SMAIC
STATE MARINE ACCIDENT INVESTIGATION COMMISSION

SIMPLIFIED REPORT

22/15

Marine Casualty

Tugboat VIRTUS
Vessel BOMAR VICTORY

collision of a tugboat with a vessel
in the fairway to DTC in Gdańsk
on 24 June 2015.

April 2017

The investigation of a serious marine casualty of the tugboat *VIRTUS* and the vessel *BOMAR VICTORY* was conducted under the State Marine Accident Investigation Commission Act of 31 August 2012 (The Journal of Laws item 1068) as well as norms, standards and recommended procedures agreed within the International Maritime Organisation (IMO) and binding the Republic of Poland.

The objective of the investigation of a marine casualty or incident under the above-mentioned Act is to ascertain its causes and circumstances to prevent future casualties and incidents and improve the state of marine safety.

The State Marine Accident Investigation Commission does not determine liability nor apportion blame to persons involved in the marine casualty or incident.

This report shall be inadmissible in any judicial or other proceedings whose purpose is to attribute blame or liability for the accident referred to in the report (Art. 40.2 of the State Marine Accident Investigation Commission Act).

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1. Facts

On 24 June 2015, in the morning, the container ship *Bomar Victory* under the flag of the Marshall Islands, was entering the container terminal DCT in Gdańsk, with a pilot on the bridge. At the same time, the tugboat *Virtus* under the Polish flag, was navigating from the Port Północny towards the container ship.

At 08:55 the tugboat *Virtus*, having passed buoy "P9" stopped near the right (northern) boundary of the fairway and then began to approach *Bomar Victory*, which was navigating with a steady speed in the middle of the fairway.

At 08:56 the stern of the tugboat came into contact with the starboard side of the vessel. The impact caused the indentation of the plating of *Bomar Victory* at the place where the bilge plate of the stern starts.

2. General Information

2.1. Ships' Data

2.1.1. Bomar Victory

Ship's name:	Bomar Victory
Flag:	the Marshalls Islands
Shipowner:	Bomar Eight LLC, Hamburg (Germany)
Operator:	V Ships Germany GmbH & Co.KG, Hamburg (Germany)
Classification society:	Lloyd's Register
Vessel's type:	container ship
Call sign:	V7EH2
IMO number:	9242649
Gross tonnage (GT):	17189
Year of built:	2002
Power:	16980 kW (B&W 6L 70MC)
Width:	26 m
Length overall:	178.5 m

Hull material:	steel
Minimum crew:	16 men
VDR recorder:	Rutter 100G 2

Photograph 1: The container ship 'Bomar Victory'

2.1.2. Virtus

Name of the tugboat:	Virtus
Flag:	Polish
Shipowner (operator):	WUŻ Port and Maritime Services Ltd Sp. z o.o., Gdańsk
Classification society:	PRS S.A.
Vessel's type:	tugboat
Call sign:	SPKN
IMO number:	9477048
Gross tonnage (GT):	334
Year of built:	2008
Power:	3530 kW (2 x Caterpillar 3512 C HD)
Width:	10.5 m
Length overall:	30 m
Hull material:	steel

Minimum crew:	4 men

Photograph 2: The tugboat 'Virtus'

2.2. Voyage Information

2.2.1. Bomar Victory

Ports en route:	Riga (Latvia)
Port of destination:	Gdańsk (Poland)
Type of navigation:	international
Cargo (type and quantity):	11,145 t (cargo in containers)
Crew (number/nationality):	1 Belarusian, 8 Russians, 9 Ukrainians

2.2.2. Virtus

Home port:	Gdańsk
Type of navigation:	in the port
Crew:	6 Poles

2.3. Accident Information

Kind:	marine casualty
Date and time of event:	24.06.2015, 08:56 LT (06:56 UTC)
Geographical position of the accident:	φ = 54° 24.5'N λ = 018° 46.2'E
Geographical area of the accident:	the Gulf of Gdańsk – the roadstead of the Port of Gdańsk
Nature of the water region:	internal waters
Weather during the event:	wind SW 4-5° B, sea state 4, Very good visibility, air temp. 17.5° C
Operating state of the vessel during the event:	loaded
Effects of the accident for *Bomar Victory*:	indentation of the plating below crew cabins at starboard, where the bilge plate of the stern starts of the following dimensions: 200 cm x 50 cm x 5 cm
Effects of the accident for *Virtus*:	damaged paint at the edge of the rail at the stern

Photograph 3: *Indentation of the plating of 'Bomar Victory' in the place of contact with 'Virtus'*

3. Circumstances of the Accident

On 24 June 24 2015, at ca. 08:30 a port pilot boarded *Bomar Victory* approaching the DCT terminal in Gdańsk down the fairway. On the bridge there was a master, a chief officer and a helmsman.

At the same time, the tugboat *Virtus* went from the Port Północny in Gdańsk in the direction of the vessel to assist her in entering the port and berthing. The tug master who was alone in the wheelhouse was maneuvering the tugboat.

At 08:55 after passing the buoy "P9" the tugboat *Virtus* stopped to wait for *Bomar Victor*y (Annex 2a), which was approaching the pair of buoys "P9"–"P10". The tugboat master turned around on the maneuvering post and after a while began to approach with the stern first the approaching vessel with the intention of entering behind her stern and giving the towline to the vessel.

At 08:56:33 the stern of the tugboat made a contact with the starboard side of the vessel (Annex 2b). As a result, the plating of the vessel's side became indented at the point where the bilge plate of the stern starts.

Once the tugboat bounced back from the side of the vessel, it lost speed and then started following the vessel (Annex 2b). Before reaching the pair of buoys "P13'–"P14" the vessel started to reduce speed. When the tugboat approached the stern of the vessel the towline was given from the tugboat to the vessel.

At 09:30 *Bomar Victory* berthed to Przeładunkowe Wharf in the DCT terminal. After berthing the representative of the vessel classification society (Lloyd's Register) made a visual inspection that showed no damage to the vessel's ability to navigate.

4. Analysis and Comments about Factors Causing the Accident with Regard to Investigation Results and Expert Opinions

The Commission has analyzed the stream of recorded AIS signals of both vessels which has rendered it possible to trace the traffic and to determine the location and mode of approach of the tugboat *Virtus* to *Bomar Victory*, as well as to determine the movement parameters of both vessels in the fairway from the moment of entering the fairway (between the buoys "P1" and "P2") by *Bomar Victory* until her entering the

Port Północny and the moment when *Virtus* (which stopped after passing the buoy "P9") made a move towards the approaching vessel and hit her side, until the towline was given to the vessel.

