July/August 2012

International Tug & OSV

INCORPORATING SALVAGE NEWS

ITS 2012 Review

A-Z Guide to Tug & OSV Builders

Arnout Damen: “You cannot chop and change: you need a long-term vision.”

Safe tug operation: Who takes the lead?

Capt Henk Hensen FNI FITA considers, for *IT&O*, tug operations near a ship's bow – the risks, the tragedies, what we can learn and what we should be doing now to prevent further catastrophes.

► *Tug* **Fairplay 1** *capsized under the bow of the passenger ship* **Italia**. *Copyright Jan Mordhorst, Germany.*

Tug operations near the bow of a ship having headway are very risky. The higher the ship's speed, the larger the risks. This is nothing new. The accident to the tug *Fairplay 1*, which came under the bow and was run down by the passenger ship *Italia* in Cuxhaven Roadstead, Germany, on 6th September 1954, is a tragic example of a tug trying to make fast at the bow of a ship having headway. This accident also illustrates the risk to human beings on board the tug. There were two casualties[1].

This, and similar accidents occurring when operating near the bow of a sea-going vessel underway prompted the German Ministry of Transport and Traffic to ask the Hamburgische Schiffbou-versuchanstalt (Hamburg Testing Tank) to carry out a study into how these accidents can happen, and in particular to find out how they can be avoided.

However, despite the study being carried out and the lessons learnt from it, it is sad to see that such accidents still occur and still have tragic consequences. There have been more accidents, and more studies, but the tragedies continue to occur.

Has nothing been learnt from any of this? How is that possible? Do we accept that in this sophisticated world, with all the knowledge we have, people on board a tug may lose their lives during tug operations in or near a port? We should not.

Therefore, with the victims firmly in mind, this article will focus on these accidents, and try to suggest ways in which they may be avoided. First, let us take a look at the studies carried out.

1. 1964

The periodical *Hansa*[2] published an article entitled *Modellversuche über Schlepperunfälle bei Übernemen der vorderen Trosse* ('Model tests regarding tug accidents while making a towline connection at the bow') by Capt W Mockel. The tests were carried out by Hamburgische Schiffbau-Versuchanstalt with tug models of different types and propulsion systems, and with a model of a tanker.

The first model tests simulated tugs that had already come alongside the ship's bow, and tried to come free again. Then they studied tugs approaching the bow from aft in order make a tow-line connection. The tests were carried out at speeds of 6 knots and below, with separation distances between tug and ship of only a few metres. The results were very interesting. Among the findings were the following:

a) A conventional tug without a bow thruster cannot turn away from the fore body of the ship once the tug is alongside in contact with the tow. Tugs with a very powerful bow thruster can get clear under certain favourable conditions, but the only tug which could get clear virtually under any condition was the Voith Water Tractor, a tug equipped with Voith Schneider propulsion under the fore body.

b) The tests showed that when a tug is overtaking a ship at close range, the forces and turning moments working on the tug change very quickly when it is passing the forward shoulder. The most dangerous position is when the tug is passing the forward part of the bow, where the out-turning moment working on the tug quickly changes to an in-turning moment. If, at that position, the tug is steering towards the ship, then it becomes problematic for the tug to avoid a collision.

c) The higher the speed of the tug, compared to the speed of the vessel, the higher the turning moments are. The turning moments increase with the square of the speed.

Subsequent accidents in ports (eg ***Hans/Hans Krüger****) showed again that passing a towline near the bow of a ship at speed is very dangerous for a conventional tug. A 1983 article[3, 12] regarding such accidents came to a similar conclusion as for the Voith Water Tractor mentioned above, but now for a tug with steerable nozzles under the bow.

Both the study and the paper state that when tugs come alongside the bow, the only safe escape manoeuvre for the tug is 'full astern'.

*The accident to the conventional tug ***Hans*** (length 26.6m; 660hp) happened in Hamburg on 10th December 1978 while assisting the general cargo ship ***Hans Kruger*** (9,019brt). The tug sank and the captain drowned.

2. 1976

Dr Dand in the UK also did model tests, with two types of ships and two single screw tug models. His findings were published in *Some aspects of tug-ship interaction* in 1976[4, 12].

The tests were carried out at speeds of approximately 6 knots.

