
# Marine Administration
*Oaseirys Lhuingys*

## Casualty Investigation Report CA 68

## EMILIA THERESA

## Cargo Tank Explosion

## 17/01/2001

## Index of Titles

## 1. Summary

On the 17/1/2001 the Emilia Theresa a 3,335 Gross Ton Chemical tanker was berthed alongside in Santa Clara, Brazil loading Benzene.

By 1252 that afternoon cargo tanks Nos. 2-6 P & S had been loaded.
The loading of the two final cargo tanks Nos. 1P & 1S was commenced at this time and completed at 1630.
Towards the end of the loading period a shore based cargo surveyor came on board.

At 1650 an explosion was heard by the Chief Officer and the Master.
Flames were seen to emanate from the hatch of No.1P cargo tank.
The general alarm was sounded and the crew mustered.
The Master immediately ordered foam on deck and went forward with one seaman to tackle the flames
Using the forward foam monitors they extinguished the fire within two minutes.

Only the cargo surveyor was injured by the explosion.

The cargo tank lid was blown off which caused some superficial damage to the deck walkway and the vent pipework.

After the tank had cooled the opening in way of the lid was temporarily sealed with canvas and the cargo tank inerted with Nitrogen from ashore.

The contaminated cargo was discharged back to the terminal and the vessel sailed on the 19/1/2001 for Rio Grande for subsequent discharge of the remaining cargo.

The vessel was gas freed on the voyage to Porto Alegre where it was presented for inspection on the 22/01/2001.

The final draft of the report was sent to the following,

Unifleet Roosendaal Netherlands
Denholm Ship management Isle of Man

Neither made any comments on the reports findings.

## 2. Narrative of Events (All times are in local time which is GMT - 5 )

On the 17/1/2001 the vessel was alongside in Santa Clara on Berth # 1loading a cargo of Benzene.

The loading was proceeding normally and by 1252 Hrs the vessel had completed loading of cargo tanks No 2 P&S, No 3 P&S, No 4 P&S, No 5 P&S and No 6 P&S.

The loading of cargo tanks No1 P & S then commenced.
By 1630 Hrs the loading of No1 S cargo tank had been completed and the Chief Officer was at the closed gauging port of No1 P cargo tank to complete the final topping off of that tank.

To obtain the final ullage reading the Chief Officer was using a MMC gauge.
(This is the correct equipment to use for this type of cargo.)

The Pumpman was on centre line walkway in a position to close the inlet valve to No1 P cargo tank when the required ullage was obtained.

During the topping off procedure the Chief Officer was approached by the Cargo Surveyor Mr Jorge L. M. Santos of Intertek Testing Services (ITS) and a conversation took place. There is no independent record of what was said as the Pumpman was out of ear shot and did not hear the conversation.

At 1635 the loading of No1 P cargo tank was completed and the Chief Officer disconnected the MMC gauge and moved it to No 6 P cargo tank in order to take the final tank ullage readings needed to calculate the total amount of cargo on board.
The MMC gauge was again connected in the correct manner.

The Chief Officer then returned to the cargo control room to contact the terminal to confirm that the ship was ready to receive the residue in the loading pipe work from ashore. (“blowing through of the lines”)
He remained in the cargo control room and did not see the cargo surveyor again until after the accident.

The Pumpman remained on deck by the valve manifold located amidships.
From this position he saw the cargo surveyor taking samples from the cargo tanks starting from the after most tanks and progressing forward.
He did not see the equipment that the cargo surveyor was using.

At 1650 an explosion was heard by the Master who was in his cabin and also by the Chief Officer in the cargo control room.
The Pumpman was still on deck by the manifold stbd side.

The Chief Officer looked out of the cargo control room window and saw flames coming from the fwd part of the cargo area. He immediately sounded the general alarm.

The crew had already assembled at the muster station starboard side aft by the time the Master arrived there.

The Master upon reaching the muster station ordered the Chief Engineer to supply foam to the deck monitor system.
The Master together with one sailor made their way forward.
Together using the forward foam monitors they extinguished the fire by approximately 1653 Hrs.
Although not called by any one on board the local fire brigade arrived at 1657 Hrs but were not required.

The cargo surveyor was injured by the explosion. After receiving first aid on board he was then taken away by ambulance.
No members of the crew or other persons were injured.

