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Schifffahrtsverwaltung
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Report

on the occurrence and causes of the accident involving the TMS Waldhof on 13 January 2011 on the Central Rhine (553.75 km mark)

SUMMARY

Foreword

In an ordinance issued on 31 January 2011, the Federal Ministry of Transport, Building and Urban Development commissioned the Waterways and Shipping Directorate Southwest (Wasser- und Schifffahrtsdirektion Südwest), as the competent policing authority, to carry out, within the framework of independent administrative proceedings, an investigation into the accident involving the TMS Waldhof which occurred on 13 January 2011.

The purpose of the enquiry was exclusively to determine the circumstances of the accident, to draft an investigation report and, as appropriate, a number of safety recommendations with a view to preventing any future incidents likely to cause damage or present a danger. *The aim was not to state the facts in order to determine whether mistakes had been made, or to apportion blame or liability, or make any other claims.* Neither was the study intended to examine and assess the consequences of the accident (occurrence of the accident, interruption of navigation on the Rhine, economic consequences, etc).

In view of the complexity of the accident and the far-reaching consequences of the wreck, an interdisciplinary group of experts covering a broad spectrum of technical knowledge was constituted in the form of an enquiry commission in order to determine the causes of the accident. The commission charged with carrying out the enquiry into the accident involving the TMS Waldhof comprised the following experts:

Igor Alexander	Waterways and Shipping Directorate Southwest *(Wasser- und Schifffahrtsdirektion Südwest)*, Mainz – nautical science
Hans-Josef Braun	Trade Association for Transport and the Transport Sector (*Berufsgenossenschaft für Verkehr und Transportwirtschaft)* – shipbuilding and marine engineering, ADN
Thorsten Dettmann	Federal Waterways Engineering and Research Institute (*Bundesanstalt für Wasserbau*), Karlsruhe – shipbuilding
Hanno Fimmen	Federal Waterways Engineering and Research Institute (*Bundesanstalt für Wasserbau*), Hamburg – shipbuilding
Hermann Haberkamp	German Federal Waterways and Shipping Administration, Traffic Technologies Centre (*Fachstelle der WSV für Verkehrstechniken*), Koblenz – radio communications and traffic safety technology, radar
Heiner Katz	Federal Waterways Engineering and Research Institute (*Bundesanstalt für Wasserbau)*, Hamburg - shipbuilding theory
Frank Krischok	Federal Institute for Materials Research and Testing (*Bundesanstalt für Materialforschung und -prüfung*), Berlin – dangerous goods and substances, chemistry
Frank Otremba	Federal Institute for Materials Research and Testing (*Bundesanstalt für Materialforschung und -prüfung*), Berlin – tankers for dangerous goods and accident mechanics
Michael Pötsch	Federal Institute for Materials Research and Testing (*Bundesanstalt für Materialforschung und -prüfung*), Berlin – tankers for dangerous goods and accident mechanics
Rolf Kentgraf	Federal Waterways Engineering and Research Institute (*Bundesanstalt für Wasserbau*), Karlsruhe – river systems
Michael Putzschke	Waterways and Shipping Directorate Southwest *(Wasser- und Schifffahrtsdirektion Südwest)*, Mainz – river police, regulations

One boatman lost his life as a result of the capsizing of the TMS Waldhof and another boatman is still missing. The members of the enquiry commission would like to express their sincere condolences to the member of the families of these boatmen in the tragic loss of their loved ones.

The enquiry commission hopes that the conclusions of its work and the recommendations included in the enquiry report will help to prevent any future occurrence of such a major accident with serious consequences as that which occurred on the morning of 13 January 2011 near the Lorelei rock.

Occurrence of the accident

The TMS Waldhof left the port of Ludwigshafen on the Rhine at about 9.30 pm on 12 January 2011, carrying a load of 2 378 tonnes of 96% sulphuric acid (UN no. 1830) and began the passage downstream towards Antwerp, the intended port of unloading.

The vessel reported to the regional traffic centre at Oberwesel at 4.29 am on 13 January 2011, and at 4.32 am reached the section of the Rhine between Oberwesel and St Goar that is monitored by radar and regulated by warning signals. After passing an oncoming pushed convoy and then a motor tanker travelling upstream, at 4.41 am the TMS Waldhof passed a container vessel heading upstream at the point on the Rhine referred to as “Betteck”, at the 553.43 km mark. At 4.42 am, the TMS Waldhof capsized over the starboard side downstream of the “Betteck”, level with the demarcation buoy for the navigation channel at the 553.75 km mark, and then disappeared from the radar screens of the Oberwesel regional traffic centre; the vessel continued to drift downstream, bottom up.

