



# MARINE ACCIDENT REPORT

**CHARLOTTE MAERSK  
FIRE  
7 July 2010**

## Danish Maritime Accident Investigation Board

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### **The Division for Investigation of Maritime Accidents/Danish Maritime Accident Investigation Board**

The Division for Investigation of Maritime Accidents was responsible for investigating accidents and serious occupational accidents on Danish merchant and fishing ships. The Division also investigated accidents at sea on foreign ships in Danish waters.

On 15 June 2011 the Division for Investigation of Maritime Accidents was abolished and the Danish Maritime Accident Investigation Board was established as an independent institution to replace the Division for Investigation of Maritime Accidents.

When the Division for Investigation of Maritime Accidents was abolished on 15 June 2011, the investigation of this accident was in process, and the preparation of this report is completed by the Danish Maritime Accident Investigation Board, in agreement with the Danish Maritime Authority.

The report is drawn up in accordance with the rules, methods and recommendations for accident investigations, which were applicable guidelines for the Division for Investigation of Maritime Accidents.

### **Purpose**

The purpose of the investigation is to clarify the actual sequence of events leading to the accident. With this information in hand, others can take measures to prevent similar accidents in the future.

The aim of the investigations is not to establish legal or economic liability.

# Contents

1	Summary .....	4
2	Conclusions .....	5
3	Actions taken .....	6
4	Factual information.....	7
4.1	Ship particulars.....	7
4.2	Voyage particulars.....	7
4.3	Marine casualty information.....	7
4.4	Cargo stowage on CHARLOTTE MAERSK .....	7
4.5	IMDG Cargo .....	9
4.5.1	Trichloroisocyanuric acid .....	10
4.5.2	Methyl ethyl ketone (MEKP) .....	10
4.5.3	Calcium hypochlorite .....	11
4.6	The site of the accident .....	12
4.7	Narrative.....	12
4.8	Consequences .....	16
4.9	Organisation .....	16
5	Analysis .....	17
5.1	Origin and cause of the fire.....	17
5.2	Organisation and fire fighting effort.....	19
6	Appendices .....	21
6.1	Enclosure 1 .....	21
6.2	Enclosure 2 .....	23

# 1 Summary

On 7 July 2010, CHARLOTTE MAERSK was en route from Port Klang, Malaysia bound for Salalah, Oman. At 2119 on 7 July 2010 approximately three hours after departure crew members on the bridge observed smoke rising from the forward part of the ship.

It was soon apparent that there was a rapidly developing fire on deck. The fire alarm was activated and the crew mustered according to the muster plan and started the fire fighting efforts.

After approximately 24 hours of fire fighting by the crew members, support ships and a fire fighting aeroplane, the fire was considered to be under control. From the evening of 9 July 2010, the fire fighting effort was organised by a salvage master and fire fighters from ashore assisted by the ship's crew.

On 18 July 2010, CHARLOTTE MAERSK sailed under own power to the Port of Tanjung Pelepas, Malaysia to discharge the cargo. The fire fighters from ashore were demobilized on 22 July 2010.

There were only minor damages to the hull and deck and some deformation due to heat on two hatches of cargo hold no. 6. Approximately 160 containers were damaged.

One crew member subsequently suffered respiratory problems from inhaling smoke from the fire.

A certificate of commendation from the IMO was awarded to the crew of Charlotte Maersk for their acts of bravery during the fire in July 2010.

## 2 Conclusions

It is the assessment of the Danish Maritime Accident Investigation Board that

- *the fire probably originated from the container containing methyl ethyl ketone peroxide (MEKP) in stowage position 230682;*
- *the response time of the crew was decisive for the containment of the fire;*
- *a wide variety of safety considerations and decisions were made and actions taken within a short timeframe and under critical circumstances. Furthermore, that the shipboard organisation was able to function effectively even when its main structure was changed in response to the unfolding events. These elements were decisive for the development and outcome of the accident which resulted in relatively minor damages to the ship and crew members.*

### **3 Actions taken**

The shipping company has informed the Danish Maritime Accident Investigation Board (DMAIB) that it has revised its procedures for shipping MEKP (UN no. 3105).

After the accident on CHARLOTTE MAERSK, MEKP (UN no. 3105) is accepted only from previously audited shippers and in compliance with the IMDG Code<sup>1</sup> requirements. As regards all other shippers, MEKP (UN no. 3015) will be accepted for carriage only after the shipping company has checked the booking information, the MSDS and the declaration of the commodity for compliance with the IMDG Code requirements, and then only for shipment in a reefer container with a set temperature of 10°C.

The Danish Maritime Authority (DMA) has informed the DMAIB that, as the report contains information of relevance to the ongoing work at the IMO on the transport of dangerous goods and fire-fighting in containers on deck, the DMA will forward this marine accident report as an INF paper to the relevant IMO Sub-Committee.

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<sup>1</sup> International Maritime Dangerous Goods Code.

## 4 Factual information

### 4.1 Ship particulars

Name	CHARLOTTE MAERSK
Home port	Fredericia
Call sign	OWLD2
IMO no.	9245744
IMO Company no.	0309317
Owner	A.P. Moeller-Maersk A/S
ISM responsible operator/owner	A.P. Moeller-Maersk A/S
Register	DIS
Flag State	Denmark
Construction year	2001
Type of ship	Container ship
Tonnage (GT)	92,198
Classification	American Bureau of Shipping
Length (LOA)	346.98 m
Engine power	63,000 kW
Area served	Trade within GMDSS Sea Areas A1, A2 and A3
Number of crew members	21
Minimum Safe Manning	13

### 4.2 Voyage particulars

Port departure	Port Klang
Port of arrival	Salalah
Type of voyage	International
Cargo information	General cargo in containers

### 4.3 Marine casualty information

Type of accident	Fire
Time and date of the accident	7 July 2010 – 2119 LT
Position of the accident	03°16.6 N – 100°34.8 E
Area of accident	Deck area
Injured persons	1
IMO Casualty Class	Serious

### 4.4 Cargo stowage on CHARLOTTE MAERSK

CHARLOTTE MAERSK is a fully cellular container ship. The containers are arranged according to their stowage number, a six digit number which refers to the position on the ship. The first two digits refer to the bay number, the second two digits the row number and the third two digits the tier number.

Starting from the forward end of the ship, each 20 foot segment in which a 20 foot container can be stowed has a bay number. The forward-most segment is bay 01. The segment immediately behind is bay 03. Bays 01 and 03 comprise bay 02 in which a 40 foot container can be stowed.

See figure 1 below of the forward part of the ship seen from above.

