



Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Bundesoberbehörde im Geschäftsbereich des Bundesministeriums
für Verkehr, Bau- und Wohnungswesen

Investigation Report 330/03

Very serious marine casualty

**Fatal accident during welding in the
engine-room workshop of
MV DRESDEN EXPRESS
on 26 October 2003**

The investigation was conducted in conformity with the Maritime Safety Investigation Law (SUG) of 24 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.

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1 Summary of the marine casualty

On 26 October 2003 MV DRESDEN EXPRESS was on a sea passage from Oakland (USA) to Yokohama (Japan).

At about 09.40 h local time¹ there was an explosion in the area of the welding workplace in the vessel's engine-room workshop. A Philippine engine fitter who was carrying out welding work there was hit so heavily by broken pieces of the detonated fitting cabinet of the gas outlet station that he died shortly afterwards.

First aid measures initiated immediately with the help of Telemedical Maritime Assistance Germany - Medico Cuxhaven were unsuccessful.

¹ Time data without any special suffix are always local times in this report.

2 Location of the casualty

Nature of the incident: Very serious marine casualty
Date/time: 26 October 2003 approx. 9.40 h (19.40 h UTC)
Location: Pacific
Latitude/longitude: φ 36°30' N λ 163°16' W



Figure 1: Sea chart, excerpt from great circle chart of the Northern Pacific Ocean, BSH No.: 2703

3 Vessel particulars

3.1 Photo of vessel



Figure 2: DRESDEN EXPRESS (photo of vessel by Hasenpusch Photo-Production)

3.2 Vessel particulars

Name of vessel	DRESDEN EXPRESS
Type of vessel	Container vessel
Nationality/flag	Germany
Port of registry	Hamburg
IMO number	8902553
Call signal	DHDE
Operator	HAPAG-LLOYD CONTAINER LINIE GMBH
Year built	1991
Building yard	Samsung Shipbuilding & Heavy Industries Co., Ltd.
Hull material	Steel
Classification society	Germanischer Lloyd / No.: 32697
Classification	GL 100A5E + MC AUT
Crew	23
Length overall	294.00 m
Width overall	32,25 m
Gross registered tonnage	53,833
Deadweight	67,713 t
Draft at the time of the casualty	13.50 m
Engine rating	36510 kW
Main engine/Manufacturer/Type	MAN B&W/Hyundai Heavy Ind. Co., Ltd./9K90MC
Speed	23 kn