After capsizing, the overturned vessel drifted (with the bow pointing downstream) past a pushed convoy travelling upstream and then, at 4:46 am at the 554.6 km mark of the Rhine, very probably collided with a motor tanker also travelling upstream. Then, at 4:48 am at the 554.85 km mark, the bow of the vessel was forced by the current into the left bank of the Rhine.

The TMS Waldhof then broke free from the left bank of the river and continued to drift downstream, bottom up and perpendicular to the navigation channel, passing another motor tanker travelling upstream at 4:49 am. At 4.51 am, the capsized TMS Waldhof passed a pushed convoy travelling upstream, then at 4.52 am the vessel ran aground at the 555.33 km mark with first the stern becoming lodged, before being righted by the force of the current. It finally came to rest on the right edge of the navigation channel with the bow pointing downstream and lying on the port side.

Consequences of the wreck

As a result of the TMS Waldhof capsizing, one boatman lost his life and another is still missing. Assistance was given to two crew members who were injured during the incident.

By the time salvaging operations were completed, the Rhine had been partially or fully closed to vessel traffic for a 32-day period; as a result, in particular upstream from the scene of the accident, as many as 450 vessels were unable to continue travelling downstream.

One direct consequence of the TMS Waldhof capsizing and lying grounded on its side was that between 343 and 523 900 tonnes of sulphuric acid quickly leaked from the release valves into the Rhine. About 555 tonnes of sulphuric acid were transhipped to another tanker before the salvaging operations were complete. Between 1 and 10 February 2011, a further 1150 to 1330 tonnes of sulphuric acid were drained into the Rhine under controlled conditions as part of the salvaging operation. Subsequently, about 150 tonnes were pumped from the TMS Waldhof as residual cargo and duly eliminated.

Analysis of the accident

Analysis of the capsizing of the TMS Waldhof has resulted in the following conclusions:

- After analysing the radar recordings, simulations carried out on a vessel handling simulator and additional three-dimensional hydrodynamic simulations (HN-3D), it transpires that the TMS Waldhof capsized to starboard near the red demarcation buoy for the navigation channel at the 553.75 km mark.

- The TMS Waldhof was built and equipped at the time of the accident (or at the time it was built or retrofitted) to comply with the specific regulations of river police regulations and the regulations on dangerous goods.

- The level of skill and the number of crew members on board complied with the provisions of the Rhine Vessel Inspection Regulations and the regulations on boatmaster's certificates.

- A number of trained and qualified specialists in the tanker transport of chemicals were on board, in compliance with the prescriptions on the transport of dangerous goods.

- The passage of the TMS Waldhof downstream on 13 January 2011, when the water level was above high water mark I, with correspondingly high current speeds, and particularly heavy traffic during the night, was in accordance with both the general and specific traffic regulations as set out in the Rhine Police Regulation for the navigation of the Rhine.

- The TMS Waldhof was permitted in terms of quality to transport 96% sulphuric acid (density = 1.84 t/m^3) in accordance with the ADNR approval certificate issued for the vessel in conjunction with the substance list issued by the classification society.

- According to the stability calculations checked, completed and validated by the classification society for the TMS Waldhof, which form part of the stability documents which henceforth are required to be kept on board in accordance with sub-section 8.1.2.3 c of ADNR 2011,

  - stability in the event of accident was only attested for the TMS Waldhof for loading conditions involving a cargo density of 1.62 t/m^3 and a maximum draught of 3.11 m;
  - loading conditions other than those checked by the classification company were only authorised if a loading calculator approved by Germanischer Lloyd was present on board; this would have made it possible to supply results on the basis of longitudinal stability, stability in intact state, and stability after an accident, but there was no such approved loading calculator on board the TMS Waldhof.

- The maximum filling level of the seven cargo tanks (70.8%) had not been exceeded; the loading levels were between 50 and 61%, meaning that there was no threat to the longitudinal stability of the hull.