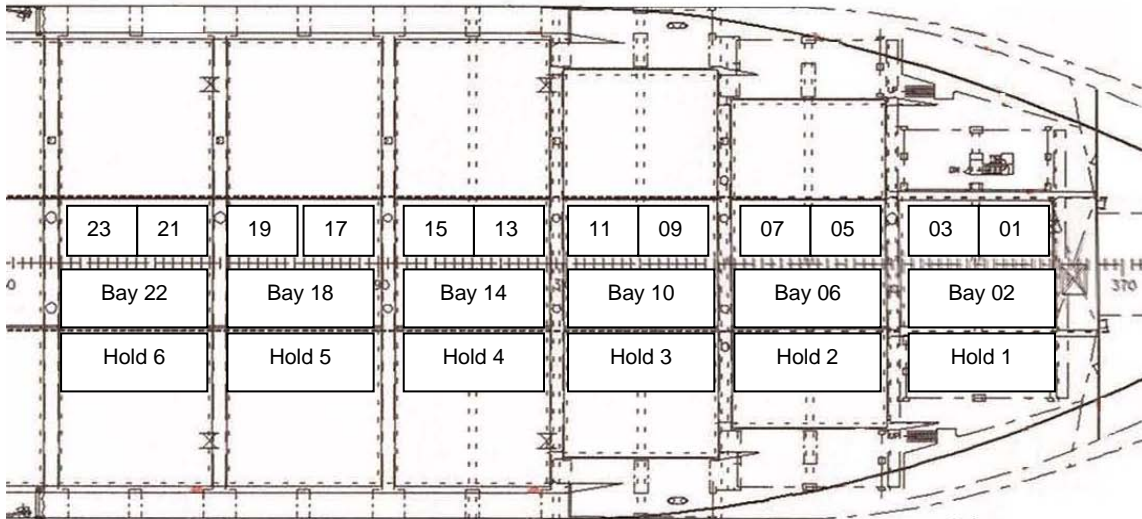


Figure 1

The containers located at the centre of the ship are in row 00. Containers on the starboard side have uneven numbers and containers on the portside have even numbers. See figure 2 below.

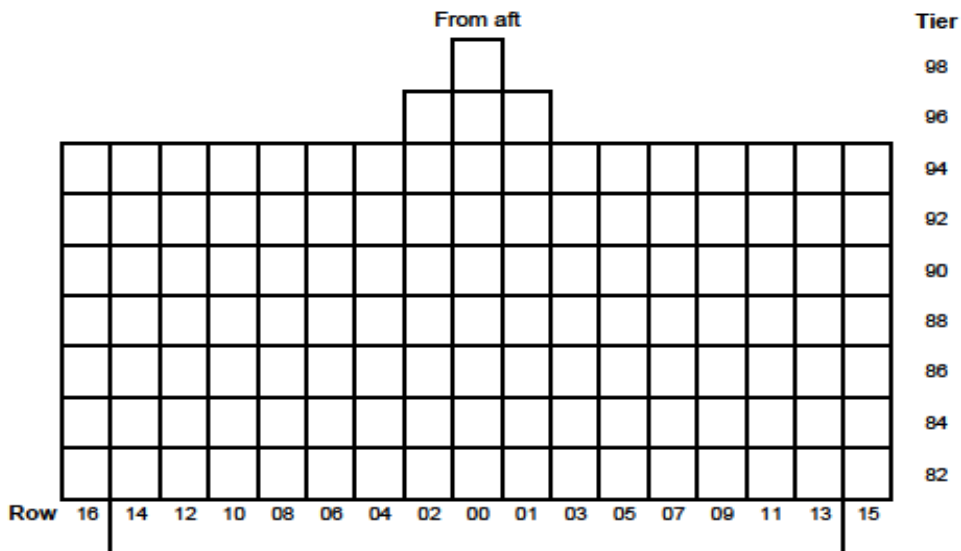


Figure 2

Each container has an individual number with four letters (company ID) and seven digits, e.g. MSKU 7878159.

Dangerous cargo containers are stowed dependent on their IMDG (International Maritime Dangerous Goods Code) classification. This information is contained in the manifest.

Before loading, the stowage position of each IMDG container is checked to ensure that each container is stowed in a safe location. The cargo handling system (LOADSTAR) is designed automatically to identify any irregularities in the stowage plan such as conflicts in the stowage position of incompatible IMDG containers in accordance with the IMDG Code.



When the IMDG containers are loaded, the officer on watch checks that the containers are actually stowed in the right position, with the right labels and appear in good condition.

The daily inspection of the IMDG containers is delegated to an able seaman (AB) who checks the labelling and ensures that there is no leakage or any other problems with the containers. The result of the inspection is then reported to the chief officer.

Reefer containers (which can also contain IMDG cargo) are furthermore checked by an electrician when they are being loaded to ensure that the temperature settings are set according to the manifest. It is checked once again before the ship departs from port. At sea it is checked on a daily basis to ensure that the reefer containers maintain the programmed temperature.

#### 4.5 IMDG Cargo

At the time of the accident, CHARLOTTE MAERSK had loaded 190 containers with IMDG cargo stowed in various bays and holds. The cargo included all IMO classes and various divisions except class 7.

According to statements made by the crew members on the bridge, the initial smoke and flames appeared on the port side of the ship. Furthermore, as the fire fighters first arrived at bay 23 and climbed up on the catwalk on the starboard side, they described the fire as being on the port side of the ship.

Two of the fire fighters described how they were not able to get closer to the fire than row 03. The focus of the investigation was therefore on the port side area on bay 23.

On bay 21/23 (22), there were 32 containers containing various IMO classes and divisions. On the port side on bay 21, there was only one IMDG container in stowage position 211488. On bay 23, there were 18 IMDG containers four of which were on the port side. See figure 3 below of bay 23 seen from the aft.

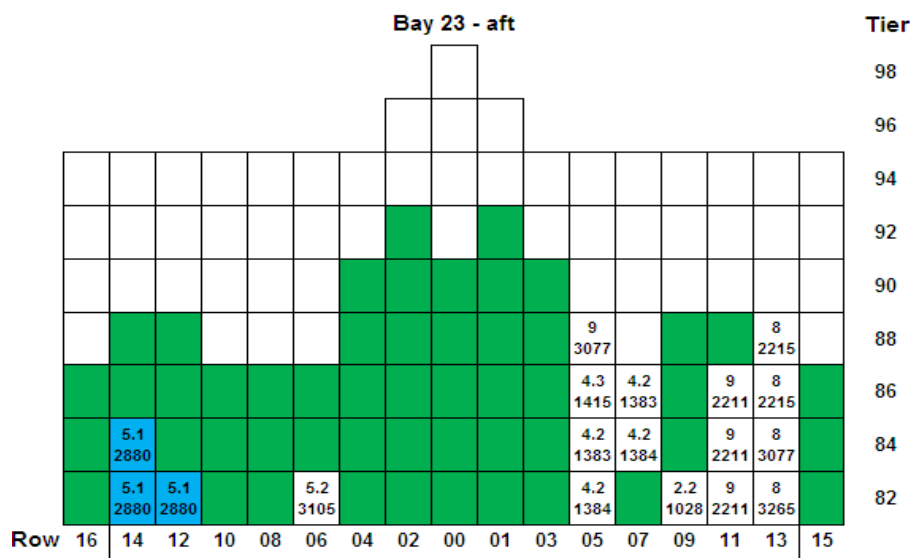


Figure 3

The numbers refer to the IMO class and UN number. The stowage positions marked with blue colour are reefer containers. The stowage positions marked with green colour are dry general cargo containers.