Among the conclusions were:

a) Near the fore body of a ship is a hazardous region for the tug as it may 'drive' itself under the ship's bow if the application of correcting rudder and reduction of power are not rapid enough.

b) Interaction forces vary, approximately as the square of the speed, and reduce with distance off. Their severity may be most easily reduced by a reduction in ship's speed.

3. 2011

On 1st August 2003, a tragic accident happened with the ASD tug ***Burcht*** near the Antwerp locks. The tug tried to make fast at the bow of a container ship, came under the bow and capsized. One person drowned. Model tests were carried out at Flanders Hydraulics Research in Antwerp. A model of a 65-tonne bollard pull ASD tug was used together with the model of a 229m long container ship. Various ship speeds, different separation distances between ship and tug, and differing tug drift angles were investigated[5].

Some of the conclusions were:

a) An ASD tug sailing in close proximity to the bow of a large container vessel will experience strong interaction forces.

b) A tug master should be aware of these interaction phenomena, since the forces are of significant magnitude to give rise to tug-handling difficulties. The tug will experience either a repulsive or attractive interaction sway force, or a bow-in or bow-out interaction yaw moment. A combination of these forces will necessitate a steering force to enable station keeping.

4. 2012

On 11th November 2010, during stormy weather, the tug ***Fairplay 22***, while trying to make a towline connection at the bow of the ferry ***Stena Britannica***, came under the bow and capsized with two fatalities – the captain and the engineer. For the investigation by the Dutch Safety Board, hydrodynamic calculations were carried out by MARIN, The Netherlands, for an assessment of the interaction between the ferry and the tug while the tug was trying to make a towline connection at the bow of the ferry. The calculations were carried out at various speeds and using various distances between ship and tug[6].

Below are some conclusions:

a) The turning moment is at one location outward, but at a more forward-lying position, when the forward perpendiculars of ship and tug are level, there is a strong inward turning moment working on the tug. This inward turning moment is significant in relation to the manoeuvring possibilities of the ASD tug.

b) If the tug is then steering with a drift angle of almost 10 degrees towards the ship, the hydrodynamic forces and turning moment working on the tug increase significantly, so consequently there is an increased risk that the tug cannot get away from the ship.

c) Suction forces and turning moments increase with ship's speed and decreasing distance between ship and tug. The recommended speed through the water should not be higher than 6 knots.

General conclusions

All the investigations carried out during the past 40 years have reached similar conclusions. There are strong interaction forces, including turning moments, around the bow of a ship making way. These interaction forces and turning moments can fluctuate and rapidly change direction. The forces and turning moments vary by ship type, so there is some difference in the outcome of the studies.

The interaction forces and turning moments working on the tug increase with ship's speed and with decreasing distance between tug and ship. In shallow and narrow waters, the interaction forces increase as well[8].

The interaction forces can be so strong that the tug's manoeuvring capabilities are not large enough to manoeuvre the tug away from the ship's hull. If a tug comes alongside the ship's bow, it may not be able to get free again. The only safe escape manoeuvre for the tug is always full astern.

Tugs with the propulsion forward, such as Voith tugs and azimuth tractor tugs can better compensate for the interaction forces, because when setting the propulsion units away from the bow the tug will move away. Conventional tugs, or ASD tugs operating as a conventional tug (reverse tractor tugs), when steering away from the bow, will experience a force towards the ship and the tug's stern will move quickly inwards. This is a consequence of the aft lying rudder(s) and propulsion.

It should be noted that most of the studies focus on tugs which are approaching the bow from aft, which is not always the case.

In the above reports, the following recommendations are given:

- *Be aware of the interaction forces.* The problem is, of course, that these interaction forces change with ship type, draft, trim, speed, underkeel clearance, width of fairway and drift angle. Although tug masters have a lot of experience and know there is a lot of difference between, for instance, a loaded bulk carrier and a container vessel, it is difficult for them to assess where the safety limits lie. I return to this point in *Important questions and what should be done* (see page 75).
- *A safe speed of not more than 6 knots is recommended.* That is a speed also recommended by the International Harbour Masters Association and the European Harbour Masters Committee[7]. A speed of 6 knots is indeed, in general, a safe speed for bow tugs. Problems can arise with ships having a very high dead slow ahead speed in combination with steering problems when the engine is stopped at a dead slow speed.
- *Furthermore, correct and safe procedures should be followed by all parties when making a towline connection forward with a ship making way.*
- *Tractor tugs, and tugs with propulsion units forward, are much safer to operate as bow tugs. They can better compensate for the interactions forces.*