- At the time of the accident, the TMS Waldhof did not meet the stability criteria specified in ADNR 2003 or ADN 2011, and did not meet the requirements of the general prescription on stability contained in Article 1.07 (3) of the Rhine Police Regulation.

- Studies on the vessel handling simulator showed that the moments of roll inertia with a heeling effect peak at the 553.75 km mark, in the sector where the accident occurred.

- HN-3D modelling showed, near the 553.75 km mark, close to the demarcation buoy for the navigation channel, the presence of currents in the navigation channel that, for a vessel moving downstream, would provoke a heeling moment to starboard.

- The three-dimensional kinetic calculations extended on the basis of the data produced by the vessel handling simulator show that it was the sum of all the heeling moments near the red demarcation buoy for the navigation channel at the 553.75 km mark that caused the capsizing of the TMS Waldhof.

Causes of the accident

The causes of the accident were as follows:

- The TMS Waldhof started out on its journey and travelled even though sufficient stability and stability in compliance with the prescriptions had not been assured, because loading had been non-compliant (partial loading of all seven cargo tanks).

The following factors also contributed to the accident occurring:

- strong crossways accelerations during passage of the “Betteck” bend, which has a very tight angle;

- heeling moments resulting from the dynamic effects caused by movements of the cargo in the tanks;

- heeling moments resulting from the three-dimensional flows around the vessel’s hull, with the formation of areas of low pressure on the starboard side of the vessel in the section where the accident occurred at the 553.75 km mark.

Added together, the heeling moments resulting in particular from passage of the bend, but also from the movements of the cargo and sloshing, as well as the three-dimensional flows around the vessel’s hull to starboard, exceeded the maximum possible righting moment, resulting in the vessel, loaded in non-compliant fashion, to capsize to starboard.

The following additional factors may also have had some impact:

- the difficult and unusual current conditions for the skipper of the TMS Waldhof because of the high water level in the section downstream of the “Betteck”;

- the effect of passing the goods vessel Acropolis (effect on course being steered) during the night;

- the density of traffic (upstream);

- the absence on board of any means of calculating loading conditions different from checked and validated conditions, and ensuring compliance with ADN stability criteria;

- the absence of an AIS device on board the TMS Waldhof.

The investigation into the accident did not identify any reliable indications of the existence on board of any defects in the construction or equipment of the TMS Waldhof, or any technical failures, engine failures, or failures in the steering equipment, leaks, or navigational errors on the part of the skipper. These factors may be excluded as partial causes of the accident, as may grounding and hitting the banks.

Proposals and recommendations

On completion of the analysis of the lessons to be learned, and taking account of the amendments and additions to the ADN which are to enter into force on 1 January 2013, the following additional measures are proposed and recommended:

- The provision contained in paragraph 7.2.4.21.3 of ADN 2011 (calculation of the maximum filling level allowed for cargo tankers) appears to be pointless, given the extensions of the scope of ADN 2013, and should be re-examined with a view to being deleted.

- On the Rhine,

  - the obligation to possess and use AIS and Inland ECDIS equipment should be decided on and introduced in the very near future;
  - a ban on overtaking applicable to vessels and convoys (except for small craft) at “Betteck”, “Bankeck”, and “Tauberwerth” when flood level mark I is reached, because of the fast current speeds and in view of the provision of Article 10.01 (1) a) and b) of the RPNR.

- The examinations for obtaining the Rhine boatmaster’s certificate (“grande patente”) in accordance with the Regulations for Rhine navigation personnel should be extended, so that stability issues (stability in intact state and after an accident) for the transport of dry goods, for tanker transport and for container transport are broadly included in the training syllabus.

- The content of the training provided by the various vocational training institutes for boatmen should be checked and if necessary supplemented so that future boatmen shall have sufficient knowledge of the stability of vessels for the transport of dry goods, tanker transport and container transport, and on the general functioning, possibilities and limits of loading calculators.

- The owners and/or operators of tanker vessels must ensure continuous training not only for their own crew members on board but also for non-navigating personnel ashore (managers), by means of in-house or external training courses on vessel stability and safety. Crew members on board should also receive regular training in manipulating and using specific loading calculators on board tanker vessels in their fleet.

