Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Ministry of Transport
Building and Urban Affairs

Investigation Report 476/06

Serious marine casualty

Collision between MV SVEN and MV COMET on 18 November 2005 in the port of Hamburg

15 March 2007

The investigation was conducted in conformity with the law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law - SUG) of 16 June 2002.

According to this the sole objective of the investigation is to prevent future accidents and malfunctions. The investigation does not serve to ascertain fault, liability or claims.

The German text shall prevail in the interpretation of the Investigation Report.

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1 Summary of the marine casualty

On 18 November 2005 at 10:22 h[1] the Container Vessel COMET coming from Bremerhaven collided with the Container Vessel SVEN in the Vorhafen in Hamburg shifting from “Waltershofer Hafen” to “Ellerholzhafen”, just as COMET was about to berth at the “TOLLERORT”-Terminal and was turning in front of the “Werfthafen” for berthing (see Fig. 1). Dense fog prevailed at the time of the accident. Both vessels were sailing under shore radar advisory services. A harbour pilot was also on board SVEN. Property damage was sustained by both vessels in the way of the bulbous bow. Both vessels were able to continue their voyage to their intended berths. After completion of the loading and discharge works the vessels shifted to Norderwerft shipyard for repair.

[1] All times in the report CET = UTC +1h.

2 Scene of the accident

Nature of the incident:	Serious marine casualty, collision in secondary side channel
Date/time:	18 November 2005, 10:22 h
Location:	Vorhafen in Port of Hamburg
Latitude/longitude:	φ 53°32.4' N λ 009°57.1' E

Section from Sea Chart 3010, sheet 12, edition 2006,
Federal Maritime and Hydrographic Agency (BSH)

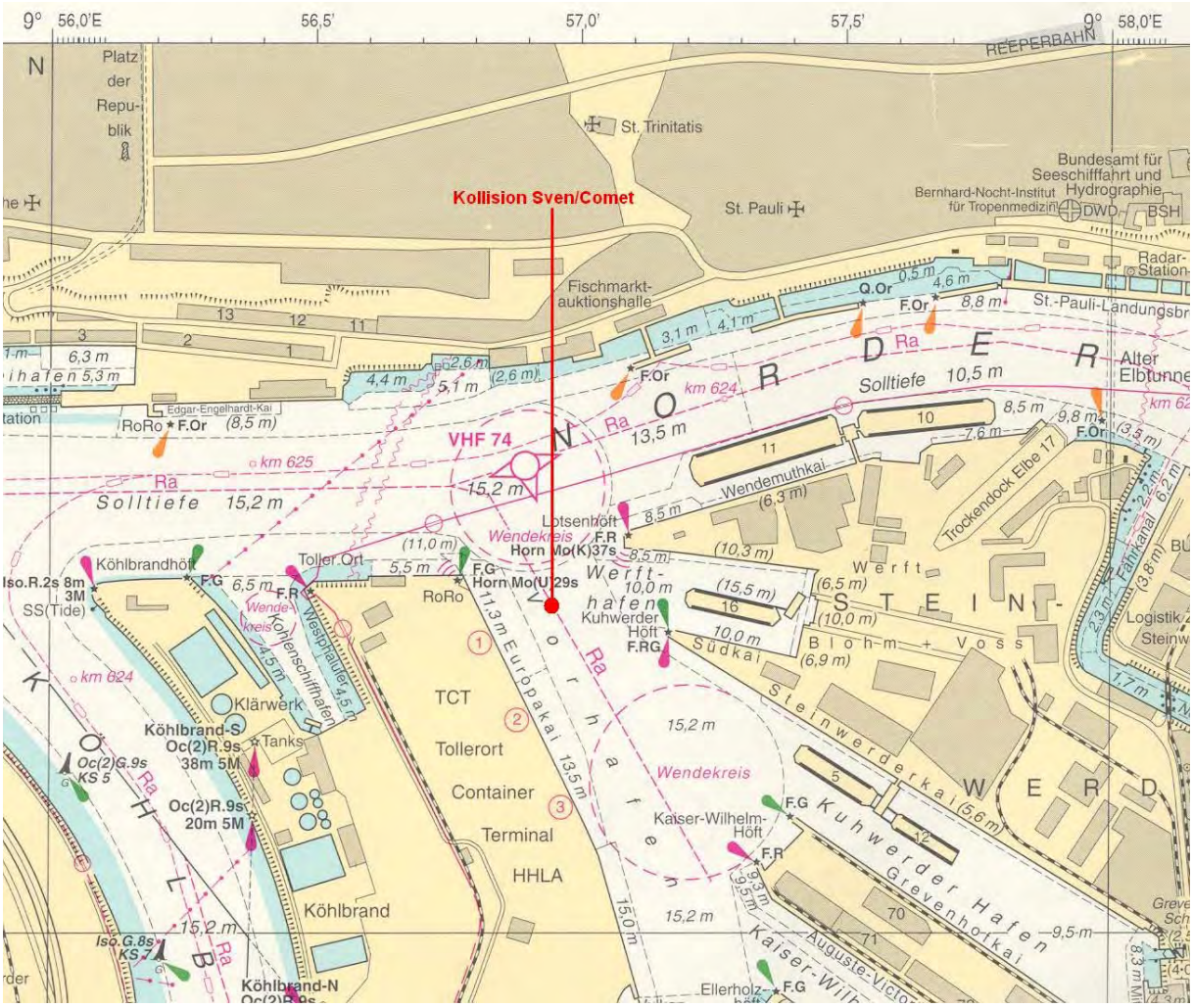


Fig. 1: Chart

3 Vessel particulars

3.1 Photo SVEN

Fig. 2: Photo of Vessel SVEN

3.1.1 Particulars SVEN

Name of vessel:	SVEN
Type of vessel:	Container vessel
Nationality/Flag:	Germany
Port of registry:	Hamburg
IMO Number:	9134139
Call sign:	DGGW
Vessel operator:	MS SVEN Wilfried Rambow KG
Year built:	1996
Building yard:	J.J. Sietas KG Schiffswerft GmbH & Co
Classification society:	Germanischer Lloyd
Length over all:	121.35 m
Width over all:	18.20 m
Gross tonnage:	6,362
Deadweight:	6,800 t
Draft at the time of the accident:	F: 4.85 m, A: 5.80 m
Engine rating:	5,300 kW
Main engine:	MAN B&W 8L 40/54
Speed:	16.5 kn
Hull material	steel
Number of crew	11

3.2 Photo COMET

Fig. 3: Photo of Vessel COMET

3.2.1 Particulars COMET

Name of vessel:	COMET
Type of vessel:	Container vessel
Nationality/Flag:	Germany
Port of registry:	Hamburg
IMO Number:	9183415
Call sign:	DPGI
Vessel operator:	MS COMET Gebr. Winter Reederei-gesellschaft mbH & Co. KG
Year built:	1998
Building yard:	J.J. Sietas KG Schiffswerft GmbH & Co
Classification society:	Germanischer Lloyd
Length over all:	101.16 m
Width over all:	18.20 m
Gross tonnage:	3,999
Deadweight:	5,300 t
Draft at the time of the accident:	F: 5.20 m, A: 6.00 m
Engine rating:	3,825 kW
Main engine:	Deutz MWM Motoren-Werke Mannheim AG TBD 645 L9
Speed:	15.3 kn
Hull material:	steel
Number of crew:	10

4 Course of the accident

On 18 November 2005 the Feeder Vessels SVEN and COMET collided in fog in the "Vorhafen[2]" of the port of Hamburg. COMET was coming from Bremerhaven and turning in front of the yard dock as SVEN was coming into the "Vorhafen" from the Norderelbe.
At 10:00 h SVEN cast off from the Waltershofer Hafen, Predöhlkai, to shift to wharf 77, Ellerholzhafen. At about 10:20 h SVEN turned over starboard into the Vorhafen. At the same time COMET was about to turn over starboard in the Vorhafen in order to go alongside with her port side at berth No. 3, Container Terminal TOLLERORT, on the west side of the Vorhafen. Visibility was 50 to 100 m. At 10:22 h the two vessels collided with their bows, roughly on the radar line shown in the chart. The bulbous bow and bulwark on both vessels (see Fig. 4 and Fig. 5) were damaged without any personal injury or environmental damage being sustained. Both vessels subsequently made fast at their intended berths. There they were inspected by the Water Police and Germanischer Lloyd and subsequently shifted to the Norderwerft repair yard.

Fig. 4: Bow damage COMET

Fig. 5: Bow damage SVEN

The bridge of SVEN was manned by the Master, the Chief Mate and the pilot. A deck hand was on the forecastle as lookout and two further deck hands were assigned on duty. The Master was operating the vessel from the conning position. From this position he could steer and manoeuvre the vessel and observe the radar display and the image on the electronic chart. The radar unit was set to operating mode NORTH UP, TRUE MOTION, and a range of 0.5 nm. The advising pilot was in front of the second radar set that was defective and not ready for operation, and he took over the radio traffic via VHF channels 7, 19 and 74. Channel 74 was for port radio and the other channels reserved for shore radar advisory services.

[2] According to the sea chart this is the designation of the port basin in front of Container Terminal TOLLERORT; in practice it is also known as Kuhwerder Vorhafen.

COMET was proceeding under the command of the Master in charge. The bridge was also manned with the Chief Mate. The second mate was on the forecastle as lookout. As on board SVEN, the Master was able to operate all the running elements from the conning position and observe the images on the radar unit and the electronic chart. Both radar sets were in operating mode NORTH UP, RELATIVE MOTION and set to a range of 0.5 nm and 1.5 nm respectively. The Master also operated the VHF channels for port radio and shore radar advisory services.

