

CASUALTY REPORT

**Danish Maritime
Authority**

Ministry of Trade
and Industry

THE INVESTIGATION DIVISION

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Case 199903239

File 01.40.50

DANCHEM WEST

Accident at work

March 5, 2000

1. The Casualty:

Type of casualty: Fall accident in cargo tank
Location of casualty: Ventspils, Latvia
Date and time: March 5, 2000. Approx. 23.15 hours
Injuries: 1 diseased crewmember

2. Ship Particulars:

| | |
|--------------------------------|------------------------------|
| <i>Name of Ship:</i> | DANCHEM WEST |
| <i>Registration No:</i> | |
| <i>Home Port:</i> | Nykøbing Mors |
| <i>Control No:</i> | D3480 |
| <i>Call Sign:</i> | OXJI2 |
| <i>IMO No:</i> | 9031636 |
| <i>Type of Ship:</i> | Chemical tanker |
| <i>Construction year:</i> | 1992 |
| <i>Tonnage:</i> | 1666 BT |
| <i>Length/breadth/draft:</i> | 73,21 m / 13,00 m / 6,20 m |
| <i>Engine Power:</i> | 1320 kW |
| <i>Crew:</i> | 9 |
| <i>Owner:</i> | K/S Herluf Trolle |
| <i>Classification Society:</i> | Lloyd's Register of Shipping |

3. Summary:

DANCHEM WEST was discharging BENZOL in Riga. The tank cleaning operation started the next morning and consequently the tanks were ventilated all day. In the evening they were going to dry by hand the last remains of the water in the tanks. The atmosphere in the tank had been measured without finding any traces of BENZOL. The crew was wearing full masks with filter while they were in the tanks drying by hand. At 23.15 when the AB was climbing out of the tank he lost his grip and he fell approximately 5 meters down.

The mask with filter was examined after the accident by the authorities in Latvia where it was observed that the filter had lost its protective function. At the autopsy in Latvia they found traces of aromatic hydrocarbons which may be BENZOL. The quantity of aromatic hydrocarbons was not determined. It has not been possible to decide how much importance the influence from Benzol and the influence from other factors had for the fact that he lost his grip and fell.

4. The Crew:

The AB who died in the accident: AB, age 30 years. Has been signed on chemical tankers for 6 months in 1996, 6 months in 1997 and 7 months in 1999. He was signed on a gas tanker for 6 months in 1998-1999. In a certificate issued 21 January 2000 it is stated that he has finished the "Tanker familiarisation training programme – STCW-95, reg. V/1".

The master: Has been sailing as Master on Chemical Tankers for 14 years of which he has sailed 5 years on DANCHEM WEST. He has certificates for oil- and chemical tankers.

The chief officer: Got his Master Certificate (Restricted) in 1990. He has been sailing on Chemical Tankers since 1991. He has been signed on to DANCHEM WEST four times – each time he was signed on for approximately 2 months. He has certificates for oil- and chemical tankers.

The first mate: He signed on to DANCHEM WEST on 24 February 2000. He got his Master Certificate (restricted) in 1997. DANCHEM WEST was the first ship where he was signed on as mate. He had been sailing as AB on chemical tankers in 1986, 1992 and 1993. He has certificates for oil-, gas-, and chemical tankers – part I.

The chief engineer: Certificates for oil- and chemical tankers.

The AB: He has been sailing on chemical tankers for approximately 5 years. He has certificate for "Tanker familiarization training programme – STCW-95, reg. v/1".

The AB: He has been sailing on chemical tankers for approximately 2,5 years. He has certificate for "Tanker familiarization training programme – STCW-95, reg. v/1".

Motor man: Certificate for "Tanker familiarization training programme – STCW-95, reg. v/1".

5. Narratives:

On the 5th March 2000 at 03.15 am DANCHEM WEST departed from Riga, where a cargo of Benzol had been discharged. The ship was going to Ventspils in Latvia.

The AB, who later fell in the tank, was signed on in Riga on the 4th March in the afternoon. For about an hour two ABs showed him the ship and they told him about the work on the deck.

