Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Federal Ministry
of Transport and Digital Infrastructure

Summary Investigation Report 415/19

Less Serious Marine Casualty

Failure of a head line on the chemical tanker THEMSESTERN in the Kiel-Holtenau lock on the Kiel Canal (NOK) on 30 November 2019 with three linesmen slightly injured

23 March 2021

This summary report within the meaning of Article 27(5) of the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG) is a simplified report pursuant to the second sentence of Article 14(1) of Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector.

The investigation was conducted in accordance with the above legislation. According to said legislation, the sole objective of this investigation is to prevent future accidents. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG).

This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Article 34(4) SUG.

The German text shall prevail in the interpretation of this investigation report.

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Table of Amendments

Page	Amendment	Date

Table of Contents

1 FACTUAL INFORMATION

1.1 Photograph of the ship

Figure 1: Chemical tanker THEMSESTERN[1]

1.2 Ship particulars

Name of ship:	THEMSESTERN
Type of ship:	Chemical tanker
Flag:	Portugal (MAR)
Port of registry:	Madeira
IMO number:	9183843
Call sign:	CQLG
Owner (according to Equasis):	MT Themsestern Schifffahrtsgesellschaft mbH & Co. KG
Operator:	MOL Chemical Tankers Pte. Ltd.
ISM manager:	TB Marine Shipmanagement GmbH & Co. KG
Year built:	2000
Shipyard, number:	Stocznia Gdynia S.A., 8189/4
Classification society:	American Bureau of Shipping (ABS)
Length overall:	162.16 m
Breadth overall:	27.01 m
Draught (max.):	8.80 m
Gross tonnage:	14,400
Deadweight:	21,871 t
Engine rating:	7,878 kW
Main engine:	H. Cegielski – Poznań S.A., 6S46MC-C
(Service) speed (max.):	12.1 kts
Hull material:	Steel
Hull design:	Double hull, Ice Class 1A

[1] **Source: Hasenpusch Photo-Productions.**

1.3 Voyage particulars

Port of departure:	Riga
Port of call:	Rotterdam
Type of voyage:	Merchant shipping/international
Cargo information:	Chemicals
Manning:	21
Draught at time of accident:	N/A
Pilot on board:	Yes
Canal helmsman:	No
Number of passengers:	0

1.4 Marine casualty or incident information

Type of marine casualty:	Less serious marine casualty; failure of a head line with three linesmen slightly injured
Date, time:	30/11/2019, 0936
Location:	Southern chamber of the NOK's new lock in Kiel-Holtenau
Latitude/Longitude:	φ 54°21.9'N λ 010°08.37'E
Ship operation and voyage segment:	Estuary mode; casting off manoeuvre prior to heading for the NOK
Consequences:	Three linesmen slightly injured; windows of a service building for personnel on the lock's middle wall damaged

Extract from the *Häfen von Kiel* [Kiel ports] Navigational Chart, BSH[2] No 34 (INT 1365)

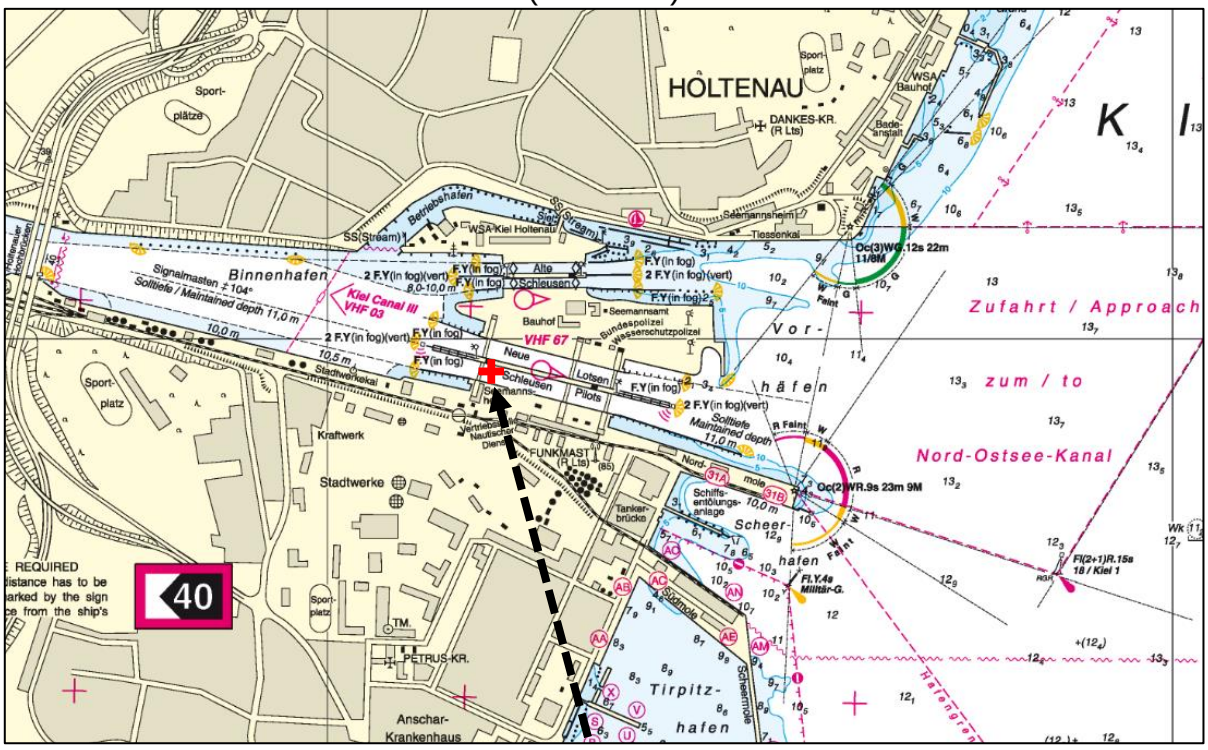

Figure 2: Scene of the accident

[2] BSH: Federal Maritime and Hydrographic Agency.