5 Investigation

The Masters in charge on the bridges of COMET and SVEN at the time of the collision had many years of experience and were exempted from the obligation to take pilots on board in the port of Hamburg in the areas relevant for their vessels. At visibilities of less then 2000 m and 3000 m respectively west of Seemannshöft they had to use radar advisory services. The navigational officers on watch and the Masters of both vessels had certificates of competence in accordance with the ship's minimum safe manning document according to STCW at management level.

Both vessels were built at the Sietaswerft yard in Hamburg and have a similar bridge design (see Fig. 6), as well as similar manoeuvring characteristics with a left-hand variable pitch propeller, Becker rudder and bowthruster. Both Masters were steering their vessels from the starboard conning position and were able to vary their speed well with the variable pitch propellers.

Fig. 6: Bridge SVEN with conning position (windbreaker jacket)

On 18 November 2005 low water at Hamburg St. Pauli had been calculated for 12:57 h. The rudders have a better efficiency with counter current due to the oncoming flow running with the current or without any current. The speed of SVEN was appropriate to the conditions on entering the Vorhafen. On board COMET the turning and berthing manoeuvre was, on the one hand, more difficult because of the adverse visibility conditions, but, on the other hand, was facilitated by the fact that there was no wind. The Master on board COMET other than the Master of SVEN was additionally engaged in radio traffic and turning the vessel. Both Masters were navigating by radar and the electronic chart (ECS). Differing from the situation on board SVEN, on the ECS screen of COMET it was possible to display the targets of the automatic vessel identification system (AIS). SVEN only had a separate display of the AIS target on the so-called minimum keyboard display (see Fig. 7).

Fig. 7: AIS installation SVEN

Both Masters and the Chief Mate of COMET stated that the vessels could only be detected as a radar target in the Vorhafen. On board COMET the crew was already at the berthing stations, i.e. the Chief Mate was in the bridge area and at the radar set, the second mate and a deckhand were on the forecastle, and the bosun with two seamen was astern. The Chief Mate of SVEN was assigned as lookout, moved between the bridge wings and was in contact with the lookout on the forecastle via hand-held radio, where there were two other seamen.[3] The pilot was on the port conning position in front of the defective port radar set of SVEN and in addition to advising the vessel command was engaged in radio traffic service with the Vessel Traffic Center and other vessels.

[3] After analysing the time sheets, no times of the Second Officer and one seaman were recorded on at least one vessel at the time in question (see also Section 5.4 Time sheets).

After casting off from Predöhlkai at about 10:00 h, SVEN proceeded eastwards at changing rates of speed and at a distance of approx. 70 m from the south shore of the Elbe River. COMET could be heard via VHF and stated that it was turning in the Vorhafen and would go to CTT 3. At this time SVEN was nearby Athabaskahöft.

When SVEN was close to Kohlenschiffhafen, the Vessel NORDERTOR reported that it proposed to sail out of Kuhwerderhafen, crossing the Vorhafen into the Elbe River. "Red to red passage"[4] was agreed with this vessel. On passing the Kohlenschiffhafen the pilot on board was informed by the radar advisor that COMET was going to turn in the Vorhafen. The pilot on board thereupon called COMET via VHF, which announced a turning manoeuvre in the Vorhafen off CTT3 in order to make fast there.

Passing TOLLERORT the distance to the south shore of the Elbe River was approx. 40 m and the operating lever with a counter-running ebb current was at a pitch of about 40 %. On turning into the Vorhafen the propeller pitch was reduced to 20 % and the vessel proceeded closely round the TOLLERORT quay so that SVEN could keep clear of NORDERTOR.

As COMET had announced that it would be turning in front of berth CTT 3, SVEN subsequently kept bearing in the direction of the middle of the Vorhafen, intending to pass COMET on the east behind its stern. Suddenly an echo with course SSW became visible on the radar screen just on the starboard side. The echo was approximately on the SSE radar line. To identify the echo the pilot on board called COMET, who thereupon confirmed that it was the subject vessel. The pilot on board then notified COMET that SVEN wanted to pass in front of its bow on the CTT side. COMET confirmed this and stated that it would remain at its position.

At the same time an attempt was made to turn SVEN clear from COMET by putting the helm hard to starboard and increasing the pitch to 50 %. At about 10:22 h the forward top light of COMET came into sight right ahead in the fog. Directly after this there was contact between SVEN and COMET. There were no injuries and apart from the property damage to the bulbous bow the vessel was in a water-tight condition. The pilot informed the VTS Hamburg Port and SVEN was able to continue its voyage to the berth wharf 77 in Ellerholzhafen. No traffic assistance was required on board COMET.

[4] "Red by red passage" means that the two vessels will pass on their port sides.

COMET had left Bremerhaven at 01:20 h on 18 November 2005. The Master was the officer in charge on the bridge up to Hamburg, following a sufficient period of rest[5]. He was exempted from the obligation to take a pilot on board on the Elbe River. Since gaining exemption, he had steered for the port of Hamburg without a pilot on board about 80 times and had in each case shifted berth 4 to 6 times within the port.

At Rhinplate on the Elbe River visibility deteriorated to between 60 m and 150 m. That was why the Master had asked the VTS for radar advisory services. From about the time of passing the Hamburg port boundary, the Chief Mate had been on the bridge with him and had occasionally gone outside to obtain a better overview. The Master was at the starboard conning position and reported several times via VHF to the VTS and radar control. He knew that SVEN was there, but had no direct VHF contact with the vessel until he reached the Vorhafen. He had announced via VHF that he would be turning over starboard in the Vorhafen and making for the proposed berth CTT 3.

According to the statement of the Master, the starboard turn was initiated solely by changing the propeller pitch to astern. When the vessel was not moving ahead any more, the pitch was set to ZERO. After this a slow, constant turn was achieved with helm hard to starboard and the bow thruster. Dense fog prevailed and only the forward mast at a distance of 60 m was visible. The port facilities could not be seen from the bridge. In addition to the sensor information of the navigation facilities, the Master had received reports from his nautical officers and was standing in direct VHF contact with SVEN in the Vorhafen. The Second Officer, according to his statement, was on the forecastle during turning, and had, at that time, reported distances of about 50 m to the CTT, whereby visibility was also estimated to be 50 m.

From outside on the bridge wing the Chief Mate reported that they were close to Kuhwerderhöft. At this time the course steered was about 210° to 230°, in other words almost crossways to the Vorhafen, and according to the electronic chart COMET was always on the eastern side of the Vorhafen with a slight astern movement. During the turn up to the time of collision SVEN was not visible as a clear echo on the radar screen. No fog signals could be heard. There were no reports from the radar control during the berthing manoeuvre. Only the Second Officer on board COMET reported via VHF on channel 17 that there was suddenly a vessel 30 m to 40 m away.

Seconds later a shadow could be seen from the bridge and subsequently the collision was felt. The collision came as a surprise for COMET. The Second Officer reported from the forecastle that COMET had been hit front on in the bow area and there were no injured persons. Only damage to the bulwark and the bulbous bow had been sustained. Then, after SVEN had passed the bow of COMET, the starboard turn was not continued, but instead the vessel was made fast at CTT with its starboard side using a propeller pitch of 20% to 40% in order to simplify the berthing manoeuvre and not start any new turn. At 11:00 h all mooring lines were fast and the position was reported to the VTS.

[5] See here time sheets, pages 23 – 25, and Analysis page 26.

5.1 Vessel Traffic Center Port of Hamburg

The Vessel Traffic Center (Nautische Zentrale), consisting of the Port Operations Office[6], the Vessel Traffic Service[7] and Radar Control[8] Room ensures the safety and ease of shipping traffic – including the feeder traffic. At the time of the accident it was staffed with two persons each. In order to optimise agreements between wharf operations, brokers, feeders and the other participants even further, a Feeder Logistics Centre (FLZ) is being built up under the coordination of the wharf operations. The FLZ supports the terminals in their stowage plan preparation, the work procedures during loading and discharging, and should thus make work procedures more fluid. The objective is to coordinate the feeder traffic in the port - including pilot assignments - even better between the participants and thus to avoid waiting times in the port.

Under the Hamburg Port Traffic Regulations, sea-going vessels must make position reports in German on VHF channel 74 stating their name, size and route when entering and leaving, as well as when shifting position in the port. Furthermore, berthing and casting off as well as passing of the state boundaries must be reported to Hamburg Port Traffic on VHF channel 14. The vessels must always be ready to receive calls on VHF channel 74. The Nautical Officer on Duty (NvD) in the Vessel Traffic Service notifies the port pilot station when visibilities west of the port pilot station are < = 3,000 m or < = 2,000 m in the area of the port, or on request by shipping, when pilots have to man the RCR to provide additional shore radar services for the shipping.

The incoming CMV COMET, holding a PEC, was scheduled for berth CTT 3 (Container Terminal TOLLERORT) and intended to turn over starboard in the Vorhafen. CMV SVEN had left its berth at Predöhlkai at 10:00 h in order to shift to Ellerholzhafen, wharf 77. Because of the poor visibility conditions the Radar Control Room was manned with two pilots and both vessels participated in the radar shore services. The communication between the NvD and radar pilots is carried out via an intercom system, by telephone and direct contact, as the Radar Control Room is located in a side room of the Vessel Traffic Service and the spatial distance is not more than 5 m. The spatial separation between the Vessel Traffic Service and RCR was selected deliberately in order to avoid disturbances between the two services by radio traffic on different VHF channels. It has proved to be successful that all conversations on the six radar channels in the Radar Control Room are transmitted not only to the headset at the relevant pilot workplaces, but also via loudspeaker, and

[6] The Port Operations Office (Hafenbetriebsbüro) is responsible among other items for berth management, reporting for waste oil disposal, agreements on tide windows of deep-draft upcoming, shifting and departing vessels and for issuing bans on departure for sea-going vessels.