The lid from No1 port Cargo tank lid was blown off by the explosion which caused superficial damage to the structures and pipework on deck.
There was some structural deformation of the tank structure but no breach.

The tank was allowed to cool until 1810 Hrs at which time a canvas cover was used to seal the tank lid opening.
The tank was then inerted with Nitrogen from ashore.

At 1125 the following morning (19/1/2001) the contents of No1 P cargo tank were pumped back ashore to the terminal.

The vessel then sailed for Rio Grande, Brazil at 1620 that afternoon to discharge the remaining cargo of Benzene.

After a normal discharge the vessel was gas freed and made ready for inspection for interested parties Porto Alegre, Brazil on the 22/01/2001.

## 3. Sources of Evidence

3.1 Statements were received from the Master and Chief Officer.

3.2 The Master, Chief Officer and Pump Man were all interviewed during the investigation.

3.3 The cargo surveyor was not made available for interview.

3.4 After the fire had been extinguished the Master and Chief Officer inspected the area of the deck around No.1 port cargo tank hatch coaming.
They found the “open ullage” port (See Appendix 1 Fig 2) open and approx. 1-2m aft of the port a brass sample can with a man-made fibre rope 2-3m long attached to it.
They also noted glass debris around the sample can.
The rope was reported as being “black and stiff” over the first 1m.

The sample can and rope were taken into custody by the Master but later removed by another ITS cargo surveyor.
The Master did not obtain a receipt for it.
There was on board a length of the rope which the master had cut off from the rope attached to the sample can (See Appendix 1 Fig 4)
This was clearly a man made fibre which was charred and blackened.

3.5 Samples of cargo in glass bottles were also found by the Master at all cargo tank hatch coamings except No 1 S.

3.6 The company ISM manual for Cargo Handling / Tank Cleaning was reviewed and two entries were found relevant to the investigation.
These are both shown in Appendix 2.

Loading Procedures.
5.13 Sampling and Ullaging.

Static Electricity
13.5 Ullaging and sampling
(A4 referenced could not be found in the manual)

The ships officers were well aware of these requirements.

3.7 A copy of ISGOTT was available on board.
Pages 60-64 clearly state that the lowering of equipment with ropes of synthetic material into cargo tanks is not permitted at any time.

## 4. Comment and Analysis

4.1 There was no check of persons coming on board nor was there any check made by the ships staff on any activities these shore persons were undertaking.
The Master stated that there were insufficient crew members to post one permanently at the gang way or to escort shore persons around the ship at all times.
Whilst every effort should have been made by the Master to ensure the safety of the ship was not jeopardised. It was reasonable for him to conclude that as the vessel was in an oil terminal that they regularly visited, persons such as cargo surveyors coming on board would be fully trained and competent to carry out their duties in a safe manner.

4.2 The working language of the ship is English which during the investigation the crew demonstrated their competence in.
It was established that the cargo surveyor had a very limited knowledge of English and probably not sufficient to use it as a working language.

4.3 The cargo data sheets for Benzene were clearly posted as required.
On them it was clearly stated in English that the cargo was "hazardous to health and closed ullaging and gauging was required".

4.4 The "open ullage" ports are secured with threaded handles (Appendix 1, Fig 2).
This allows them to be opened without the use of any special tools or keys.
This arrangement clearly allowed the sampling to take place independent from the ship's staff.

4.5 The ISGOTT guide is very clear that the sampling equipment undoubtedly used by the cargo surveyor is not allowed at any time and the Unifleet safety manual only allows it to be used 30 minutes after loading has been completed.
The correct and safe Closed sampling equipment (Appendix 1, Fig 3) was available on board.
This was stored in the aft pump room.
The deck officers were fully aware of this and proficient in its operation.

4.5 Crew certification was examined and all officers had appropriate chemical endorsements to their certificates of competency.
The crew had evidence of training on tankers.
However no officers on board had an endorsement issued by the Isle of Man Marine Administration recognising the validity of their certificates of competency.
This is a legal requirement under the Merchant Shipping (Manning and Training) Regulations 1996. Reg. 15

## 5. Conclusions

Since there were no other possible sources of ignition in way of cargo tank No1 port. The explosion of the vapour in the ullage space of the tank was undoubtedly caused by the spark produced by the electrostatic dissipation of the accumulated charge when the cargo surveyor introduced the metallic sample can into the tank.
(The process of static electricity generation and the mechanisms for spark generation are given in Appendix 3.)