On the 5th March at 06.45 am the tank cleaning operation began. The tank cleaning ended at 09.00 am. The tanks were cleaned with 60°C hot fresh water – 20 minutes in each tank. 5 m³ water was used for each tank and the water was constantly pumped out of the tanks. The 1-tanks were cleaned first and the 6-tanks last. The 4-tanks were cleaned between 07.45 am and 08.05. am. The ventilation in each tank was started as soon the cleaning was ended.

The weather at noon was according to the logbook: Wind NW 5, sea 4. Temperature -2°C.

They had not drained the ejector pipes on deck, which are used in connection with the pumping out the remains from the pump wells and the pipes were therefore frozen. The crew worked long time to defrost the pipes – which they did.

From approx. 16.30 to 17.00 the atmosphere in all tanks were measured. The Chief officer and the first mate did the measuring. They measured the 1-tanks together, while the first mate was instructed, because he was new on board. The Chief officer measured oxygen and explosive level in all tanks. The first mate measured Benzol PPM with Dräger test pipes. When the chief had finished the measuring of oxygen and the explosive level, he helped the first mate. The Chief officer measured with Dräger test pipes in the 6-tanks, the 5-tanks and 4-tank starboard. The first mate measured with Dräger test pipes in the 2-tanks, the 3-tanks and 4-tank port.

At approx. 17.00 the crew began drying the tanks by hand. This was continued until approx. 17.45, where the crew had their dinner and began to prepare for arrival. At 19.00 the ship was alongside the jetty in Ventspils.

All tanks were ventilated until a crew member went down into a tank, except when the atmosphere was measured in a tank. To get down into the tank, the flexible pipe from the ventilation tower was lifted up from the tank hatch. The tank was not ventilated, during the time the crew member was down in the tank. When the crew member came up from the tank again the ventilation pipe was placed in the tank hatch again.

The reason why ventilation was stopped during the period when the crew member was down in the tank was, that the ventilation pipe in the tank hatch shaded the light. The two other ABs have told, that they normally keep the tanks ventilated, when somebody is down in the tank, but not this day. The two ABs have experience from tankers. They have told that they knew the procedure prescribed on ventilation in the tank saying that ventilation has to be continued when somebody is down in the tank.

The Chief officer has told that it is standard procedure to ventilate, when somebody is down in the tank. On the day of the accident he did not see if the tanks was ventilated, when somebody was down in the tanks.

The three ABs and the motor man worked in two teams. One crew member on each team was standby on deck at the tank hatch, while the other was down in the tank. They changed position on each team, so both in turns were down in the tanks. The crew member down in the tank was wearing full mask with filter, safety shoes and gloves.

On the day of the accident they were particularly busy with the drying up in the tanks where the water had begun to freeze to ice because of the frosty weather.

At approx. 19.30 they continued drying the tanks by hand.

The AB, who later fell, was down in tank 2 starboard 20 to 30 minutes. The same AB was later down in tank 4 starboard in approx. 20 minutes. After that the other AB was down in tank 4 starboard in approx. 20 minutes.

At approx. 23.00 the AB, who later fell, went down in tank 4 starboard for the 2. time. At approx. 23.15 he was climbing up the ladder. The second time he had been in the tank for 10 to 15 minutes.

The AB, who was standby at the hatch, has told, that the AB climbing up lost his grip with the left hand, when he was 1-1,5 meter from the hatch. He fell backwards and also lost his grip with the right hand. The fall was approx. 5 meter. Until he lost his grip he had climbed normally up the ladder. The AB was not wearing gloves while he climbed up the ladder. He wore gloves while he was drying the tanks by hand.

Ventilation had been on in tank 4 in starboard side from approx. 08.05 to approx. 22.20 except from a short period round 17.00, when the atmosphere was measured.

The other team was working in tank 4 port, when the accident occurred.