[7] Tasks of the Vessel Traffic Service (Verkehrszentrale) supervision and regulating of shipping traffic in the port of Hamburg, handling radio traffic of the coastal radio station and the port radio service, identifying vessels that must report in the port radar system, publishing nautical warning news, shipping police orders, traffic situations and emergency announcements.

[8] The Radar Control (Radarzentrale) is staffed exclusively with port pilots on request by the Vessel Traffic Service, chiefly in cases of reduced visibility within the framework of traffic support in accordance with § 2 Para. 1 No. 24 SeeSchStrO (German Traffic Regulations for Navigable Maritime Waterways). These advise vessel commands on navigation in the port of Hamburg via reserved VHF channels.

at the same time with optical indication of the channel being used, as it frequently happens, that for example, the vessels call the radar pilot on a wrong VHF channel. Thanks to the optical indication the radar pilots hear the call of the vessel and at the same time can see on which channel it is calling, so that the vessel can be contacted. Also at the Vessel Traffic Service the staff focuses on listening to VHF channels 14, 74 and 16 and depending on the circumstances, additional further work channels are read, as well as the service radio of HPA (Hamburg Port Authority). If the two services were spatially placed together, it would, because of the excess noise level, no longer be possible to listen to all channels at the same time, which in turn would reduce safety.

The NvD must conduct continuous observation and evaluation in the Vessel Traffic Service in order to ensure a general overview in the port. From the analysis of the situation in the area of the middle freeport, at the time of the accident the Nautical Officer on Duty could not see any disturbance or danger that would have made an uninterrupted observation necessary, especially since both vessels were receiving radar advice on VHF channel 19. The NvD usually refrains from transmitting advice to vessels using the shore radar services - where there is no fault or danger - as continuous observation and information are provided by the port pilot in the Radar Control Room. The NvD, however, would be authorised to release shipping police orders, to interrupt the radio traffic of the radar pilots and to commission them e.g. with the task of transferring announcements to the vessels if necessary. The two vessels in this case had agreed on what they planned to do on VHF channel 74. Taking into account the constant radar service for both vessels there was no reason for the NvD to conduct an uninterrupted observation of the passage.

The 13 land radar stations in the port of Hamburg (each with double transmission/reception facilities) allow uninterrupted recording of shipping movements. At present altogether ten workplaces are available for the Vessel Traffic Service, the radar control and for service purposes. 50% of the workplaces can also show VTS [9] or AIS tracks in addition to the actual radar echo. The planning provides for further expansion of shipping control technology and the Data Network System DV - Elbe in the years 2006/2007. Up to the end of 2007 all workplaces will support 'mosaic'-working and tracking indication[10]. The existing magnetic wall chart to visually display the berth allocation will be replaced by an electronic traffic situation visualisation[11] to improve the overview. Furthermore, in addition to the existing VTS, a redundant emergency VTS will be set up elsewhere that can take over the function of the actual VTS at any time.

Due to the large number of radar stations there is a desired overlapping of the individual transmission/reception areas. Thereby the targets can be observed from several radar stations. The area in question here is mainly covered by the radar station Ellerholzhöft. However, the radar stations Altona and St. Pauli also partly

[9] Vessel Traffic Services/Schiffsverkehrsdienste
[10] This technology offers the possibility of being able to identify traffic participants at any time and to structure the radar image at the workplace in accordance with the needs of the radar observer.
[11] It is not yet clear when the traffic visualisation will be introduced as some detailed technical problems are yet to be solved. It was observed that deflection of the AIS signals occur in individual port areas that thus lead to imprecision in the display.

cover this area. The radar image information is represented as a radar echo with a precision of distance measurement of 10 m, a radial resolution of 15 m, and an azimutal resolution of 0.6° at a probability of 95% of the measured values.

In addition AIS or VTS tracks can be displayed (see Fig. 8 and Fig. 9). Due to the interface with DV-Elbe, the VTS tracks are also linked with the data set of the relevant ship's data and shown on the VTS display of the Control Centre. Vessels that send an AIS signal are automatically displayed on the radar screens with an AIS track that permanently displays the vessel name and the system number. According to the findings of the Vessel Traffic Center, the reliability of the AIS data received frequently does not meet requirements. Insufficient installation regulations, lack of acceptance tests of AIS transponders on board or system faults can lead to transmission or receiving of wrong information (see Fig. 8 footnote[12]). Inaccurate AIS tracks are deleted by the nautical operating staff and can be replaced by VTS tracks. All tracks are subject to continuous surveillance by the NvD. The radar signal processing system offers the possibility of calling up time/path diagrams. This function, however, is only used in special cases because in the port of Hamburg course and speed data constantly change and due to shipping traffic collision warnings would be permanently given. To avoid this, it would be necessary to switch to a very small range that would be unsuitable for the actual purpose of collision warnings.

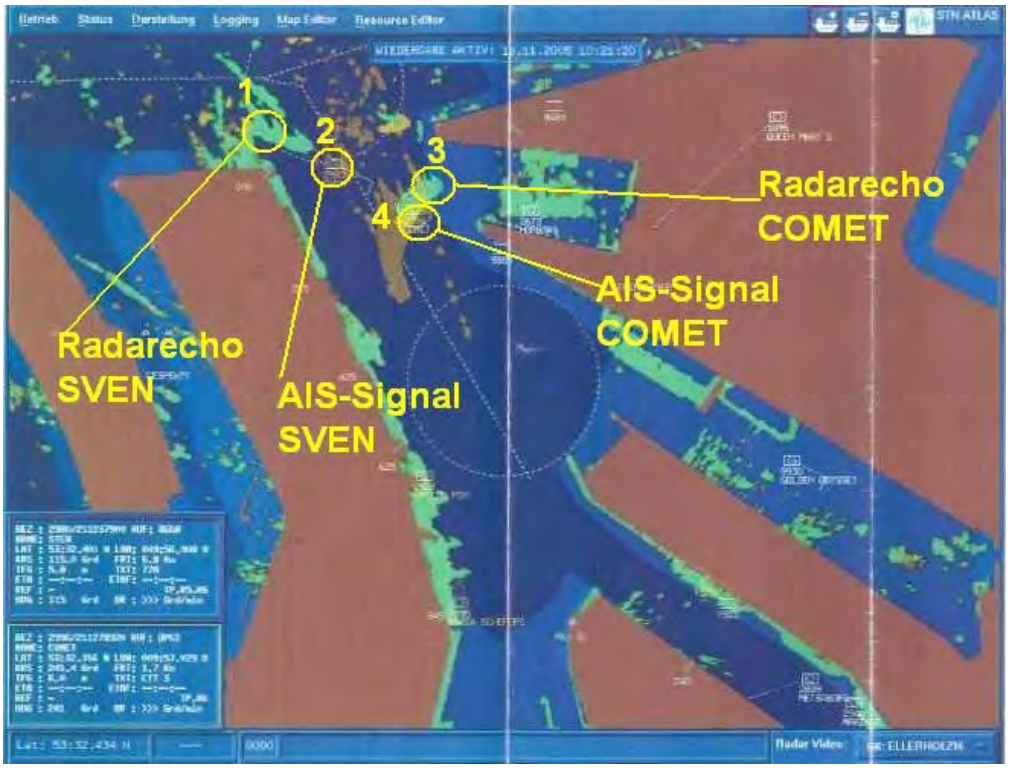


Fig. 8: Radar plot of the Vessel Traffic Service at 10:21:20 h [12]

[12] The AIS signal on SVEN does not coincide with the radar echo. This is a system error that is currently being investigated. There appear to have been no system and configuration faults of the AIS system on board SVEN and COMET (cf. Fig. 10 and 11 ECS records COMET with the radar plots of the Vessel Traffic Service).