By starting from the after most tanks which had been allowed to settle for over 3 hours and therefore all the static charges had dissipated naturally.
The surveyor may have become convinced that his equipment was safe to use.
It is clear that the time elapsed (approx. 20 minutes) from completion of loading of No 1 port cargo tank to the time the sample can was introduced was insufficient for the static charges to disperse.

Whether or not the cargo surveyor was told to wait before starting to take samples, he was left unsupervised on the vessel and this is not in accordance with the company ISM system.

Apart from the oversight cargo operations were conducted in a safe and proper manner by the ship's staff.

The crew are to be commended for their prompt and thoroughly professional response to the explosion and subsequent fire.
Their actions certainly prevented a far more serious incident developing**.**

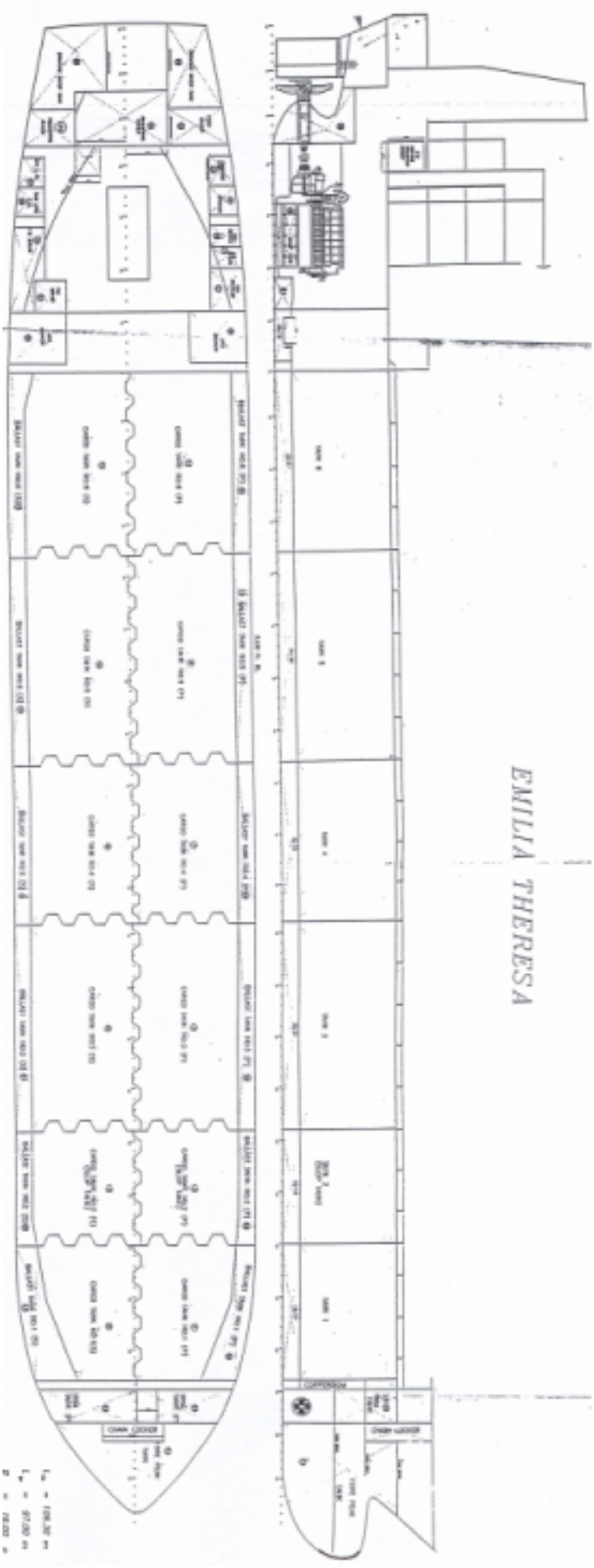
## 6. Recommendations

6.1 The supervision of shore side personnel has to be improved by the company.
As a minimum this should include notices requiring them to report to the cargo control room and await the officer in charge.
Shore side persons should also be supervised when in the cargo area.
This may mean that additional persons are carried to comply with this recommendation.