#### 4.5.1 Trichloroisocyanuric acid

The 20 foot container in stowage position 211488 (UN 2468/IMO class 5.1) contained 17.78 MTS of trichloroisocyanuric acid, in 360 plastic drums. It was loaded in Hong Kong and was to be discharged in Port Said, Egypt.

#### 4.5.2 Methyl ethyl ketone (MEKP)

The 20 foot container in stowage position 230682 (UN no. 3105/IMO class 5.2) contained 13.44 MTS of methyl ethyl ketone peroxide (9.2%), type D, liquid, in 2688 cans and in 672 cartons. It was first loaded on a feeder ship in Xingang, China and shipped to Shanghai, China. The final destination was Alexandria, Egypt.

It was loaded on CHARLOTTE MAERSK in Shanghai, China and was to be discharged in Port Said, Egypt.

MEKP type D is an organic peroxide. It is a colourless oily liquid and this particular liquid was diluted by 55% dimethyl phthalate which supposedly makes it more stable.

It is stated in the material data sheet from the manufacturer that organic peroxides are generally unstable and extremely flammable. Shock and friction should be avoided, see enclosure 1.

After the fire, there were no remains of the chemical and only small remains of cardboard and plastic were found in the aft end of the container.

There have been other accidents involving maritime transport of MEKP in containers:

On 7 May 2007, in the port of Bandar Shahid Rajaei, Iran, a container containing MEKP, type D, caught fire after having been discharged and moved to the terminal area. When attempts were made to move the container, it exploded.

In July 2008, the Iranian government submitted an incident report and a proposal (DSC 13/6/11) on the above incident to the IMO Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC). The proposal stated that MEKP should be transported in reefer containers in certain months of the year when the temperature and humidity was relatively high. Furthermore, that a revision of column 17 in the dangerous cargo list in the IMDG Code should be made describing that fume from MEKP is poisonous.

In September 2008, the DSC at its 13<sup>th</sup> session took the following decision:

- Agreed to the importance of underscoring the need to comply with the requirements of the IMDG Code;
- Supported, in principle, indicating in column (17) of the dangerous goods list of the IMDG Code, that the fume stemming from methyl ethyl ketone peroxide (MEKP) is poisonous and agreed to forward the proposal to the Editorial and Technical Group for finalization and inclusion in the draft amendment 35-10 to the IMDG Code; and
- Having considered the need to carry these types of cargoes in refrigerated containers when destined for ports with relatively high temperature and humidity, agreed that further information was required and the matter was multimodal in nature and therefore should also be considered at the Sub-Committee of Experts on the Transport of Dangerous Goods (UNSCOE) level and, in this context, requested the Islamic Republic of Iran to submit revised proposals to DSC 14 and the Secretariat to advise the UNSCOE of the outcome of its consideration.

In September 2008, the matter was brought up at the 34<sup>th</sup> session of UNSCOE. The Sub-Committee noted that the accident, described in the IMO informal documents, concerning a fire and subsequent explosion in a container loaded with methyl ethyl ketone peroxide, would probably not have happened if all requirements contained in the IMDG Code had been complied with. A requirement for carrying this specific organic peroxide in temperature-controlled containers could only be justified if it could be demonstrated that the current requirements are not appropriate.

At UNSCOE in June 2009, it was noted that the International Council of Chemical Associations (ICCA) said that a study<sup>2</sup> containing an evaluation of the current requirements for temperature control during transport of organic peroxides had just been published, and that the conclusion was that the current requirements for the need of temperature control were adequate.

Furthermore the ICCA stated that it should also be mentioned that under long-term storage conditions of non-temperature controlled products (including storage in e.g. harbours) the industry involved insisted on avoiding stowing containers in direct sunlight (making use of e.g. sun-shield, cover, shadow etc.).

In June 2009, the results from the UNSCOE sessions were brought forward at the 14<sup>th</sup> session of the DSC (DSC 14/3/1). It has since been amended to the IMDG Code column 17 that the substance may evolve irritant or toxic fumes.

On 13 July 2010, an IMDG container caught fire on the container ship CAPE FRESCO.

The Danish Maritime Accident Investigation Board has received information stating that the origin of the fire was in a container containing 2688 cans of Methyl Ethyl Ketone Peroxide (M-50, 9,2%), UN no. 3105. The container was loaded at Xingang, China and was stowed on deck.

The fire on CAPE FRESCO was extinguished within two hours using four hoses. There were only minor damages to the vessel mainly to the electrical equipment on deck and cargo hold hatches.

There is no information indicating that the MEKP on CHARLOTTE MAERSK and CAPE FRESCO came from the same manufacturer

IMDG reefer containers shipped with Maersk Line are always surveyed before being shipped and a survey report is issued, including pictures of the content. As the MEKP was not stowed in reefer containers, the container in stowage position 230682 had not been surveyed and there is no information on the content and stuffing of the container except what is described in the bill of lading and dangerous cargo manifest.

#### 4.5.3 Calcium hypochlorite

There were three 20 foot reefer containers on bay 23 in the port side containing calcium hypochlorite (UN no.2880 /IMO class 5.1), hydrated mixture packed in 800 drums in one container and 622 drums in each of the two other containers.

The containers were stowed in positions 231282, 231482 and 231484 (see figure 3). One container contained 12 MTS and the two other containers contained 14 MTS. All

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<sup>2</sup> Validation of the UN criteria for the uncooled sea transport of liquid organic peroxides: Full-scale test and modelling, Journal of Loss Prevention in the Process Industries 21 (2008), 635-641 M. Steensma, and P. Schuurman (Akzo Nobel Technology & Engineering), W.A. Mak (TNO, Netherlands).

three containers were loaded in Shanghai, China and were to be discharged in Port Said, Egypt.

Calcium hypochlorite is a strong oxidizing agent and presents a serious fire and explosion risk if in contact with combustible materials. See data sheet from the manufacturer of the product, enclose 2.

The Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC), at its fifth session, having received a considerable number of submissions by governments and international organizations and prompted by recent incidents involving the transport of calcium hypochlorite by sea, agreed that there was a need for guidance on the transport provisions of the IMDG Code for these products. The revised conditions of carriage for the various forms of calcium hypochlorite have been amended to the IMDG Code in 2001 to align with MSC Circular 963.