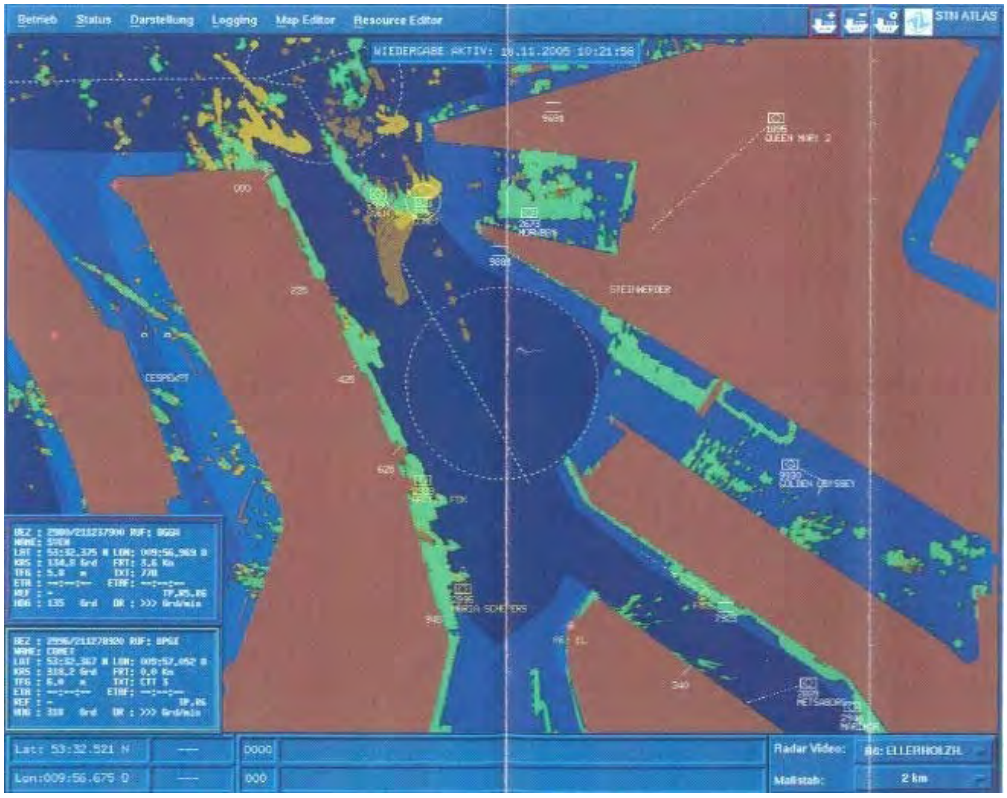


Fig. 9: Radar plot of the Vessel Traffic Service at 10:21:56 h

According to the records on channel 74, COMET passed the Parkhafen at 10:02:26 h and SVEN reported at 10:04:54 h that she had left her berth in Parkhafen. At 10:08:20 h COMET reported passing buoy 135/KS1 at the entrance to Köhlbrand. At 10:14:01 h SVEN reported that she was passing the berth Athabaska 10 and going upwards to the Vorhafen. This location lies about 300 m west of the entrance to the Köhlbrand. At 10:17:11 h SVEN passes the Kohlenschiffhafen and has radio contact with NORDERTOR, she is leaving Kuhwerder Hafen, and with COMET. Here the following conversation was recorded literally: COMET: „Ich bin gerade am Drehen. Ich bin halbwegs vor meinem Platz. Ich bin gerade am Drehen, noch.“ (COMET "I am just turning. I am half way in front of my place. I am still just turning".) SVEN: „Welcher Platz ist das bitte?“ (SVEN: "What place is that, please?") COMET: „Ich geh‘ auf 3, geh ich.“ (COMET: "I am going to 3, going.") SVEN: „Ah ja, okay.“ (SVEN: "Ah yes, okay.") At 10:20:50 h SVEN reports that she is turning into the Vorhafen and has radio contact with COMET (wörtlich: COMET, sind Sie das da vor dem Werfthafen am Drehen?” (literally: "COMET, are you that turning in front of the Werfthafen?") After this COMET reports that she is turning, will remain in her position, and SVEN reports that she will go past by CTT 3. At 10:23:52 h COMET reports that it has been pushed into the Werfthafen.

The recordings on channel 19 show that at 10:00:16 h SVEN reports to the pilot in the Radar Control Room that she is departing from Predöhlkai berth 6, turning over port, and announces that she is shifting to wharf 77 (Ellerholzhafen). The radar pilot informs her that there is no movement in Waltershofer Hafen and that the next vessel coming up, COMET, is under radar advice close to Bubendey pier. The Radar Control Room reports further shipping traffic at 10:08:26 h (vessel coming up at buoy

135/KS1, small vessel from the Köhlbrand and at 10:10:46 h IJSSL DELTA 100 m north of the radar line Neumühlen). At 10:14:38 h COMET reports that she still has to turn over starboard and ahead. The radar pilot calls at 10:18:14 h and asks whether SVEN has agreed with COMET. SVEN replies at 10:20:11 h that everything is clear with COMET. According to the radio recordings on channel 19 it is reported that a collision occurred between SVEN and COMET at 10:23:07 h. At 10:26:51 h COMET is in the Werfthafen and SVEN off berth CTT2. The vessels are both in dense fog and not visible for each other.

According to the recordings on channel 7 at 10:03:46 h COMET is off Parkhafen and at 10:04:58 h off the berth Athabaskakai No. 8 (ATA 8). At 10:11:07 VERONA is advised to remain northerly, while SVEN is identified as an upcoming vessel on the radar line off ATA 8. At 10:12:19 h SVEN keeps south of the radar line, while COMET enters the Vorhafen. NORDERTOR runs well past COMET to the east at 10:17:04 h. SVEN is just at the Köhlbrandhöft. NORDERTOR is advised before it proceeds into the Elbe main fairway to coordinate with SVEN. At 10:17:57 h SVEN has reached the Kohlenschiffhafen.

5.2 Electronic chart

BSU was able to download and evaluate the COMET data. SVEN had an ECS system installed that had no external data interface. Therefore ECS data from SVEN could be saved. The certificate of exemption to set up and test the system had expired since 1997.[13] In Fig. 10 it is apparent that SVEN entered the Vorhafen with a speed over ground (SOG) of 6.8 kn, while COMET was east of the radar line displayed and an SOG of 0.7 kn is shown. One minute later (see Fig. 11) shortly before the collision a speed of 4.3 kn is shown for SVEN and a speed of 0.3 kn for COMET, whereby the course over ground of COMET had changed distinctly from 069° to 135°. Both vessels were now with their bows on the radar line. At the scale of 1:4000 set during the replay, the AIS symbols of SVEN and HORNBAY were evident. The system did not cover NORDERTOR as no AIS was installed on NORDERTOR. For the setting in the figures it should be remembered that these are settings on the replay system. The actual setting at the time of the accident could have been different. Furthermore, this is an ECS system that worked with data in the proprietary TRANSAS_Format. In other words, due to the status, the vessels should formally have navigated with paper charts.

[13] The electronic chart system has been replaced in the meantime by the system Transas Navi Sailor 3000 ECS.