More warnings

There is at least one country that has drawn attention to the risks for a tug trying to pass or take a towline near the bow of a ship making way, and that is the UK. In February 1977, Merchant Shipping Notice No M 792 was issued[8]. Apart from the interaction effects mentioned above, the Merchant Shipping Note warns of other dangers:

Especially in shallow waters, the tug has to exert appreciably more power than it would use in open water to maintain the same speed, as the ship and the effect is strongest near the shoulders. In addition, the flow around the ship is acting on the underbody of the tug causing a consequent decrease in effective stability.

An example is mentioned where a tug was instructed to make fast on the starboard bow of a 1,600-tonne vessel in ballast which was proceeding inwards with a speed of only 4 knots. The distance between ship and tug was 6m. As the towline was being passed, the tug took a sheer to port and before this could be countered, the two vessels touched, the ship's stern striking the tug's port quarter. The tug capsized within seconds; one man was drowned.

Despite the studies carried out in the past and the warnings included in the UK Merchant Shipping Note, tragic accidents near the bow still happen. How is that possible? Two recent accidents will now be considered in more detail.

Recent tug accidents

The tug ***Barta*** came under the bow of the empty general cargo vessel ***Magdalena*** in the port of Klaipeda on 10th April 2008. Particulars of the tug and ship are:

Tug *Barta*

Tug type: Conventional tug
Year built: 1988
Number of crew members: 3
LOA: 29.30m
Maximum speed: 11.5 knots
Engine power: 1,600hp
Bollard pull: 22 tonnes
Propellers: 2 x controllable pitch propellers in steerable nozzles.

Cargo ship: *Magdalena*

Flag: Malta
Type of ship: General cargo
LOA: 149m
Draft forward/aft: 2.5m/6.8m
Bow thruster: approximately 800hp
Ship has a bulbous bow

Weather conditions: NE'ly wind 8-10m/sec; overcast; air temperature 60 degrees C
Current: outgoing
Daylight

▼ *The tug* **Barta**. *Photo: Gena Anfimov, Klaipeda.*

Magdalena, in ballast with the bulb far above the water, arrived with the pilot in the port of Klaipeda. The speed was 6 knots, which is the maximum allowable speed in the port according to local regulations. Three tugs were ordered because of the wind, and the tug ***Barta*** would make fast forward, central lead, with a ship's line. The pilot asked the tug master whether the ship's speed was too high, because it could be reduced, but the tug master said he could probably take the rope.

It was common practice in the port to lower the rope to the water, then the tug crew would pull it on board with a hook fastened to the end of a 6m-long pole.

Ship's heading was about 160 degrees and the wind was almost abeam on the port side. The tug ***Barta*** approached the ship's port bow from aft, at the windward side. The tug master positioned the tug in such a way that two-thirds of the tug was ahead of the ship's bow, and he came very close to the bow in order to be able to pick up the rope.

As soon as the rope was on the tug's towing hook, the tug engine was set to full ahead and the propellers were set at an angle of 12 degrees with the tug's centre line. This angle, which improved steering performance, reduced the maximum speed from 11.5 down to 7.5 knots. With full ahead on the engine, the tug did not move ahead, and the after part of the tug came into contact with the bulb. The tug was then forced quickly to starboard, came under the bulb and capsized. The tug master and a sailor drowned. The Lithuanian Maritime Safety Administration investigated the accident and published various findings and conclusions[9]:

- The ship's speed was too high. The Safe Working Procedures applicable to towing operations in the port state that tugs are only allowed to take the towing rope from a ship when the ship's speed is at a safe minimum.
- Tug's speed margin was too small.
- Economic pressure may have played a role.
- The procedures used for passing the towline may, under the given circumstances, not be regarded as safe.
- Visibility from the tug's wheelhouse was too limited to accurately position the tug.
- The tug ***Barta*** was not suitable to perform the manoeuvres it was expected to carry out for taking the towline.

The next example is the tragic accident with the tug ***Fairplay 22*** which came under the bow of the ferry ***Stena Britannica*** near Hook of Holland on 11th November 2010. Two persons drowned, the captain and engineer.

