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Azimuth stern-drive tugs

Guidelines for tug captains, shipmasters, pilots and operators of azimuth stern-drive tugs

Captain Henk Hensen, Fellow of The Nautical Institute, Marine Consultant, Maasland, The Netherlands

There have been a number of accidents with azimuth stern-drive tugs. Some involved a lack of awareness of the interaction forces surrounding the bows of different types of vessel; some related to the limits imposed by the design of the tug; and some related to issues of familiarity with engine and steering controls, seamanship, weather conditions or speed. This article provides a summary of key points from a comprehensive, 25 pp monograph, designed to provide practical guidance to avoid problems that can arise from operating these powerful, highly manoeuvrable vessels as bow tugs.

Introduction

Although there are a wide variety of names for different tug types, all those tugs with azimuth thrusters under the stern are increasingly known as ASD tugs. A large number of ASD tugs, such as those operating in the USA and many Pacific ports, are designed for operating at the ship's side; for instance for push-pull operations. These tugs, also called reverse tractor tugs or pusher tugs, are specifically built to operate over the bow. They seldom have a stern winch and often a long deckhouse. If there is a towing point aft (in most cases just a towing hook) it lies at a very close horizontal distance forward of the thrusters. This makes these tugs unsuitable for effective towing over the stern during harbour operations.

The other kind of ASD tug is designed so that it can effectively operate as a conventional tug by using the stern winch and as a tractor tug by using the bow winch. Sometimes the stern winch is optional and can be installed later.

Figures 1 and 2 show how tugs operate bow-to-bow or stern-to-bow.

Bow-to-bow versus stern-to-bow

For both bow-to-bow and stern-to-bow when fastened, speed is the most crucial factor. With respect to ship's speed, bow-to-bow operations will be considered here.

The difference in the underwater design of azimuth stern drive tugs, and in particular with respect to skeg configuration, may result in totally different capabilities when the tug is running astern while fastened to the bow. As long as the tug is running astern in line with the vessel (see Figure 1 (B) position 1) there may be no problem as long as the ship's speed is well below the maximum astern speed of the tug, taking wave conditions into account. Problems may arise when the tug has to deviate from that course in order to apply steering forces to the ship (see Figure 1 B position 2). Then more thruster force is needed to pull the tug's body through the water against the incoming water flow; and consequently tug's speed in the direction of ship's movement drops. At a certain ship speed and towing angle, the hydrodynamic force of the incoming water flow may become so large it cannot be overcome by the thruster forces: the ship will overtake the tug and the tug will swing around and may end up alongside the ship (tripping).

This may result in damage to the tug and ship, particularly at higher speeds. Also it must be recognised that the tug's pulling effectiveness decreases fast with increasing speed. The higher the ship's speed, the more power is needed to pull the tug's hull through the water and the less steering force can be applied to the ship.

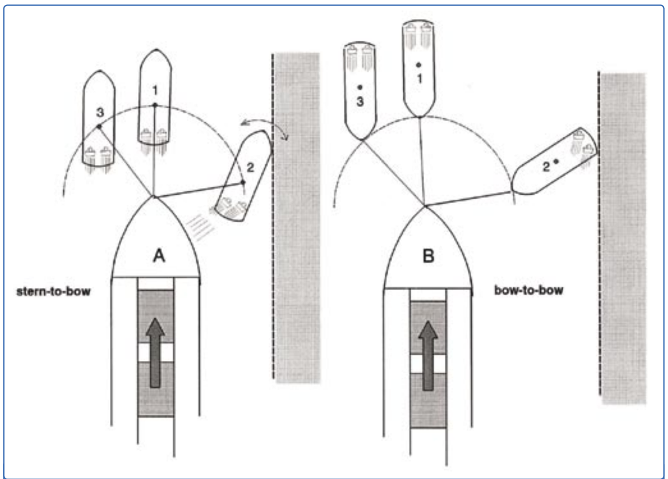

Figure 1. Stern-to-bow and bow-to-bow.