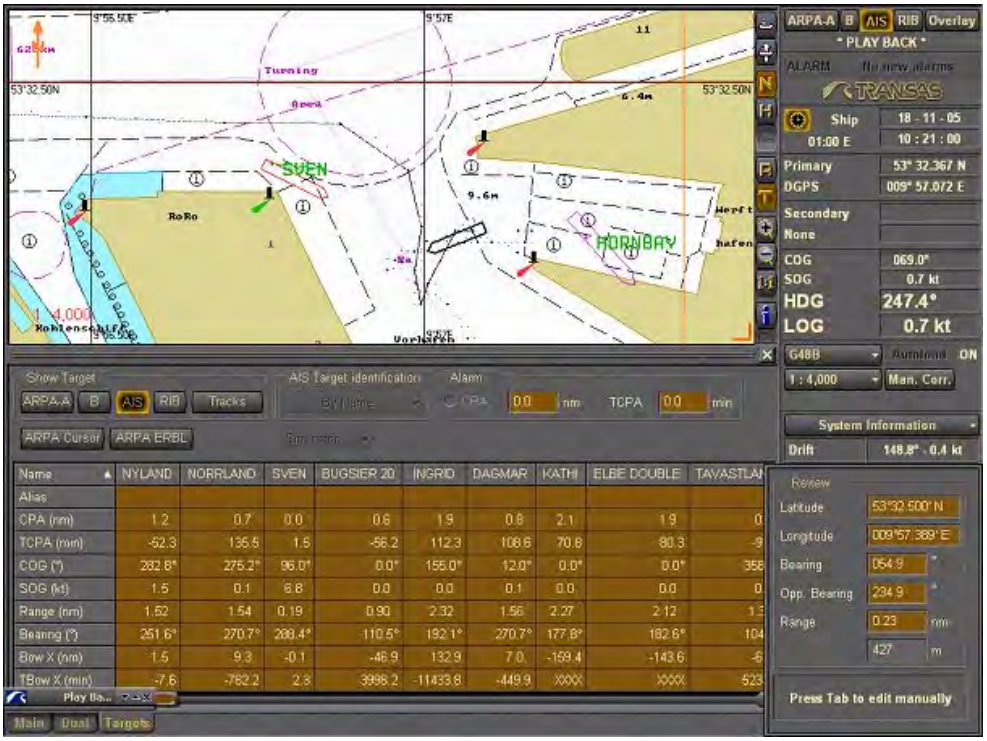


Fig. 10: ECS record COMET with AIS data 10:21:00 h

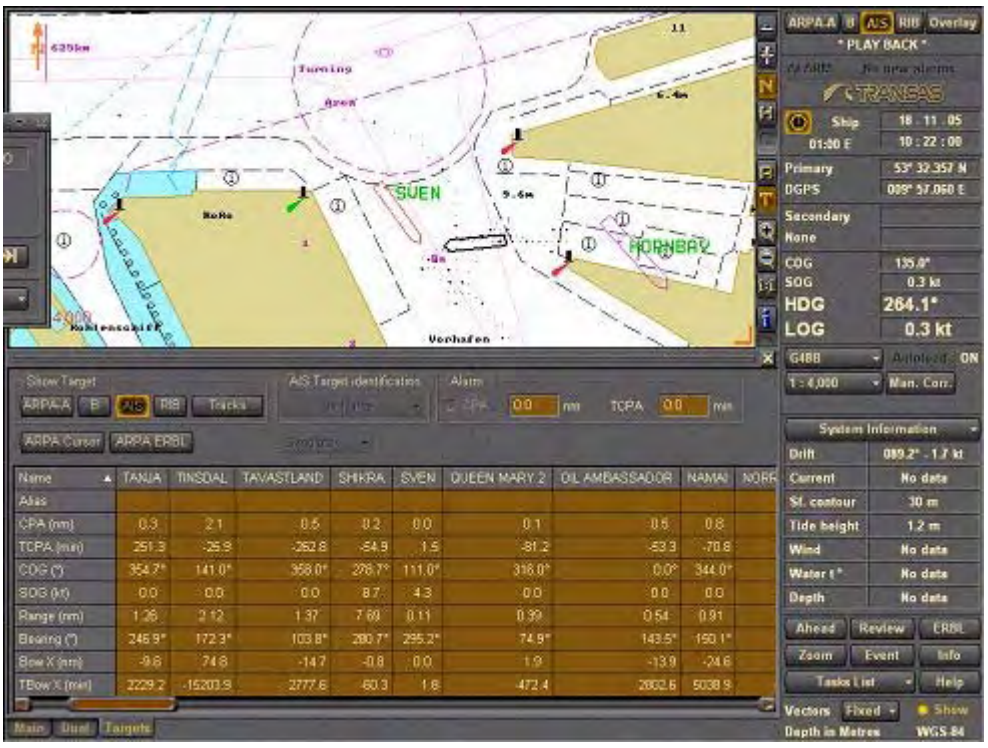


Fig. 11: ECS record COMET with AIS data 10:22:00 h

5.3 Navigation equipment

5.3.1 SVEN

Navigational equipment	Type designation	Manufacturer
Speed measuring system	JLN - 203 D	Japan Radio Comp.
Echo sounder	FE 606 N	Furuno Electric Co. Ltd. , Japan
Course regulating system	NAUTOPILOT 2010	Raytheon Marine GmbH, Kiel,
Gyro compass	STANDARD 20 PLUS	Raytheon Marine GmbH, Kiel
GNSS	NAV398	Raytheon
GNSS	NAV398	Raytheon
Magnetic compass	REFLECTA 1/REFLECTA 2	Cassens & Plath GmbH, Bremerhaven
Radar system/ARPA	M3425/7X-U	Raytheon, Hudson, USA
Radar system/ARPA	TM M3410/12S-U	Raytheon, Hudson, USA
Daytime signal lamps		no data
Whistle		no data
Bell		no data
Gong		no data
Manoeuvre signalling system		no data
Radar transponder	SF 4251	Hagenuk
Radar transponder	SF 4251	Hagenuk
Morse signalling lamp		no data
ECS	NAUTOPATH ECDIS/IBS C 26 TYP EC 02-U01	Raytheon Marine GmbH, Kiel
AIS	FA-100	Furuno Electric Co. Ltd.,

5.3.2 COMET

Navigational equipment	Type designation	Manufacturer
Speed measuring system	DEBEG 4675	C. Plath GmbH, Hamburg
Echo sounder	FE 606 N	Furuno Electric Co. Ltd. Japan
Course regulation system	NAUTOPILOT 2010	Raytheon Marine GmbH, Kiel, Deutschland
Gyro compass	STANDARD 20 DIGITALGYRO	Raytheon Marine GmbH, Kiel, Deutschland
GNSS	NT 200 D	Trimble, USA
GNSS	NT 200 D	Trimble, USA
Magnetic compass	REFLECTA 1/REFLECTA 2	Cassens & Plath GmbH, Bremerhaven, Deutschland
Daytime signal lamps		no data
Whistle		no data
Bell		no data
Gong		no data
Manoeuvre signalling system		no data
Radar transponder		no data
Radar transponder		no data
ECS	NAVI SAILOR 2400 ECS	Transas Marine Ltd.,UK
Radar system/ARPA	BRIDGEMASTER II (KL. IB)	Litton Marine System, Großbritannien
Radar system/ARPA	BRIDGEMASTER II (KL. IB)	Litton Marine System, Großbritannien
AIS	SAAB R4 AIS CLASS A TRANSPONDER SYSTEM	Saab Transponder Tech, Schweden

5.4 Time sheets

5.4.1 SVEN

Schiff Sven DGGW — AfA Hamburg
Monat November 2005 — (Amt für Arbeitsschutz Hamburg)

See
Revier / Lotse
EL / AL Schleusen
Hafen
Verholen

"x" = Arbeitszeit
"0" = dienstfrei
= Unfalltag

Blatt-Nr. 1 — Arbeitszeiten eingeblendet von: Anzahl Wachgänger

Zeit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	"0"
Tag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
So 13	2 2	1 1	1 1	1 1	1 1	1 1	2 2	2 2	1 2	2 2	2 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	2 2	2 2	1 1	1 1	0
Mo 14	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 1	1 1	1 1	2 2	1 1	1 1	2 2	2 2	0,5
Di 15	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 2	2 2	2 1	1 1	1 1	1 1	1 1	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0
Mi 16	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	2 2	2 2	2 2	1 1	1 1	1 1	1 1	1 1	2 2	1 1	1 2	2 1	1 1	1 1	1 1	0
Do 17	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	2 2	2 2	1 1	1 1	1 1	1 1	0
Fr 18	2 2	2 2	1 1	1 1	1 1	1 1	1 1	0 0	1 2	2 2	2 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	2 2	2 2	2 1	1 1	1 1	1 1	1
Sa 19	1 1	1 1	1 1	1 1	1 1	1 2	2 2	2 2	2 1	2 1	1 1	1 0	1 1	1 1	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0,5

Häufig beim Ein und Auslaufen nur eine Person anwesend, 1.Offz fehlt nachts beim Einlaufen und Start der Cargo Operations

Blatt-Nr. 3 — Arbeitszeiten eingeblendet von: Kapitän

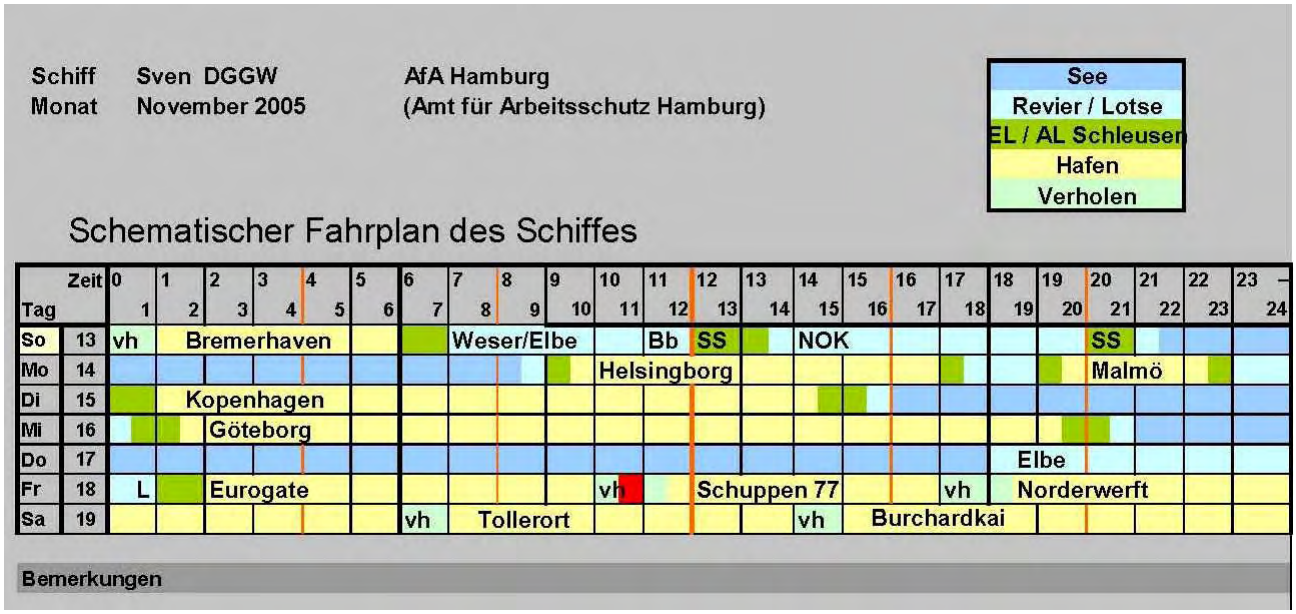
Zeit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	"x"
Tag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
So 13	x x						x x	x x	x x	x x	x x	x x	x x								x x	x x	x x	x x	11
Mo 14	x x								x x	x x	x x	x x					x	x x	x x	x x			x x	x x	10,5
Di 15	x x								x x	x x	x x	x x				x x					x x	x x	x x	x x	10
Mi 16	x x								x x	x x	x x	x x									x x	x x	x x	x x	9
Do 17	x x								x x	x x	x x	x x							x x	x x	x x	x x	x x	x x	11
Fr 18	x x	x x								x	x	x	x x					x x	x x	x x	x				8
Sa 19						x	x x	x x	x x	x x	x x	x			x x										7

Blatt-Nr. 4 — Arbeitszeiten eingeblendet von: 1. Offzier

Zeit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	"x"
Tag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
So 13							x x	x x	x	x x	x						x x	x x	x x	x x	x x	x x			10
Mo 14					x x	x x	x x	x x												x x	x x	x x	x x	x x	9
Di 15							x x	x x	x	x x	x						x x	x x	x x	x x					8
Mi 16							x x	x x		x x	x x	x x						x x	x x	x x	x x				9
Do 17					x x	x x	x x	x x									x x	x x	x x	x x					8
Fr 18							x x	x x		x x	x x	x							x x	x x	x x	x x	x x	x x	10,5
Sa 19							x x	x x	x	x									x x	x x	x x	x x	x x	x x	9

Blatt-Nr. 6 — Arbeitszeiten eingeblendet von: 2. Offizier

Zeit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	"x"
Tag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
So 13	x x	x x	x x	x x	x x	x x							x x	x x	x x	x x									10
Mo 14	x x	x x	x x	x x	x x								x x	x x	x x	x x									8
Di 15	x x	x x	x x	x x	x x	x x							x x	x x	x x	x x									10
Mi 16	x x	x x	x x	x x	x x	x x							x x	x x	x x	x x	x x	x x							12
Do 17	x x	x x	x x	x x	x x								x x	x x	x x	x x									8
Fr 18	x x	x x	x x	x x	x x	x x							x x	x x	x x	x x	x x								11
Sa 19	x x	x x	x x	x x	x x	x x							x x	x x	x x	x x	x x	x x							12



Schiff Sven DGGW AfA Hamburg
Monat November 2005 (Amt für Arbeitsschutz Hamburg)

See
Revier / Lotse
EL / AL Schleusen
Hafen
Verholen

Schematischer Fahrplan des Schiffes

Tag		Zeit 0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24
So	13	vh	Bremerhaven						Weser/Elbe				Bb	SS		NOK						SS			
Mo	14											Helsingborg										Malmö			
Di	15		Kopenhagen																						
Mi	16			Göteborg																					
Do	17																			Elbe					
Fr	18	L	Eurogate									vh		Schuppen 77				vh		Norderwerft					
Sa	19							vh	Tollerort							vh	Burchardkai								

Bemerkungen

Often only one person is present when the vessel is running into the port or leaving the port, one officer is missing in the night when the vessel is running into the port and commencing the cargo operations.