First, the main particulars of both vessels:

Tug: *Fairplay 22*
Flag: Antigua & Barbuda
Type of tug: ASD
Year built: 1998
LOA: 35.55m
Width: 10.8m
Engine power: 4,500hp
Bollard pull ahead: 52 tonnes
Speed: 12.5 knots
Persons on board: Five, of which two trainees

Stena Britannica
Flag: United Kingdom
Type of ship: Ro-ro passenger ferry
Year built: 2010
LOA: 240m
Width: 32m
Draught on arrival: 5.58m/5.80m
Propulsion: Two CPP
Bow thruster: Yes
Engine power: 45,000hp

Weather conditions: Stormy. Good visibility.
Wind: Beam winds 15-18m/sec with gusts of 25m/sec.
Current: 1-1.5 knots

Normally the ferry ***Stena Britannica*** does not use tugs, requiring them only when the wind is too strong, which was the case on the day in question. The ship had no pilot on board. The captain had a Pilot Exemption Certificate, but had not undertaken a simulator training course on ship handling with local tugs in case tugs are needed, as captains of ferries calling at Europoort in Rotterdam are required to do.

Two tugs were ordered, and ***Fairplay 22*** would make fast forward at the starboard bow. The tug would operate as a conventional tug by using the aft winch. A speed of 7 knots was agreed between the tug master and the ferry. Because of the stormy wind, the tug master decided to position the tug on the lee side, close to the port bow, to pick up the heaving line. However, the attempt to pick up the line failed. The ship's speed through the water was 8.4 knots at that moment.

Fairplay 22 increased speed and passed the bow of the ferry. From a position to port and forward of the bow, the tug master let ***Stena Britannica*** approach the tug. The tug master manoeuvred his tug on the port side of the ferry with the after part of the tug abeam of the bulb to try to pick up the heaving line again. However, the attempt failed a second time. The speed of the ferry was now 7.9 knots through the water, still higher than the agreed speed, and much higher than the 6 knots recommended by the towage company. The distance between the tug and ferry decreased fast and the tug was then hit by the bulb, capsized, and inverted, with the loss of two crew members.

The Dutch Investigation Board published a number of findings and recommendations[6], including:

- The high speed played a crucial role.
- The current and drift angle of the ferry may have played a role as well.
- The investigation could not determine to what extent the limited visibility of the tug master, his ability to react, and the wind influence may have contributed to the tragedy.
- After the collision, the tug master could not manoeuvre the tug free from the bow of the ferry, due to the hydrodynamic forces working on the tug and the insufficient reserve power.
- ***Fairplay 22*** was pushed over by the ferry and then capsized. The limited stability of the tug and the fact that the vents of the engine room and a door leading to the afterdeck were open, contributed to the rapid capsize.
- There was no longer specific training for tug masters (except for tug masters on vessels with engine power of more than 3,000kW). Therefore, knowledge and experience of the specific risks related to towage operations is no longer taught or passed on in a structural way.

Based on the findings, several recommendations were made and are summarised below:

- To the towing company with respect to:

Identifying the risks of a tug sailing close to the bow of a sea-going vessel; measures to be taken to keep these risks under control, particularly attention to be paid to speed through the water to be maintained,

◄ *Tug* **Fairplay 22**.
Photo: Harry van den Berg, Hook of Holland.

stability and tug position when making a towline connection; implementing the safety management system; monitoring of operational procedures, including speed during tug assistance, and the closing of watertight and weathertight openings during operations (see also[10]).

- To the ferry company with respect to:

Identifying the risks involved in making a towline connection; measures to be taken to control these risks; ferry masters to be competent in tug use in the Port of Rotterdam; written agreements with towing companies which should include safety criteria.

- To the harbour master of the Port of Rotterdam with respect to:

Regulations for a maximum allowable speed when a towing connection is made; requirements for ferry captains with a pilotage exemption certificate regarding training and experience with respect to tug assistance.

- To the Ministry of Infrastructure and Environment:

To investigate the possibility of setting up formal training for tug masters, and making it compulsory for all tug masters on Dutch tugs and tugs in Dutch ports;

To investigate, if possible with IMO member states, the possibility of making a Voyage Data Recorder compulsory on tug newbuildings.

Conclusions regarding the two accidents

Various questions can be asked when reading both reports, such as with respect to the procedures followed by the tug and/or ship for making a towline connection, the tug's suitability for operating as a bow tug or for operating in the way it did, etc. Nevertheless, both reports give a good impression of what happened, and the recommendations deserve serious attention.