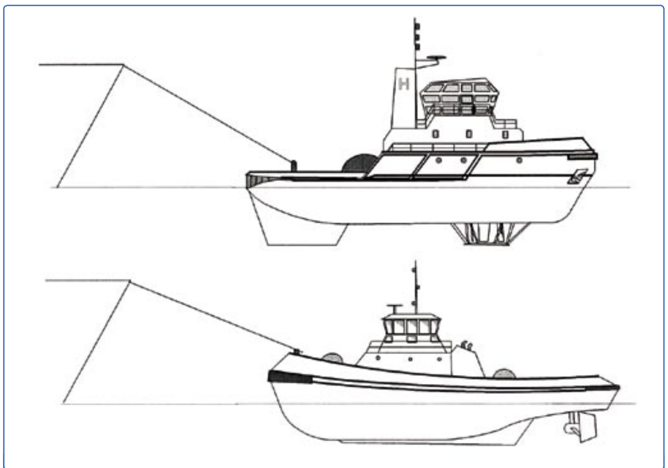

Figure 2. An azimuth stern drive tug operating bow-to-bow (as a reverse tractor tug) is more or less comparable to a tractor tug.

The better underwater hull and skeg design for operating astern, the better a tug can apply steering forces and the higher safe astern speeds are possible. When the underwater hull and skeg design is such that the centre of pressure of the hydrodynamic side forces is located as far as possible forward, a smaller thruster force is needed to compensate for the hydrodynamic side force and the higher steering forces can be applied. In other words, the tug can deviate more safely from a straight course at higher ship speeds and return to the ship's original track straight ahead of the vessel. It can apply higher steering forces as well. Of course, a low underwater resistance and a high available engine power are contributing factors.

On making fast when approaching the bow of a ship with an azimuth stern drive tug, the following aspects are of relevance:

- Type of ship and draft
- Speed of the ship
- Tug's capability and behaviour
- Wind direction
- Wave conditions

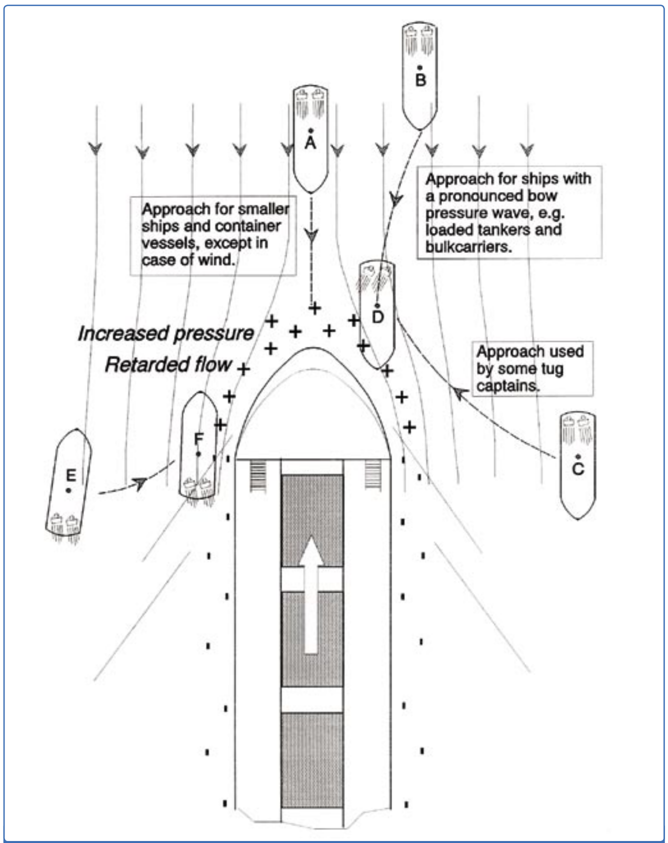

Figure 3. Tug approaches towards the bow.