The AB who had been standby at the hatch ran into the mess and warned the Chief officer who was on duty. The Chief officer ran out on the deck. He noted that the AB was lying lifeless on the bottom of the tank. The master was notified. The Chief officer put on breathing air equipment and at 23.20 he went into the tank. He noted that the AB' head had been seriously injured and that he had no pulse. The Chief officer was certain that the AB had been killed immediately at the fall.

In the meantime the master had called the agent for the purpose of calling an ambulance and a doctor. It was decided to bring the AB on deck. The Chief officer and the motor man went into the tank wearing breathing air equipment and the AB was put on a stretcher. At 23.50 he had been brought on deck.

When all this was taking place they forgot to measure the atmosphere in the tank. When they later on wanted to measure the atmosphere, they had started to ventilate the tank again.

At 24.00 the ambulance arrived together with a doctor who stated that the AB was dead. At 00.40 the Ventpils Police arrived in order to question the crew about the accident.

6. Supplementary investigations:

The AB:

The AB, who later fell, signed on the 4th March in the afternoon. At approx. 19.00 he went ashore with permission from the master, to get some winter clothes in his home. He was on board again before midnight and went to bed. On 5th March at 02.30 to 03.30 he was on deck during departure from Riga. At 07.00 to 09.00 he participated in the tank cleaning. After that he was off duty until 17.00 when the drying of the tanks by hand began.

The AB did not eat dinner the day the accident occurred.

The AB had not been drinking alcohol.

There was found two kinds of medication on the AB's cabin the day after the accident. The medication was sent ashore in Latvia together with the AB's possessions. The medication was Tailolol (cold) and Tempalgin (pain). The medication had not been used.

Full mask/filter and gloves

The filter was marked ABEK2 HgSt – product AUER, expiry date 2005. The chief Officer had given the mask and the filter to the AB the day before the accident. The filter was new/not used when the AB received it.

The mask was a full mask – product AUER 3S.

Every crew member had it's own mask. The masks were kept in a locker specially made for that purpose. Every crew member had a specific place for their mask.

Regarding the use of the mask. The AB did not have a beard and he was not wearing glasses.

The filter was changed when taste or smell came through the mask according to the chief officer.

According to an instruction from ArSima it says as follows: *The gas filter has to be changed at the latest when the contamination can be smelled. This is the only certain prove that the filter has to be changed. Always use air supply and never use filter for avoiding smell less gasses or gasses that presents immediate danger for life or health.*

The AB also used the filter mask in the morning in connection with the tank cleaning. It is procedure to use filter masks on deck when the tanks are opened in connection with tank cleaning.

The gloves are made of rubber, they are chemical resistant and are from ArSiMa. The AB was not wearing gloves when climbing the ladder and it is not known at what exact time he took them off.

The mask and the filter that were used were brought ashore and have been tested by the authorities in Latvia – “State fire fighting and rescue service, the Science and Research Department”. The test showed that:

- The valves of the mask are in order and functioning
- The given filtration body is foreseen for job conditions in the presence of benzol
- The filtration body has lots its protective functions and is not to be used

The expertise was effectuated 20 March 2000. The filter was tested by a flow of a mixture of air benzol where benzol was registrated in the air after passage of the filter container. This indicates - according to the expertise – that filtered material in the filter is saturated, i.e. the filter has lost its protection ability.

Ventilation

A ventilating tower is placed at every set of tanks. Two flexible air pipes (diameters approximately 40 centimetre), which can be placed in the hatches, is connected on each ventilating tower. The ventilating tower produces 6000 m3 per hour, i.e. 3000 m3/hour for each tank.

Arrangements of tanks/ladder/lights

The tanks are coated with GALVOSIL 1570 – Hempel and they were last coated when the ship was built in 1992.

There is a well with a pump in every tank. Furthermore, there is an attached ejector pipe, which runs from the well to the deck. The pipe will suck up the water that is not sucked by the pump.

There is some water left in the well and at the bulkhead aft in the tank after the tank cleaning and the ejector suction. The water has to be dried up by hand. They also have problems with shells from the coating which have to be removed as well.