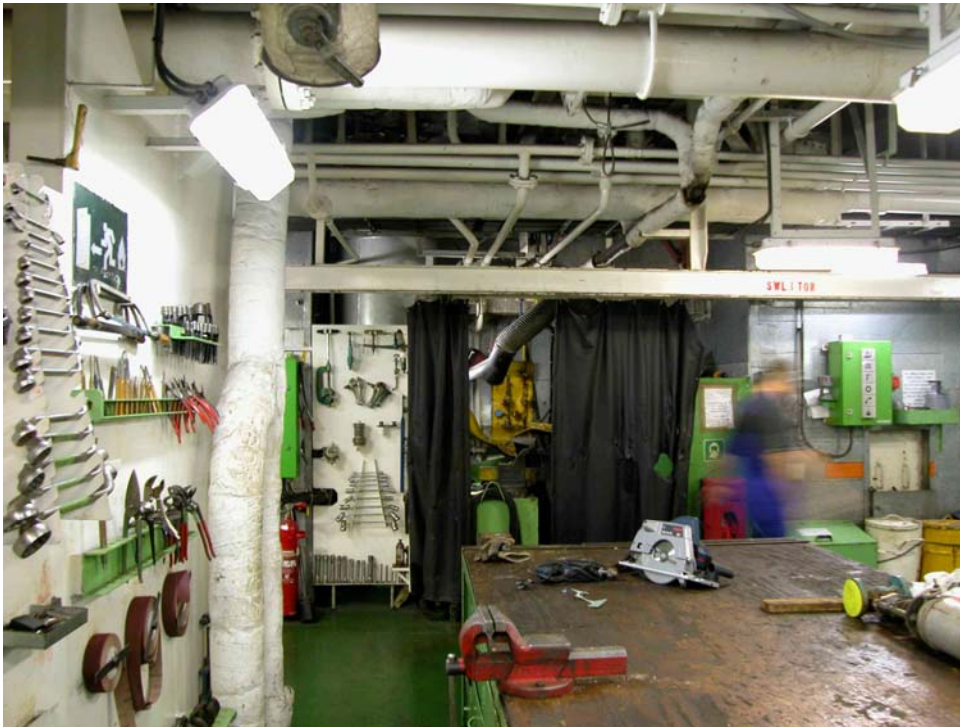


Figure 4: Welding workplace separated by curtain (view 1)

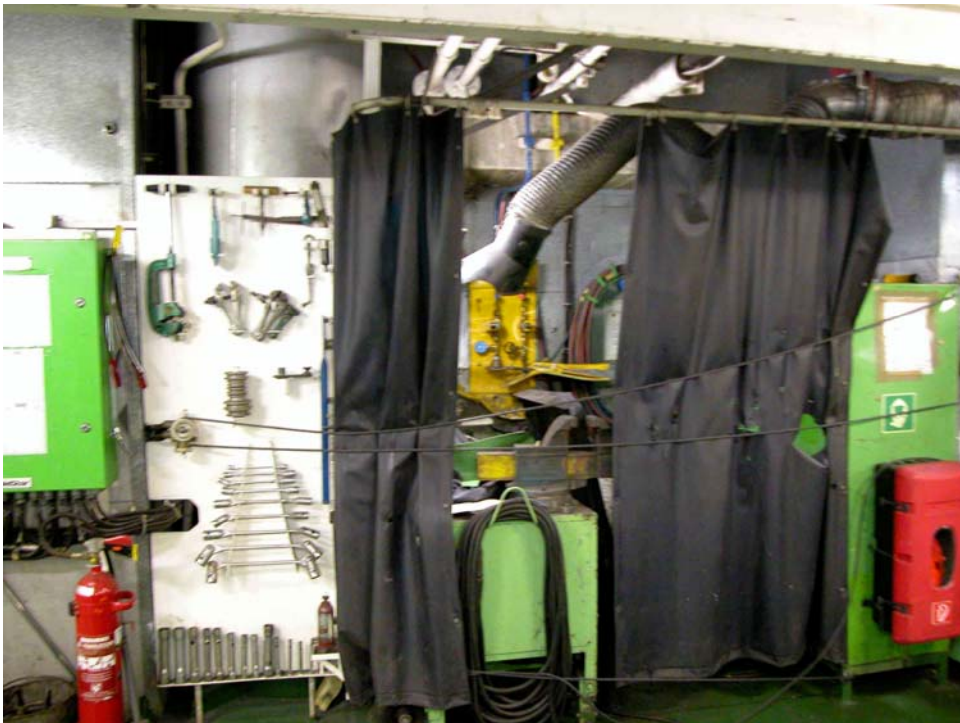


Figure 5: Welding workplace separated by curtain (view 2)

5 Summary of the loss/damage

The fitting cabinet of the gas outlet station was heavily deformed as a result of the explosion and the pressure gauges and shut-off devices inside were destroyed. The cabinet door was ripped off and flung over several meters into the workshop room by the force of the pressure wave.

The welder was hit so unfortunately by the door flying like a projectile through the room that he died shortly afterwards, despite first aid measures initiated immediately. The other crew members present in the engine-room workshop (Second Engineer and ship's mechanic) were not injured. The explosion did not trigger any fire or other impairment of the ship's safety.