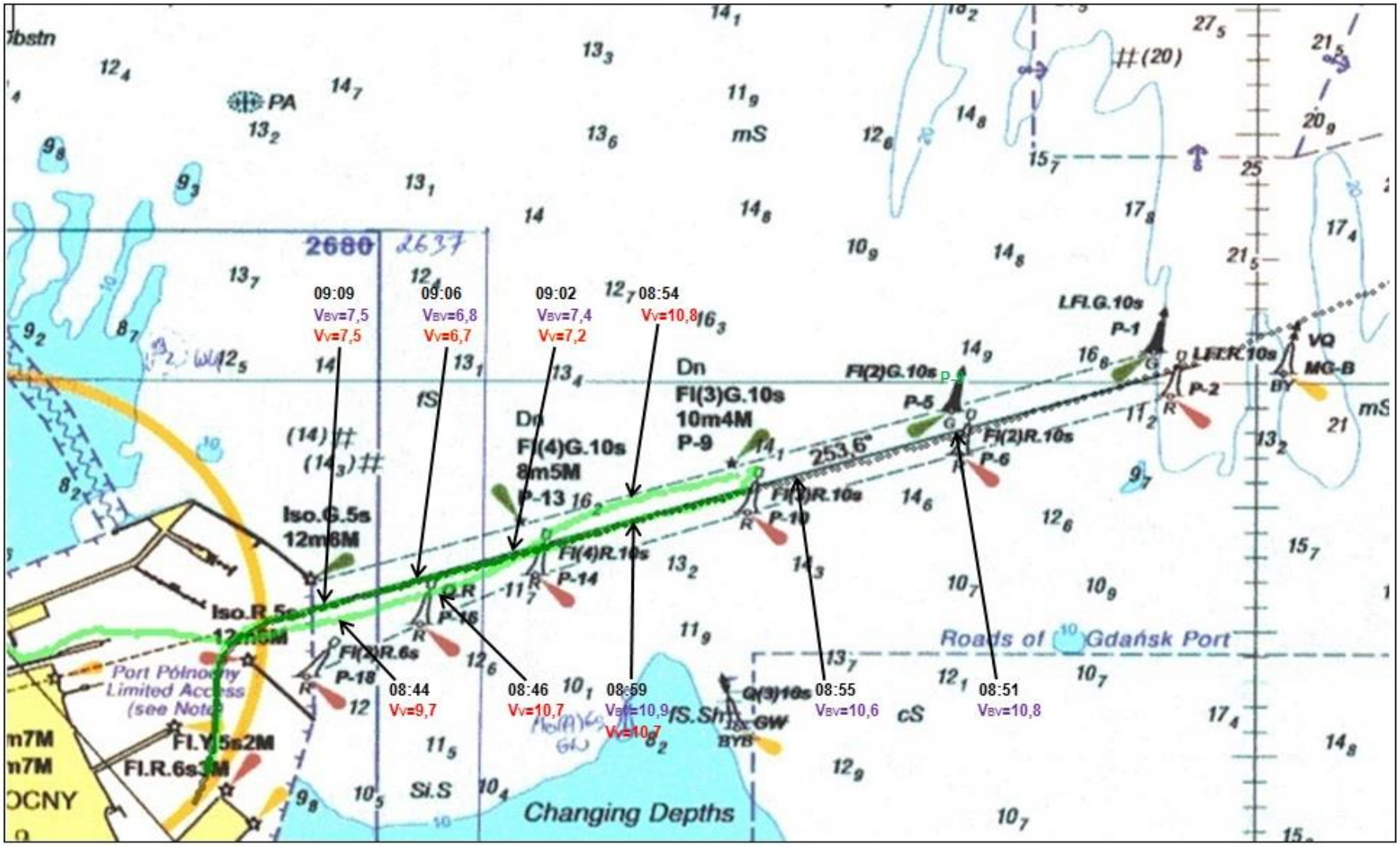

Figure 1: The track of movement of the vessel and the tugboat with time and speed markers

The *Bomar Victory* with the pilot on board had passed the first pair of buoys ("P1" and "P2") in the DCT fairway at a speed of 14 knots[1]. After reducing the speed to about 10.5 knots, she passed with this speed two next pairs of buoys "P5" and "P6" and "P9" and "P10". At the time when the tugboat *Virtus* was approaching the vessel, she was navigating at a speed of 10.4 knots staying at the COG of 254.8°, about one degree more than the course indicated by the leading marks.

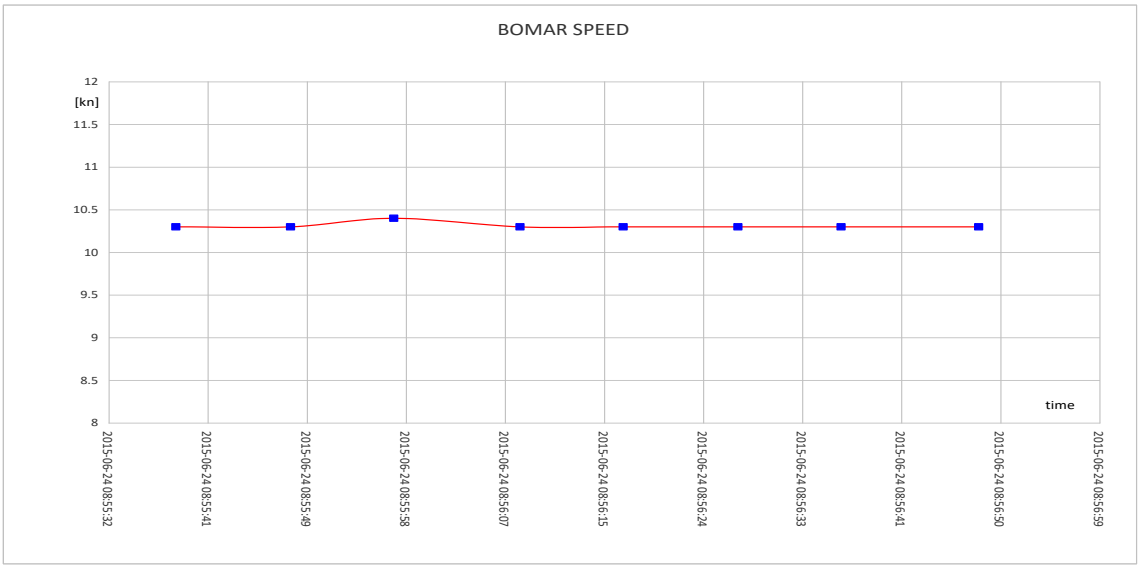

Figure 2: The speed diagram of 'Bomar Victory'

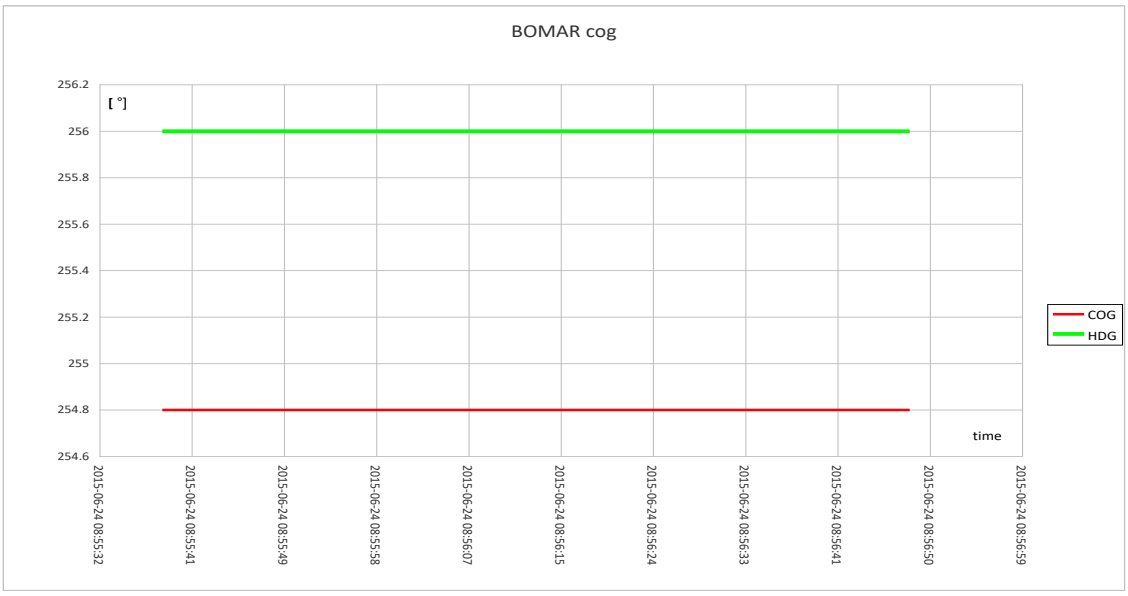

Figure 3: HDG and COG diagram of 'Bomar Victory'

[1] *Bomar Victory* exceeded twice the speed permissible in that place, which at the roadstead of the Port of Gdańsk is 7 knots (Par. 101, subparagraph 1, point 1 of the Order No. 5 of the Director of the Maritime Office in Gdynia of 20 February 2013 Port Regulations (Official Journal of the District of Pomerania, item 1314).