6.2 The communication between the ship's staff and the terminal staff needs to be improved.
This is particularly important when specific instructions are given.

## 7. Ship Details

| | |
|---|---|
| Name | Emilia Theresa |
| IMO No. | 9165451 |
| Classification Society | Bureau Veritas |
| Vessel Type | Chemical Tanker Type 2 |
| Owner | Emilia Shipping Ltd Douglas Isle of Man |
| Time Charterer | Herning Shipping A/S Denmark |
| Sub Charterer | Navegacao Gurita Porto Alegre Brazil |
| Managers | Unifleet Roosendaal Netherlands<br>Denholm Ship Management Isle of Man |
| Date of Keel laying | 15 / 03 / 1997 |
| Date of Delivery | 03 / 07 / 1998 |
| Builder | Tuzla Gemi Endustri Tuzla Turkey |
| Gross Tonnage | 3356 |
| Deadweight | 5529 metric tonnes |
| Length Registered | 97.10m |
| Breadth Moulded | 16.00m |
| Depth Moulded | 7.25m |
| Draught Moulded | 5.73m |
| Engine | MAN B&W Alpha Type 8228/32A-F 8 Cylinder |
| Engine Power | 1960 kW |
| Service Speed | 12 knots |
| Crew | 10<br>Master Finish, Navigating Officers Russian & Ukrainian<br>Engineer Officers Polish, Ratings Polish & Russian |


EMILIA THERESA

**Tank Plan**

## Appendix 1 Photographs


Fig 1. Example of Sampling and Ullage arrangements for each tank. (Behind is the open ullage port with the easy open handles in front is the restricted ullage / sampling port)

Fig 2. Close up of an open ullage port.

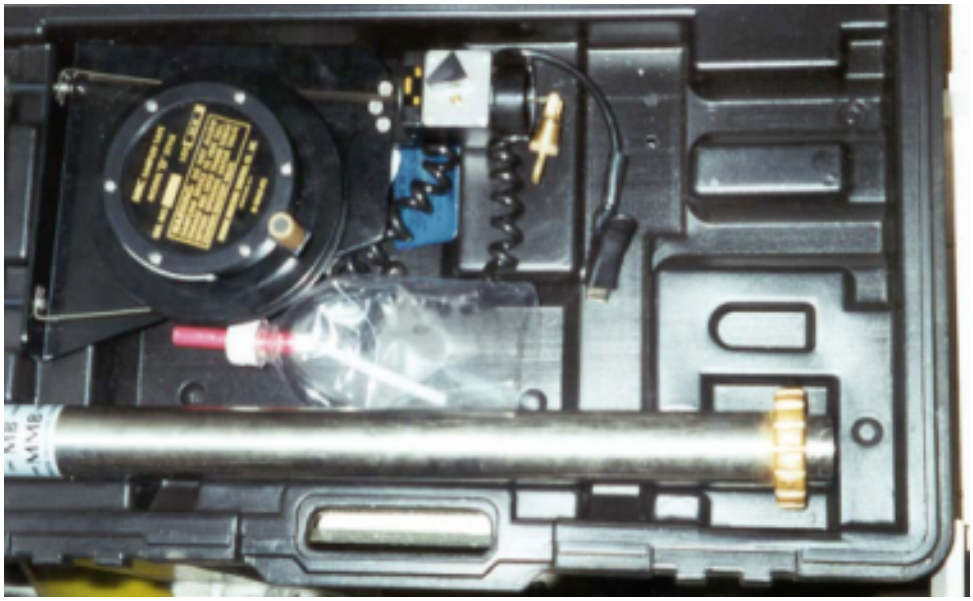


Fig 3. Sampling Equipment available on board.

Fig 4. Sample of the rope found attached to the sampling can after the explosion

Fig 5. Damage to the tank entrance to No 1 Port Cargo tank

Fig 6. View from the cargo control room of the cargo area.

Fig 7. A example of a MMC gauge in use

**Appendix 2 Extracts from the Unifleet ISM manual**

When loading overall, the valves in the hose train on the ship must be opened before the valves ashore. Prior to loading the First Officer or his designated representative should inspect the vessel line up, and satisfy himself that it is correct in every way, and that all pump and line drains are closed. Ships manifold valves should not be opened until the responsible shore operator informs the ship that shore is ready to commence, and until the ship is also ready in every respect.