Figure 6: Curtain ripped away and heavily deformed fitting cabinet door

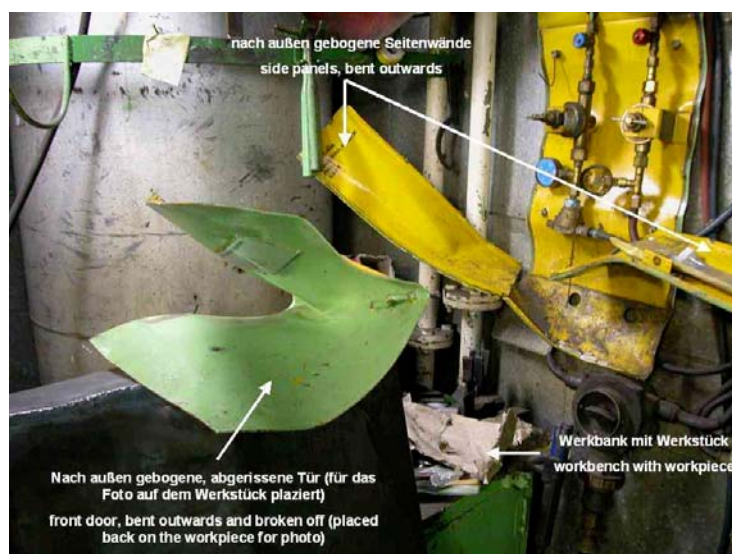


Figure 7: Detonated fitting cabinet (view 1)

6 Analysis

6.1 Preface

The following analysis of the marine casualty is based on the testimony of the Second Engineer and ship's mechanic cited above. Furthermore the BSU considered the expert opinion by the surveyor of the classification society (Germanischer Lloyd) made available by the vessel operator and the photos also handed out by the vessel operator.

The cause of the accident was ascertained in cooperation with the Institute for Material Science and Welding Engineering of the University of Applied Sciences Hamburg. However, the expertise issued by this facility could essentially only be drawn up on the basis of the above sources of information.

On the other hand, the additionally planned laboratory-specific examination of the broken fragments of the welding station that would have allowed a more reliable analysis of the accident could not be carried out.

On 31 October 2003 it was agreed between the BSU and the vessel operator that the remains of the destroyed welding station should be dismantled and secured and that it should be arranged to ship them to the BSU. The vessel operator forwarded the appropriate directions to the command of MV DRESDEN EXPRESS too, but these were not implemented consistently there. On 17 December 2003, shortly before it was planned to ship the installation, the vessel operator notified the BSU that the installation had been dismantled as agreed and stored on board for a few days too, but that within the framework of clearing up in the engine room it had then been thrown overboard in the Pacific during the passage from Yokohama to Seattle at the instruction of the Second Engineer.

In response to questioning by the BSU the responsible engineer could not provide any special motive for his action, but drew attention to the fact that he personally had not been informed of the agreement between the vessel operator and the BSU.

Despite the aforementioned difficulties, the Institute commissioned with the expertise was still able to provide a reliable judgement of the course of the accident and the probable main cause of the accident on the basis of the information available.