When the vessel arrived at the pair of buoys ”P13” and “P14” (about 8 cables in front of the port heads) she reduced the speed to about 7 knots and at that speed she passed the entrance head of the Island Breakwater of the Port Północny in Gdańsk.

The tugboat *Virtus* sailed out of the Inner Basin of the Port Północny to meet the vessel and after passing the breakwater it increased the speed to over 10 knots[2]. At this speed it initially was navigating on the left, and then on the right side of the fairway (Figure 1) until reaching the buoy “P9”. After passing the buoy, the tugboat stopped and set perpendicularly to the course of the approaching vessel. The skipper of the tugboat turned at the steering position and started approaching the coming vessel with the stern taking courses appropriate to changing bearing (Figure 4), trying to go behind her stern and keeping as close to the vessel as possible at the time she would pass her by.

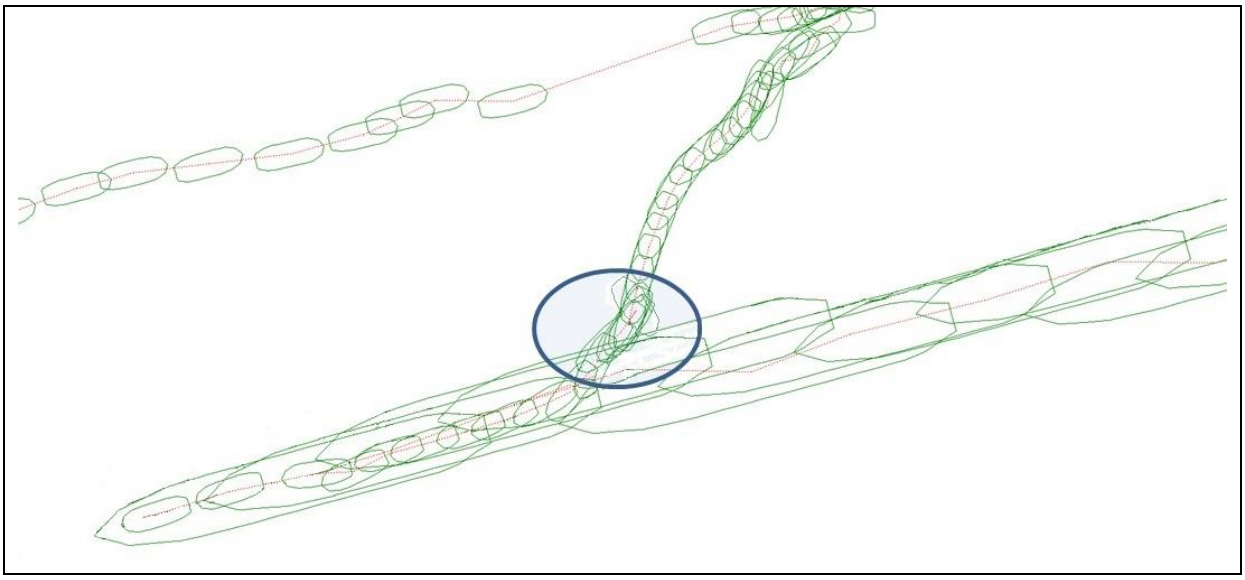

Figure 3: Visualisation of movement of ‘Bomar Victory’ and ‘Virtus’

The skipper of the tugboat began to increase the speed (blue line in Figure 5) until reaching 6.5 knots. Then he realized he might have gotten too close and tried to slow down to avoid collision. In Figure 5, it can be clearly seen that after reaching the speed of 6.5 knots, it begins to rapidly decrease in a very short time to the value of 0 at the moment of impact[3].

[2] The tugboat was also moving at a speed forbidden in the fairway.

[3] The tugboat *Virtus* “tractor” type (ATD – *Azimuth Tractor Drive*), had excellent maneuverability. It was equipped with two azimuth propellers (rotary propeller columns) with a total power of over 3,500 kW.

Another parameter of the decoded AIS recording – the course over ground (COG – red line), followed by the tugboat[4] shows that after hitting the hull of the vessel there was a rapid change of the direction of movement of the tugboat – from 220º to 020º.

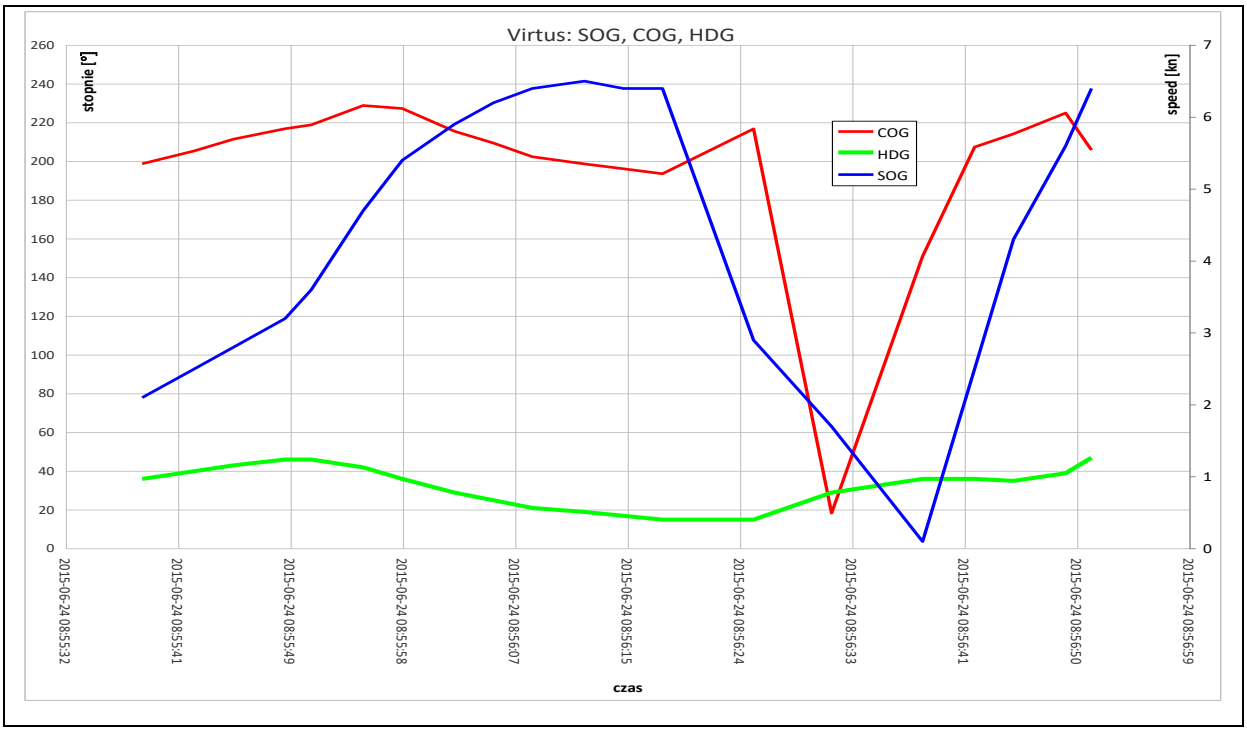

Figure 4: Global diagram of SOG, HDG and COG of Virtus

Such a rapid change was the result of "bouncing back" of the tugboat off the hull of *Bomar Victory*. The lack of obvious change in the heading (HDG – green line) indicated by the tugboat's gyrocompass confirms that she has remained on the previously taken approach and only for a moment – just after bouncing back off the vessel – it was found on the counter-course (when losing speed) and then continued entering into the wake of the vessel which passed by.