## 5.10 START OF FLOW / LOADING RATE.

Loading should start at a low rate. The First Officer should check all tanks (including empty ones) to ensure that cargo is entering the correct tanks only and that there is no leakage into pumprooms, cofferdams or the sea. When all checks have been made and the operation is found to be in order the loading rate may be increased to a maximum, taking into account the following:

a) the need of safety
b) the nature of the cargo
c) manpower available
d) the working pressure of ship's lines and hoses being used
e) the capacity of gas lines
f) the capacity of and the required ullage in cargo tanks
g) the need to minimise electrostatic charging
h) until the bottom longitudinals and tank suction are covered, loading speed should not exceed 1 meter per second 110 m3/hr through an 8" line
i) thereafter, loading may be increased to 12 meters per second, i.e. 1330 m3/hr through an 8" line (electrostatic limit only, to be moderated by other circumstances)

## 5.11 CONTROL OF FLOW.

a) When loading two or more tanks simultaneously with the same grade of cargo:
b) the flow of cargo to a given tanks must be controlled by the tank suction valve, or specified tank manifold valve, whichever is applicable (unless loading overall)
c) such valves must not be closed unless another tank is open to receive the flow
d) on completion of a grade the flow must be stopped on shore and NOT BY SHUTTING SHIP'S VALVES
e) shore personnel must be instructed to lower the loading rate when finally topping off a grade, arrangement for slow down and stop procedures having been made before commencement of loading.

## 5.12 STERN LINE LOADING.

Immediately on completion of operations the line is to drain down into the cargo tank and isolated.

## 5.13 SAMPLING AND ULLAGING.

a) first foot and final samples will normally be obtained by the shipper's representative
b) first officer is to ensure that samples are taken from the cargo tank and if possible from a sample cock at the manifold, in such a way as to not discriminate against the Company. A set of sealed and labelled samples must be placed on board
c) final ullages should be taken in conjunction with the shipper's representative. If the tanks have to be opened for this purpose, full safety precautions must be taken
d) to protect the Company's interests, the times of sampling and final ullaging must be recorded in the port log.
e) Samples must be kept on board for a period of three Months. In case of contamination etc. samples must be kept until further notice.

| UNIFLEET | Cargo handling/Tank Cleaning<br>Static electricity | Number 02.13<br>Version 02<br>Date 14-04-2000<br>Page 3 of 3 |
|---|---|---|

To minimise the hazard flow rates for cargo prone to electrostatic charging must be restricted during loading as follows:

a. into tanks not free of flammable vapour

The initial flow velocity through the loading line into each tank is not to exceed 1 meter per second until cargo has well covered the filling inlet, the tank bottom longitudinals or to a depth of about 0.5 meter whichever is the greater height above the tank bottom. Thereafter the flow rate can be increased but must never exceed 12 meters per second through any line.

b. into tanks free of flammable vapour

If the cargo is volatile flow rates must be restricted as in a. No restriction if fire hazard rating non-volatile.

c. into tanks inert before loading

Flow rates need not be restricted. At the start of cargo discharge, the initial pumping rate is to be kept and may be increased only on request.

## 13.5 ULLAGING AND SAMPLING.

If the restriction in A.4 on flow rates apply, then, to minimise static electricity hazards, metal sample cans and ullage tapes must never be used during loading nor for thirty minutes after loading the tank has been completed. These restrictions do not apply when float gauges or pneumatic gauges are used for ullaging or when the ullage tape is made on non-conductive material. Nor do these restrictions apply to the use of wooden dip sticks or the use of wooden floats on the end of a measured and knotted line (natural fibre only). The normal practice in company vessels will be to use closed ullaging devices during loading. Suitable equipment will be supplied to all the company's vessels.

Note that these ullaging and sampling precautions are not necessary for lubricating, animal, vegetable oils and other high flash point cargoes. As long as the tank into which they are being loaded is free of flammable vapour.