The ladder in the tank is vertical. It is made in rustless steel. The steps are shaped as a diamond, approximately 20x20 mm and the breadth is 400 mm. The side of the ladder has a breadth of approximately 100 mm. The ladder has been welded in the top and in the bottom.

There are heating coils in the bottom of the tank.

Tank 4 starboard is 213 m³.

They use flameproof flashlights when working in the tank. And they also get light from day and deck light from the tank hatch.

ISM – Tank cleaning/entry

The following pages from the ship's ISM has been presented:

- Tank cleaning plan – F. 6.9 B: Procedure for tank cleaning (appendix 1). Signed by the chief officer
- Tank cleaning – F. 6.9 B: Filled scheme on tank cleaning in every tank (appendix 2). Signed by the chief officer.
- Measurement of the atmosphere on deck and in the pump room – F. 6.9 C (appendix 3). Signed by the 1st mate.
- Tank entry permit after tank cleaning – F. 10.5.4.1. Scheme with results of the measurement and permission for each tank. Signed by the chief officer and the AB. Page 2 describes the safety precautions in connection with “tank entry” (appendix 4).

It says in the “Tank entry permit” that the permission is valid from 06.00 – 24.00 (5/3-00). The chief officer has explained this to be a mistake. The scheme was filled as the measurements were done from 16.30 – 17.00. It should have said “valid from 17.00 – 24.00. There were persons in the tanks before the measurements were done.

On page 2 concerning safety precautions in connection with “tank entry”, it says among other things as follows:

“The tanks has to be ventilated before, and during, entry into tanks.....”

“The Tank Entry Permit is valid for those tanks entered on the permit. However, certain circumstances may demand additional atmosphere tests to be made, and a new permit to be issued, such as, but limited to:

- *After having carried benzene, which often, regardless of washing and cleaning, leaves vapours over the maximum acceptable limit value of 5 ppm, or*
- *If the tank/s, after tank cleaning/washing have been closed without ventilation (when vapours may be released from the tank coating).*

Nobody enters a cargo tank without carrying an A-1-filter.

The TLV for benzol has been changed to 0.5 ppm.

Notice on dangerous cargo

CARGO DATA SHEET – Form No.: F 6.2.2 - for benzol had been put on a notice board at the mess.

“Safety Data Sheet” on benzol from EXXON CHEMICAL was on board.

Measure instruments – the carrying out of the measurements

The ship's measure instruments were calibrated and checked by the company Ashland Chemical, Netherlands, 19 –20 October 1999.

The concentration of Benzol was measured with Dräger pipes – Benzol “0,5/a”. The Dräger Pipe used for the measuring has to be broken in both ends and on a third spot on the pipe where the pipe is covered by rubber. An ampoule is situated behind the rubber. It is the pump – concertina type – on the pipe, which decides the speed of the measurement. The condition for measuring with Dräger pipe Benzol 0.5/a is a temperature of 10-40°. The measure areas are between 0,5 and 10 ppm.

The pipe was put on the end of the tube and lowered into the tanks. The length of the tube was approximately 5 meter. The measurements were done approximately 2 meters over bottom, i.e. the tube from the measuring instrument was lowered to this height.

The measurements for all tanks show as follows: Benzol less than 0,5 ppm (TLV 0,5 PPM). This meaning that the testing material in the testing pipe not has been coloured. The Explosive gasses LEL 0.0 % (Max. 1%). Oxygen 20.9% (Min. 20.8%). See appendix 4.

If the benzol concentration is 10 ppm or more, the testing material will take colour after 2 strokes of the pump. The testing material will take colour after 40 strokes of the pump, if the benzol concentration is 0.5. The chief officer effectuated many strokes of the pump but he does not remember how many.

After the measurements were done, the chief officer went briefly down to each tank without carrying a mask. The purpose was to push the check valves to make certain that there was not water in the pipes. He did this himself because he knew that it could be complicated if the water in pipes would mix with the new cargo. He could not smell benzol or notice anything during his stay in the tanks.