2 COURSE OF THE ACCIDENT AND INVESTIGATION

2.1 Course of the accident

At about **0936**[3] on **30 November 2019**, the head line of the THEMSESTERN, a chemical tanker registered in Madeira, Portugal, failed in the southern chamber of the NOK's new lock in Kiel-Holtenau.

Final preparations were being made on board the ship to leave the lock chamber for the NOK after the tug STEIN. She was moored at the foremost position on the middle wall of the lock with one head line, two springs and one stern line, i.e. in the usual manner for this size of ship. There was a direct temporal connection between the line failure and shortening up[4] of the lines. The end of the head line that was ashore, which was under tension and still attached to the bollard, shot back, struck several windows of a service building on the middle wall of the lock with great force, and caused some of them to shatter (see **Figure 3 ff.**). A linesman who was standing in the doorway of the building at that precise moment was struck on the leg by the line and slightly injured. Two other linesmen in a rest area inside the building were hit by shards of glass from the shattered windowpanes but fortunately only suffered minor injuries. Nobody came to physical harm and there was no material damage on board the THEMSESTERN.

Figure 3: Service building on the lock wall with damaged windows[5]

[3] All times shown in this report are local (CET/UTC + 1 hour).
[4] 'Shortening up' is a nautical term used to describe the successive casting off and hauling in of mooring lines during a casting off manoeuvre.
[5] The red marking shows the door area of the building where the linesman with an injured leg was standing. The blue marking shows the rest area's partially destroyed windows. The black marking shows the bollard with the end of the head line that was ashore still placed over it. The yellow marking shows the front part of the building, i.e. pointing toward the NOK (workplace of the lock foreman). **Figures 3 to 6 source: Waterway Police (WSP) Kiel.**

Figure 4: Service building (close-up of the affected part of the building)

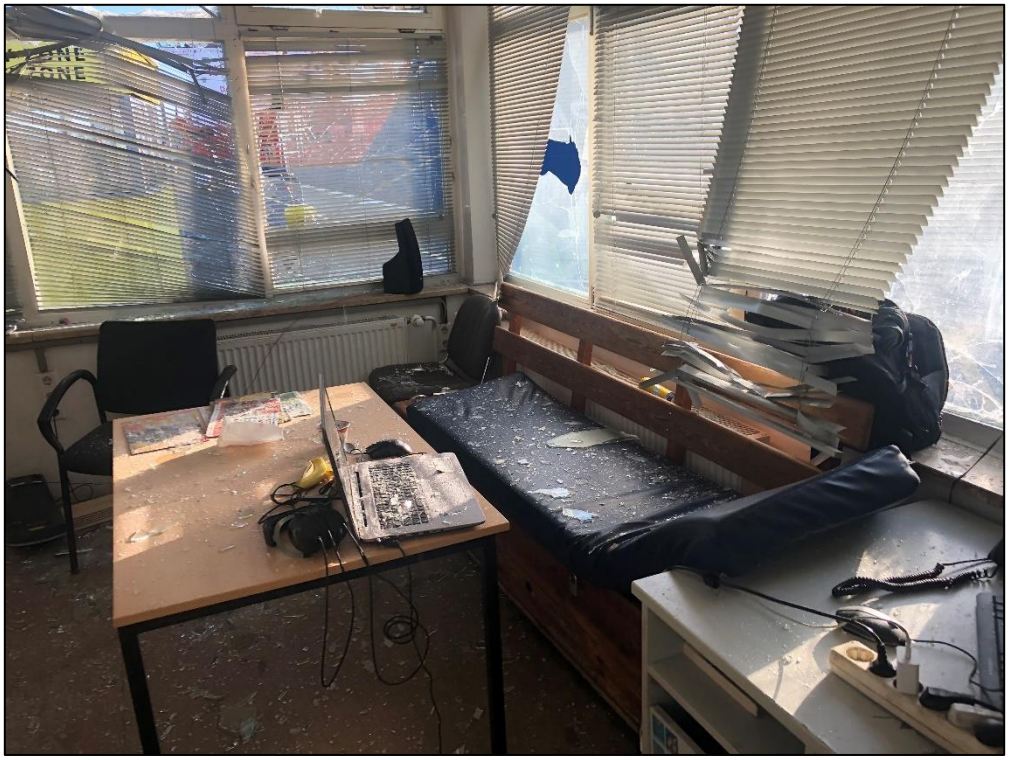

Figure 5: Service building (interior view showing part of the rest area)

After the line failed, the THEMSESTERN's pilot reported the incident to the lockmaster responsible for lock operations via VHF radio. The people manning the ship's bridge (master, chief officer, pilot and two helmsmen) received information about the accident from the forecastle. The manoeuvring station there was duly manned by the third officer, the bosun and two other seafarers.

The lockmaster did not see the accident occur, either. His workplace was in the lock control station (see red marking in **Figure 6**), which is also located on the middle wall of the lock but some 350 m away at the other end of it. However, he was informed about the accident by the lock foreman, who was in the front section of the service building (unaffected by the line failure; see yellow marking in **Figure 3**) when the accident happened, just before the pilot's call and had immediately alerted the emergency medical services. An emergency doctor and an ambulance arrived at the scene of the accident about 15 minutes later. The three linesmen were treated at the scene and then taken to hospital temporarily as a precaution.

The THEMSESTERN drifted a few metres aft as a result of the sudden failure of the head line. The ship's command and crew members at the manoeuvring stations managed to manoeuvre the ship back to the lock wall very quickly and made her fast again so as to enable the police to investigate. (A loop was temporarily tied at the end of the failed head line that was on the ship and this was used as the new head line.)[6]

Figure 6: The THEMSESTERN after she had been made fast again in the lock[7]

[6] The bollard now used for the head line is about 20 m away from the one used originally.
[7] The red marking shows the main lock building at the other end of the middle wall of the lock, which points toward the Baltic Sea. The end of the failed head line that was ashore is visible in the foreground of the picture.