6.2 General remarks on setting up the gas welding system

Structure of a Gas Welding Plant

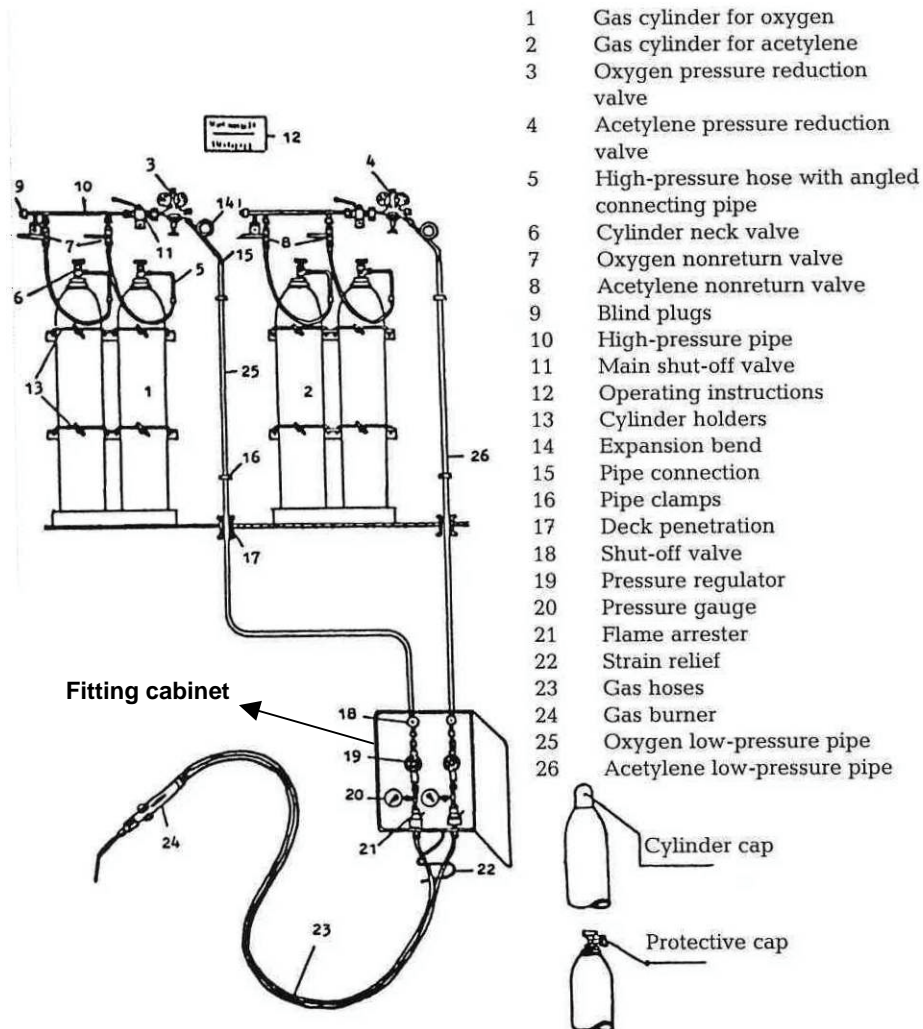


Figure 8: Set-up of the gas welding system²

Figure 8 shows the proper set-up of a gas welding system in diagram form in accordance with the Guidelines of the See-Berufsgenossenschaft (Safety Organisation) for Building, Fitting-out, Testing and Operating Welding Installations on Ships (Welding Guidelines) sailing under German flag.

In accordance with this Regulation, due to their particularly high explosion risk the gas cylinders (oxygen and acetylene) are to be stored in separate cylinder spaces or cylinder cupboards located above the highest continuous deck, gastight separated from the rest of the ship's spaces by steel walls, and they must be accessible through steel doors from the free deck.

² Source: Welding Guidelines of the See-Berufsgenossenschaft Hamburg (Safety Organisation) of 10 April 1985, p. 23.