Sheet No. 1	Working hours of the watchkeepers
Sheet No. 3	Working hours of the master
Sheet No. 4	Working hours of the 1st officer
Sheet No. 6	Working hours of the 2nd officer
Last sheet	Schematic schedule of the vessel

“x”	working hours
“0”	off duty
☐	day of the accident

5.4.2 COMET

1 Comet DPGI AfA Hamburg
Monat November 2005 (Amt für Arbeitsschutz Hamburg)

See
Revier / Lotse
EL / AL Schleusen
Hafen
Verholen

"x" = Arbeitszeit
"0" = dienstfrei
= Unfalltag

Blatt-Nr.

1 Arbeitszeiten eingeblendet von **Anzahl Wachgänger**

Tag		0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24	"0"
So	13	1 1	1 1	1 1	1 1	1 1	1 2	2 2	1 1	0 1	1 1	1 1	1 1	0 0	3 3	3 3	3 3	3 3	3 3	0 0	0 0	1 1	1 1	1 1	1 1	3,5
Mo	14	1 1	1 1	1 1	1 1	1 1	0 0	1 1	1 1	1 2	2 2	2 2	1 2	0 1	1 1	1 1	1 1	1 1	1 1	2 2	2 2	2 2	2 2	2 2	2 2	1,5
Di	15	2 2	2 2	2 2	1 1	1 1	0 0	1 1	1 1	1 2	2 2	2 2	2 2	0 0	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	2
Mi	16	1 1	1 1	1 1	2 2	1 2	1 1	2 2	0 1	1 1	2 2	2 2	2 2	2 2	1 1	1 1	2 2	2 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0,5
Do	17	1 1	1 1	1 1	1 1	2 2	1 2	2 2	2 2	1 2	2 2	2 2	2 2	1 1	1 1	1 1	1 1	2 2	0 0	0 0	1 1	1 1	1 1	1 1	1 1	2
Fr	18	1 1	2 2	2 2	1 1	1 1	1 1	2 2	1 2	2 2	2 2	2 2	2 3	1 2	2 2	2 2	1 1	1 1	0 0	1 1	2 2	0 0	0 0	0 0	0 0	5
Sa	19	1 1	1 1	1 1	1 1	1 1	1 1	1 1	0 1	2 2	2 2	2 2	2 2	1 1	2 2	2 2	2 2	3 3	3 3	0 0	0 0	1 1	0 0	0 0	1 1	4,5

Bemerkungen

3 Arbeitszeiten eingeblendet von **Kapitän**

Tag		0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24	"x"
So	13						x x	x x		x	x x	x x	x x		x x	x x	x x	x x	x x							10,5
Mo	14									x x	x x	x x	x x							x x	x x	x x	x x	x x	x x	10
Di	15	x x	x x	x x						x x	x x	x x	x x		x x					x x	x x					10
Mi	16				x x	x x	x x	x x			x x	x x	x x	x x			x x	x x								10
Do	17					x x	x x	x x	x x	x x	x x	x x	x x					x x								9
Fr	18		x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x													10,5
Sa	19									x x	x x	x x	x x		x x	x x	x x	x x	x x						x x	10

Bemerkungen

4 Arbeitszeiten eingeblendet von **1. Offzier**

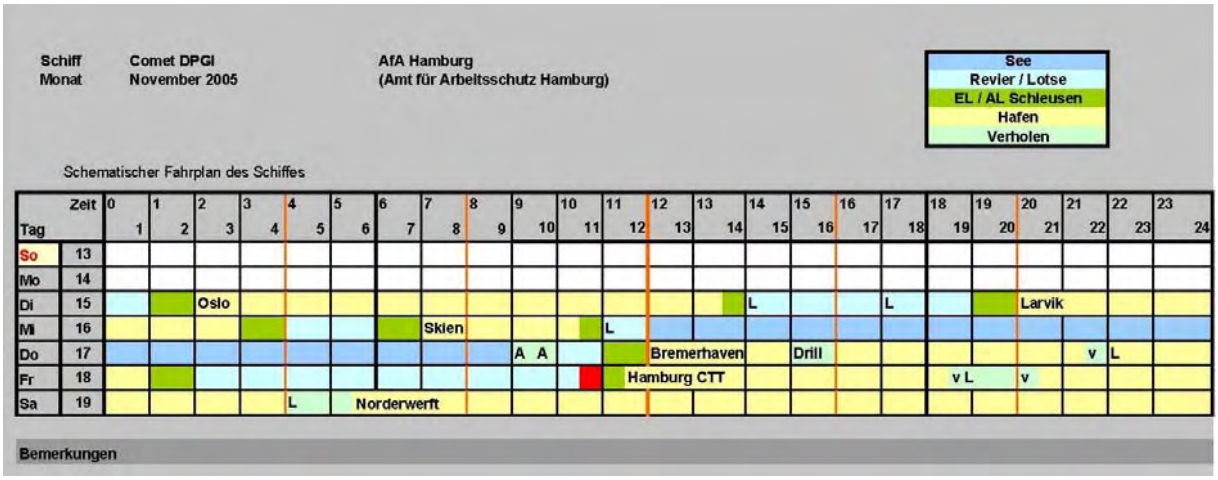
Tag		0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24	"x"
So	13							x x	x x						x x	x x	x x	x x	x x			x x	x x	x x	x x	11
Mo	14							x x	x x	x	x x	x x	x							x x	x x	x x	x x	x x	x x	11
Di	15							x x	x x	x	x x	x x	x x									x x	x x	x x	x x	9,5
Mi	16							x x	x	x x	x x	x x	x x							x x	x x	x x	x x	x x	x x	11,5
Do	17							x x	x x	x	x x	x x	x x								x x	x x	x x	x x	x x	10,5
Fr	18							x x	x	x x	x x	x x	x	x	x x	x x				x x	x x					10
Sa	19					x x	x x	x x	x	x x	x x	x x	x x					x x	x x			x x				10,5

Bemerkungen

5 Arbeitszeiten eingeblendet von **2. Offizier**

Tag		0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24	"x"
So	13	x x	x x	x x	x x	x x	x								x x	x x	x x	x x	x x							10,5
Mo	14	x x	x x	x x	x x	x x								x	x x	x x	x x	x x	x x							10,5
Di	15	x x	x x	x x	x x	x x									x x	x x	x x	x x	x x							10
Mi	16	x x	x x	x x	x x	x								x x	x x	x x	x x	x x	x x							10,5
Do	17	x x	x x	x x	x x	x x	x							x x	x x	x x	x x	x x	x x							10,5
Fr	18	x x	x x	x x									x x	x x	x x	x x	x x	x x			x x					10
Sa	19	x x	x x	x x	x x									x x	x x	x x	x x	x x	x x							10

Bemerkungen



Schiff Comet DPGI
Monat November 2005

AfA Hamburg
(Amt für Arbeitsschutz Hamburg)

See
Revier / Lotse
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Schematischer Fahrplan des Schiffes

Tag		Zeit 0 1	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24
So	13																								
Mo	14																								
Di	15			Oslo												L			L			Larvik			
Mi	16								Skien				L												
Do	17										A	A		Bremerhaven			Drill						v	L	
Fr	18												Hamburg CTT							v L		v			
Sa	19					L		Norderwerft																	

Bemerkungen

5.4.3 Analyses of time sheets SVEN/COMET

According to the Seaman's Act, for working time on sea-going vessels there is basically a working duration of eight hours per day for seamen on watch and eight hours a day on workdays for crew members not allocated to watch service. It is mandatory to observe maximum working hours and minimum rest periods. Except in cases of emergency, working hours may not exceed 14 hours in any 24-hour period. Crew may not work more than 72 hours within any period of seven days. The rest periods may not be less than 10 hours in any period of 24 hours and 77 hours in any period of seven days. The daily rest time may be divided into at most two periods with one of these has to have a minimum duration of six hours. The period between two consecutive periods of rest may not exceed the maximum working time of 14 hours. The rest time criteria must have been observed in the preceding 24 hours each time a working hour starts. The operator must organise the ship's operation in such a way, i.e. man his vessel, that the Master can observe the provisions on working hours under the assignment conditions to be expected for the vessel. Time sheets are to be kept recording the hours of work. These documents must be kept in storage on board for three years. The operator is obliged under the Seaman's Act to evaluate the time sheets with a view to assessing any dangers, and if appropriate must take remedial action. This includes protection against fatigue. This procedure is supervised by work protection authorities.

When evaluating time sheets of the officers on both vessels it became apparent that all of them had fully used up the maximum working times of 72 hours in each period of seven days. In the week shown, and reckoned over the month, there were no formal indications of essentially exceeding working hours and undercutting rest periods. However, it is conspicuous that, for example on SVEN during port entry and departure, and on COMET during an emergency drill, there was only one officer present. In some cases inconsistencies appear on days on which no officer worked, which is relatively improbable on a vessel in feeder service.