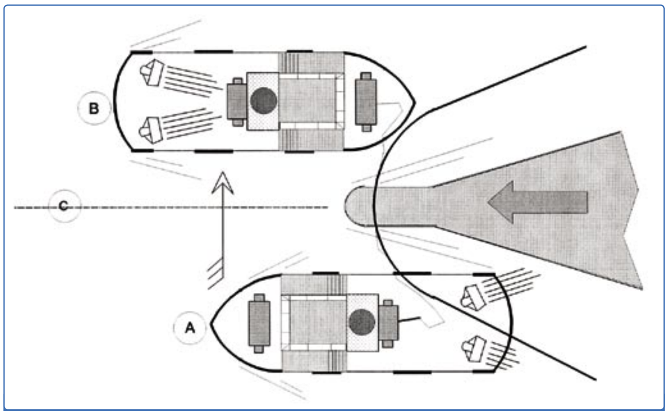

Figure 4. Tug positions at the bow of a container ship for connecting heaving line.

Figure 5 (top). Approaching the bow for connecting bow-to-bow. The ship's bulb is just underwater. Ship's speed brought down till approximately 4.5 knots. (Middle): connecting heaving line. (Bottom): passing towline.

Pressure fields and flow patterns differ largely according to the ship's hull form and draft. Loaded bulk carriers and tankers have a pronounced bow pressure wave around the bow, which increases with speed and with a low under keel clearance. Speed of water flow at the bow pressure wave is considerably lower. The situation near the bow of more slender vessels, such as container ships, car carriers, and ships in ballast, is different. The bow pressure wave as shown in Figure 3 is more or less absent, or located more aft, and the undisturbed water flow comes closer to the bow.

Connecting

There are risks when connecting bow-to-bow or stern-to-bow. It is assumed that the tug's towline is to be used. (The tug manoeuvres do not differ if the ship's lines are used as towlines, so the contents of this paragraph apply here too). The most critical phase during the procedure of connecting the towline is picking up the heaving line (Figure 4). The tug is then at the closest position to the bow. When the heaving line is connected and the messenger line is being passed to the ship, the tug can move a little further away from the ship.

Picking up the heaving line and passing the messenger line and towline does not always go as smoothly as planned. The tug captain has to keep his tug in a good position all the time. Wind, waves and low visibility are additional factors in making these operations near the bow of a ship at speed a complicated and risky operation.

Figure 5 shows how critical speed and distance becomes when coming in close to pick up a heaving line.

Releasing the towline

The same effects around the bow of a ship that has headway, as mentioned above, play a role with respect to the tug and its behaviour when releasing the towline. The tug again comes very close to the bow, with the towline slack, in order to enable the ship's crew to take the towline from the ship's bollards and lower it on the tug's deck. This means that when releasing the towline, the ship's speed should not be higher than the safe speed for fastening the towline. This, however, may become problematic for certain vessels because ships may pick up speed quickly when leaving the berth, terminal or harbour basin. Letting go the tugs

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should be well planned in advance therefore, particularly when the bow tug has been made fast bow-to-bow.

Conclusions

The relevant conclusions about the use of azimuth stern-drive tugs in bow-to-bow or stern-to-bow towing operations are:

- **Capabilities of the various azimuth stern drive tugs differ considerably** due to the differences in design. The difference in ASD tug capabilities is of particular importance when operating backwards, bow-to-bow, and attending a ship having headway.
- **Tug's capability for bow-to-bow operations.** The most crucial factor as to whether an ASD tug can safely assist a ship (that has a certain speed ahead) bow-to-bow is the specific tug's capability to run astern safely and to apply steering assistance to the ship at that speed safely. This depends on the tug's underwater hull form and to a large extent on the tug's skeg design. Other factors are the tug's engine power, stern design, type of manoeuvring controls, trim, loading condition, and wave conditions in the port approaches.
- **Safe speeds**. Speed is a crucial factor for safe bow-to-bow operations. The safe speed limits for a particular azimuth stern drive tug should be clearly established when approaching the bow for making fast bow-to-bow and when operating bow-to-bow. Wave conditions should be taken into account. The tug captain and the pilot should know these safe limits and the ship's speed should not be higher than these.