The police finished its investigations on board after about two hours and the THEMSESTERN was able to begin transiting the canal at about **1130**. Apart from the aforementioned injuries to the linesmen and the service building's damaged windows, the accident was without consequences.

2.2 Course, sources and material details of the investigation

Due to the relatively minor consequences of the accident, the BSU was not informed about it immediately afterwards. Accordingly, an immediate investigation on board the THEMSESTERN was no longer an option. The BSU was not provided with VDR[8] recordings from the ship. However, reconstructing the course of events posed no problem whatsoever thanks to the AIS[9] recordings and audio recordings of the VHF radio traffic provided by Vessel Traffic Service (VTS) NOK and the lock operation logs. The BSU was also provided with reliable investigation results from the WSP.

The main steps in the BSU's investigation consisted of evaluating the sources already discussed. Moreover, during two visits to the NOK locks in Kiel-Holtenau and for comparison Brunsbüttel, the investigation team gained an impression of the structural and organisational conditions and characteristics of the respective lock facilities. Discussions were held with the personnel responsible for lock operation during the visits. Another visit to the lock in Kiel-Holtenau was used as an opportunity to speak with the two linesmen affected by the line accident and a representative of their employer personally.[10]

These discussions and surveys focused on operational procedures within the locks and aspects of practical occupational safety for linesmen and other individuals in the lock facilities. With regard to the related questions, the BSU also contacted the Waterways and Shipping Administration (WSV) responsible for operation of the NOK and its locks[11], which provided relevant information. Contacts with the alderman of the NOK II Pilot Association and the THEMSESTERN's pilot, as well as obtaining a weather report rounded off the investigation work.

Efforts of the BSU to speak with the skipper of the STEIN, which passed the THEMSESTERN immediately before the accident and was the first vessel to leave the lock, were unsuccessful. Initial suspicions that the handling of the tug may have been (partly) responsible for the line accident were not substantiated in the course of the investigation. Accordingly, there were no further attempts to make contact.

[8] VDR: Voyage data recorder.
[9] AIS: Automatic identification system (standardised radio system for exchanging ship particulars both among vessels and for shore-based traffic monitoring).
[10] Note: The third linesman affected was also supposed to be present at the meeting but was forced to cancel due to illness. The employer of the linesmen is the Kiel-based company FESTMACHEREIGESELLSCHAFT NORD-OSTSEE-KANAL MBH.
[11] The Brunsbüttel and Kiel-Holtenau waterways and shipping offices, which are responsible for lock operation at the respective locations, have been merged into the new Waterways and Shipping Office NOK as of 22 March 2021. It had already been the case that certain administrative tasks were carried out on an inter-office basis for the NOK, however. For the sake of simplicity, the generic abbreviation, WSV, is therefore used in this investigation report instead of the office designations.

2.3 Findings of the investigation

2.3.1 Reconstruction of events in the lock chamber

The technical log entries for the lock gate operating times (see relevant extract in **Figure 7**) indicate that the gate through which the THEMSESTERN was to sail for the NOK started and finished opening at **0930** and **0936**, respectively.

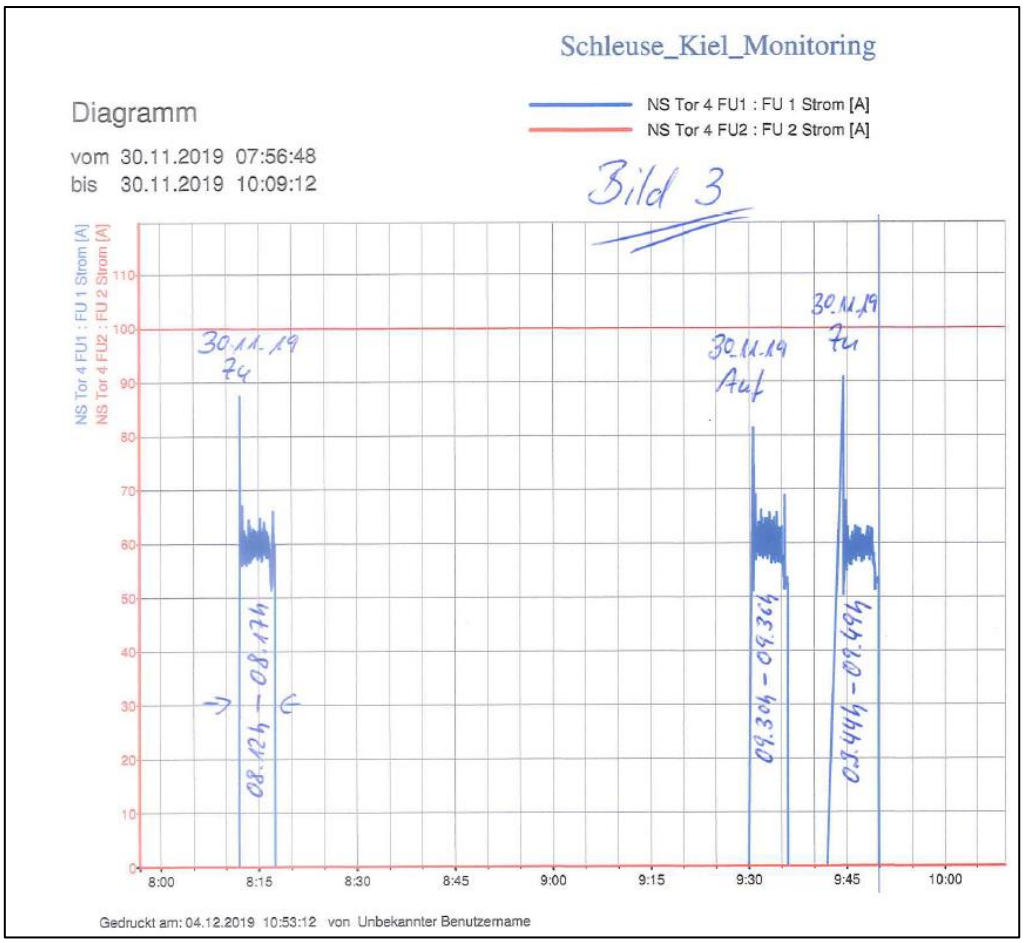

Figure 7: Extract from log of lock gate operating times[12]

The corresponding AIS recordings made at that time (see **Figure 8 ff.** below) show that the STEIN (IMO number: 9241243; German flag; engine rating: 2,650 kW; see **Figure 12** below) started to pick up speed at about **0934** and passed through the lock gate shortly after **0935**, i.e. before it had been fully opened.