5.5 Weather expertise

Between a long, extended high-pressure zone over Western Europe and the Eastern Atlantic and low pressure over the Baltic, cold sea air came into North-West Germany with a north-westerly to northerly flow on 17 November 2005. A stationary trough of low pressure resulted in slight shower activity. The West European high pressure zone mentioned expanded eastwards on 18 November 2005 so that the cold air flowing in came to rest, and in the North German coastal area the skies cleared up already during the night. This was caused by strongly rising air pressure and widespread lowering of the air masses in the atmosphere, connected with dissolution of clouds.

The analysis revealed that between 01:20 h and 10:22 h on 18 November 2005 there were only weak winds blowing over the whole area between Bremerhaven and the port of Hamburg, initially from a westerly direction and later more from a south-westerly direction. The average wind speeds in the first part of the area up to the Elbe estuary were 3 to 6 kt (Beaufort 2), and in the Elbe River then below 3 kt (Beaufort 1). Especially in the last part of the area and in the area of the port of Hamburg the wind was partly also circulating weakly. Under these wind conditions naturally no notable sea developed. At 01:00 h the air pressure in Bremerhaven was 1013 hPa and at 10:00 h in Hamburg 1018 hPa. When the voyage started in Bremerhaven the air temperatures were 4.7° C and in Cuxhaven at 04:00 h still 2.5° C. During the onward voyage towards Hamburg the temperatures then sank rapidly into the frost zone and at about 10:00 h in the port of Hamburg were minus 1.5 °C (Hamburg-Fuhlsbüttel: minus 2.1 °C).

The sky was initially clear and over the North Sea visibilities were over 30 km. At first visibilities declined slowly on the Elbe River, as wide-spread fog formed inland in the cold air in the second half of the night. In Hamburg-Fuhlsbüttel visibility dropped between 04:00 h and 05:00 h from 12 km to 300 m, initially still with the sky being visible. From 08:00 h onwards the layer of fog was so thick that it was no longer possible to see the sky. Between 10:00 h and 11:00 h visibilities in Fuhlsbüttel were at or below 100 m. As a consequence of the lack of air movement and the low level of the sun in mid-November, the fog remained in Hamburg throughout the entire day and only lifted slightly in the course of the afternoon. There are no visibility measurements from the port of Hamburg area. However, it can be assumed that in the weather situation described above and the still very high water temperatures on the Elbe River of about 9°C in late autumn, the visibility conditions in the port of Hamburg were more likely to be poor, as the difference between air and water temperature of more than 10 Kelvin was very high and promoted additional transportation of water vapour from the Elbe into the atmosphere. Sunrise in Hamburg on 18 November 2005 was 07:52 h.
The data on the average wind force in Beaufort (Bft) correspond to the 10 minute average of wind speeds measured at a height of 10 m.

In the sea area under consideration here, the wave height of the sea in the first part of the area up to about the Elbe River estuary was less than 0.5 m caused by the weak wind. On the Elbe River up to Hamburg it can then be assumed that the water conditions were largely smooth. The data on wave height are fundamentally related to the significant wave height. This corresponds to the arithmetical average from the upper third of the wave heights in a period of observation. This means that a number of individual wave higher than the significant wave height occur. In rare cases individual waves can exceed the significant wave height by 70% to 100%.

The analysis of the weather data presented revealed that in the port of Hamburg (Vorhafen to TOLLERORT Terminal) at 10:22 h on 18 November 2005 with slight frost and at most very weak air movement there was very dense freezing fog with visibilities well below 100 m. The water conditions were virtually smooth. With due caution it can be stated that the fog set in inland at about 04:00 h to 06:00 h, in other words well before the time of the collision.

6 Analysis

In addition to the technical equipment in the Vessel Traffic Center and the navigational equipment on the vessels, VHF communication is of major importance in the port of Hamburg for supporting traffic and for personnel staffing on land and on board.

Under technical aspects there were crucial differences between SVEN and COMET. According to the statements made by the Masters the targets were mutually not visible on both radar sets shortly before SVEN entered the Vorhafen, probably due to the masking by TOLLERORT Container Terminal. However, both vessels could be identified by AIS. The advantage of AIS lies in the fact that even with radar masking, targets can still be displayed. Admittedly it was not possible to display the AIS targets additionally on a radar screen on both vessels, but a display of AIS targets with the electronic chart was possible, at least on board COMET. However, on board SVEN there was only a so-called minimum keyboard display. But this does not allow suitable geographical allocation. Therefore essentially only COMET was able to use the advantages of AIS.

Thus there were differing displays on the electronic charts of the two vessels. Irrespective of the fact that no official chart data were used and that SVEN did not have a valid permit for operating the system, on board SVEN radar, AIS and chart data had to be evaluated on three different screens, while on board COMET two screens were necessary. The matter was further rendered difficult by the fact that on board SVEN one radar set was defective. Formally, the proprietary chart data of the two ECS should not have been used for navigation. However, this would have meant that the crews would have had to work with official paper charts creating additional analog data sources outside the conning position, and not all the information could have been called up from the conning position.

Both vessels were making use of shore radar services and reported their positions to the reporting stations stated on the chart via VHF. For this it is necessary to operate different VHF channels and to listen to at least two channels. Channel 74 is very much overused due to the many shipping movements in the port of Hamburg. In addition, on board communication with the bridge and the crew at their stations is carried out using walkie-talkies. The pilot on board possesses a handheld VHF set that he can use for additional channels if necessary. Furthermore, radio discipline leaves much to be desired, so that in addition to actual traffic information lots of other information is exchanged. On channel 74 only so-called PR (Position Report) data are to be reported, with the name, position and destination and heading of the vessel, to the reporting stations entered in the chart and the VTS Guide Germany. The position reports are crucial for assessment of the traffic flow in the port of Hamburg, as not all relevant data are available with sufficient precision and reliability or uniformity from the sensor information e.g. radar and AIS data. The degree of automation also varies, so that depending on the equipment fewer or more staff are necessary to operate the systems. While on board COMET the Master was navigating, communicating and at the same time manoeuvring the vessel, on board

SVEN at least the Master was relieved from VHF traffic, as the pilot on board took over this task. Both Chief Mates were assigned as lookouts on the bridge.

Considering the technical equipment of the vessels, the dense fog and high rate of traffic in the port of Hamburg as well as the services to be conducted with the Vessel Traffic Center, the allocation and manning of the bridges on both vessels were inadequate and inexpedient. Instead of transferring the tasks of lookout to a deckhand, the Chief Mates were engaged in this task on both vessels and could not support the Master appropriately e.g. by taking over VHF on board COMET or analysing the AIS targets on board SVEN. Furthermore, due to the fact that both vessels should have been navigating with a paper chart, an officer[14] would have been necessary for this task.

Ultimately, apart from fog signals, all the information needed to avoid a collision was available. However, it could not be used efficiently. The way in which the information reached those responsible was inadequate. For example according to the VHF records it was not clear on board SVEN until shortly before the collision whether the other party in the collision was COMET (VHF channel 74 "COMET are you that turning in front of Werfthafen"). COMET had been presumed to be in front of berth CTT 3. In front of CTT 3 a turning circle with a diameter of 385 m is displayed on the chart, that would have facilitated a turning towards CTT 3 for COMET. On the other hand, probably due to the variety of tasks to be performed, the Master of COMET was not in a position to concentrate sufficiently on the VHF traffic. This led to formulations giving rise to misunderstandings about the position and location of his vessel. On the basis of the VHF records it was not possible to assess finally why the vessel turned already in front of the Werfthafen. Accordingly the formulation on VHF channel 74 (...I am halfway in front of my place") could have led to misinterpretations on board SVEN, although the positions of COMET actually transferred by AIS were available and reflected the situation in front of Werfthafen. It should be taken into account here that prompt evaluation of the AIS data in real time is not possible with a minimum keyboard display and the paper chart. Issuing of fog signals could have improved the attentiveness and response times of the lookouts[15]. The estimation of distances by the Second Officer on board COMET of 50 m from the Containerterminal TOLLERORT does not coincide with the radar records of the Vessel Traffic Service and the ECS records of COMET. According to these at the time of the collision COMET was eastwards of the radar line and before this at least 100 m away from the quay.

With 11 and 10 crew members respectively on SVEN and COMET, the feeder service poses particularly high demands in the trading area and the port of Hamburg. With weekly round trips, long times on the estuary on the Kiel Canal and on the Elbe River, as well as frequent shifting up to seven times in the port of Hamburg in order to load and discharge containers in different port basins, it is easily possible for

[14] An electronic chart representation system (ECS) is by contrast with an electronic chart display and information system (ECDIS) not recognised by the shipping administration as a substitute for paper charts (see SOLAS Chapter V Rule 19, 2.4).
[15] According to § 18 Port Traffic Regulations the fog signals specified in the Collision Prevention Rules and the SeeSchStrO (German Traffic Regulations for Navigable Maritime Waterways) be issued at least every minute.

working times to be exceeded and rest periods in accordance with the Seaman's Act to be undercut. On the day of the accident the Master of COMET had not exceeded his daily maximum working hours and before this he had not undercut the periods of rest in Bremerhaven. However, after eight hours of uninterrupted rest time he was on the bridge for the entire voyage from Bremerhaven to Hamburg. These long times on watch should be avoided by different organisation of duties on board. The Master of SVEN had had a rest period of 7.5 hours before starting the shifting operation and was able to start his period on watch in rested condition.