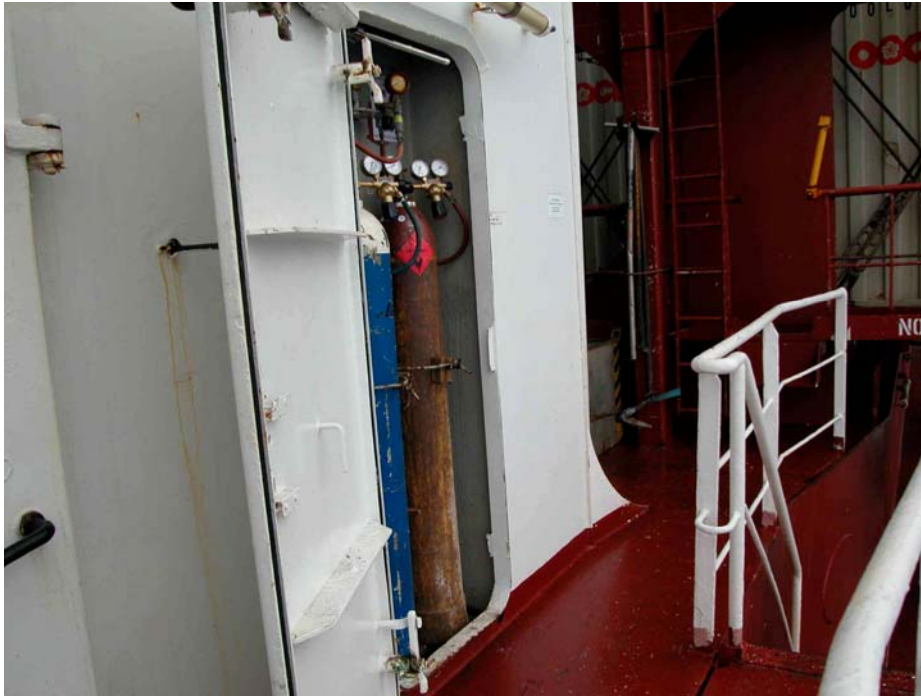


Figure 9: Cylinder space on the upper deck

The gas is supplied from the gas cylinder system to the consumer facility in the workshop via a piping system. The consumer facility (cf. figure 8 No. 18-24) is located in the engine-room workshop at the welding workplace. The gas outlet station with the shut-off valves, pressure regulators, pressure gauges and the Dry Use Storage is protected against mechanical influence on board by a fitting cabinet.

6.3 Probable course of the casualty

There must have been a leak in the acetylene supply line (pipe lengths, pressure gauges, shut-off valve, pressure regulators) in the fitting cabinet or in a union fitting located between these components (hereinafter referred to altogether as "acetylene line"), which led to acetylene escaping. As a result it was possible for an explosive mixture of air (oxygen!) and acetylene to form in the cabinet that must have been ignited by a spark or welding spatter.

In the subsequent explosion the cabinet was destroyed completely and the welder working directly next to it was hit fatally by the cabinet door ripped off in the detonation.

Since it was no longer possible to carry out a laboratory investigation of the remnants of the welding station, it was not possible to determine the exact place and cause of the leak within the acetylene line.

However, the analysis of the photos submitted (cf. figure 10) shows that changes to the original equipment status must have been made at some stage prior to the accident in the acetylene line inside the fitting cabinet. Although the surveyor of Germanischer Lloyd did not find defects or (inadmissible) modifications of the system during his survey of the destroyed welding station in Yokohama, the accuracy of these statements must be doubted.

This is due on the one hand to the different material condition of the acetylene line (shiny material that appears newer) by comparison with that of the oxygen line. Furthermore, the so-called Dry User Station adapter that is mandatorily specified in accordance with the aforementioned Welding Guideline to avoid flame backfiring is missing in the acetylene line.

(Note: The lack of the User Station adapter is not by itself connected with the accident, however.)



Figure 10: Detonated fitting cabinet (view 2)

It was no longer possible to reconstruct whether, when and by whom repairs / modifications of the installation had been carried out within the fitting cabinet. No special logbook for such work is specified and so none is kept on board.

6.4 Cause of the casualty

The enrichment of the air inside the fitting cabinet with the acetylene escaping due to the leak made it possible for a concentrated, high-explosive air (oxygen!) -acetylene mixture to form.

A concentration of this gas mixture necessary for the explosion would not have developed if the fitting cabinet had been equipped with sufficiently dimensioned ventilation apertures.

Instead there were only through apertures for pipes/hoses in the box that was closed in a relatively airtight manner. Although the two drill holes located at the bottom of the cabinet (cf. figure 10) were not used to pass the gas hoses through, since these were guided out of the box at the sides, these apertures were in any case too small to ensure the necessary ventilation of the fitting cabinet.