[12] **Figures 7 to 11 source: WSV.**

According to the lockmaster's log, the tug entered the lock after the THEMSESTERN and made fast against the outer wall of the southern lock chamber.

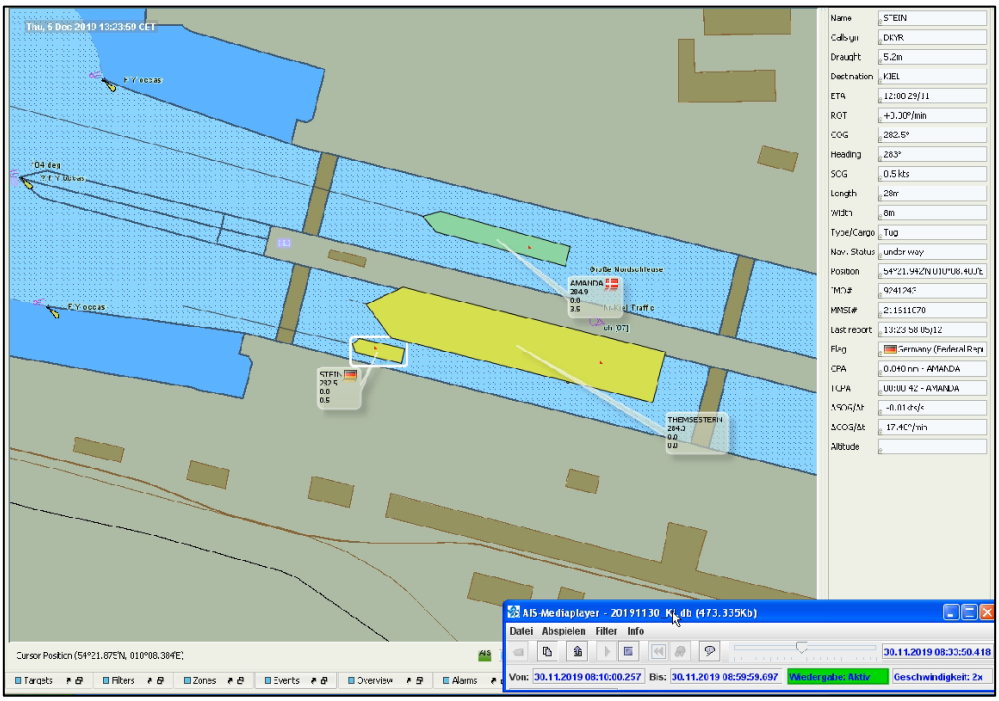

Figure 8: AIS data from 093350
(THEMSESTERN and STEIN in southern lock chamber)

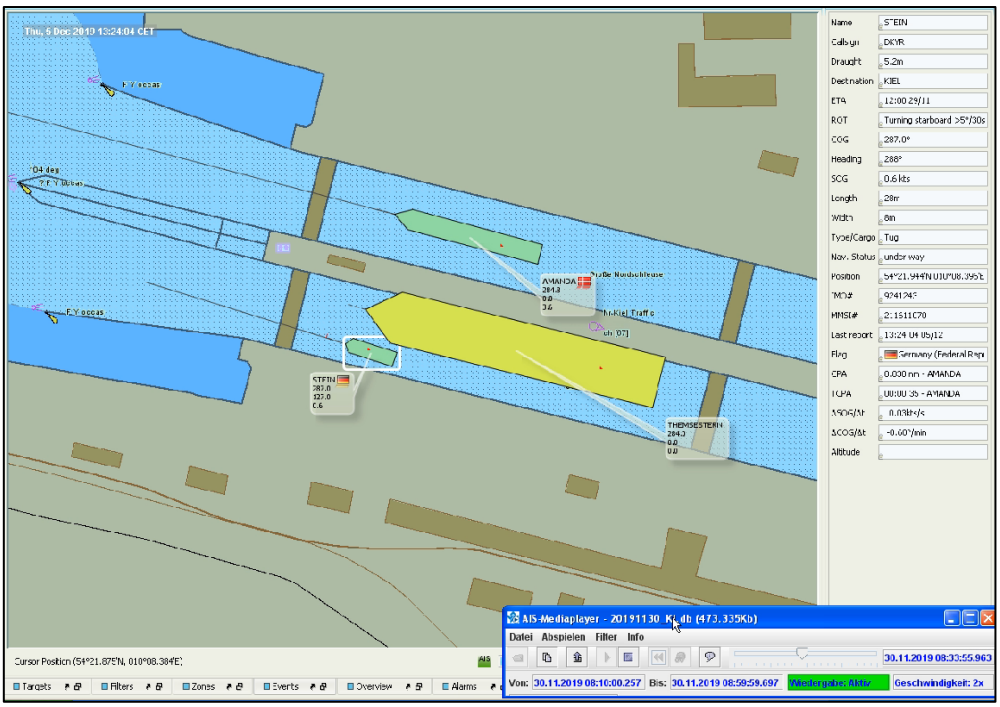

Figure 9: AIS data from 093355 (STEIN gets underway[13])

[13] Note: As compared to Figure 8, the AIS system is now displaying the STEIN as a green object.