When comparing the findings of both investigations it can be seen that the following factors played a role:

- Ships' speeds, and related interaction effects between tug and ship.
- Visibility from the tug wheelhouse.

The findings of the investigation of the ***Fairplay 22*** accident show that the drift angle may have played a role, along with the visibility from the wheelhouse and wind influence. It is not clear to what extent each of them contributed to the outcome.

- Wind.
- The procedures used for passing a towline forward.
- Openings not closed and limited stability (***Fairplay 22***).

Furthermore:

- Type of tug, operating mode and suitability played a role.

A few remarks occur to the author at this point:

1. The ferry sailed with a drift angle up to 10 degrees. There were wind gusts up to 50 knots. A tug positioning itself to take the heaving line will normally sail on the lee side close to the ship and parallel to it. It is therefore always important that the pilot or ferry master tells the tug the drift angle he is steering, so the tug master can take that into account.

2. Although mentioned in the ***Fairplay 22*** accident report, more attention must be paid to the safest way to approach different ship types for making a towline connection forward, depending on tug type and operating mode.

3. It is the ship's captain who orders the tugs. The pilot and/or captain form a team with the tug masters. This means that a pilot and/or ship's captain should operate in such a way that the tugs are never brought into danger by the ship. In this respect, the pilot and/or ship's captain have a certain responsibility for the safety of the tugs. However, it is only through proper training that they will be able to recognise the dangers and prevent them from happening.

It must be noted that it is not only conventional tugs which may come under the bow of a ship making way. It also happens with modern ASD tugs, particularly when, like ***Fairplay 22***, they are operating as a conventional tug. See also the earlier-mentioned ASD tug ***Burcht***. Not all such accidents have tragic consequences, but the risks of operating in close proximity to the bow of a ship making way are very high for the tug and its crew members.

▲ *Lifting of the capsized tug* **Fairplay 22**.
Photo: Harry van den Berg, Hook of Holland.

Important questions and what should be done

Over a period of almost 50 years, research has shown the dangers of tugs operating close to the bow of a ship making way. The research published in 1964 demonstrated that tractor tugs can operate more safely near the bow of a ship having headway. But despite all the research carried out and publications issued ([9,12]) , still these serious, and tragic, accidents continue to happen. How is that possible?

Three questions must be asked:

1. Do the results of the studies find their way to the training institutes, towing companies and, most important of all, to the tug masters?

2. Can these accidents be avoided under the present method of tug operations near the bow?

3. What can be done to ensure that such accidents do not happen again?

With respect to question 1, it is the author's opinion that, in the daily practice of tug operations, there is insufficient background knowledge about the risks related to operating with a tug close to the bow of a ship making way and what effect speed has on those risks. The situation can be improved by a better information exchange between research institutes, training institutes, towing companies and tug masters. For tug masters, the situation can be improved by implementing the lessons learnt from accidents in their training. But do tug masters in all ports of any relevance around the world have a certified training system focused on ship handling, including refresher courses? The answer should be 'yes', but is mostly 'no'. This means that many tug masters, perhaps all, miss a lot of vital information.

Tug masters know of interaction effects from experience, and some simulator manufacturers are gradually paying more attention to them. However, the largest problem in daily practice is that a tug master often cannot judge when it becomes too risky for his tug and crew around the bow of a ship at speed. There is a very small margin between safe and unsafe, and the risks often are not realised or cannot be properly assessed. In addition, a tug master is often forced to come closer to a ship than he wants because of, for instance, improper heaving line usage or inexperienced crew on board the ship to be attended.

Speed is absolutely the most crucial factor. However, the possible minimum speed of a ship depends on several variables, such as the dead slow speed, the steering performance, wind and current effects. It is not always possible to sail at a minimum speed which is safe for both the ship and for the tug while trying to pass a towline near the bow.

With regard to question 2, accidents near the bow or bulb can be avoided under the present method of tug operations if a few safety measures are implemented:

- Studies should be conducted on the safest approach procedure for different ship and tug types and operating modes when they have to pass a towline near the bow.
- Proper and effective use of suitable heaving lines is needed.

Note: It is worth considering the use of a line-throwing gun on board the tugs. The tugs can then stay at a safer distance from the ship's bow when a heaving line is used.