It is stated in § 34 Para 1 No. 6 of the Accident Prevention Regulations "Welding, cutting and related processes" of 1 April 1995 (version of 1 April 2001)³ that individual (gas) cylinder installations and cylinder battery installations may not be set up in areas that are not sufficiently ventilated. It is pointed out in the implementation instruction for this Regulation that insufficiently ventilated areas are, *for example (!)*, cylinder cabinets or workshop carriages with ventilation apertures that are too small. Adequate ventilation apertures are accordingly at least one aperture of at least 100 cm² each in the bottom and top areas.

The Regulation cited does not explicitly list fitting cabinets such as are used on board vessels to protect the gas outlet station against board-specific mechanical influences as areas that are to be ventilated. Nor does the fitting cabinet belong to the "gas cylinder installation" in the closer sense of the word. Instead, the cabinet is a component of the consumer device in the engine-room workshop (see above, section 6.2).

The above considerations are probably the reason why up to the time of the accident fitting cabinets were not generally classified as confined spaces particularly subject to the risk of explosion. Accordingly the cabinet under review here had been accepted by both the classification society and the safety organisation See-Berufsgenossenschaft and no objections had been made during surveys.

However, all this alters nothing in the fact that the purpose of the cited Regulation is to prevent the creation of explosive gas concentrations in narrowly confined spaces by ensuring adequate ventilation.

Against this background the fitting cabinet is in fact most definitely an area that must be adequately ventilated in view of the narrowly confined space and the large number of components and screw fittings inside it that are liable to leaks.

³ BGV D1 (previously VGB 15); issued by the Employers' Accident Insurance for Fine Mechanics and Electrical Engineering (note: the registration is also binding for (German) shipping enterprises via § 3 Para 1 Accident Prevention Regulations Sea).

6.5 Possible ventilation variants

Figure 11 shows a fitting cabinet that satisfies the ventilation requirements defined under section 6.4 in model manner. Cut-outs are evident at the top and bottom which according to the manufacturer's data measure 180 x 75 mm each and are thus even one third larger than the required value of 100 cm².



Figure 11: Fitting cabinet ventilated in accordance with regulations

In the cabinet model illustrated below, ventilation apertures were worked into the box housing at the top and bottom. This alternative is expedient especially when cabinets existing on board are to be adapted to the necessary ventilation requirements with little outlay. However, it should be noted here that the apertures to be worked in must indeed achieve the necessary size of at least 100 cm² each in order to ensure sufficient air circulation.

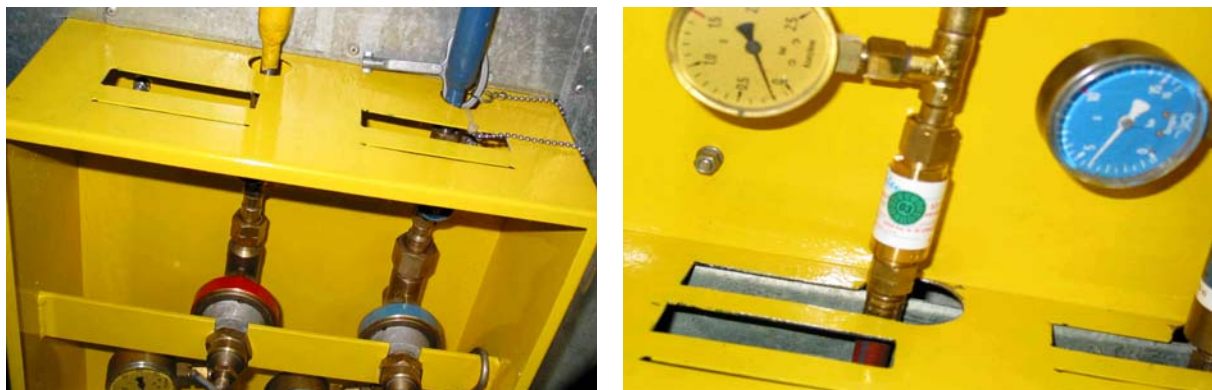


Figure 12: Fitting cabinet with ventilation apertures worked in at the top and bottom sides

7 Safety recommendations

The Federal Bureau of Maritime Casualty Investigation (BSU) drew attention to the dangers in connection with insufficiently ventilated fitting cabinets on 20 January 2004 even before completion of the investigation in a safety recommendation published in advance (cf. annex). Directly after the publication both the operator of DRESDEN EXPRESS and the See-Berufsgenossenschaft launched measures to implement the recommendation.