#### 4.6 The site of the accident

The accident occurred while CHARLOTTE MAERSK was northbound in the Strait of Malacca approximately three hours after departure from Port Klang, Malaysia. Approximately three hours after the fire had started CHARLOTTE MAERSK was anchored in a position approximately 10 nautical miles east of the initial position of the accident. See map below.



Map of Malaysia and Strait of Malacca

Google Earth

#### 4.7 Narrative

*The narrative is compiled from different sources and describes the main events in chronological order. The timing of some of the events is given as estimates because there are some discrepancies in the statements.*

CHARLOTTE MAERSK departed from Port Klang at app. 1730 on 7 July 2010 en route for Port Salalah, Oman. At app. 2000, after the pilot had disembarked, there was a change of bridge watch. The master remained on the bridge until the ship had cleared the narrows of One Fathom Bank. He then went down to his cabin.

The 3<sup>rd</sup> officer was then the watchkeeping officer on the bridge together with an able seaman (AB) who was the lookout. There was dense traffic and the night was clear with good visibility and the ship was on full navigational speed.

At 2115 on 7 July 2010, the 2<sup>nd</sup> engineer and cadet came to the bridge to report on the completion of minor maintenance work on the ventilation system.

At 2119 on 7 July 2010, the crew members on the bridge noticed a small puff of white smoke rising from the port side on the forward part of the ship. The officer on watch told the AB to go to the deck area to observe what was going on. Within 30 seconds, a large cloud of smoke was observed.

The officer on the watch then immediately sounded the fire alarm. After 10 to 15 seconds, the first flames were observed from the bridge. The officer on watch turned the ship about 50° to starboard to bring the ship out of the traffic lane and to direct the smoke to the port side.

The lookout heard the fire alarm on his way to the deck area. He decided to go to the cargo control room (CCR), which is the emergency muster station, and wait for the rest of the crew members.

The master heard the fire alarm at 2120 on 7 July 2010 and immediately ran to the bridge and took over the control of the ship. Within moments of his arrival on the bridge, large flames appeared in the same area as the smoke. The crew members on the bridge soon realized that the fire was on bay 22.

The master turned the ship further to starboard to keep the relative wind on the starboard side of the ship, thereby minimizing the risk of the fire spreading towards the starboard side. The speed was reduced from full navigational speed to dead slow ahead.

The chief officer came on the bridge shortly after the alarm had sounded. He took a UHF radio from the charger and went to the CCR which was his muster station.

Meanwhile, the 2<sup>nd</sup> officer arrived on the bridge which was his muster station according to the muster list. His responsibility was to assist the master and conduct communication from the radio station. He was ordered to type a record of the main events directly on the bridge computer. Furthermore, he was instructed to transmit a MAYDAY by DSC VHF, DSC MF/HF and by SATCOM B and C. The distress messages were sent at 2133. At 21.45 a response came from Falmouth Coastguard and RCC Stavanger. The Malaysian Coastguard responded and informed that they were sending support ships to the position of CHARLOTTE MAERSK.

Within the first half hour, the master informed the owner about the situation and received advice and precautionary measures related to fighting the fire in the IMDG cargo.

Within two minutes, the crew had mustered at the emergency muster station in the CCR. The chief officer divided the crew into two teams to fight the fire. Team A and Team B. Four ABs were appointed as fire fighters, two in each team. There was initially a primary team and a backup team. However, it was soon apparent that both teams were needed to fight the rapidly developing fire.

The remaining crew (apart from the chief engineer and the fourth engineer who were sent to the engine room) were to prepare the fire hoses and act as backup for the two fire fighting teams.

The 3<sup>rd</sup> officer was told to go to the bridge to identify the IMDG cargoes in the relevant part of the ship.

While the fire fighters prepared the equipment, the other crew members went on deck to prepare the fire hoses. It had been decided that the fire should be approached from the starboard side of the ship, which was the windward side, thereby minimizing the crew members' exposure to the smoke.

At 2127 on 7 July 2010, fire fighting team A approached the catwalk between bay 26 and bay 22 and decided to climb up on the lower catwalk. Fire fighting team A realized that the fire was close to the centreline of the ship and they could not get any closer than row 03 on bay 23. The fire appeared to be spreading aft to bay 26.

At 2129, fire fighting team B joined fire fighting team A and fought the fire from the same position as team A on the lower catwalk. The fire was described as fierce in row 04 (port side).

The chief officer sent the chief steward, the steward and the 2<sup>nd</sup> engineer to assess the situation on the port side and to ascertain how far the fire had spread and, if possible, to fight the fire from that side.

At approximately 2150, there was an explosion on bay 23. Fire fighting teams A and B retreated for a while, but took up their positions shortly after.

On the port side the chief steward, the steward and the 2<sup>nd</sup> engineer saw the above mentioned explosion. Initially when they arrived at bay 22 on the port side, there was no fire on rows 14 and 16 (outermost row). When they tried to climb the ladder to the catwalk, a container in row 12 or 14 exploded and the flames enveloped the container on the outer row 16.

In the first hour, the crew prepared about seven fire hoses and nozzles each manned with two crew members. The nozzles were placed in various locations on the lower and upper catwalks between bay 22 and bay 26.

In order to get as many nozzles in operation as possible, it was decided to lash some of the nozzles with rope to railings. This enabled one crewmember to operate the nozzle so that the crew members could leave the pressurized nozzles to attend to other duties.

Between the first and second hour of the fire, the master had concerns about a liquefied petroleum gas (LPG) container<sup>3</sup> located on deck on bay 30. In response the chief officer initiated cooling by three-four nozzles aft of bay 26.

At 2300 on 7 July 2010, the 3<sup>rd</sup> officer reported that he thought he could see flames coming out from inside hold no. 6. The master decided to shut down the ventilation in the cargo hold.

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<sup>3</sup> It was a 40 foot dry container on stowage position 300082 containing 1,360 kg of LPG (UN no. 1075 /IMO class 2.1) in pressurized receptacles and packed in fibreboard boxes.

At 2308 on 7 July 2010, the master ordered the release of CO2 into holds no. 6 and 7 as they were linked. The chief engineer released the CO2 assisted by the chief officer.

At 0051 on 8 July 2010, the ship was anchored app. ten nautical miles east of the initial position of the accident. The decision to do so was made because the ship was running out of space to manoeuvre while keeping the wind on the starboard side. Furthermore, it would ease the evacuation of the ship, if necessary. The decision to evacuate depended on whether the fire would reach the container on bay 30 containing LPG.

A Malaysian Coastguard ship arrived at 04.05 on 8 July 2010 and a second one at 0452. They were there to monitor the situation and evacuate the ship if necessary.