For connecting bow-to-bow the safe ship speeds for some ASD tugs may be as low as three to four knots, while for capable azimuth stern drive tugs a speed of approximately five to six knots is recommended. This applies in calm waters. With tugs capable of this, speeds can be somewhat higher as soon as the towline is fastened.

For rendering assistance when fastened bow-to-bow, safe speed limits for some ASD tugs may lie in the range of four to five knots, while for well-designed azimuth stern drive tugs the limits can be as high as approximately seven knots. This applies in calm waters as well.

When making fast stern-to-bow, the ship's speed should not be higher than seven knots, while for stern-to-bow operations a speed of seven knots can be regarded as the safe maximum in calm waters, although in such conditions higher speeds may be safe with a good tug and an experienced tug captain. When releasing the towline the same safe speeds should be maintained as when fastening it. Special attention is required for departing ships when the bow tug is made fast bow-to-bow, as these ships may pick up speed quickly. Releasing the towline should be well planned.

- **Alternatives**. If the ship's speed cannot be kept at the safe limits for the attending tug operating bow-to-bow, the bow tug should be employed in a different way, either stern-to-bow if possible, or alternatively alongside the ship near the bow; otherwise a more suitable tug should be employed.
- **Bow approach procedures**. Factors that influence how to approach the bow when making fast for bow-to-bow operations are, other than the tug's capabilities: type of ship and draft, speed of the ship, wind direction and wave conditions.

  For bow-to-bow operations an approach from a position ahead of the bow is considered safest; additionally, with this approach, there is no risk of hitting the flare of, for example, a containership with the tug's superstructure. Where a bow tug is to make fast for stern-to-bow operations, it will approach the bow more or less as with a conventional tug.
- **Risks** are smaller during the procedure of making fast bow-to-bow compared with stern-to-bow. There is very little risk of hitting the ship's hull with the tug, hitting the bulb with the thrusters or fouling the tug's propellers by a towline slipped into the water, when the above-mentioned bow approach procedures are taken into account.

Risk of capsizing when fastened bow-to-bow is minimal; this risk exists when operating stern-to-bow, unless the quick release mechanism of the towing winch is used in time.

- **Training and experience**. It should be emphasised that tug captains must have thorough training and proper experience to handle azimuth stern drive tugs safely and efficiently. The training should focus on azimuth tugs in general, particularly focussing on the specific tug a tug captain has under his command, as behaviour and performance of ASD tugs differ in design, while manoeuvring controls may differ greatly as well. Additionally, training in assisting methods to be applied, as well as building up experience with these methods during day-to-day practice, is a necessity.
- The monograph B*ow tug operations with Azimuth Stern Drive Tugs* is available from The Nautical Institute at £10.50 to members, £15 non-members, postage extra.

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ABOUT THE AUTHOR AND THE ORGANISATION

Captain Henk Hensen is a Master Mariner and was a Port of Rotterdam pilot for 23 years. During his years as a pilot he was stationed at the Pilot Office of the Rotterdam Port Authority for five years and started the first simulator courses for harbour pilots and tug captains, participating in many port studies, including simulator research. Following his pilot career he continued to work as marine consultant on the nautical aspects of port studies, harbour tug advice and simulator training. Projects have included pilot and tug captain simulator training courses, port entrance and port development studies.

Furthermore he has carried out and has been involved in various other nautical studies, such as nautical safety studies, tug performance studies for ship bridge simulators, studies for the development of LNG terminals, container terminals, mooring simulation studies, simulator studies for safe bridge passages, studies on safe and efficient harbour tug use, etc.

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H. Hensen FNI
Marine Consultant
Pr. Beatrixlaan 4
3155 TJ Maasland
The Netherlands

Tel: +31 10 5915763
Fax: +31 10 59 15763
Email: hhensen@kabelfoon.nl