The temperature on the time of the measurements was around freezing point. The Dräger Pipe should only have been used between 10-40°C.

Marstal Navigationssskole has made some tests with Dräger Benzol pipes 0,5/a. In the test the pipe and its surroundings were freezed down to 0°. The atmosphere was measured with MultiRae Gas monitor PGM-50. The test indicated that benzol pipe 0,5/a also indicates the actual concentration but with less accuracy.

According to the supplier, there is more deviation, when the pipe is used in temperatures outside the indicated temperature.

Benzol

Basic information regarding Benzol can be found in appendix 5, “Cargo data Sheet”.

It has not been possible to calculate an estimated concentration of benzol vapours in the tank on the time of the accident, because the data is uncertain. The calculations that are done on temperatures below approximately 5.5° - the temperature where benzol hardened – are very uncertain.

It is not known how much washing water there was left in the tanks, which had to be dried by hand. A cautious assumption is that in each tank there were 1-2 litre washing water at the bulkhead and 1-2 litre in the well. The surface of the washing water was all together approximately 2.5 m².

It is not known if there was any remains of benzol in the washing water.

Benzol can be absorbed in the coating and afterwards evaporate steam. When the tanks have been washed with hot water for 20 minutes and ventilated for 14 hours, it is estimated that the quantity of benzol in the coating is very small. It cannot be excluded though that the low temperature has changed the conditions and that the remaining quantity of benzol has been ventilated away at a lower speed.

Evaporation of benzol vapours from a liquid surface with benzol is normally bigger than evaporation from the coating.

The temperature in the tank is estimated to have been approximately 0°C because the air from outside was ventilated into the tank until the drying by hand begun. The temperature has probably risen shortly after the ventilation was stopped because the sea temperature was approximately 4°C.

The TLV for benzol is 0.5 ppm. Benzol is marked “H” and “K”, i.e. benzol can be absorbed by the skin and it is carcinogenic.

From the literature found on toxicity among others regarding inhalation of benzol vapours, the following approximate limits can be derived:

The smell limit for benzol varies a lot, approximately 0.5-320 ppm.

Headache, dizziness, malaise, may start at approximately 250 ppm.

Actual poisoning symptoms at approximately 1.500 ppm.

Deadly concentrations at approximately 20000 ppm.

Absorption by the skin:

If a person is wearing mask with fresh air supply while he is using his hands in connection with liquid benzol, he has to do this for 26 hours or more in order to reach a quantity which results in headache and dizziness. Therefore it unrealistic to assume that the accidents happened alone as a consequence of absorption of benzol through the skin.

Exercise / Instruction:

Normally the Chief officer gives instruction to new Crew members about the work on the deck and in the tanks, but because the Chief officer was busy he had no time to give instruction to the new crew member before the accident occurred. The day the new AB was signed, two ABs showed him the ship and they instructed him on the work on the deck for about an hour.

The AB's have told, that the master, the Chief officer and the first mate gave instruction when appropriate, about safety in connection with tank cleaning and the work on deck. The ABs had seen the video “Enclosed spaces” on board.

One AB has told that he and the AB, who was signing off, showed the new AB the ship and instructed him about the work on the deck and in the tanks.

The video concerning access to enclosed spaces, “Enclosed spaces” was shown to the all of the crew members on 3 March 2000 (the injured AB did not sign on until 4 March 2000). The EX-OX-TOX was demonstrated. The instruction was registrated in the ISM of the ship on form No. F.2.18.11.

Every member has a page in ISM (form No. F.2.18.7) on which all exercises/instructions that the crew member has attended are stipulated. The instructor and the crew member confirms in writing each exercise/instruction. It appears that the crew members are introduced to the work when they sign on. The AB who had signed on the day before the accident did not yet have a page in the ISM.

Working Environment Manual

In the Danish edition of the manual in the sections regarding Tank-cleaning notes had been filled in the chapter "on this ship". It referres to relevant sections in the QA-manual (ISM). Rules for entering the tanks were also described. The notes were not described in the English edition. This is according to the Master because all of the Crew had been Danish until October 1999. They had furthermore not had the time to enter the notifications in the English Working Environment Manual

Safety meetings

Safety meetings were held regularly on board.

