voith-Schneider Tractor Tug (employing Voith-Schneider cycloidal propellers) was introduced mainly for ship-handling due to its exceptional manoeuvrability and safety in operation, which is inherent in the tractor principle.

Skeg-First Escort Tug

An advance in tractor tug technology, primarily designed for active escorting of large vessels on long approaches/passages. Similar in construction to the conventional Voith-Schneider Tractor; however, designed specifically for exerting much larger steering forces (generated by in-direct towing techniques).

Azimuthing Tractor Tug (ATT)

Tractor tugs using azimuthing propulsion units were first built in the 1970's as a possible alternative to the Voith-Schneider system, introduced some years earlier. The azimuthing units are placed in the same location as the Voith-Schneider propellers, i.e., under the forward part of the hull.

Differences between the Voith-Schneider tractor tug and the azimuthing tractor tug are:

- Propulsion systems, cycloidal propellers verses screws in nozzles
- Response time of Voith-Schneider tug is faster
- Azimuth tractor tug is more efficient (in terms of tonnes bollard pull per BHP)

Variations on the ATT design are the "ROTOR-Tug" and "Ship Docking Module" (SDM). At this time, no ROTOR-Tugs or SDM-Tugs are operating in the Port of Liverpool.

Main Characteristics of Tug Types (ASD, VST & ATT)

Tug Type	Azimuth Stern Drive (Z-Peller)	Tractor Tugs (Azimuth Tractor or Voith-Schneider Tractor)
Typical Example	Harbour/terminal/escort tug	Same as stern drive
Main purposes	Mooring/un-mooring	Same as stern drive
Propulsion	Mounted under tug's stern Azimuthing (360^{o}) propulsion unit (May be optimised by the use of controllable pitch propellers or slipping clutches)	Propulsion units ⅓ aft of bow Voith-Schneider propellers or Azimuthing propulsion units
Manoeuvrability	Excellent for use in harbour/terminal towage.	Voith: very rapid response time due to the fast pitch changing of the blades, excellent for dangerous operations.
Bollard Pull & related power	30 tonnes and over	30 tonnes and over For similar BHP, VST will have a lower BP than ATT
Offshore Capabilities	Good	Reasonable
Main disadvantage	Limited offshore capabilities	Draft and unable to undertake long distance tows.

Propulsions Systems

At the heart of every tug, and the feature that probably attracts most attention, is the propulsion system. In order to give an overview of the various propulsion systems, the following table has been prepared.

Propulsion System	Function	Tug Type	Manoeuvrability
Conventional screw propellers	Straight ahead propulsion, limited performance running astern	Conventional single or twin screw tugs	Limited (better with twin screws)
Special rudders	Increase the manoeuvrability of conventional screw tug	Conventional single or twin screw tugs	N.A
Propulsion nozzles	Fixed/Steerable tubular shroud fitted around the propeller to increase the BP of the tug	Conventional tugs, ASD and ATT	N.A
Controllable pitch propellers	The pitch of the blades can be adjusted to suit the operation. Offers fast response from ahead to astern.	Conventional tugs, ASD, ATT and VST (cycloidal). Also fitted to Ocean-going tugs	Decreases the response time, especially from ahead to astern.
Azimuthing propulsion	Entire propeller can be rotated 360^{o} Effectiveness may be increased by use of CPP or slipping clutches.	ASD and ATT as harbour or terminal tugs	Excellent for mooring/un-mooring
Voith-Schneider Cycloidal Propeller	Propulsion units have blades attached to a hub that rotates about a vertical axis. Changing the angle of the blade gives a new pitch and thrust direction.	Voith Tractor Tugs only.	Control is superior to other propulsion types. Efficiency of BP/BHP is lower than screw props.
Bow thruster	Bow thruster provides additional thrust to tug @ 90^{o} to centre line Fitted to a single screw tug (operating as a combi-tug), a retractable azimuthing bow thruster enables the possibility to perform more services.	All types except Tractor Tugs	Improves Manoeuvrability Retractable thrusters enable tugs to be multi-functional

Bollard Pull

The bollard pull of a tug is the amount of static force (pull) that can be exerted when tethered to a measuring device. Mostly this is done through a secured towing line connected to a dockside bollard. Due to the requirements of the classification society/authority, the locations of these trials are mostly in very secluded places, where weather conditions would have little affect on the results. These trials have been introduced because the variety of propulsion systems available at this moment no longer make it possible to judge the force available from a tug by the horsepower of its engines alone. Particularly with ship-handling tugs, the trials will include the pulling both ahead and astern, due to the fact that both functions are used during different modes of operation.

The towing force (pull) of the tug depends on its engine power and on the type of propeller, as becomes evident in the following table.

Type of Propeller	BP Ahead in tonnes/100 BHP (approximate value)
Conventional (with Nozzle)	1.50
Azimuthing with Nozzle (ahead pull)	1.35
Conventional (without Nozzle)	1.30
Voith-Schneider propeller	1.15

Conclusion:
For the same installed horsepower, an ASD or ATT tug will have a higher bollard pull rating than a VST tug.