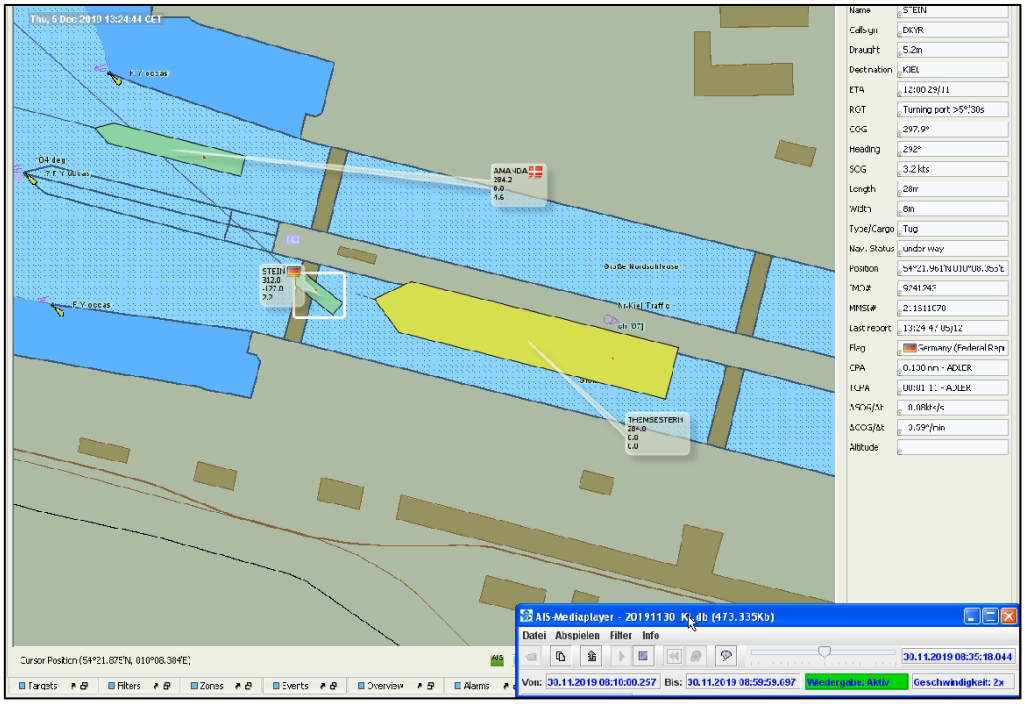

Figure 10: AIS data from 093518 (STEIN passes through lock gate)

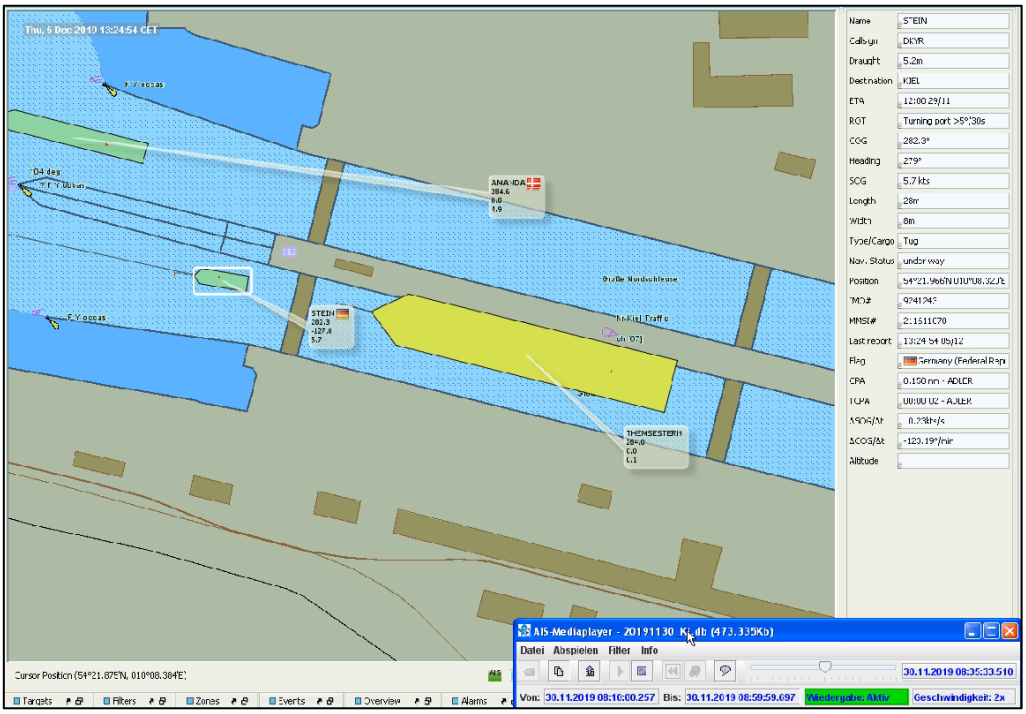

Figure 11: AIS data from 093533 (STEIN has left the lock chamber)

Figure 12: STEIN[14]

Due to the lack of a direct technical recording (e.g. in the form of an audio or video sequence) the time at which the line failed cannot be determined to the second. Witness testimony indicates that the STEIN had reportedly just passed or was in the process of passing the lock gate when the line failed. The relevant period indicated by the AIS recordings (between **0935** and **0936**) is consistent with the time stamp of the audio file in which the aforementioned radio contact between the lockmaster and THEMSESTERN's pilot concerning the line failure was recorded. The time of the accident is therefore considered to be **0936**.

2.3.2 The STEIN's influence on the course of events leading up to and during the accident

The fact that the THEMSESTERN's head line failed shortly after the STEIN sailed in front of her bow so as to leave the lock through the only partially opened lock gate initially implied that the tug's hydrodynamic effects could have (partly) caused the accident.