Constant overstressing in work can lead to fatigue. Excessive stress occurs when crew persistently work too long or have to carry out physically strenuous work, or work leading to psychic strain. Many hours of overtime and fatigue can have the following negative effects:

- Increased number of accidents and accidents with fatal consequences
- Increased dependence on drugs, tobacco and alcohol
- Poor sleep quality and sleep disturbances
- More frequent occurrence of cardiovascular disturbances as well as respiratory or digestive complaints
- Increased risk of infection
- Loss of appetite[16].

Accordingly the Master of COMET considered it sufficient to order the Chief Mate onto the bridge to support him only on reaching the boundary of the port of Hamburg, although according to his own statement dense fog on the Elbe River occurred already at Rhinplate. The risk of accident could have been reduced by more crew and more efficient assignment of crew on the bridge, e.g. during increased risk situations such as fog and estuary traffic.

The Vessel Traffic Center consisting of the Port Operations Office, Vessel Traffic Service and Radar Control Room has the task of ensuring ease and facility of shipping traffic in the port of Hamburg. To this end it disseminates traffic information via VHF, provides traffic assistance and where appropriate traffic instructions[17]. Traffic planning in the meaning of traffic guidance for instance as in air

[16] See Directives on Relieving Fatigue and Fatigue Management.

[17] Extracts from the Service Instructions of the Hamburg Port Authority on the operation of the Nautical Centre:

§ 26 Traffic information consists of individual items of information that are passed onto shipping on the known working channels as needed or on request.

§ 27 Traffic assistance comprises notes and warnings to shipping and recommendations within the framework of shipping consultancy in the meaning of § 1 para 1 No. 12 of the Entering Requirements Ordinance and § 2 para 1 No. 24 of the SeeSchStrO, that depending on the requirements of the traffic situation the navigation channel, weather and tidal conditions can as well cover positions, passing times, courses, speeds or manoeuvres of certain vessels.
In the case of individual enquiries from vessel commands about the possibility of certain manoeuvres, generally only purely factual information (e.g. traffic situation) are to be given so that the responsibility recognisably remains with the vessel command. Irrespective of this applications for exemption from traffic regulations are to be answered clearly.
Traffic assistance comprises :
- Notifications and warnings

traffic by awarding so-called slots, is at present essentially carried out for vessels constrained by their draft for which time windows are reserved. Apart from the obligation to report and with a few exceptions, for example technical failures, the rest of shipping has no special regulations regarding coordination of mooring and unmooring within the port.

On its way to Ellerholzhafen SVEN had to pass the area in which COMET intended to turn. The intentions of both vessels were known to the Vessel Traffic Center. Ideally SVEN could have waited for COMET to carry out the turning and berthing manoeuvre in the fog at its old berth. This would have substantially reduced the risk of collision.

At the time SVEN announced it was going to leave the old berth the time window in relation to COMET proceeding ahead was considered to be sufficient. It was not found necessary to make SVEN wait at its old berth.
Both the Nautical Officer on Duty (NvD) and the radar pilot assumed that COMET would use the turning circle intended for this purpose in the Vorhafen for its turning manoeuvre. In addition to the time window there would then be sufficient space for safe passage of both vessels. This supposition was backed up by COMET's announcement over VHF that it would turn in front of CTT 3.
Despite this, the Nautical Officer on Duty and radar pilot then saw from the radar image that COMET was carrying out the manoeuvre further north, at the entrance to the Vorhafen.
If a critical situation in the Vorhafen had not yet been predictable at the time SVEN left its old berth, it was at least foreseeable before Sven turned into the Vorhafen.
Intervention by the Vessel Traffic Center would have been necessary here. At this time a measure would have been possible both within the framework of traffic information by the NvD, through radar advice as traffic assistance by the radar pilot, and also through traffic instructions again by the NvD.
However, due of the fact that the pilots in the Radar Control Room sit spatially separated from the NvD of the Vessel Traffice Service, coordinated procedures by radar pilot and NvD is rendered difficult.

Notifications and warnings by the Nautical Officer on Duty (NvD) of the Vessel Traffic Service are intended to draw the attention of traffic participants to hazardous situations.
As far as necessary short-term corrections are to be given limited to the geographical references and traffic situations.

- Recommendations within the framework of shipping consultancy by port pilots.

§ 28 Traffic instructions are orders by the shipping police from case to case and are issued where support measures are not sufficient. The vessel commands are to be instructed to perform, tolerate or omit certain actions by shipping and/or river police orders with consideration given to the prerequisites of intervention standards, especially the principle of commensurability.
The nature in which the orders are met most expediently is decided as a matter of principle by the vessel command.
In areas in which ship manoeuvres can no longer be analysed with regard to the success targeted, the Vessel Traffic Service may not intervene in the way in which the vessels proceed. A warning to the ship's commands concerned is not affected by this.
If shipping and river police orders are issued or if an exemption is issued that may reflect on other traffic participants, the vessel commands and pilots affected and others concerned are to be informed.

As a consequence of the reduced visibility there was continuous radar advice for both vessels by the Radar Control Room of the Vessel Traffic Center by the port pilot. In the case under review here the NvD assumed that the turning manoeuvre of COMET and the passage of SVEN had been agreed between the vessels and radar pilot. However, because of the spatial division, the NvD could not know that such discussion and agreement had not taken place. Without this knowledge he could not intervene either.
The radar pilot left the passing of the vessels solely to the agreement on manoeuvres between the relevant bridge teams and on the grounds of the VHF traffic assumed that they would behave in line with the traffic situation and did not intervene with additional traffic assistance. The NvD was unable to know this either because of the spatial separation. Accordingly the Nautical Officer on Duty again had no reason to act within the framework of a measure.
According to the statement by the Port Pilot Association Hamburg, it happens every day that vessels have to leave their berth although it is known that the next berth is not yet free. The Association also points out that traffic instruction measures would impair the ease of shipping traffic and could be detrimental to the traffic frequency. At present there are not suitable planning instruments to support traffic instruction. Traffic would come to a standstill. Slots to regulate the traffic as exists in air traffic would be a hindrance in the Port of Hamburg. Shipping traffic is already restricted at Köhlbrand when the channel is barred by the river police for traffic heading for the CTA (Containerterminal Altenwerder).

Accidents that are attributable to agreements rarely happen in the Port of Hamburg. It is possible that stringent, traffic measures would be detrimental to ease of shipping. Shipping traffic within the port is very dynamic and under certain conditions depends sensitively on the initial conditions so that behaviour does not appear to be predictable on a long-term basis. On the other hand, improved logistic concepts could minimise shipping frequency already in advance. This would lead to a considerable relief of the burden on feeder traffic within the port and reduce the risk of accident.

In conclusion the collision in the Vorhafen between SVEN and COMET is attributable to deficient agreement and coordination between the vessel bridge teams and the Vessel Traffic Service and Radar Control Room within the Vessel Traffic Center, as well as to manning inappropriate to the situation, inexpedient assignment of bridge personnel, and incomplete integration of all information available on both vessels.

7 Safety recommendations

The BSU issues the following recommendations:

The masters and nautical officers on watch must ensure by bridge management that the relevant individuals are always assigned on watch duty at the locations at which they can fulfill their tasks most efficiently and effectively. In line with circumstances and in particular during voyages with increased risk such as fog and dense traffic, as well as in the area of Vessel Traffic Services (VTS), care should be taken to ensure that sufficient personnel is available. It must be suitably taken into account what bridge equipment and navigation aids are available for use and to what performance limits they are subjected. One additionally qualified person would be necessary solely to evaluate AIS signals with the so-called Minimum-Keyboard-Display and the paper chart.

Owners, operators and masters in feeder service are recommended to describe the bridge management in detail in the ISM manual of their vessels and to work towards a watch system in which under normal circumstances four hours sea watch and eight hours free are provided for. In the Port of Hamburg the frequent shifting in feeder service (in some cases 6 to 7 times within a period of two days) should be facilitated by additional staff, e.g. board pilots and bridge personnel. The vessel operator must ensure that the master is provided with the necessary means for this.

The Hamburg Port Authority is recommended to review regulations whether in addition to the obligation to use land radar advice at visibilities below 2,000 m or 3,000 m respectively, masters who are exempted from the obligation to take on a pilot should be additionally obligated to use an on-board pilot. Furthermore, it should be achieved that radio traffic in port radio service is always carried out by a person who is not manoeuvring the vessel at the same time. Better radio discipline should be enforced in the Port of Hamburg to relieve the burden on the port radio frequencies, especially channel 74.

In the intended expansion of shipping traffic management technology by the Hamburg Port Authority in the years 2006 – 2007, the development of a strategy with suitable planning instruments to disentangle predictable hazardous encounter of vessels and improved port logistics should also be considered.

The Federation of Port of Hamburg Businesses should optimise cargo management in the Port of Hamburg in cooperation with the Hamburg Port Authority in such a way that the cargo of a vessel can be discharged or loaded at a minimum of berths. This alone could substantially reduce feeder traffic within the port and reduce the risk of accidents as well as relieving the burden on the vessel crews.

At the Vessel Traffic Center of the Port of Hamburg closer cooperation between the radar pilots and the Nautical Officer on Duty (NvD) is to be ensured when radar advice is used. Within the framework of joint traffic support the tasks of the NvD include consulting the relevant radar pilot when hazardous situations are recognised to ensure that the danger is encountered appropriately. Conversely the radar pilot is obliged to pass on information about hazardous situations promptly to the NvD. It should be ensured that appropriate personnel resources are made available for this traffic assistance.

8 Sources

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- Official weather expertise Germany's National Meteorological Service (DWD)
- Radar records
  - Vessel Traffic Center

- Documents
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  - SOLAS chapter V Vessel Reporting System
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