- All around visibility from the wheelhouse is an important factor.
- Optimum teamwork between the pilot and/or captain and tug master is needed, based on experience and (team) training.

Simulators used for tug master training should have implemented realistic interaction effects.

- Most important are:

1. A safe ship's speed, which may depend on tug type and/or operating mode. Tug masters should not make fast if they find it too risky to pass a towline near the bow.
2. A suitable tug.

If these important factors are taken into account, then the risks for tugs and crew will reduce when operating near the bow of a vessel. However, the risks caused by a ship's speed and related interaction effects will still be there and can still cause problems for a conventional tug.

Regarding question 3 (on previous page), there are a number of possibilities to prevent such serious accidents in future:

- All the suggestions made in answer to question 2 are vital.
- Safe alternatives are:

1. The use of suitable and powerful tractor tugs – as already indicated by the research in 1964 – RotorTugs or modern reverse tractor tugs.
2. The use of a new tug concept, the tug EDDY, which has one thruster forward and one aft[11]. This tug can effectively cope with interaction forces. In addition, the tug is very effective in delivering steering forces because the towline forces increase with speed. With only one thruster the tug has a speed of 12 knots (*see image, above*).
3. A change in the assisting mode of the forward tug(s). The forward tug should operate near the forward shoulder, with the towline fastened at the forecastle, as is the case with container ships in Hong Kong. Accidents with bow tugs as described in this article have never happened there.

It goes without saying that all openings which can be closed and rendered watertight or weathertight must always be closed during operations.

The purpose of this article is to draw the attention of all responsible professionals to these tragic tug accidents, and stimulate discussion which may lead to ideas in addition to those mentioned above. Then, finally, an awareness of the dangers of bow tug operations, and how to overcome them, may be achieved.

Unfortunately, accidents can happen and will happen. A number of accidents with bow tugs have been analysed. There are more such accidents than have been mentioned here, and there may be ones we don't even know of. In this modern world it is not acceptable that crew members are killed during accidents with bow tugs, when so much research has been carried out over a period of more than 45 years, which every time has clearly shown the reasons why such accidents occur.

▲ *New tug concept EDDY.*
Photo: Baldo Dielen Associates Ltda.

References

[1] Schlepper. Jan Mordhorst, Verlag Maritim GmbH, Hamburg, Germany, 1988.
[2] Modellversuche über Schlepperunfälle bei Übernehmen der vorderen Trosse, Kapt W Möckel, HANSA-Schiffahrt-Schiffbau-Hafen-101 Jahrgang-1964-Nr 12.
[3] Der KORT-Düsenschlepper in der Seeschiffassistenz. Dipl-Ing C-P Buhtz. Schiff und Hafen/Kommandobrück, Heft 1/1983, 35, Jahrgang.
[4] Some aspects of tug-ship interaction, I W Dand, Paper 4th Tug Convention New Orleans, 1976.
[5] *Hydrodynamic Forces in Ship-Tug Interaction*, Stefan Geerts, Marc Vantorrre, Ghent University, Belgium; Katrien Eloot, Flanders Hydraulic Research, Belgium; René Huijsmans, Delft University of Technology, The Netherlands; Niko Fierens, Unie van Redding- en Sleepdiensten (URS), Belgium, *Tugnology '11*, May 2011, Antwerp.
[6] Aanvaring en kapseizen sleepboot ***Fairplay 22*** op de nieuwe Waterweg te Hoek van Holland, De onderzoeksraad Voor Veiligheid, Den Haag, Maart 2012 (www.onderzoeksraad.nl; Dutch and English version).
[7] *The Chain*, Awareness and best practices in the nautical chain, Video, 2011.
[8] Merchant Shipping Notice No M 792, February 1977, UK, which is now marine Guidance Note MGN 199 (M), Maritime and Coast Guard Agency, UK, April 2002.
[9] Accident Investigation Report regarding tugboat ***Barta*** accident in the port of Klaipeda on 10-04-2008, 26th September 2008, No LS-33, Lithuanian Maritime Safety Administration.
[10] *Loadline Instructions for the Guidance of Surveyors*, Marine and Coast Guard Agency, UK. These instructions include the former Merchant Shipping Note No M 1531 *Safety of Tugs While Towing*, June 1993.
[11] www.eddytug.com
[12] *Tug Use in Port, A practical Guide*, Henk Hensen, The Nautical Institute, London, UK, 2003.