On the bridge of the THEMSESTERN no movement was detected in the ship in connection with the close-quarters situation in question, however. Furthermore, AIS recordings indicate that the STEIN was sailing at a speed of only 3 kts when she passed the lock gate, which, taken in isolation, means the generation of strong water movements is unlikely.

[14] **Source: Hasenpusch Photo-Productions.**

During the survey of the Brunsbüttel lock control station, the investigation team put forward the theory that the accident may have been the result of hydrodynamic interaction while speaking with the NOK Brunsbüttel lock's experienced lockmaster, who as a neutral expert and authority on the vessels in question as well as the effects of water movement in the lock chambers ruled out such an interaction as the cause of the accident. The opinion of the NOK II Pilot Association's alderman, who has a detailed knowledge of the conditions in the NOK's Kiel-Holtenau lock both from his own professional activities and in his capacity as a well-informed representative of all pilots working there, was similar. In his response to related questions from the BSU, he claimed that based on his own experience and knowledge, hydrodynamic effects of work maintenance craft or support tugs in the lock on adjacent seagoing ships were generally not noticeable due to the low water displacement of the small vessels. He was reportedly not aware of any such accident in the Kiel-Holtenau lock.

Based on the above information, the BSU refrained from pursuing the theory that a hydrodynamic interaction caused the accident. Moreover, verifying this reliably would not have been possible even with the considerable scientific effort this would have entailed because – as already stated above – the exact time at which the line failed cannot be determined. However, this would have been an indispensable benchmark for all possible calculations.

2.3.3 Other possible causes of the line failure

As with every line accident, in the case of the THEMSESTERN's failed head line, too, the possibility that previous damage to the line used and/or seafaring deficits while handling the line at the manoeuvring station, for example, might have caused the accident was already considered during the preliminary police investigation on board. No reliable evidence could be found on board for either aspect, however. Apart from the damage caused by the failure, the condition of the head line appeared to be good. However, as the BSU has already found when it has investigated line accidents in the past, it cannot necessarily be concluded from this that the line in question had not already suffered damage (possibly not visible on the surface) previously.[15] It is therefore also conceivable that an earlier overload event had reduced its tensile strength and that this was not visible on the surface. It is an unfortunate fact that reliable methods for assessing a line after it has failed with a view to determining whether it was overloaded at any time before the event are still not available. Accordingly, it was not possible to investigate this aspect.

As the THEMSESTERN passed through the lock, she was raised in the lock chamber by about 0.16 m and the line's tension possibly increased in the process. Whether this fact was relevant to the line accident cannot be determined retrospectively for lack of reliable information about the winch settings and the exact line routing at the time of the accident.

[15] With regard to the options for investigating failed mooring lines, see the BSU's Investigation Report 302/07 (Personal accident with stern line on the MS [sic] NORTHERN FAITH on 4 July 2007 in port of Koper). Source: www.bsu-bund.de.

Moreover, it is always possible that wind pressure may have caused or contributed to line failures. The official report of Germany's National Meteorological Service (DWD) obtained by the BSU indicates that at the time of the accident wind peaks from the west of up to 10 m/s[16] prevailed at the scene of the accident, which were caused by the unobstructed impact of the wind and a funnel effect.[17] In principle, it is hardly conceivable that such a reading would be the sole cause of a line failure (especially for a ship with a relatively small windage area). That the wind factor could have contributed to the line failure when combined with other conditions cannot be ruled out, however.

2.3.4 Traffic rules and regulations in the lock – observance by the STEIN

The analysis of the relevant sources (see above) has unequivocally demonstrated that the STEIN passed through the lock gate before it was fully open. Furthermore, this vessel left the lock first even though she had entered it after the THEMSESTERN.

Irrespective of the fact that the actions of the STEIN had no demonstrable influence on the accident, in the interest of establishing an overall view of the accident and its attendant circumstances, the BSU considered whether this (typical) handing would have impaired safety.

Section 29(5) of the German Traffic Regulations for Navigable Maritime Waterways (SeeSchStrO) states the following with regard to conduct in locks:

"No vessel shall leave a lock until the lock-gates have been completely opened. The lock [chamber] shall then be left without delay. When setting off, the ropes shall be handled in such a manner as to enable the vessel to be stopped dead immediately in the event that the vessel were about to proceed in a wrong direction. Unless otherwise agreed among those in command of the vessels involved, these shall leave the lock in the same sequence as they have entered."

As regards whether or to what extent it is – despite the legal position already outlined – reportedly common for smaller vessels in particular (e.g. recreational craft, work maintenance craft or support tugs) to pass through the lock gate before it is fully open and to deviate from the order in which they entered the lock in the process, various parties have advised the BSU that in practise it is quite possible that extremely small craft and recreational craft will leave the lock when the gate is only half open. Such a deviation from the order in which they entered was reportedly usually even beneficial for the safety of these vessels because they would avoid sailing into areas of rough water caused by the wake and bow thrusters of merchant shipping. Such vessels would not have negative hydrodynamic effects on the mechanics of a lock gate that is not yet fully open. On the other hand, it was reportedly in any event usual and justifiable for larger work maintenance craft and tugs to leave the lock if the gate only required a few metres until it had reached the open position.

[16] Note: This corresponds to a wind force of between 4 and 5 Bft.
[17] Source: Official report on the weather conditions between 0800 and 1000 on 30 November 2019 at the NOK's Kiel-Holtenau lock; DWD, 30 December 2019.

Although the relevant technical recordings show that the STEIN had passed through the lock gate well before this moment, there is no evidence to suggest the existence of a causal link between this and the THEMSESTERN's line failure.