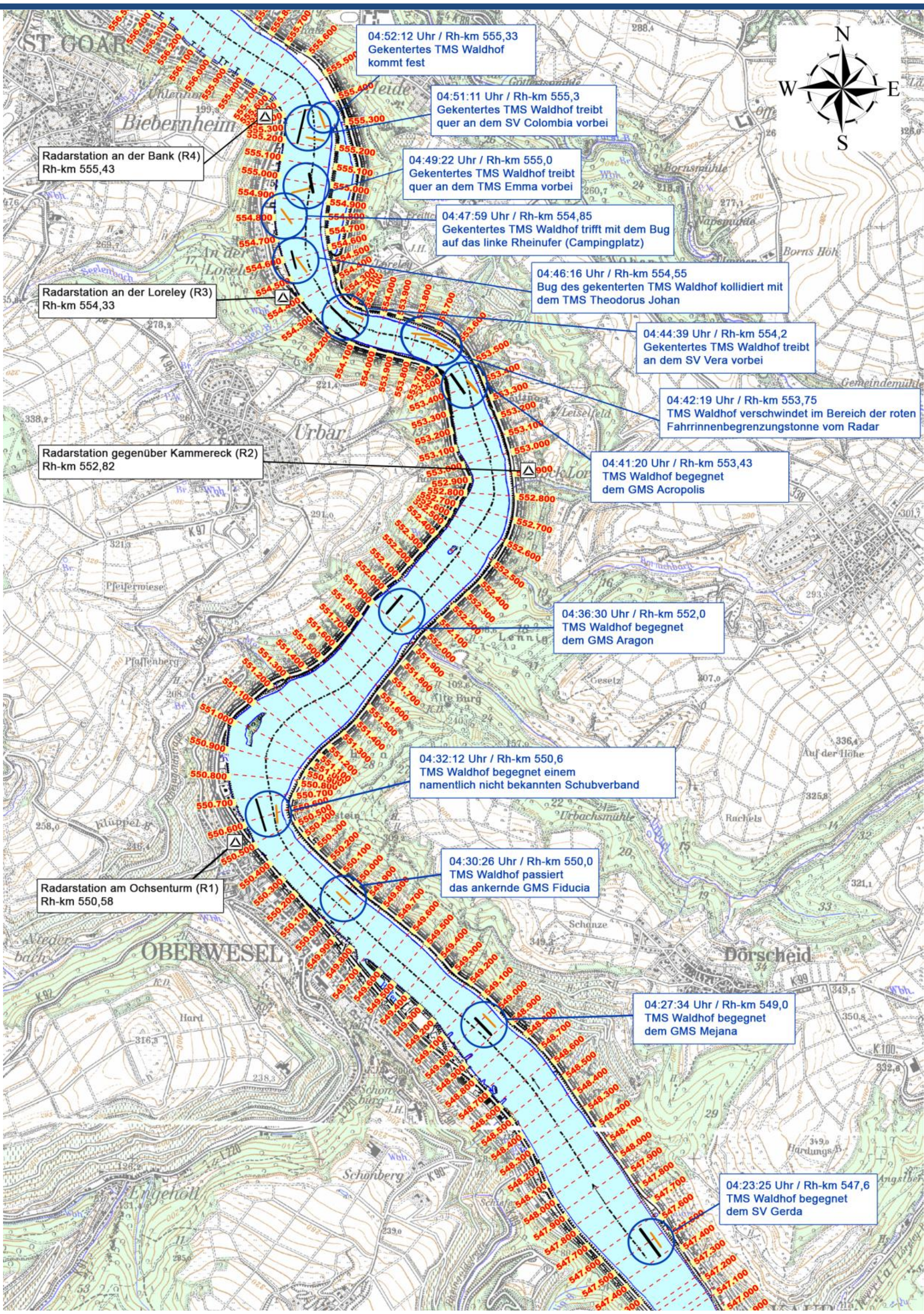
- The authorities competent for issuing the inspection certificate should as far as possible indicate the maximum draught on the certificate whenever possible, taking into account the least draught permissible for stability, solidity and freeboard.

- The competent authorities should examine the possibility of signalling the Gebirge sector of the Rhine between Oberwesel and St Goar as a “Caution Area”, in order to draw boatmen’s attention to the specific features of this sector (such as current conditions in the event of flood level mark I being exceeded).