The crew continued fighting the fire throughout the night. In the morning of 8 July 2010, at about 08.00, seven of the crew members were advised to get some rest. This coincided with the arrival of an aeroplane from the Malaysian Coastguard which would drop water on the fire. It was not considered safe for the crew to fight the fire while the aeroplane dropped the water. The seven crew members were instructed to be back on deck at noon on 8 July 2010.

At 0900 on 8 July 2010, the aeroplane was dismissed after three attempts because it did not have any apparent effect on the fire. The crew members resumed the fire fighting.

At 1200 on 8 July 2010, a third Malaysian support ship arrived. It was equipped with a small fire monitor and started fighting the fire from the port side. The rested crew members relieved the crew members still on deck.

At 1600 on 8 July 2010, the 2<sup>nd</sup> officer relieved the chief officer. By this time most of the flames had been extinguished, but there was still an immense heat and regular flare-ups.

At 1752 on 8 July 2010, a salvage master arrived on board.

At 1807 on 8 July 2010, a tug arrived equipped with a large fire monitor. It also started fighting the fire from the port side of the ship. About this time most of the crew members switched to six-hour watches. Seven crew members were fighting the fire on each watch.

At 2200 on 8 July 2010, the chief officer came back on deck and donned a breathing apparatus so that he could rig hoses closer to the fire. By this time the fire was considered to be contained and under control. The crew gradually started cooling the surrounding area.

The fire fighting effort continued throughout 9 July 2010.

Around 1900 hours on 9 July 2010, the fire fighting teams from the Netherlands arrived in two groups and took over the fire fighting effort assisted by the crew members. Additional equipment was mobilized from ashore, including air compressors, air breathing apparatus, hoses, etc.

The fire remained under control and boundary cooling was ongoing by the fire fighters and three support ships. During 10 July 2010 and the following days, nearby containers were opened, inspected and minor fires extinguished.

During the following days, the effect of stopping boundary cooling was tested, but the fire flared up again. It was deemed necessary to keep boundary cooling on bays 18, 22 and 26 for a prolonged period of time. By this time three vessels with fire monitors were supporting the fire fighting effort.

Cargo holds nos. 6 and 7 were inspected. Only minor damages were noticed to the cargo in the holds, which had apparently occurred during the early stages of the fire. The CO2 had extinguished the fire and was at 100% for a couple of days thereby hindering flare-ups.

During the evening of 16 July 2010, CHARLOTTE MAERSK sailed under own power to the anchorage of Port of Tanjung Pelepas and arrived in the morning of 18 July 2010.

In the evening of 18 July 2010, the ship berthed at the Port of Tanjung Pelepas.

The ship and cargo were monitored during discharge of the cargo and the fire was officially extinguished on 19 July 2010. The salvage team and fire fighters were demobilized during 20 July 2010.

#### *4.8 Consequences*

Primary damages to the ship occurred on bays 21/23 (22) and bays 25/27 (26) and the lashing bridges between the bays. The hatches to holds nos. 6 and 7 suffered heat damages and the plating was cropped and renewed. The electrical systems and fire fighting system was repaired.

The hull and main structure of the ship had suffered minor damages to the coating, etc. but was otherwise intact.

There were approximately 160 damaged reefer and general cargo containers of different sizes.

One crewmember later suffered respiratory problems from inhaling smoke from the fire.

#### *4.9 Organisation*

On CHARLOTTE MAERSK, the fire muster plan outlines the overall plan for an initial response to a fire. The crew muster stations are as follows:

- Master and 2<sup>nd</sup> officer – bridge
- The chief officer and the rest of the crew in the CCR.

The muster plan also describes the different tasks assigned to the individual crew members.

The master is responsible for the fire and emergency drills on the ship. Once a month a planned fire drill is conducted, and once a year one unscheduled drill is held. Furthermore, an additional drill is held when more than 25% of the crew has been changed since the last drill.

At the monthly drill the relevant protective equipment, the air breathing apparatus and the fire pumps and hoses are tested. For each fire drill a scenario is created involving a fire in a particular location on the ship. The crew members are to react as if the situation is real. This involves using the relevant equipment, putting on fire suits and air breathing apparatus and fighting the imaginary fire.



At least once in every three drills, the crew members practise fire fighting by covering the fire masks so that the crew can experience what it is like to fight a fire in conditions where smoke restricts the visibility.

## 5 Analysis

### 5.1 Origin and cause of the fire

No physical evidence or witness statements clearly state the origin or cause of the fire. However, a number of circumstantial evidence suggests the origin of the fire.

The statements by the crew indicate with reasonable certainty that the fire started on bay 21/23 (22). This is based on the witness statements made by the crew members on the bridge, the fire fighting teams and, furthermore, on observations of the damaged containers.

The crew on the bridge who first saw the smoke and flames have given statements that indicate that the smoke came from the port side of the ship. It was also stated that a slight breeze came in from about 30° on the starboard bow and the ship was at full navigational speed. Below is a photograph of the view that the officers had.



View from bridge

Photo: Burgoynes

From this view, there are nine holds to the location of the fire on bay 23. From this distance and perspective, it is difficult to identify the exact location of the smoke and flames considering the effects of wind and the speed of the ship. The witness statements do, however, agree that the smoke came from the port side at a location which varies from just port of the centreline to row 08.

If the origin of the fire was an IMDG container on the port side, then there are five possible containers on bay 22 port side. They are stowed in the following positions (see figure 3):

- 211488 containing trichloroisocyanuric acid
- 231282 containing calcium hypochlorite
- 231482 containing calcium hypochlorite
- 231484 containing calcium hypochlorite
- 230682 containing MEKP

*Container containing trichloroisocyanuric acid (211488)*

The circumstantial evidence indicates that the origin of the fire was not in the container containing trichloroisocyanuric acid in stowage position 211488. It is supported by the intensity of the fire during the early stages on bay 23, tier 82, and the limited localized heat damages at the bottom of the doors of the container. The container was otherwise intact. See photograph below.



View of bay 22 port side

Photo: Burgoynes

*Container containing calcium hypochlorite (231282, 231482, 231484)*

About half an hour after the fire alarm had sounded some crew members were able to climb up on the catwalk on the port side and witness the fire reaching the container in row 14. They witnessed an explosion in row 12 or 14. Considering the time that had passed since the start of the fire, this indicates that the fire had its origin further towards the starboard side and, thus, not in the containers containing calcium hypochlorite.

From the witness evidence of the electrician, it appears that the reefers were cooled continuously from the time of loading and were kept at 10°C. If so, de-composition of the material in the reefer containers is only a remotely possible scenario.

Pictures from the cargo survey report did not show anything out of the ordinary. The content of the container seemed to be stowed, lashed and labeled sufficiently.

### *Container containing MEKP (230682)*

Below is a photograph of the interior of the container.



Inside view of MEKP container Photo: Burgoynes

The witness evidence suggests that the fire started in a location approximately in the position of the MEKP container.