It results from the analysis of the global diagram of SOG, HDG and COG of the tugboat (Figure 5), that the changes in the parameters of its movement (speed and course) were the result of the forces resulting from the operation of the tugboat (maneuvers performed by the tugboat skipper) and the contact with the hull of the vessel. Significant change of navigation parameters occurred almost at the same time (the difference of 8 seconds).

[4] The COG of the tugboat was in fact its course, since the tugboat was moving with its stern forward.

4.1. General Rules of Cooperation Between a Vessel and a Tugboat

The method of approaching of a tugboat to a vessel depends on the place of giving (receiving) the towline, the vessel's type and the tugboat type[5]. In the case of ATD (Azimuth Tractor Drive) and ASD (Azimuth Stern Drive) tugboats operating with the towline given to the stern of the vessel, it is safe to approach the stern of a vessel, which should take place in the following stages:

1) the tugboat enters the wake of the vessel at a safe distance (depending on the evaluation of the skipper),
2) the tugboat approaches the vessel at a distance of the towline to be given,
3) the speed of the tugboat and the vessel must be matched,
4) the tugboat must be kept in the position for the time of giving the towline.

The difference between the ATD tugs (with propellers on the bow) and the ASD tugs (with propellers at the stern) makes the ATD tugboat, such as *Virtus*, capable of approaching with its stern the stern of the vessel, thus a person maneuvering the tugboat must turn back at their maneuvering station or maneuver backwards to the direction of the tug, while the ASD tugboat approaches the stern of the vessel with its bow as if naturally and it does not require to change position by a person maneuvering the tug. For these reasons, ATD tugboats are most commonly employed at the bow and ASD tugboats at the stern of a vessel. However, there are no specific contraindications for employing ATD tugs at the stern and ASD tugs at the bow of a vessel.

The speed of 6-8 knots is assumed safe for ATD/ASD tugs when approaching the stern of a vessel, whereas 6 knots when approaching the side. The speed of ATD/ASD tugboats when moving forward and backward is almost identical. Slight differences appear in the possibility of transverse movement in favor of ATD tugs, which is related to their construction[6].

Speed variations at the approach to the bow or stern of a vessel considered safe are due to much more unfavorable distribution of hydrodynamic forces and interaction between a vessel and a tugboat coming to the bow of a vessel. Such interactions do not appear at proper approach to the stern.

[5] In the attachment to the report, the Commission presented an overview of the changes that took place in the construction of tugboats and their type of propulsion in the historical context.

[6] The possibilities and differences in performance of these two types of tugboats compared to other tugboats with conventional propulsion are presented in the guidelines issued by the European Tugowners Associations: *Guidelines for Safe Harbor Towage Operations*, 1st Edition, February 2015, pages 4-12.

Around the moving vessel, there are areas of varying pressure. There are high pressure areas around the bow, while along the sides of the vessel from the pivoting point of the vessel (P) towards the stern, there are areas of reduced pressure (Figure 6)[7].

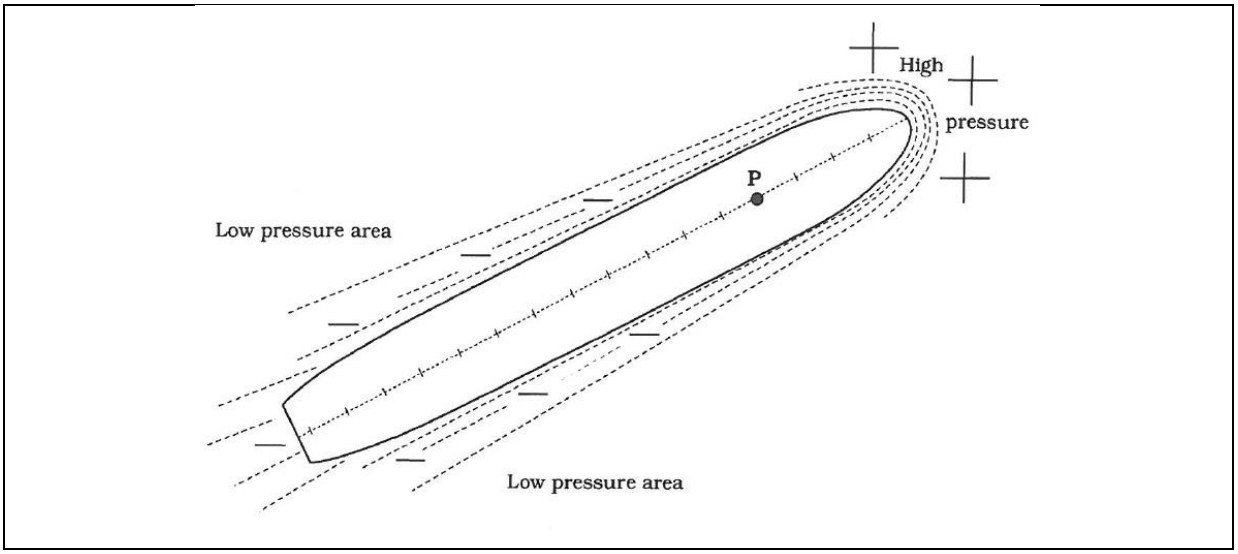

Figure 5: Simplified presentation of the distribution of pressure around the vessel in motion

Hydrodynamic interactions are associated with the movement of vessels that produce areas of varying pressure around their hulls. Areas of varying pressure create attractive or repulsive forces and torque moments affecting the vessels. Interactive forces change and depend on a number of factors, such as the type of a vessel (the shape of a hull), its size, draft, trim, keel and fairway width.

The greater the speed of vessels the greater interactive forces. They increase with the square of speed, i.e. the speed increased twice causes the forces to increase four times. Interactive forces increase as the distance between vessels diminishes. Potential danger increases with the increase of difference between the size of vessels. A smaller vessel is subjected to greater impact than the larger one.

Larger impact forces and a much higher risk of collision exist in the case of a tugboat approaching the bow of a ship than its side or stern. Nevertheless, the tugboat approaching the stern of a vessel, not directly in the ship's jet stream but approaching it slightly from the side (Figure 7), especially to a vessel that has not reduced speed, is exposed to the attracting forces of the ship's hull.

[7] R. W. Rowe, The Shiphandler's Guide, Nautical Institute in conjunction with Warsash Maritime Center, London 2010, p. 55.