On 8 March they held an extraordinary Safety meeting because of the accident. They decided to use safety belt and line when entering and leaving the tanks. The safety line had to be handled by the person who was standing by at the tank hatch. This had to be done until a more permanent solution could be found. The rules for entering the tanks were discussed at the meeting.

Language Qualifications

It appears from the inquiry that the language qualifications of one of the AB's were limited and that the motor man language qualifications were poor. This is why a Latvian AB acted as interpreter during the questioning of the motor man.

The Shipping Company's operator has stated that they co-operate with a shipping office in Riga. The operator makes demands concerning English qualifications and tanker experience when new crew members are hired. The operator furthermore receives information in writing regarding earlier employment. After the accident, the operator makes a telephone interview with first time employees for the purpose of learning their English qualifications. The operator has sent persons home a couple of times because their English qualifications were inadequate.

From 11 – 14 June 2000 the Shipping Company's operator carried out an ISM-audit on board together with Bureau Veritas. During audits it is established procedure to check each person's English qualifications. They evaluated at this audit that the English qualifications of the motor man were adequate.

Autopsy

The Autopsy made by "The State Medical Centre for Forensic Expertise" in Latvia, concludes that:

- The AB died from a blunt, heavy trauma of his body from the fall
- Ethyl spirits, narcotic substances or any other intoxicating substances had not been detected
- Traces of the aromatic hydrocarbons (possibly benzol) were found in the tissues, which indicates that the injured AB before his death was in the presence of benzol.

The medical assistant on Maritime Medical Training Centre has evaluated the autopsy report.

It involves a 30 years old man with athletic body building and average weight. At the autopsy traces of aromatic hydrocarbons were found. It is indicated that it possibly could be benzol but the body has not been specifically tested for benzol. The quantity of aromatic hydrocarbons has not been determined.

It is not possible to determine from the autopsy report whether benzol had a bearing on the accident. On the other hand it cannot be excluded whether benzol did have a bearing on the accident alone or together with other factors.

7. Comments made by the Division for Investigation of Maritime Accidents (DIMA):

The tank atmosphere has been measured 6 hours before the AB went down into the tank for the last time. The tank had been ventilated from 8.00 to 22.00 where the drying of the tank by hand began – except from the time where the measuring were done.

After 19.30 the AB has been in the tanks for approximately 1 hour all together when the accident occurred.

The atmosphere in the tank was not measured right after the accident. It has not been possible to determine whether there had been benzol in the atmosphere when the AB was in the tank. The 13-14

hours of ventilation of the tanks and the measurements at approximately 17.00 indicate that benzol was not in the atmosphere in the tank at the time of the accident.

The following indicates, however, the possibility of benzol in the atmosphere in the tank. The measuring of the atmosphere was uncertain because they used a Dräger pipe, which should not have been used around the actual 0°. The measuring was solely done one place in the tank. The tank was ventilated until the measuring was done. The mask filter was consequently examined in Latvia. The examination indicates that the filter had lost its protective ability. The autopsy showed traces of aromatic hydrocarbons, which could have been benzol.

The fact that benzol hardened into a solid mass at +5,5° and the actual temperature was 0° is an element of uncertainty, which has to be considered when estimating and calculating the possible quantity of benzol in the atmosphere. At temperatures higher than + 5,5°, less quantities of Benzol in the tank would probably have evaporated and evacuated after 13-14 hours of ventilation. It cannot be excluded, however, that the tank contained hardened benzol, which had not been evacuated by ventilation. Hardened benzol also gives off vapours but much slower. In this connection it must be considered that the temperature had risen locally in the tank after the ventilation had been stopped, but the temperature had not risen above +4° which was the sea water temperature.