The statements made by the witnesses on the bridge indicate that the fire came from a location between row 08 and just port of the centre line.

After the fire, the container was essentially empty, there being only small remains of plastic and cardboard at the forward end.

Furthermore, the fire fighting teams reported that they were not able to get closer to the fire than row 03 in the starboard side and they saw a fierce fire at a short distance from the centre line.

The other accidents involving MEKP in a terminal in Iran and on the ship CAPE FRESCO give reason to believe that the substance can undergo an explosive reaction.

*It is the assessment of the Danish Maritime Accident Investigation Board that the fire probably originated from the container containing methyl ethyl ketone peroxide in stowage position 230682.*

### **5.2 Organisation and fire fighting effort**

The fire fighting effort started at 2127 on 7 July 2010, and the fire was considered by the ship crew to be under control during the evening of 8 July 2010.

The crew managed to contain the fire to hold 6/bay 22 and bay 26.

The crew members had mustered at the emergency station within approximately two minutes. Within 10 minutes the fire fighting had started. It was therefore possible to initiate the fire fighting effort on the catwalk between bay 22 and bay 26.

*It is the assessment of the Danish Maritime Accident Investigation Board that the response time of the crew was decisive for the containment of the fire.*

The ship was immediately turned starboard to direct the smoke and flames to the port side.

It was decided to anchor the ship, thereby enabling the crew to position the ship relative to the wind to keep the smoke and flames to the port side.

Contact was made early on to relevant authorities and the owner, thereby obtaining useful information about the prospects for assistance and additional valuable information on the characteristics of the IMDG cargo.

The crew members were early aware of the position of the IMDG cargo.

Preparations were made to evacuate the ship.

Effective measures were taken to prevent the fire from spreading to the container containing LPG in stowage position 300082.

The crew members were re-positioned frequently during the fire, thereby containing the fire as the events unfolded.

In the morning of 8 July 2011, seven of the crew members were advised to get some rest and rejoin the fire fighting at 12.00 on 8 July 2010.

The function as fire team leader shifted from a senior officer to a junior officer, thereby giving the senior officer an opportunity to get some rest.

At one point all crew members were directly engaged in the fire fighting effort except two engineers in the engine room and the master on the bridge. The management was thereby able to make use of the majority of the crew members in the fire fighting effort.

The calm and determined management of the critical situation had a positive influence on the crew members and their determination to fight the fire.

*It is the assessment of the Danish Maritime Accident Investigation Board that a wide variety of safety considerations and decisions were made and actions taken within a short timeframe and under critical circumstances. Furthermore, that the shipboard organisation was able to function effectively even when its main structure was changed in response to the unfolding events. These elements were decisive for the development and outcome of the accident which resulted in relatively minor damages to the ship and crew members.*

## 6 Appendices

### 6.1 Enclosure 1

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#### MATERIAL SAFETY DATA SHEET

##### **SECTION I**

PRODUCT NAME: MEKPO M-50 type

Components: Methyl ethyl ketone peroxide 45%  
Dimethyl phthalate: 55%

Active oxygen content: 9.2%

PRODOCT DESCRIPTION: Methyl ethyl ketone peroxide dissolved in dimethyl phthalate, is an excellent curing catalyst for unsaturated polyester resins.

##### **SECTION II HAZARD DATA**

Emergency and First Aid procedures

Skin: Avoid direct contact with the skin, it may cause irritation or some injury. In such cases, wash area with soap and water.

Eyes: Immediately flush with liberal amounts of water.  
Call a physician.

Personal Protection

Hand Protection: Wearing protective gloves before work  
Eye Protection: Wearing goggles before work  
Body Protection: Wearing closed working clothing before work

##### **SECTION III FIRE AND EXPLOSION HAZARD DATA**

Possible hazards: Since organic peroxides are generally unstable, they must be handled with greatest care. They are extremely inflammable and under certain conditions, they may decompose violently as an explosive.

FIASH POINT: 90 °C

EXTINGUISHNG MEDIA: Water Fog, Foam; Dry Extinguishing Media

##### **SECTION IV PHYSICAL DATA**

Form: Liquid

Colour: transparent, colourless

Boiling point/range: Do not distil (decomposes)

Melting point/range: turbid < -10°C

Decomposition temperature (SADT): 60°C

Specific Gravity (20°C): 1.155~1.165

Refractive Index (20°C):1.46~1.48

Moisture: 2% max

Flashing point: 90°C

##### **SECTION V HANDLING AND STORAGE**

Handling: Protection against fire and explosion, keep away from sources of ignition,  
NO SMOKING; Avoid heavy shock and friction.

Storage: Keep in a dark and well-ventilated place; keep away from heat sources such as radiators or steam pipes.

#### **SECTION VI SPILL OR LEAK PROCEDURES**

Treatment for spilling:

Spilled MEKPO should be absorbed with absorbent such as a saw dust or the trace of EKPO is thoroughly washed out: In case of concrete floor, washing with soapy water may be satisfactory. But solvents (e.g. alcohol, acetone and carbon and carbon tetrachloride) should be applied to wash out the trace on a wooden floor.

#### **SECTION VII SPECIAL PROTECTION INFORMATION**

Prevent contamination with foreign materials, especially heavy metal particles since it may cause decomposition. Never mix directly with accelerators such as cobalt naphthenate.

Direct. Mixing with it may cause violent decomposition like an explosive. To mix with the resin in the processing, either MEKPO or an accelerator is diluted with the resin and the remainder is added to the mixture.

#### **SECTION VIII TRANSPORTATION INFORMATION**

SEA TRANSPORT

IMDG/GGVESEE CLASS: 5.2 UN NO.: 3105

MARINE POLLUTANT: YES

## 6.2 Enclosure 2

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### SECTION 1 – CHEMICAL PRODUCT IDENTIFICATION

**MSDS Name:** Calcium Hypochlorite

**Catalog Numbers:** AC199030010

**Synonyms:** Calcium oxychloride; Bleaching powder; Calcium Salt; Chlorinated lime

**CAS Registry Number:** 7778-54-3

**PIN (UN/NA Number(s)):** 2880

**RTECS Number(s):** NH3485000

**Chemical Family:** Salt of hypochlorous Acid

**Molecular Formula:** O-Cl-Ca-Cl-O

**Structural Formula:** Ca(OCl)<sub>2</sub>

### SECTION 2 – COMPOSITION, INFORMATION ON INGREDIENTS

**Specifications:** Available chlorine: 65% min.-70% min.; Water: 5.5%-10%; Granular size (14-50 mesh): 90%min.

**Ingredients (by weight %):** it contains up to 65% min.-70% min. of Ca (OCl)<sub>2</sub>, the remainder includes sodium chloride, water, calcium chloride, calcium carbonate, calcium hydroxide and calcium chlorate, etc. Water content should not be too high or too low in an effort to avoid product to react with organic contaminants violently.