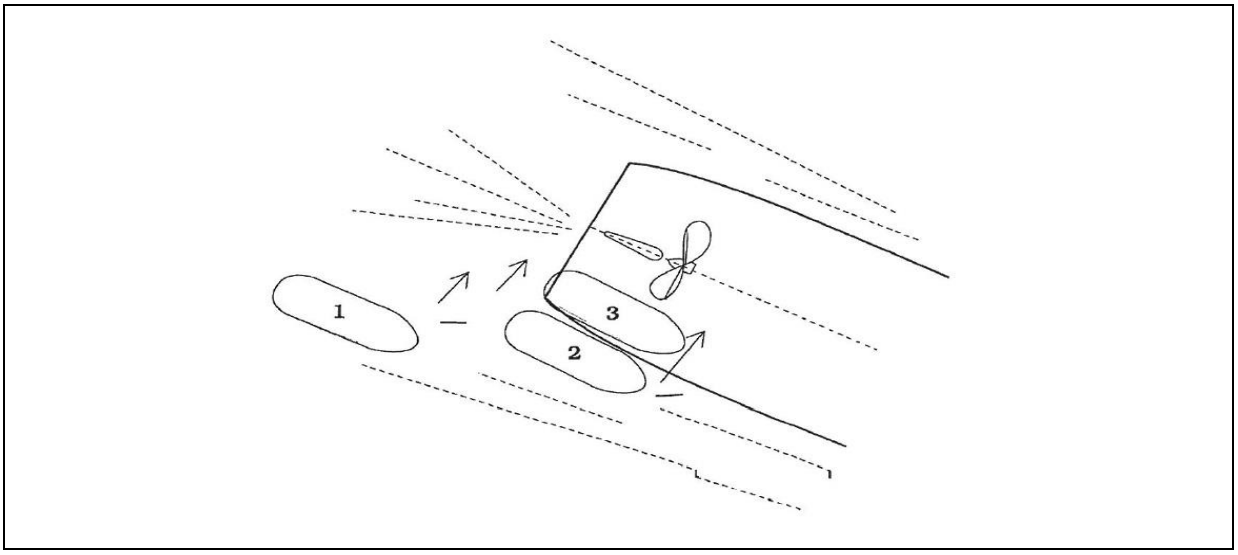

Figure 6: The effect of hydrodynamic forces on a tugboat approaching the stern of a vessel

The skipper of a tugboat coming up from the stern, when in the position No. 1, must expect an unforeseen increase of the tugboat's speed due to reduced resistance of water in the area. If the tugboat skipper does not stop this additional movement immediately, it will most likely be at the ship's side in the position No. 2. When the area of lower pressure is strong, in the event of a delayed response, wrong steering and lack of adequate engine power to depart from the hull of the vessel, the tugboat can be found in the position No. 3 and can be pulled under the overhang of stern and suffer severe damage to the hull and superstructure[8].

The speed of the vessel when approaching the stern should allow the tugboat to maintain its position in the direct propeller race for the time required for safe giving or taking the towline. At higher speeds and larger turbulences behind the stern, tugboats are unstable (they yaw), which poses a threat to the crew of a vessel receiving the towline and to the crew of a tugboat. In addition, the tugboats in the direct propeller race must work with much higher power than it would result from the speed of the vessel. At higher speeds, it might turn out that the power of the tugboat is too small. In each case, 75% of the tugboat power is considered critical and such tugboat should report such fact to the vessel (pilot) and the remaining 25% of power is reserved for emergency and safety maneuvers. When the towline is given and extended the speed of a vessel may become increased again the maximum possible speed of the tugboat. The tugboat is safe now, at its worst it can become an object under tow.

[8] *Ibidem*, p. 133.

A tugboat at a standstill (not moving in relation to water) and waiting for the vessel to pass does not produce areas of varying pressure around itself. Such areas occur only around the vessel passing nearby. In open water (such as the approach fairway to DCT), such interactions are of no practical significance. A tugboat standing at a certain distance from the passing vessel should remain approximately at the same distance after the vessel had passed by.

The situation is different when the tugboat is moving and producing areas of varying pressures around itself. When such areas of the vessel and the tugboat meet, there appear hydrodynamic forces which affect both vessels, while the results of their interactions are much stronger on a smaller vessel.

The tugboat approaching the midship by the converging or almost parallel course with the intention of being overtaken by the vessel to stay behind it, is subjected to the vessel's attracting forces and at the moment of passing from the reduced pressure area along the side to the increased pressure area in the vicinity of the vessel's stern, additionally to the torque in such a way that initially the bow of the tugboat (or its stern, if it approaches with the stern) may suddenly turn towards the vessel[9].

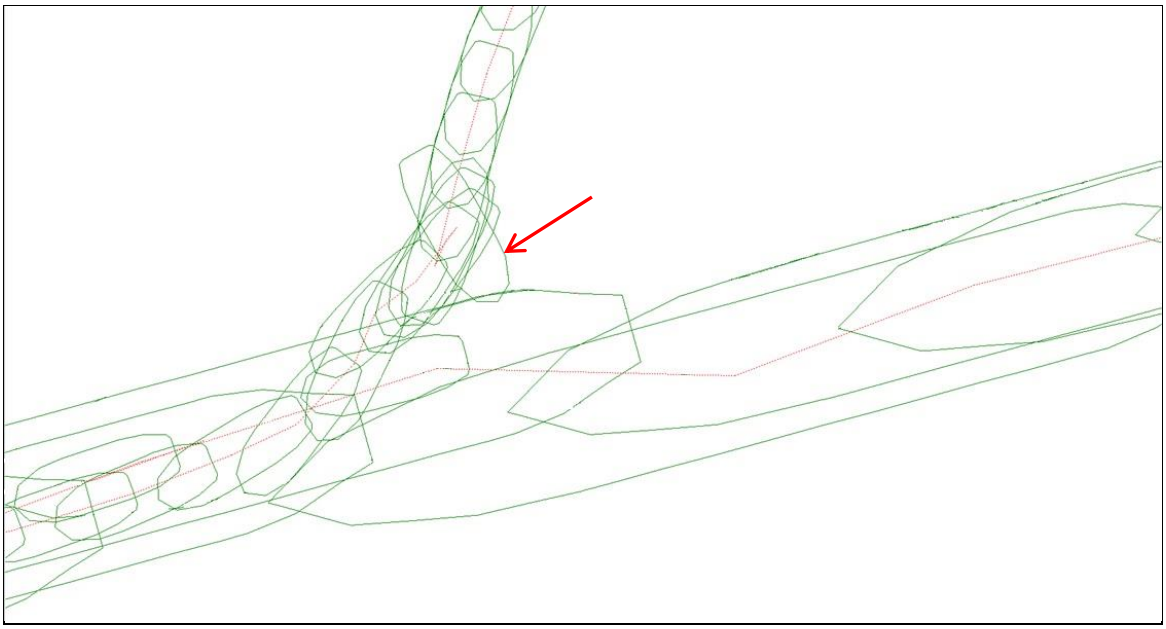

Figure 7: Visualization of the AIS recording of 'Virtus' immediately before the impact against 'Bomar Victory'

[9] The analysis of Figure 8 of the VTS image shows that the vector of movement direction of *Virtus* just before the collision tilted towards the vessel. On one hand this could indicate the hydrodynamic effect, but on the other hand it cannot be ruled out that it was the result of the action of the tugboat skipper.

4.2. Human Factors (fault and neglect)

The tugboat skipper who had received the order to render service for *Bomar Victory* had a 10-years long practice in manoeuvring *Ares*, a tugboat with conventional propulsion. He performed the function of *Virtus* skipper occasionally for about a year before the accident and he had had about 30 individual watches on that tugboat[10].

In the opinion of the Commission, the tugboat skipper wrongly assessed the situation in terms of distance and speed of approaching the vessel. Before commencing the approach to the vessel, the skipper turned the chair on the maneuvering position to face the stern of the tugboat, i.e. in the direction of movement (backwards), which involved changing the manipulators (propulsion controls - power and direction). What was left became right and vice versa, the "maneuvering philosophy" changed. The ATD tugboat became the ASD one from the perspective of the direction of its movement. When the tugboat came too closely to the vessel the situation might have become too demanding for the skipper. The skipper of the tugboat did not have sufficient experience in steering the tugboat with such a propulsion.