The operator arranged for the fitting cabinets installed on board its vessels to be examined, and modified any cabinets not provided with sufficient ventilation already by the manufacturers by retrofitting in accordance with the requirements.

In its circular of 04 February 2004 the safety organisation See-Berufsgenossenschaft called upon all full-time technical surveillance officers to check the ventilation apertures in fitting cabinets in forthcoming ship surveys, and if appropriate to arrange for such apertures to be constructed or enlarged.

The following safety recommendations build on the above-cited publication of 20 January 2004:

1. The attention of **Manufacturers of fitting cabinets, shipyards**, as well as **owners, outfitters** and **operators** of seagoing vessels is drawn to the fact that fitting cabinets in which the gas outlet stations of welding facilities are installed must be equipped with ventilation apertures in order to prevent the formation of explosive gas concentrations within the cabinet in the event of leaks. One aperture in the bottom and one in the top area of at least 100 cm² each are necessary.
2. In the case of new installations being installed it should be ensured by the **addressees named under 1** that the fitting cabinets satisfy the necessary requirements.
3. The **owners and operators** of seagoing vessels are requested to equip cabinets already installed on board subsequently with correspondingly large cut-outs in the top and bottom areas if the ventilation apertures are not yet sufficiently dimensioned.
4. The **See-Berufsgenossenschaft (Safety Organisation)** and the **Classification Societies** are called upon to supervise the implementation of the recommendations set out under Nos. 2 and 3.
5. The **See-Berufsgenossenschaft** is advised to include the ventilation requirement for fitting cabinets of gas outlet stations expressly in the Guidelines it issues for building, outfitting, testing and operating welding facilities on seagoing vessels (Welding Guidelines of 10 April 1985) to clarify this.
6. The **owners and operators** of seagoing vessels are called upon to ensure that no inadmissible modifications and inexpert repairs are carried out to gas welding installations on board their vessels.

7. The Federal Bureau of Maritime Casualty Investigation (BSU) advises the **See-Berufsgenossenschaft** to check the possibility of compulsory introduction of a "welding installation logbook" in order to document the nature, extent and execution of any maintenance work on welding installations. The BSU admittedly sees the problem of a further mandatory documentation on board connected with further administrative input for the engine staff. However, the surveyors of the classification societies could orient their relevant acceptance tests more specifically to possible weak points within the welding installations if such a document were available.⁴

8. Independently of the aspect of mandatory introduction of a welding installation logbook by the See-Berufsgenossenschaft contained in No. 7, **owners** and **operators** of seagoing vessels are advised to arrange for such a logbook to be kept, even without any corresponding legal obligation, in the interest of more effective supervision of welding installations on board the vessels. At least a documentation should be required for any work carried out on the welding installations within the framework of the existing maintenance system.

⁴ In its comment on the draft of the Investigation Report, the See-Berufsgenossenschaft pointed out that in view of the large volume of documentation that already had to be conducted on board, the introduction of an additional welding installation logbook would represent an incommensurate administrative outlay. Moreover, under certain circumstances the incomplete keeping of such a log could provide deceptive security for the surveyor. In any case, it was already possible to document work on/with the welding equipment in the engine log.

8 Annex

Original wording of the Safety Recommendation of 20 January 2004:

" The German Federal Bureau of Maritime Casualty Investigation (BSU) issues the following safety recommendation in accordance with § 9 Para. 2 No. 2; § 15 Para. 1 and 10 of the Maritime Safety Investigation Law (SUG) of 16 June 2002 in conjunction with § 19 Law Relating to the Investigation into Accidents and Incidents Associated with the Operation of Civil Aircraft (FIUUG) of 26 August 1998:

The German Federal Bureau of Maritime Casualty Investigation (BSU) is investigating the marine casualty of a Philippine engine fitter who lost his life during welding work in the engine room workshop of a container vessel due to an explosion on 26 October 2003.