In the context of the capsizing of the TMS Waldhof, there was extensive discussion in specialist circles and among the people concerned on whether or not it was necessary to have longitudinal central partitions on double-hulled tanker vessels. The enquiry commission issues the following opinion on this point:

Double-hulled vessels in inland navigation that are fitted with “central” tanks are basically safe, as long as the prescriptions on stability set out in the ADN are strictly respected and applied and, when the vessel is being loaded, full account is taken of the calculations of stability corresponding to the vessel (stability guide), which have been checked by the classification society.

Consequently, the enquiry commission does not find it necessary to amend the prescriptions contained in the ADN concerning construction to require double-hulled tanker vessels to be fitted with longitudinal central partitions. The provisions of ADN 2011 on stability and the supplemented prescriptions on this point contained in ADN 2013 offer a comparable level of safety to that assured by the presence of longitudinal central partitions and, consequently, owners should be left the choice of one or other of these options.


N
W
E
S
ST. GOAR
Biebernheim
Urbar
OBERWESEL
Dörscheid
04:52:12 Uhr / Rh-km 555,33
Gekentertes TMS Waldhof kommt fest
04:51:11 Uhr / Rh-km 555,3
Gekentertes TMS Waldhof treibt quer an dem SV Colombia vorbei
Radarstation an der Bank (R4)
Rh-km 555,43
04:49:22 Uhr / Rh-km 555,0
Gekentertes TMS Waldhof treibt quer an dem TMS Emma vorbei
04:47:59 Uhr / Rh-km 554,85
Gekentertes TMS Waldhof trifft mit dem Bug auf das linke Rheinufer (Campingplatz)
04:46:16 Uhr / Rh-km 554,55
Bug des gekenterten TMS Waldhof kollidiert mit dem TMS Theodorus Johan
Radarstation an der Loreley (R3)
Rh-km 554,33
04:44:39 Uhr / Rh-km 554,2
Gekentertes TMS Waldhof treibt an dem SV Vera vorbei
04:42:19 Uhr / Rh-km 553,75
TMS Waldhof verschwindet im Bereich der roten Fahrrinnenbegrenzungstonne vom Radar
Radarstation gegenüber Kammereck (R2)
Rh-km 552,82
04:41:20 Uhr / Rh-km 553,43
TMS Waldhof begegnet dem GMS Acropolis
04:36:30 Uhr / Rh-km 552,0
TMS Waldhof begegnet dem GMS Aragon
04:32:12 Uhr / Rh-km 550,6
TMS Waldhof begegnet einem namentlich nicht bekannten Schubverband
Radarstation am Ochsenturm (R1)
Rh-km 550,58
04:30:26 Uhr / Rh-km 550,0
TMS Waldhof passiert das ankernde GMS Fiducia
04:27:34 Uhr / Rh-km 549,0
TMS Waldhof begegnet dem GMS Mejana
04:23:25 Uhr / Rh-km 547,6
TMS Waldhof begegnet dem SV Gerda

04.52.12 / 555.33 km
Capsized TMS Waldhof runs aground

04.51.11 / 555.3 km
Capsized TMS Waldhof drifts at an angle past SV Colombia

Bank radar station (R4)
555.43 km

04.49.22 / 555.0 km
Capsized TMS Waldhof drifts at an angle past TMS Emma

04.47.59 / 554.85 km
Bow of capsized TMS Waldhof strikes left bank of Rhine (camp site)

04.46.16 / 554.55 km
Bow of capsized TMS Waldhof collides with TMS Theodorus Johan

Lorelei radar station (R3)
554.33 km

04.44.39 / 554.2 km
Capsized TMS Waldhof drifts past SV Vera

04.42.19 / 553.75 km
TMS Waldhof disappears from radar in area of red channel marker buoy

04.41.20 / 553.43 km
TMS Waldhof passes GMS Acropolis

Radar station opposite Kammereck (R2)
552.82 km

04.36.30 / 552.03 km
TMS Waldhof passes GMS Aragon

04.32.12 / 550.63 km
TMS Waldhof passes pushed convoy (name unknown)

Ochsenturm radar station (R1)
550.58 km

04.30.26 / 550.0 km
TMS Waldhof passes GMS Fiducia at anchor

04.27.34 / 549.0 km
TMS Waldhof passes GMS Mejana

04.23.25 / 547.6 km
TMS Waldhof passes SV Gerda

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