In addition, the Commission has considered that the skipper should not have approached the vessel until he had received information from the pilot that the crew of the vessel was ready to take over the towline, and that the speed of the vessel would allow it to be safely given. By that time he should have been moving near the vessel on standby and should not have attempted a risky manoeuver of approaching the stern of a fast-moving vessel to keep up with it and give the towline as soon as possible[11], the more so as he had no information from the pilot that the crew was ready to take the towline.

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[10] To inform how important it is to be experienced in the maneuvering of a two-propeller tugboat like *Virtus*, the Commission quotes fragments of the analysis written by Captain H. Hensen, a pilot with 23 years of experience, the instructor on simulator courses for pilots and skippers and the author of several publications on the use of tugboats: "(...) *it is essential that a tug captain should be experienced with, and should have knowledge of, the situations he may expect during his work (...). But only experience is required for the specific tug a tug captain has under his command, as tugs of a different type vary by design, such as with regard to hull design, rudders and propulsion, Deck and wheelhouse equipment. This applies particularly to azimuth stern drive tugs with their two 360 ° steerable thrusters under the stern and extensive capabilities. After being trained (...) during day-to-day practice a tug captain's experience will increase step by step. A dedicated tug captain will further explore the capabilities of the tug and will learn the operational limits. A well-experienced and capable tug captain of an ASD tug (...) in a large European port was declared, it took him three years before he was fully acquainted with his ASD tug and its capabilities, which shows how important experience is*." (partial underlining of the last sentence was made by the Commission). Henk Hensen, Bow tug operations with azimuth stern drive tugs. Risk and effectiveness. Guidelines for tug captains, ship masters, pilots and tug operators. Nautical Institute 2006, p. 2.

[11] The Commission has noted that in the case of a tugboat with a construction like *Virtus*, when it reaches the vessel with its stern at a speed of more than 8 knots, water coming on board becomes an additional hindrance for people working on a tugboat.

The task of the pilot on the bridge of the vessel entering the port is to assist the master and provide him with information and advice consistent with customs and regulations binding in that port. The speed of the vessel navigating in the fairway to the DCT, which was operated by the pilot was not only too high to give the towline safely but also inconsistent with the permissible speed (7 knots) allowed in the fairway by port regulations.

4.2 Organizational Factors

In the course of investigation, the Commission has determined that in the Polish ports there are no established rules of communication between the vessel (pilot) and the tugboat (skipper) during their cooperation, the location (water area) where the towline is to be given or received is not determined or the speed at which the tugboat is to approach the vessel and do it. In other words, there are no procedures to ensure safe operation of tugboats and their crews while performing towing services.

According to the Commission, it is necessary to establish such procedures, jointly developed by shipowners of tugboats and their skippers and pilots, including the representatives of maritime administration (including such matters as the safety of navigation), which will address such issues as the way the tugboat should approach the vessel in order to give or receive the towline (depending on the type of a tugboat), the recommended water region (regions) where towlines should be given, and the speed of vessels at that time, the range of necessary information exchanged between the tugboat and the pilot on board a vessel, including the speed at which the towline can be fixed, the location and time of approach of the tugboat to the vessel and the time of fixing the towline, the readiness of the crew to receive or give the towline, planned maneuvers and mooring details - would help to improve safety of towing and would highlight important elements of safe cooperation between a tugboat and a vessel.

In addition, the Commission has determined that at the approach to the Port Północny in Gdańsk, vessels navigate in the fairway at higher speeds than permitted by port regulations. Tugboats give towlines with not prior communication with the pilot attempting to complete the operation before entering the port and the officers of the harbour master's office do not pay enough attention to vessels and tugboats moving in water regions of the port and roadstead with forbidden speed.

5. Description of Examination Findings Including the Identification of Safety Issues and Conclusions

In the 1980s, there were launched new types of tugboats with two or sometimes three rotary propeller columns (azimuth propellers) placed in different places under the hulls of tugboats instead of a conventional shaft propeller. Such propellers allow the tugboats to move freely around the hull of a vessel in various directions, irrespective of the position of the tugboat's hull in relation to the hull of the vessel.

Due to the use of a modern type of drive, the tugboat control system has also changed. The skipper who was operating *Virtus* on the day of the accident had many years of experience in conventional tugboats. He had undergone practical training under the supervision of a permanent skipper of *Virtus*, but he himself was in charge of it for just a short time. It is much easier to move from a tugboat with azimuth propellers to the one with conventional propulsion (one screw propeller and a rudder) than vice versa, where the direction and speed are adjusted by means of two manipulators - with both hands and simultaneously, while both the direction and the speed of the tugboat can only be adjusted by setting the direction of propellers or just their revolutions or both parameters at the same time. This kind of maneuvering requires a lot of experience and practice, which the skipper of *Virtus* did not have.

The speed of the vessel which is going to take the towline is essential for the safety of co-operation between it and the tugboat, also due to hydrodynamic forces whose value is difficult to assess. In practice, it is not possible to evaluate these forces and safe distance of the tugboat from the vessel.[12] The Commission does not rule out that hydrodynamic interactions between the vessels could have contributed to the collision, but cannot explain why the tugboat was in such a close zone of these interactions.

[12] A similar casualty, as far as the size of the vessel, the size of the tugboat and the place of damage are concerned occurred in 1998 in Brisbane, Australia between the *Austral Salvor* and the vessel *Barrington*. At a speed of about 6 knots the (approaching from the stern, but at a much smaller angle than *Virtus*) hit the stern of the vessel where the bilge plate starts with its metal fender. For the purpose of analyzing that case, model studies were performed to determine forces and momentums affecting the tugboat and it was determined that the place where the pressure changes was in the vicinity of the stern of the vessel. The change of pressure areas and the associated change in the torque acting on the tugboat occurred at the time when the bow of the tugboat was at the bow of the vessel at a distance of 0.7 lengths of the vessel. The report of the Australian *Marine Incident Investigation Unit* states that at that speed, the width of the zone of hydrodynamic interactions would be between 3.5 and 4 m between the vessels.

Also, the Commission does not exclude a maneuvering error made by the tugboat skipper immediately before the collision. However, according to the Commission, the basic mistake was to bring the tugboat too closely.

The excessive speed of *Bomar Victory* could have contributed to the collision if the vessel (pilot) asked the tugboat to approach its stern to give the towline. But even then, the final decision is made by the skipper and if for whatever reasons he would think that the risk of approach was too great and it posed a threat to the tugboat, he should inform the vessel (pilot) about it.

In the course of investigation of the casualty in the fairway to DCT, the Commission has determined that the skippers of tugboats - not only in the Port of Gdańsk but in all Polish ports - are being prepared for this work by learning from their more experienced colleagues and gradually acquiring the necessary practical knowledge. Such a system does not raise objections, provided that it is complemented with specialist courses on simulators, in particular for skippers of ATD and ASD tugboats provided by specialist centers which also give additional knowledge of hydrodynamic interaction between a vessel and a tugboat, where skippers may have "practical" (i.e. on a simulator) contact with the effect of these forces[13].

Proper communication between the vessel (pilot) and the tugboat is a separate issue having great impact on the safety of the towing service. The investigation of the casualty of *Virtus* showed that in Polish ports there are no procedures and proper communication between a vessel and a tugboat. Neither the place where to give the towline is determined nor the moment of giving it or the speed at which the tugboat should give (or take) the towline. There is a kind of "freedom" that can lead to an accident with far greater consequences than the one that took place on 25 June 2015 in the fairway to DCT in Gdańsk.

The Commission considered that better communication of the skipper with the pilot of the vessel (including the specific location of giving the towline) and appropriate response of the duty officers of the harbour master's office to excessive speed of the vessel (clear violation of speed limits) in the approach fairway could have prevented the collision of *Virtus* with *Bomar Victory*.