The VHF radio traffic recordings do not indicate an agreement between the ship's command of the THEMSESTERN and that of the tug on a change of order when leaving the lock. However, it can be deduced from a radio call between the lockmaster and a vessel in the NOK waiting for tug assistance that the change of exit sequence – at least by the lock operating staff and with regard to the support tug STEIN having priority – was apparently regarded as a legitimate or usual procedure that, even without any special arrangements between the vessels in the lock, did not require any special agreements. In any case, this is indicated by the radio call between the lockmaster and cargo ship waiting for a tug, which took place at about the same time as the gate began to open and contains the following, quoted verbatim: *"The tug is actually the fourth but she will probably sail out first and head toward you."*[18]

2.3.5 Measures taken by the WSV (in the sense of earlier accident prevention)

During face-to-face discussions with the WSV staff responsible for occupational safety in the NOK locks and in the course of reviewing the relevant regulations, the BSU's investigation team found that the considerable – unfortunately never completely avoidable – dangers posed by lines failing in a lock are the subject of a wide variety of precautionary measures. Previous line accidents have led to the enhancement of existing technical and organisational precautions that are primarily concerned with minimising risks to people caused by lines failing.[19]

In particular, the *Schleusenbetriebsverordnung* [lock operation regulations][20], the *Betretungsordnung* [entry regulations] for NOK locks[21] and the *Gefahr durch brechende Schiffsleinen* [hazard due to lines failing] operating instruction, which was last updated in May 2019, contain important information and binding specifications that should minimise the consequences of line failure if complied with. The above regulations must be observed by every individual present in the lock facility and as such also by linesmen, in particular. The latter group of people is also made aware of the danger posed by lines failing by their employer when they are recruited and during regular occupational safety briefings.

[18] Source: VHF radio recording of VTS NOK.
[19] See also the comments in Section 4.7 of the BSU's Investigation Report 557/08 (Fatal accident caused by a mooring line of the TMV COVADONGA breaking on 28 October 2008 in Brunsbüttel Lock). Source: www.bsu-bund.de.
[20] Full title: *Verordnung über den Betrieb der Schleusenanlagen im Bereich des Nord-Ostsee-Kanals, des Achterwehrer Schifffahrtskanals, des Gieselau-Kanals und der Eider vom 30. August 1999* [regulations for the operation of lock facilities in the area of the Kiel Canal, the Achterwehr Canal, the Gieselau Canal and the Eider of 30 August 1999] (VkBl. [Gazette of the BMVI] 1999, 653).
[21] Full title: *Betretungsordnung für die Schleusenbetriebsgelände Brunsbüttel und Kiel-Holtenau des Nord-Ostsee-Kanals* [entry regulations for the Brunsbüttel and Kiel-Holtenau lock facilities of the Kiel Canal].

In addition to the aforementioned regulations and regular occupational safety briefings, the prominent warning signs and large notice panels displaying safety instructions, which the WSV has installed at the NOK's Brunsbüttel and Kiel-Holtenau locks, make an important contribution to occupational safety (see **Figure 13**).

Figure 13: Warning sign and safety instructions at the NOK's Kiel-Holtenau lock facility

Moreover, following line accidents that occurred a number of years ago various shelters were installed especially for this purpose on the NOK's Kiel-Holtenau and Brunsbüttel lock walls. These are intended as a safe place to stay for linesmen waiting for their assignments, as well as readily accessible places of refuge when typical noises or vibrations indicate that a line may be overloaded (see **Figure 14 ff.**).

Figure 14: Shelter on the middle wall of the lock in Kiel-Holtenau

Figure 15: Shelter (close-up)

Figure 16: Shelters on the lock walls in Brunsbüttel

During a survey of the shelters, it seemed doubtful to the BSU's investigation team that they were actually equipped with shatterproof glass given their external appearance. However, the WSV staff responsible for safe lock operation in Brunsbüttel and Kiel-Holtenau confirmed this was the case when asked.

As an additional occupational safety measure for the lock facilities, yellow marking has been applied across the entire length of the area immediately adjacent to the edge of the lock walls in Kiel-Holtenau and Brunsbüttel. To minimise the risk of falling, this area must not be entered (see **Figure 17**).

Figure 17: Edge marking on the lock walls in Kiel-Holtenau (left) and Brunsbüttel (right)

Accordingly, the BSU's investigation has shown that the WSV has acted in a variety of ways to protect against the effects of a line failure in recent years.

However, the failure of the THEMSESTERN's head line has revealed a hitherto insufficiently identified deficit in the package of measures described above, i.e. that prior to the accident in question the WSV had evidently not considered that a failing ship's line could ultimately smash into the windowpanes or glazed door of a building located in the immediate vicinity of the lock walls. Accordingly, the relevant glazing in the (small) service building damaged during the THEMSESTERN accident, but also that of the large lock control station on the middle wall of the lock in Kiel-Holtenau, was not shatterproof or protected by wire mesh, for example. On the other hand, following a corresponding request for information the BSU was advised that safety glass has reportedly been installed in the buildings (which are exposed to similar risks) at the Brunsbüttel lock facility for many years (see **Figure 18**).

Figure 18: Lock control stations in Kiel-Holtenau (left) and Brunsbüttel (right)

2.3.6 Actions taken

The WSV has notified the BSU that both the small service building damaged by the line failure on the THEMSESTERN and the ground floor and first floor of the lock control station on the middle wall of the new lock in Kiel-Holtenau have now been fitted with safety glazing. In addition, the glazing of the shelters installed on the lock walls in Kiel-Holtenau and Brunsbüttel was inspected and found to be safe.

3 CONCLUSIONS

3.1 The particular hazard posed by a line failure

The THEMSESTERN accident has once more shown that a failed mooring line can pose a considerable risk to people on board and ashore, including those in a permanently fixed building.

The risk of a line failure can be significantly reduced by careful and diligent handling of mooring lines, by regular visual inspections, by timely replacement and by observing the specific load limits.