## 13.6 LOADING OVERALL.

Loading overall can be done in two ways

1. Splash filling whereby cargo is delivered through the tank coaming by way of an open ended hose.
2. Drop line filling whereby cargo is delivered to the bottom of the cargo tank by way of a portable or permanent drop line

If the cargo has been charged by flow through a shore pipe line, splash filling will deliver it to the liquid surface in the presence of flammable vapours. For these reasons splash filling of static generating cargoes is not permitted if:

a. the tank is not free from flammable vapour
b. the tank is initially free from flammable vapour but the cargo is volatile

For other reasons loading overall is not permitted if the cargo produces harmful vapours. With dropline filling the same precautions must be taken as when filling a tank through a ship's normal bottom lines, except that droplines are not to be used for cargoes which are volatile or which are toxic, unless the connection between the dropline and the deck is gastight.

## Appendix 3 Precautions against static electricity

Static Electricity Generation

When two dissimilar materials come into contact there is electron transfer from one to the other. This results in a charge separation at the interface.
One surface becoming negatively charge and the other positively so.

Fig 1. shows how such charge separation can occur by the splashing or agitation of a liquid in a tank during loading.

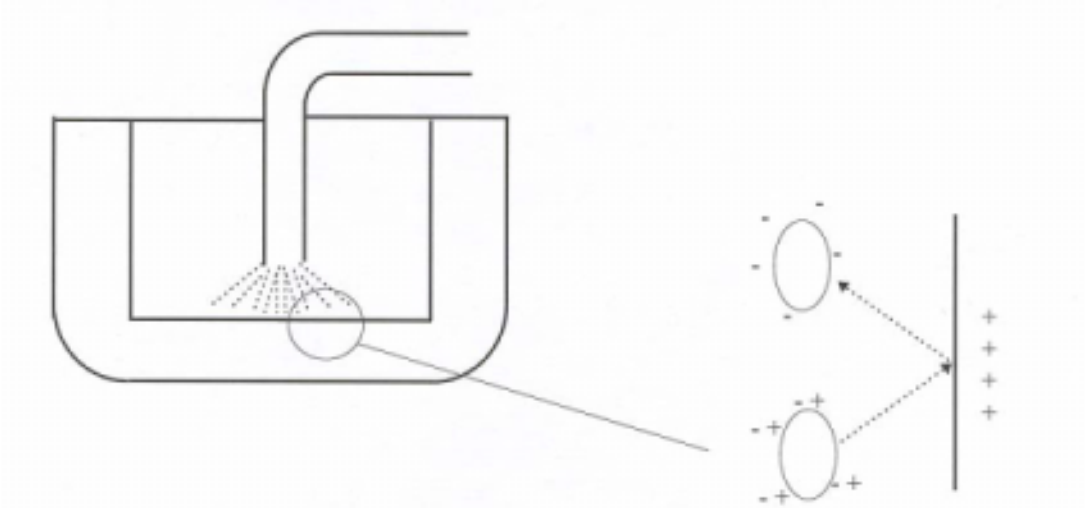


Fig 1. Generation of charged mist by loading

As the materials are separated a potential difference will exist between the two materials. During loading the separation process is constantly being repeated. Therefore the separation charge can become very large. This generates a large potential difference between the liquid and the tank structure.

Once loading has been completed the charges will recombine and neutralise each other.

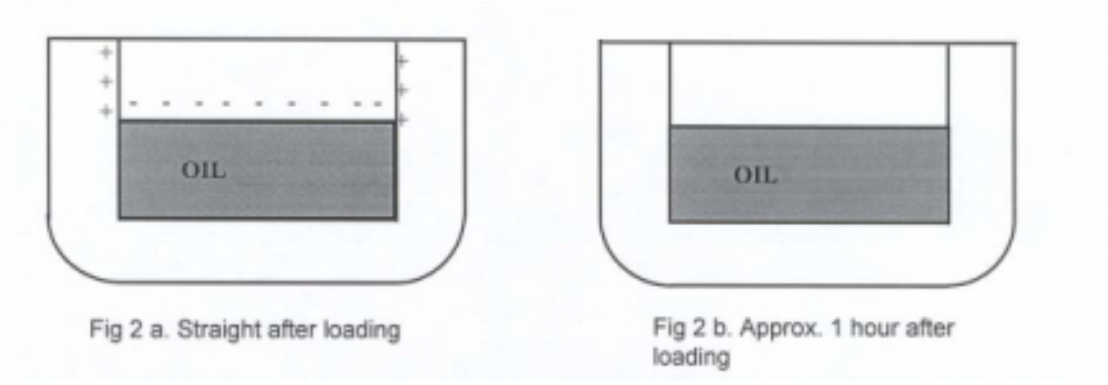



Fig 2 a. Straight after loading

Fig 2 b. Approx. 1 hour after loading

Clean oils are in general accumulators of static electricity because of their low conductivity.