[13] Practically all pilots and managers of s know about a phenomenon of hydrodynamic effect but this knowledge is general and derived from theoretical work of managers on courses preparing for the 1st class skipper of domestic navigation without being able to 'feel' that effect, which can only be shown on a simulator.

6. List of Photographs

7. List of Figures

8. Glossary and Abbreviations

B – Beaufort (wind force)

B&W – the producer of ships' engines

COG – course over ground

DCT – Deepwater Container Terminal in Gdańsk

LT – local time

SOG – speed over ground

SW – south-west (wind direction)

UTC – Universal Time Coordinated

9. Information Sources

Notification about the accident

Material from the witnesses interviews

AIS recording from the VTS Zatoka

CCTV recording from the camera in the Port Północny in Gdańsk

Expert opinion made by the master mariner J. Marzec – the sea pilot

Expert opinion made by Innovation Centre of the Maritime Academy of Szczecin under the supervision of W. Ślączka, D. Eng., Professor of the Maritime Academy of Szczecin

10. Composition of the Accident Investigative Team

The team conducting the examination was composed of:

the Team Leader: Marek Szymankiewicz – the Secretary of the SMAIC

the Team Member: Krzysztof Kuropieska – the Member of the SMAIC

the Team Member: Cezary Łuczywek – the Chairman of the SMAIC

Annexes

Annex 1

Safety Card of *Virtus*

0000000638

KOPIA

DOPUSZCZONY DO SAMODZIELNEJ ŻEGLUGI W DROBNYM, LUŹNYM I POKRUSZONYM LODZIE

RZECZPOSPOLITA POLSKA

KARTA BEZPIECZEŃSTWA

Nr **56/GDY/2015**

wydana na podstawie

art. 23 ust. 1 ustawy z dnia 18 sierpnia 2011 r. o bezpieczeństwie morskim (Dz. U. Nr 228, poz. 1368, z późn. zm.)

W IMIENIU RZĄDU RZECZYPOSPOLITEJ POLSKIEJ
przez Urząd Morski w Gdyni

Nazwa statku: **VIRTUS** Armator: **WUŻ Port & Maritime Services Ltd Sp. z o.o. - GDAŃSK** Sygnał rozpoznawczy: **S P K N**

Port macierzysty: **Gdańsk** Nr rejestru: **PRS-210188** Klasa: *** KM TUG II L 3**

Typ statku: **holownik** Materiał: **Stal**

Rok budowy: **17.01.2009** Stocznia: **Gdańska Stocznia Remontowa SA, Gdańsk**

Pojemność brutto: **334.00** Pojemność netto: **100.00** Nośność: **519.02 t**

Długość całkowita: **30.00 m** Długość między pionami: **28.36 m**

Wolna burta: **859.00 mm** Wysokość boczna: **3.95 m** Zanurzenie maks.: **2.70 m**

Szerokość: **10.50 m** Liczba grodzi wodoszczelnych:

Napęd: (liczba, typ, moc [KW], nr fabryczny, powierzchnia i rodzaj ożaglowania):
2 silniki spalinowe Caterpillar o mocy 2 x 1765 kW

Urządzenia radiokomunikacyjne i radionawigacyjne:
Patrz: Wykaz Wyposażenia do Certyfikatu Bezpieczeństwa Radiowego
radar, AIS

Stanowisko	Dyplomy lub certyfikaty / Liczba osób	
	żegluga reda / VTS	żegluga
Kapitan	szyper kl. 1 ż.k.	
Oficerowie pokładowi		
Starszy mechanik	2 of. mech. 750-3000 kW	
Oficerowie mechanicy		
Radiooperator	SRC	
Marynarze pokładowi	2 x marynarz wachtowy	
Motorzyści		
Inni		
Minimum / Maksimum	4	

Środki ratunkowe (liczba sztuk/osób)				
- łodzie ratunkowe		dla		osób
- łodzie ratownicze		dla		osób
- tratwy pneumatyczne	1	dla	4	osób
- tratwy sztywne		dla		osób
- koła ratunkowe	2	dla	-	osób
- pasy ratunkowe	6	dla	4	osób
- kombinezony ratunkowe	-	dla	-	osób
- łącznie dla			4	osób
- wyrzutnia linki ratunkowej				
Dopuszczalna liczba pasażerów				
- w żegludze portowej				osób
- w żegludze osłoniętej				osób
- w żegludze przybrzeżnej				osób
- w żegludze krajowej				osób
- w żegludze międzynarodowej				osób
Łączna liczba pasażerów i załogi				
- w żegludze portowej				osób
- w żegludze osłoniętej				osób
- w żegludze przybrzeżnej				osób
- w żegludze krajowej				osób
- w żegludze międzynarodowej				osób

Inne wymagania i warunki: W rejsach powyżej 12 godzin kierownik jednostki i kierownik maszyn muszą mieć zastępców.

NINIEJSZYM STWIERDZA SIĘ, że wyżej wymieniony statek został poddany inspekcji i dopuszczony do uprawiania żeglugi jako:
holownik

w żegludze portowej z wyjściem na redę w granicach VTS przy sile wiatru - °B i stanie morza - (wysokość fali -m)

w żegludze przy sile wiatru °B i stanie morza (wysokość fali m)

Został/nie został* wydany certyfikat zwolnienia

Niniejsza karta ważna jest do dnia: 2019-01-16

Niniejsza karta traci ważność, jeżeli statek zostanie uszkodzony lub nastąpią zmiany konstrukcyjne zagrażające jego bezpieczeństwu lub w przypadku braku rocznego potwierdzenia w okresie od 3 miesięcy przed upływem daty rocznicowej karty do 3 miesięcy po upływie tej daty

Wydano w:

Gdynia, 2015-02-17

Miejscowość, data

URZĄD MORSKI w GDYNI

Pieczęć

Z up. DYREKTORA URZĘDU MORSKIEGO W GDYNI
inż. kpt. ż.w. Zbigniew Wyganowski
Główny Inspektor
Inspektoratu Państwa Bandery (FSC)