However, the options for eliminating a line failure altogether are limited. Completely unbreakable lines do not exist in the maritime shipping sector. Moreover, the unique conditions when mooring a ship, be they due to external (e.g. weather-related) circumstances or technical errors or human errors at the manoeuvring stations or while manoeuvring, mean that line failures represent an operating risk for ships that is almost inherent in the system and can probably never be ruled out completely. This theory is confirmed by the fact that each year there is a more or less constant total of some 25 line failures equally distributed across the NOK's Kiel-Holtenau and Brunsbüttel locks.[22]

From a maritime perspective and in this respect especially in the case of lock passages, but also in the case of other operational activities (e.g. cargo handling), it must be considered that even small changes in the position of a ship due to her being raised or lowered in a lock or also in port due to changes in her load condition can have a major effect on the load mooring lines are exposed to. Although the mooring winches regularly in use on board seagoing ships today are generally designed to automatically compensate for changing tensile loads, this does not relieve a ship's crew of its responsibility to check the line routing or carefully monitor the proper functioning of winches.

One of the WSV's staff members who has been observing operational processes in the NOK's Brunsbüttel lock for many years in the course of carrying out his profession reported to the BSU's investigation team that this important shipboard duty is sadly often neglected. For example, seafarers on deck would – quite understandably from a human perspective – use some of the time spent in the NOK locks for contacting friends and relatives at home with their smartphones due to the lock facility having mobile network coverage. It is quite obvious that such distractions are not conducive to the focused monitoring of mooring lines.

[22] Source: Information from the WSV.

3.2 Occupational safety ashore

Of course, there are very few options for minimising the risk of line failure ashore. At most, it would be conceivable for the WSP or other supervisory bodies to pay greater attention to the condition of deployed lines in the course of their official duties and to urge a ship's command to take immediate action in the event of apparent deficits.

Due to the extreme lack of options for influencing shipboard aspects of safe line handling ashore, but especially due to the fact that a line failure will never be completely avoidable, organisational and technical measures ashore aimed at protecting people from the effects of a line failure are of particular importance.

The investigation of activities at the NOK's lock facilities in Kiel-Holtenau and Brunsbüttel has shown that the departments responsible at the WSV have taken important and effective precautionary measures structurally (shelters), through rules and regulations, as well as through the installation of warning notices and marking of especially hazardous areas.

The installation of shatterproof glazing in the two buildings on the middle wall of the new lock in Kiel-Holtenau following the THEMSESTERN's line failure is another building block in the WSV's package of measures.

3.3 Traffic rules and regulations in the NOK's locks

Despite the fact that there is no reliable evidence to suggest the existence of a causal link between the THEMSESTERN's line failure and handling of the STEIN, the analysis of the technical recordings demonstrates that in practise the relevant provision for manoeuvring in the NOK's locks (Section 29(5) SeeSchStrO) is evidently interpreted less strictly than its unambiguous wording has thus far required. Both with regard to the requirement of having the lock gates fully opened when sailing out of the lock and to the conditions for changing the order when leaving the locks, practises that are not readily accounted for by and do not fully comply with the content of the provisions have evidently evolved.

Indeed, regardless of when they enter the lock, that small recreational craft leave it first is certainly understandable and possibly even necessary for reasons of safety and expediency. Moreover, there is no discernible compelling technical or navigational reason why the respective lock gate would necessarily have to be fully open at the time in question. With regard to a change in the order of departure, it should also be noted that giving priority to support tugs may also be expedient. This applies to tugs whose imminent task is to assist vessels entering the lock, in particular. Avoiding unnecessary delays and optimising the overall flow of traffic from or into the NOK by quickly establishing towing connections is one reason that serves to increase traffic safety.

Such underlying conditions give rise to the question as to whether the aforementioned regulations in Section 29(5) SeeSchStrO, as amended, are actually fully consistent with the practical requirements and actual conditions in the NOK's locks. If and to the extent that procedures deviating from the content of the provisions have developed and proven themselves in practise, then the BSU believes that the rules that may contain procedural inconsistencies in this regard should be reconsidered so as to ensure legal certainty and clarity both on the part of traffic users and pilots, as well as on the part of authorities monitoring the provisions.

3.4 Final remarks

The cause of the failure of the THEMSESTERN's head line could not be clarified. That the line in question had previous damage (not visible on the surface) is conceivable. Having said that, it is also conceivable that an error was made when operating the relevant winch on the forward manoeuvring station during preparations for the casting off manoeuvre, i.e. that the line was tightened instead of loosened. A strong gust of wind and/or the STEIN's wake cannot be completely ruled out as cumulative accident factors but the BSU believes it to be highly unlikely that they were the primary cause of the accident.

The focus of the BSU's investigation was on the occupational safety measures taken by the WSV, which is responsible for the operation of the NOK's locks. It became clear that the hazards posed by failing lines have already been the focus of considerable attention for years through a wide range of regulatory and technical activities. As a consequence of the accident, a remaining gap in the safety strategy was closed by installing shatterproof glass in the buildings on the middle wall of the new lock in Kiel-Holtenau. Accordingly, it is not necessary for the BSU to issue a related safety recommendation.

However, the BSU does consider it appropriate to publish a summary investigation report on the THEMSESTERN's line accident. The report is intended to draw attention to the inherent dangers of mooring lines. Although this is a widely known risk factor (at least in maritime circles as well as among shore-based personnel in ports and locks), the fact that a line failure – regardless of actual cause – can happen suddenly at any time and have serious consequences for life and limb makes it imperative to raise awareness of this accident risk repeatedly.

4 SOURCES

- Investigation results and photographs of WSP Schleswig-Holstein
- Photographs of the MV THEMSESTERN and tug STEIN, Hasenpusch Photo-Productions, Hamburg
- Technical recordings, log extracts and other relevant documents and information from the WSV
- Official report on the weather conditions between 0800 and 1000 on 30 November 2019 at the NOK's Kiel-Holtenau lock, DWD, 30 December 2019
- Discussions with representatives of the operating staff of the NOK's Brunsbüttel and Kiel-Holtenau locks, as well as with other NOK administration staff
- Discussion with linesmen at the Kiel-Holtenau lock and a representative of their employer
- Statement by the THEMSESTERN's pilot and by the NOK II Pilot Association's alderman