The presence of magnesium oxide in lime used to prepare calcium hypochlorite may lead to the formation of magnesium hypochlorite, which is dangerously reactive.

Impurities such as rust (iron oxide) or other metal oxides can catalyze decomposition of the material and must be kept at very low levels.

**Product Use:** Water-treatment agent; Bleaching Agent; Bactericide; Algaecide.

### SECTION 3 – HAZARDOUS IDENTIFICATION

**Appearance:** white solid (or tablet as requested); products may have a strong chlorine odour resulting from decomposition of calcium hypochlorite.

**Danger Overview:** Strong oxidizer. Contact with such material as oil, etc. may cause a fire. Corrosive. May be harmful if swallowed. Cause eye and skin burns. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns.

Potential Health Effects

**Eye Contact:** Exposure to calcium hypochlorite dust and mist can cause eye irritation. Concentrated solutions can cause burns which may result in permanent eye damage.

**Skin Contact:** Calcium hypochlorite dust and solutions can cause irritation, and in severe cases, chemical burns with permanent scar.

**Ingestion:** Calcium hypochlorite may cause burns to the mouth and digestive tract. Symptoms include abdominal pain, vomiting, difficulty in breathing, confusion, delirium and, in severe cases, coma and death.

**Inhalation:** Dust and mist may irritate the nose and throat and upper respiratory tract. When mixed with acids, chlorine gas releases. This gas can cause severe irritation of the nose and throat. Prolonged exposure to high concentration of chlorine gas may result in severe lung damage.

**Chronic:** Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis. Effects may be delayed. Laboratory experiments have resulted in mutagenic effects.

## **SECTION 4—EXPOSURE CONTROLS, PERSONAL PROTECTION**

**Engineering controls:** Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate ventilation to keep airborne concentration low.

### **Personal Protective Equipment**

**Eyes:** Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

**Skin:** Wear appropriate protective gloves to prevent skin exposure.

**Clothing:** Wear appropriate protective clothing to prevent skin exposure.

**Respirators:** A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirement or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

## **SECTION 5 – FIRST AID MEASURES**

### **Eye Contact:**

Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20-30 minutes, by the clock, holding the eyelid(s) open. Neutral saline solution may be used as soon as it is available. **DO NOT INTERRUPT FLUSHING.** Take care not to rinse contaminated water into the non-affected eye or on to face. If irritation persists, repeat flushing. Quickly transport victim to an emergency care facility

### **Skin Contact:**

Avoid direct contact with this material. Wear impervious protective gloves if necessary. Once contacted, as quickly as possible to flush contaminated area with lukewarm, gently running water for at least 20-30 minutes, by the clock. **DO NOT INTERRUPT FLUSHING.** If necessary, keep emergency vehicle waiting. Under running water, remove contaminated clothing, shoes and leather goods (e.g. watchbands, belts). Discard contaminated leather goods and transport victim to an emergency care facility immediately.

### **Ingestion:**

Never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing.

Have victim rinse mouth thoroughly with water.

Do NOT induce vomiting. Have victim drink 240 to 300ml (8 to 10 oz.) of water to dilute material in stomach. If vomiting occurs naturally, rinse mouth and repeat administration of water.

Obtain medical attention immediately.

### **Inhalation:**

Get medical aid immediately. Remove from exposure to fresh air immediately. If breathing is difficult, give oxygen. **DO NOT** use mouth-to-mouth respiration. If breathing has ceased, apply artificial respiration using oxygen and a suitable mechanical device such as a bay and a mask.

### **Comments:**

Provide general supportive measures (comfort, warmth, rest). Consult a physician and/or the nearest Poison Control Centre for all exposure except minor instance of inhalation or skin contact.

## **SECTION 6 – FIRE FIGHTING MEASURES**



**Flash Point:**

Not combustible (does not burn). However, calcium hypochlorite is a strong oxidizing agent and is a serious fire and explosion risk.

**General Information:**

This strong oxidizer may cause a fire as it contacts with combustible materials; Contaminating or mixing with foreign materials such as combustibles, grease, and fuels can cause fire;

Containers may explode when heated;

As in any fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear during a fire.

**Extinguishing Media:**

Use water spray to cool fire-exposed containers. Contact professional fire-fighters immediately. Cool containers with flooding quantities of water until well after fire is out.

For small fires DO NOT use dry chemicals, carbon dioxide or foams. USE WATER ONLY. For large fires, flood fire area with water from a distance.

**SECTION 7 – ACCIDENTAL RELEASE MEASURES****General Information:**

Use proper personal protective equipment as indicated in Section 3.

**Spills/leaks:**

Vacuum or sweep up material and place into a suitable disposal container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the protective Equipments section. Avoid generating dusty conditions. Remove all sources of ignition. Provide ventilation. Do not get water inside containers. Do not use combustible materials such as paper towels to clean up spill.

**SECTION 8 – HANDLING AND STORAGE****Handling:**

Use only in a well ventilated area. Minimize dust generation and accumulation. Do not get in eyes, on skin, or on clothing. Label containers and keep containers tightly closed after use. Avoid contact with heat, sparks and flame. Avoid contact with clothing and other combustible materials. Do not ingest or inhale. Discard contaminated shoes. Wash thoroughly after handling. Remove contaminated clothing and wash before re-use.

**Storage:**

Store in original container. Store tightly closed containers in a clean, cool open or well ventilated area. Keep out of sun, sparks and flame. The storage area should have a non-combustible, corrosion-resistant floor and approved drainage. Protect containers from damage or breakage. Keep away from incompatible material.

Avoid storage for prolonged periods. Regularly and carefully inspect containers for damage and corrosion. Only corrosion-resistant equipment should be used in storage area.

**SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES**

**Physical state:** Crystalline granular

**Appearance:** White

**Odour:** Strong chlorine like

**Molecular Weight:** 142.9848

**Conversion Factor:** Not applicable

**Melting Point:** Not applicable

**Boiling Point:** Not applicable

**Flash Point:** Not applicable

**Decomposition temperature:** 100 deg C

**Specific Gravity/Density:** 2.0 (water=1)

**Solubility in Water:** 21.5g/100ml at 0 deg C; 23.4g/100ml at 40 deg C  
**Solubility in Other Liquids:** Not available. Calcium hypochlorite reacts with many organic materials.  
**Vapour Pressure:** Not applicable  
**Vapour Density:** Not applicable  
**Evaporation Rate:** Not applicable  
**pH Value:** not available

## SECTION 10 – STABILITY AND REACTIVITY

### **Chemical Stability:**

Normally unstable, it readily undergoes violent chemical changes, but does not detonate. Small amount of water added to a container of calcium hypochlorite may generate enough heat to initiate the hazardous decomposition of this material. However, it is stable at room temperature in closed container under normal storage and handling conditions.