The investigation process has not yet been completed. However, the cause of the accident has been determined. The structural design of the fitting cabinet at the welding workplace within the engine room workshop did not comply with the requirements of § 34 of the Accident Prevention Regulations for Safety and Health at Work (Accident Prevention Regulation Welding, Cutting and Related Processes, BGV D1, previous VBG 15, in the version of 1 April 2001). The implementing instruction of the said regulation that is binding via § 3 Para. 1 UVV See (Accident Prevention Regulations Sea) for shipping enterprises too specifies that insufficiently ventilated areas must be equipped with ventilation apertures in the floor and ceiling area of at least 100 cm² each.

In the cited regulations, fitting cabinets such as are used on board vessels in order to protect pressure gauges and shut-off devices against ship-specific mechanical influences are not explicitly listed as areas to be ventilated. However, these cabinets contain components and screw fittings with an elevated risk of leaks. If this risk materialises, there is a particularly high risk within the cabinet that a highly explosive air-acetylene mixture might accumulate. This can explode when the welding gun is switched on or due to spark-over when welding. Parts of the bursting metal cabinet can cause serious or fatal injuries, as in the case under investigation here.

The BSU therefore addresses the manufacturers of fitting cabinets and owners and operators of all sea-going vessels that have equipped the welding facilities on their ships with fitting cabinets, and in accordance with § 15 Para. 1 SUG in conjunction with § 19 FIUUG draws their attention to the following:

Fitting cabinets with insufficient ventilating apertures also belong to the insufficiently ventilated areas in the meaning of the Accident Prevention Regulations governing the operation of welding facilities on sea-going vessels. Openings for lines or hoses cannot be considered as sufficient ventilation apertures. Sufficient ventilation apertures comprise at least one aperture at floor and ceiling level of at least 100 cm² each.

The manufacturers of the fitting cabinets, the owners, and the operators of all sea-going vessels who have equipped the welding facilities on their vessels with fitting cabinets are therefore instructed to implement this requirement immediately in consultation with the safety organisation See-Berufsgenossenschaft and the relevant classification society."

9 Sources

- Statement of Facts by the vessel's command
- Written testimony by
 - Second Engineer
 - Ship's mechanic
- Hearing of the Second Engineer
- Information supplied in writing and orally by the vessel operator
- Comments on the draft of the report by the vessel operator and the safety organisation See-Berufsgenossenschaft
- Survey Statement (Attachment to Class Certification) of Germanischer Lloyd dated 1 November 2003
- General Plan MV DRESDEN EXPRESS
- Medical Report of Telemedical Maritime Assistance Service Germany (Stadtkrankenhaus Cuxhaven)
- Federal Maritime and Hydrographic Agency Hamburg/Rostock (BSH); Excerpt from the great circle chart of the Northern Pacific Ocean, BSH No.: 2703
- Documents of the See-Berufsgenossenschaft (See-BG - Safety Organisation for Shipping)
 - Accident Prevention Regulations for Shipping Enterprises (UVV-See); Status 1 October 2003
 - Guidelines for Building, Outfitting, Testing and Operating Welding Installations on Seagoing Vessels (Welding Guidelines) of 10 April 1985
 - Survey reports MV DRESDEN EXPRESS
- Accident Prevention Regulation BGV D1 (formerly VGB 15): "Welding, cutting and related processes" of 1 April 1995 in the version of 1 April 2001 with implementing instructions of April 2001; issued by the Employers' Liability Insurance for Fine Mechanics and Electrical Engineering (BGFE)
- Test Report by the Institute for Material Science and Welding Engineering of the University for Applied Sciences Hamburg (Prof. Dr. J. Happ)
- Photo of vessel MV DRESDEN EXPRESS; Hasenpusch Photo Productions