The ventilation (gasfreeing) was started as soon as the tank cleaning had been finished in each tank. When the air was blown in through an open tank hatch as was the case, the air returning through the hatch could have resulted in large concentrations of benzol on deck at the hatches while there were still persons on deck in the morning during the tank cleaning. Filter masks were used during the tank cleaning.

Using of filter which earlier has been saturated with benzol, e.g. in connection with tank cleaning can expose a person to Benzol regardless of no Benzol in the present atmosphere.

Besides from the fact that the AB did not eat dinner on the day of the accident, the Division for Investigation of Maritime Accidents has not received any information indicating that the AB should have been ill.

When the AB climbed the ladder and he was approximately 1 meter from the hatch he first lost his grip with one hand, fell backwards and after that, he lost grip with the other hand. He was not wearing gloves when climbing up.

It is the opinion of the DIMA that the AB has breathed in benzol through his respiratory passage – irrespective the autopsy does not establish this as a fact. The AB may have breathed benzol in times and ways as follows:

- In the morning when the tanks were opened in connection with the tank cleaning and the gas freeing afterwards
- From the filter which may have been polluted/saturated in the morning at the tank cleaning
- From benzol in the tanks during the drying by hand

The quantity of aromatic hydrocarbons, possibly benzol, which were found during the autopsy, has not been established. They did not examine for benzol specifically. That is why, it cannot be established if the AB lost his grip because he was either unwell or dizzy because of the benzol.

Instruction

The Master, the chief officer or the first mate did not instruct the AB when he signed on but he was instructed by two other AB's

It is the opinion of the DIMA that the officers should have ensured that the AB had the necessary knowledge on the usage of mask and changing of filter before the tank cleaning. The AB had experience from chemical- and gas tankers in the period 1996 – 1999 and he had finished “ Tanker familiarisation training programme – STCW-95, reg. V/1. Therefore, he was assumed to be familiar to the usage of filter masks.

The ships notes which were indicated in the Working Environment Manual in Danish should have been put into the English edition. The officers should have made sure that everybody were instructed in the contents of latter and the contents of the relevant pages in the QA manual, which is referred to in the Working Environment Manual.

Ventilation

The procedure prescribed that ventilation had to be on while the AB's stayed in the tanks to the drying up by hand. The AB's have after the accident stated that ventilation normally is on while persons are staying in the tanks. On the day of the accident the ventilation had not been put on because of the flexible ventilation pipe's shadowing for light. The AB' have stated that they knew that the ventilation had to be on during their stay in the tanks. The chief officer did not notice whether the ventilation was during the AB's stay in the tanks doing the drying up by hand.

As benzol is evaporating very fast, ongoing ventilation in tanks used for benzol transportation is very important.

According to DIMA's opinion the chief officer should have controlled whether the ventilation was on while staff members were in the tanks, regardless of the AB's knowing that the procedure prescribed it to be.

Mask and filter

The chief officer had issued a new filter to the AB the day before the accident. The AB used the mask on deck during the tank cleaning in the morning and during the drying up by hand in the tanks in the evening.

The procedure for changing the filter is that the filter has to be changed when smell or taste goes through.

The examination of the filter in Latvia showed that it was saturated and has lost it's protective ability.

The DIMA is of the opinion that the filter had lost it's protective ability because the AB in the morning by the cleaning and the gas freeing or in the evening during the mopping up in the tanks has been staying in an atmosphere containing benzol.

To carry out the measuring in the tanks

The application area to Dräger pipe Benzol 0,5/a is according to the manual temperatures from 10 – 40 Celsius degrees. The temperature was on the measuring time about 0. The examination of using Dräger pipe Benzol 0,5/a indicates that exact results are not likely to be obtained at this temperature.

Other sorts of Dräger testing pipes for benzol are available, sorts that according to the manual can be used down to 0 Celsius degrees. None of these have got measure area 0,5 – 10 ppm like the actually used Dräger pipe Benzol 0,5/a had. At temperatures at 10 or higher it is natural to use the actual used testing pipe, because TLV for benzol is 0,5 ppm.