### **Condition to Avoid:**

High temperatures, incompatible materials, ignition sources, dust generation, acids, excess heat, combustible materials, organic materials, reducing agents.

### **Incompatibility-Material to Avoid:**

Reducing agents, carbontetrachloride, ammonia, aliphatic amines, aromatic amines, sulphur, sulphides (inorganic, e.g. ferric sulphide, lead sulphide, sodium sulphide), metal oxides, glycerol, phenols, diethylene, glycol monomethyl ether, carbon, acetic Acid + potassium, cyanides (e.g. potassium cyanide, sodium cyanide), ammonium chloride, charcoal, N,N-dichloromethylamine+heat, ethanol, menthol, iron oxide, rust, 1-propanethiol, isobutanethiol, turpentine, sodium hydrogen sulphate + starch + sodium carbonate, acetylene, hydroxy compounds (e.g. ethanol, ethylene glycol, glycerol, sugar), combustible material (e.g. anthracene, grease, oil, mercaptans, methyl carbitol, nitromethane, organic matter, and propylmercaptan).

### **Hazardous Decomposition Products:**

Hydrogen chloride, irritating and toxic fumes and gases, oxygen, chlorine.

**Hazardous Polymerization:** does not occur.

### **Comments:**

The stability of solid calcium hypochlorite depends on the content of moisture, lime and impurities (e.g., magnesium hypochlorite and metal oxides), and the temperature and humidity of the storage area. Anhydrous calcium hypochlorite containing 1% moisture may lose 1-3% available chlorine per year

## SECTION 11– DISPOSAL CONSIDERATIONS

Untreated waste calcium hypochlorite must never be discharged directly into sewers or surface water. Following decontamination, disposal of residue by secure landfill may be acceptable.

## SECTION 12 – TRANSPORT INFORMATION

**Description and Shipping Name:** Calcium hypochlorite, hydrated or calcium hypochlorite hydrated, mixtures with not less than 5.5% but more than 10% water.

**Product Identification Number (PIN):** 2880

**Classification:** 5.1 – Oxidizing substance

**Special Provisions:** 109

**IMO Classification:** 5.1

**ICAO Classification:** 5.1

**Packing Group:** II

## SECTION 13 – TOXICOLOGICAL INFORMATION

### **Animal Toxicology:**

**Acute Toxicity:** Inhalation LC50: Approximately 1300 mg/cubic-meter (1 hr., rat) – based on acute inhalation toxicity for chlorine. Oral LD50: 850 mg/kg. (rat) Dermal D50: >2 g/kg. (rabbit) Causes burns to eyes and skin.

**Chronic Toxicity:** There are no known or reported effects from repeated exposure.

**Target Organ Toxicity:** Reproductive and Development Toxicity: Calcium hypochlorite has been tested for Teratogenicity in laboratory animals. Results of this study have shown that calcium hypochlorite is not a teratogen.

### **Carcinogenicity:**

This product is not known or reported to be carcinogenic by any reference source, including: IARC, OSHA, NTP, OR EPA. One hundred mice were exposed dermally 3 times a week for 18 months to a solution of calcium hypochlorite. Histopathological examination failed to show an increased incidence of tumors.

IARC (International Agency for Research on Cancer) reviewed studies conducted with several hypochlorite salts. IARC has classified hypochlorite salts as having inadequate evidence for carcinogenicity to humans and animals. IARC therefore considers hypochlorite salts to be not classifiable as to their carcinogenicity to humans.

**Mutagenicity:** Calcium hypochlorite has been tested in the dominant lethal assay in male mice, and it did not induce a dominant lethal response. Calcium hypochlorite has been reported to produce mutagenic activity in two in vitro assays. It has, however, been shown to lack the capability to produce mutations in animals based on results from the micronucleus assay. In vitro assays frequently are inappropriate to judge the mutagenic potential of bactericidal chemicals due to a high degree of cellular toxicity. The concentration, which produces mutations in these in vitro assays, is significantly greater than the concentrations used for disinfection.

## SECTION 14 – ECOLOGICAL INFORMATION

### **Aquatic Toxicity:**

Bluegill, 96 hr. LC50: 0.088 mg/1 (nominal, static)

Rainbow Trout, 96 hr. LC50: 0.16 mg/1 (nominal, static)

Daphnia magna, 48 hr. LC50: 0.11 mg/1 (nominal, static)

### **Avian Toxicity:**

#### **Wildlife Toxicity:**

Bobwhite quail, dietary LC50: >5,000 ppm

Mallard ducklings, dietary LC50: >5,000 ppm

Bobwhite quail, oral LD50: 3474 mg/kg.

## ENVIRONMENTAL HAZARDS (PR Notice 93-10)

This product is toxic to fish and aquatic organisms. Do not contaminate water by cleaning of equipment or disposal of wastes. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your State Water board or Regional Office of the EPA.

## SECTION 15 –REGULATORY INFORMATION

### **This chemical appears on the following lists:**

(X) SARA Title 3: Hazard Categories, per 40 CFR 370.2:

Health: Immediate (Acute) Physical: Fire and Reactivity  
(X) TSCA

NSF Limits: NSF Drinking Water Treatment Chemicals Listing? Cal Hypo granules and tablets are certified for maximum use at 15 mg/L under NSF/ANSI Standard 60

Emergency Planning and Community right to know, per 40 CFR 355, APP. A: Extremely Hazardous Substance ? Threshold planning quantity: None established Supplier Notification Requirements, per 40 CFR 372.45: None established Regulated Under FIFRA, USDA & FDA

## **SECTION 16 –ADDITIONAL INFORMATION**

This MSDS replaces the 10/03/2003 version. Any changes in information are as follows:

**In Section I - 24 hr emergency telephone number** ALWAYS COMPLY WITH ALL APPLICABLE INTERNATIONAL, FEDERAL, STATE AND LOCAL REGULATIONS REGARDING THE TRANSPORTATION, STORAGE, USE AND DISPOSAL OF THIS CHEMICAL. Due to the changing nature of regulatory requirements, the REGULATORY INFORMATION listed in Section XV of this document should NOT be considered all- inclusive or authoritative. International, Federal, State and Local regulations should be consulted to determine compliance with all required reporting requirements. The information in this MSDS was obtained from sources, which we believe are reliable. HOWEVER, THE INFORMATION IS PROVIDED WITHOUT ANY WARRANTY, EXPRESS OR IMPLIED, REGARDING ITS CORRECTNESS. The conditions or methods of handling, storage, use, and disposal of the product are beyond our control and may be beyond our knowledge. FOR THIS AND OTHER REASONS, WE DO NOT ASSUME RESPONSIBILITY AND EXPRESSLY DISCLAIM LIABILITY FOR LOSS, DAMAGE OR EXPENSE ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE HANDLING, STORAGE, USE OR DISPOSAL OF THE PRODUCT. This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.