Methods of Operation

Today there are principally two methods of ship handling operations:

- On-the-line or European method
- Push-pull method

Over the last decade, passage escort has emerged as an operational requirement for the marine service provider at marine terminals, and is often referred to as either PASSIVE or ACTIVE escorting, depending upon the service provided.

Passive Escorting is when a tug shadows the ship, but does not make fast. Active Escorting is when the tug does make fast, usually as the stern tug, and is often referred to as the INDIRECT towing mode.

On the Line

"On the line" towing means that the tug is connected to the assisted vessel by a towline. This is the traditional method of harbour assistance in many European ports.

The towline is connected to the tug by a towing hook, towing winch or secured to towing bits (all of which are known as the towing point). The location of the towing point will vary between tugs types: conventional, ASD or Tractor.

The danger with towing on the line is the risk of girting and capsizing. Girting happens when the towline comes at right-angles to the tug. The tug is pulled bodily through the water by its tow, which can lead to deck-edge immersion, flooding and capsize; unless the towline is released in good time. The location of the towing point on ASD tugs (when operating over the bow) and Tractor tugs reduces the risk of girting.

When made fast to a vessel's bow, the effectiveness of tugs towing on a line will decrease with increasing headway. This is because, as headway increases, more of the tug's power is used in maintaining its position relative to the vessel, as opposed to being applied as an assisting force through the towline.

Push-Pull

The push-pull operation means that the tug is connected to the assisted vessel by a short line (ASD and conventional tugs will use a bow line, whilst tractor tugs will use a stern line) and remains in close proximity to the vessel. This enables the tug to push on the vessel, but then check/control the vessel by pulling-back on the short line. This method originates from Japan and South-Asia.

Due to the limited power of conventional tugs when running their propellers astern, their ability to pull-back on the line will be limited.

When the tug is not connected to the vessel by a bow or stern line, this is simply called pushing. This method of operation is used by (amongst others) conventional tugs operating in North America.

Indirect Towing

Indirect towing is a way of enlarging the exerted force when turning and/or decelerating the tow. This mode applies only to the trailing tug, here referred to as the stern tug. The tug is made fast to the vessel by a towline and is dragged by the assisted vessel. The tug uses its thrust to maintain a sheered position relative to the tow's heading whilst the towing force is generated by the drag forces acting on the tug's hull and transmitted via the towline. The drag forces on the tug can be substantially higher than the bollard pull when the speed through the water is greater than 6 knots (approx).

With the towline at a large angle to the tug's centre line, indirect towing is a potentially dangerous manoeuvre. Indirect towing requires a highly skilled tug master to achieve the high towline forces without girting and capsizing the tug. The advent of the purpose-built escort tug, designed for exerting such high loads, has made this operation much more controllable and therefore much safer.

Tug Types and Methods of Operation

The table below summarises the suitability of the three distinct tug types in relation to the basic ship-handling methods as earlier discussed. It also gives a very clear reason why Marine Service Providers favour ASD and tractor tug types over conventional tugs for ship handling.

Given the fact that, where possible, Push-Pull is the preferred method of operation, it could be said that to undertake the equivalent operation employing conventional tugs only, double the number of conventional tugs could be required when compared to a similar operation employing either ASD or tractor type tugs.

Table of Tug Types and Methods of Operation

TUG TYPE	METHOD	REMARKS
Conventional Tug	On the line	Poor manoeuvrability at large sheering angles
	Push-Pull	Only pushing or pulling
	Indirect	Very difficult due to lack of directional control of the tug
Azimuth Stern Drive Tug (ASD) (Z-Peller)	On the line	Good performance when working over the stern, but risk of girting exists at higher speeds. Working over the bow reduces girting risk.
	Push-pull	Very good performance working over the bow
	Indirect	Good performance working over the bow
Tractor Tug (VST or ATT)	On the line	Good performance with reduced risk of girting.
	Push-Pull	Good performance
	Indirect	Good performance with reduced risk of capsizing

Conclusions Regarding Tug Types

Assuming normal port operations with **maximum ship speeds of six to seven knots**, it can be concluded – with some reservations – that the suitability of different tug types can broadly be ranked as follows:

As forward tug towing on a line:

- ASD-tugs (operating from stern winch)
- Combi-tugs
- Conventional tugs
- Tractor Tugs and ASD tugs (operating from bow winch)

As stern tug towing on a line:

- Tractor Tugs and ASD tugs (operating from bow winch)
- Combi tugs
- Conventional tugs

When operating at a ship's side:

- ASD tugs and Tractor tugs
- Combi-tugs
- Conventional tugs

At speeds of over 7 knots as stern tug:

- Escort tugs

A list of current ship-handling tugs operating in the Port of Liverpool is available on the Company's website.