Based on tests with Dräger pipe Benzol 0,5/a the DIMA is of the opinion that it is most likely that the actual measures with Dräger pipe Benzol 0,5/a would have shown more than 0,5 ppm if the Benzol concentration had been strong in the tank at the time of measuring.

According to the DIMA's opinion it was a failure that no such pipes had been used according to the manual could be used at the temperature in question. The officers should have provided the measuring of Benzol in the tanks to be carried out with testing pipes or instruments which according to manuals could be used at the temperature in question, before *Tank entry permit* had been issued.

The officers should have accomplished supplementary measures in the tanks to take place because Benzol had been transported in them. In the ISM of the ship *Tank entry permit* page 2 (appendix 4) attention is brought to this matter.

According to the opinion of the DIMA, the measures ought to be made just before entering a specified tank when Benzol and items causing similar risks have been transported in it. Furthermore, ventilation is to be deactivated at least 10 minutes before the measuring is done and activated again as soon as the measuring has taken place.

Preventing falling down

Regarding this accident it comes clear that some kind of fall arrest system that can be used in tanks without any risks could have changed the accident considerably.

New rules will take effect as from January 2001 on among other things preventing falling down in cargo tanks. The rules will only come into force for new ships.

Language abilities

It appears from *Technical Regulation on the crews command in cargo ships* that the Master, the officers and the AB's of among others tankers with chemical cargo should be able to communicate in a common work language. From the report of the inquiry it appears that communication in English with the motor man was not possible. At an ISM audit on board in June it was evaluated that the motor man was able to speak English. According to DIMA's opinion the motor man's language abilities are not of any relevance to the accident.

The diseased AB had on the evening of the accident a conversation with the Master. All together, he had been signed on as AB for the company KIL for 27 months since 1996. Based on this the DIMA have to presume that the diseased AB was capable of communicating in English.

8. Conclusion:

Due to the findings in this report it is the opinion of the Division for Investigation of Maritime accidents that the AB has breathed in benzol. It has not been possible to determine the quantity of aromatic hydro carbonates – possibly benzol – at the autopsy. Therefore it cannot be determined how much effect the benzol had on the accident. As well as it cannot be determined whether other factors had an effect on the fact that he lost his grip on the ladder.

The Division for Investigation of Maritime Accidents mentions different factors, which might have had an influence on the accident:

- The filter that had lost its protective ability. The only sure indication that the filter has to be changed is the smelling of the pollution, but the limit for that varies from person to person.
- It is not known whether the AB knew the procedure on when to change the filter.
- During tank cleaning and gas freeing the AB may have stayed in large quantities of benzol. He also used filter mask while doing this.

- The measurements in the tanks are inadequate because the test pipe was not meant for use under the current temperature.
- The measurements were done approximately 6 hours before the accident occurred.
- The temperature was below the solidifying point for benzol, which means a much slower evaporation.
- They did not ventilate while the AB's were drying up by hands in the tanks.

It is the opinion of the Division of Maritime Accidents that the officers on board the ship should have considered the above mentioned before the mopping up and the tank cleaning was begun.

9. Recommendations:

The Division for Investigation of Maritime Accidents recommends that full mask with air supply is used in stead of filter mask in tanks where there is the slightest risk of presence of Benzol, because the only indication, that the filter has to be changed, is smell or taste. The smell limit for benzol varies very much from person to person.

10. Enclosures:

Annex 1: Tank cleaning plan – F 6.9 A: Procedure for tank cleaning. Signed by the chief officer.

Annex 2: Tank cleaning – F. 6.9 B: shows scheme over tank cleaning in each tank. Signed by the chief officer.

Annex 3: Measurement of the atmosphere on deck and in pump room – F 6.9 C. Signed by the first mate.

Annex 4: Tank entry permit after tank cleaning – F 10.5.4.1: Scheme with measurement results and permission for each tank. Signed by the chief officer and the AB. Page 2 describes the safety precautions in connection with “tank entry”.

Annex 5 Cargo data sheet form No. F6.2.2 (on the notice board).