Charge Dissipation

If the charge is not given time to dissipate naturally as shown in Figs 2 a & b. There is a chance that the charge can be dissipated suddenly by the introduction of a metallic object into the tank.

This sudden recombining of the charges occurs in a relatively small area.
There is therefore a greater concentration of energy.
If the energy is sufficient then there will be a spark leading to the ignition of any vapour in the tank.
Figs 3 a & b. Show the likely mechanisms that would have produced the spark in this particular instance.

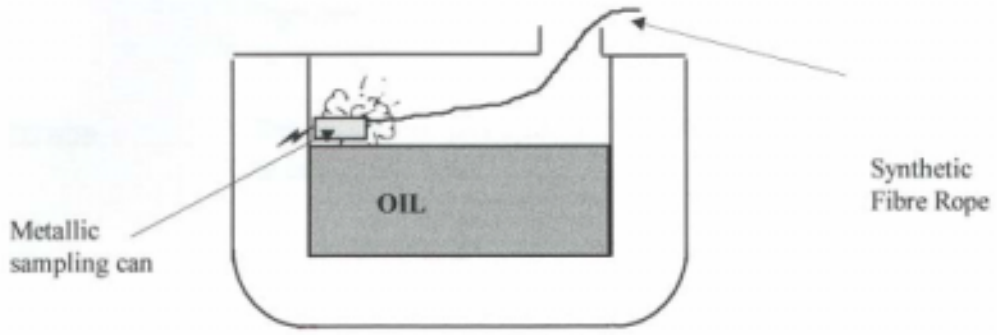



Fig 3 a. The metal can floats on the surface of the liquid . and quickly attain the potential of the liquid. Upon contact with the tank structure there will be an electrostatic discharge.

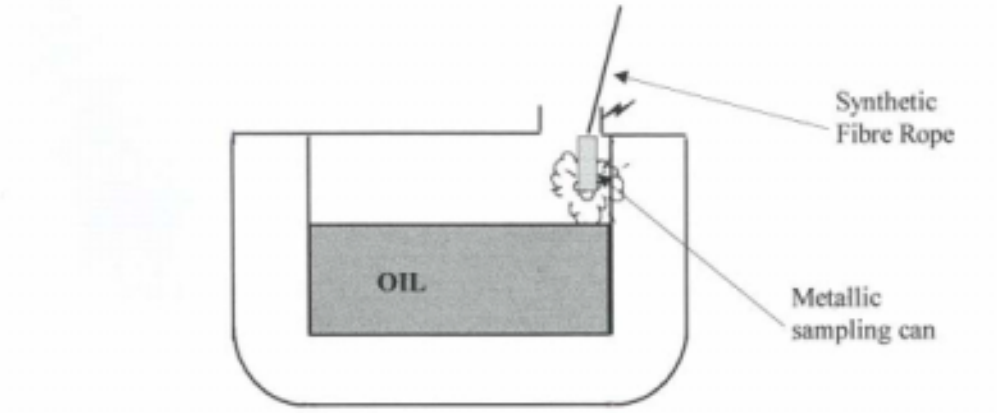



Fig 3 a. The metal has been immersed in the liquid and has attained the potential of the liquid. During the extraction from the tank the can makes contact with the tank structure and electrostatic discharge occurs.

## Appendix 4 Glossary of Terms Used

| | |
|---|---|
| ISM | International Safety Management System as required by SOLAS Chp IX. |
| ISGOTT | The International Safety Guide for Oil Tankers and Terminals. |
| MMC gauge | A hand held device which connects onto a fitting on the top of the tank. The device is thus earthed to the ship' s hull. Therefore there is no danger of spark generation in the tank due to potential difference. An example of this type of gauge and its correct use is shown in Annex 1 Fig 7. |
| Topping off | The operation of completing loading of a tank to a required ullage. The loading rate is normally slowed to allow the required final ullage of the tank to be obtained accurately. |
| Ullage | The height of the space between the top of the tank and the top of the liquid in the tank. |