1/3

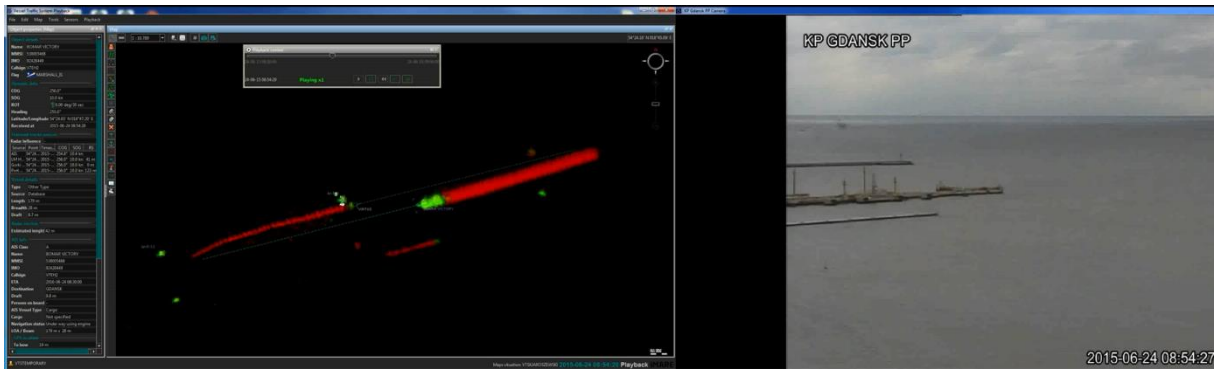
* Niepotrzebne skreślić

Kwituję odbiór oryginału i kopii
Gdynia, dnia 20 02 2015

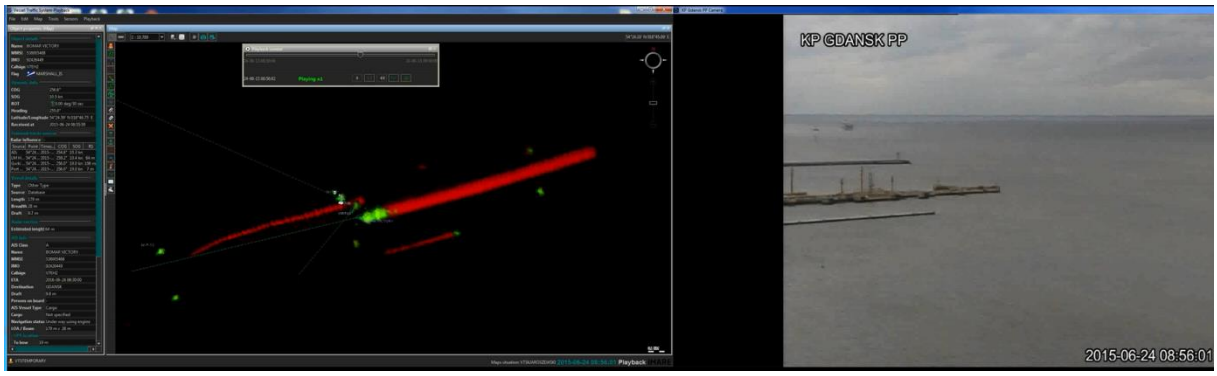
Annex 2a

Screen dumps from the monitor of the duty officer of the Harbour Master's Office in Gdańsk in the Port Północny

08:50:50: *Virtus*, having passed a pair of buoys "P13"-"P14" is heading towards *Bomar Victory* approaching a pair of buoys "P5"-"P6"



08:56:26: *Virtus* is passing by a buoy "P9". *Bomar Victory* is found between a pair of buoys "P5"-"P6" and a pair of buoys "P9"-"P10"



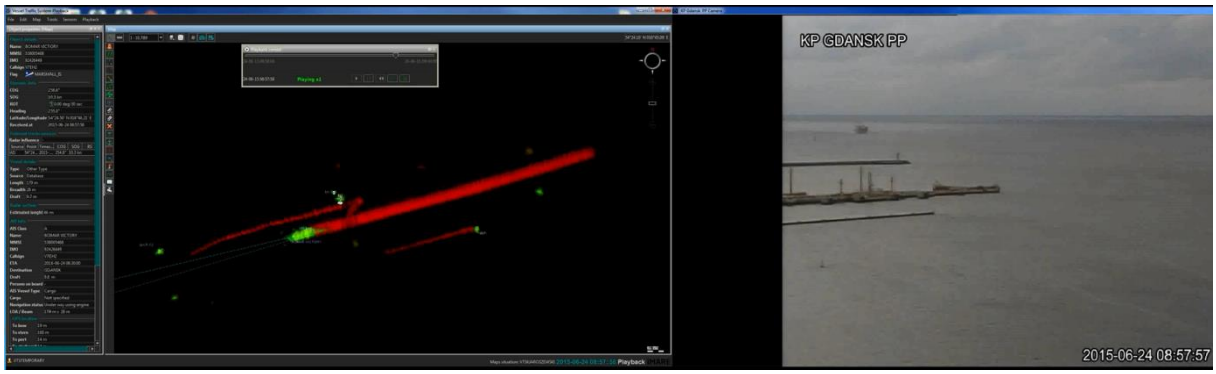
08:56:01: *Virtus* stops and then starts approaching *Bomar Victory*

Annex 2b

Screen dumps from the monitor of the duty officer of the Harbour Master's Office in Gdańsk in the Port Północny

08:56:26: *Virtus* is coming up the side of *Bomar Victory*

08:56:33: the moment of impact of *Virus* against the side of *Bomar Victory*



08:57:57: *Virtus* navigating in the wake of *Bomar Victory*

Annex 3

Stages of changes in the construction of tugboats and types of their propulsion

1830 - First Paddle tug in service

1900 - Screw tugs take precedence over paddle

1900 – 1950 – Tug design concept refined but little fundamental change

1955 - Voith introduce the first water tractor.
- Steam and diesel tugs built in UK
- Kort nozzle gaining popularity

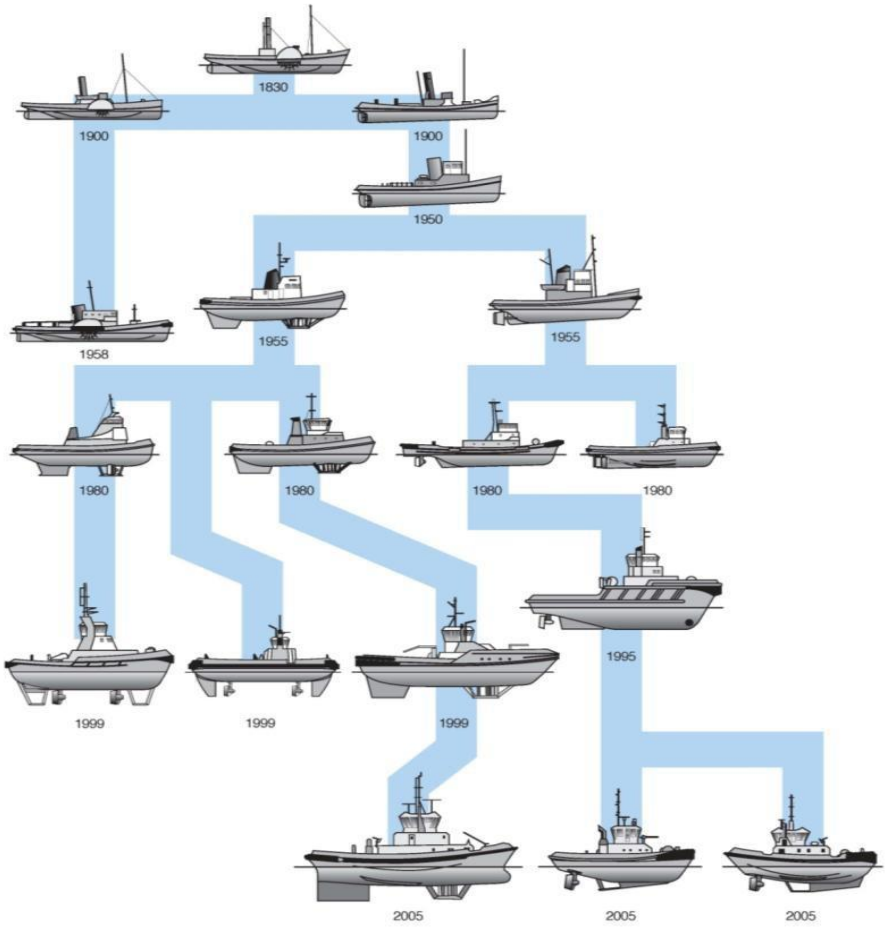
1958 - 7 diesel-electric paddlers for RMAS

1980 – Voith twin unit tractors well established
Azimuth tractor compete with Voith
First ASD tugs introduced in UK
Use of Kort nozzles universal

1996 - Purpose built ASD escort tugs introduced

1999 - First 'Rotor tug' in service
First 'Ship Docking Module' in service
Voith escort tugs in service

2005 - Voith escort tugs refined
High performance 'Compact' ASD tugs gain popularity Z-TECH tugs in service



Source: Jack Gaston, *Tug development, past, present & future*, International Tugmasters Associations, 2014.