



# Safe transport of organic peroxides in refrigerated containers (reefers)

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Guidelines on safety aspects  
of handling, transport and operation

**Nouryon**

# Introduction

In the transport regulations, organic peroxides are classified in transport division 5.2. A number of organic peroxides have to be transported under temperature controlled conditions because they are thermally unstable. Usually, this takes place in refrigerated containers, so-called reefers.

This type of transport requires special attention to reefer containers taking into account the properties of the products transported.

This guideline was developed by leading organic peroxide producers, members of the European Organic Peroxide Safety Group, and can be considered the best current practice regarding the safety aspects of handling, transport and operation of reefers containing organic peroxides.



Front view reefer



Back view reefer

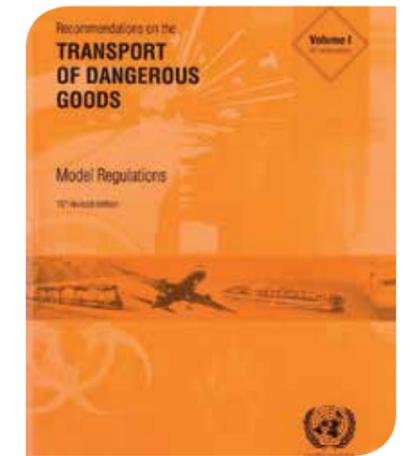
# Objective

Objective of this guideline is to give a minimum set of standards regarding the safety aspects of handling, transport and operation of organic peroxides in reefers which are recommended to achieve safe transport of these products under temperature controlled conditions

## Background and legal requirements

The transport of organic peroxides under temperature control is laid down in the various modal transport regulations (i.e. sea and land; transport of temperature controlled products is forbidden for rail and air mode). These regulations are all based on the United Nations Recommendations on the Transport of Dangerous Goods. In these UN recommendations, criteria are given for the requirement of cooling (temperature control) and temperature settings of the refrigerated container.

In the modal regulations you will find general descriptions of the accepted types of cooling (coolant, mechanical refrigeration, single or dual) and emergency procedures. For legal purposes this may be sufficient, however details regarding technical equipment, procedures on operational issues like pre-loading, container preparation, combined loading, electrical connections, instruction manuals, hand-over procedures, emergency procedures are not described in detail, but are necessary for safe handling, transport and operation.



The authors' opinion is that the contents of this brochure will facilitate the safe handling, transport and operation of organic peroxides in reefers and will lead to a safer transport of organic peroxides for all stakeholders.

The starting point of this brochure is the IMO-IMDG code (sea transport regulations) requirement.





# Technical equipment and description

To ensure the proper and safe transport of organic peroxides, the reefers have to fulfill the requirements of the IMDG code. This code describes in general terms the requirements of several technical features and equipment a reefer has to be provided with.

More technical details of the reefer containers as operated by organic peroxide manufacturers are given below. They go further than required by the IMDG code.



## Power supply

The reefer container requires a power supply of 380/460 V and 50/60 Hz.

Each container has a separate diesel engine generator-set to supply electrical power as alternative if the power supply is not available. Diesel fuel is protected against freezing.

Capability of gen-set is for continuous operation.



## Cooling system

All company managed reefer containers are equipped with two independent and redundant cooling systems to ensure a safe transport even if a technical malfunction may occur.

Each individual system is adequate to ensure a proper cooling and to maintain the pre-set temperature. Each cooling system is monitored by a separate control unit which also indicates failure report by signal lamps.



Unit 1



Unit 2

## Temperature monitoring and recording

Temperature inside the container is continuously recorded and displayed even without electrical power. At least two separate temperature probes and indicators are available per reefer container.

Two set points are defined to indicate an increase over the set-temperature (Ts) (see graph on page 6).

$T_s + 5$  centigrade: H-Alarm  
 $T_s + 10$  centigrade: HH-Alarm

## Insulation

Reefer-containers are completely insulated. The cold air circulates inside of the reefer in a closed loop.

The insulation fulfills or exceeds the requirements of the IMDG code.

## Monitoring and alarm

The proper function of the systems and the temperature inside of the reefer container are permanently monitored. Any failure will be showed with an audible and visual alarm. Potential-free connector allows plug-in of remote alarm connection to the vessel's system (adapter plug or cable needed)



# Operational

It is essential that all operations done with reefers have to be executed by trained and skilled personnel!



## Pre-loading procedure

### Explanation and relevance of product temperatures

Prior to stowage of reefer containers, all temperature controlled organic peroxides are pre-cooled at least to or below the set-temperature ( $T_s$ ).

$T_s$  is the working-temperature adjusted at the cooling-equipment.  
 $T_s$  is set lower than the control temperature ( $T_c$ ).

If a variety of products are transported together  $T_s$  is always based on the product with the lowest  $T_c$ .

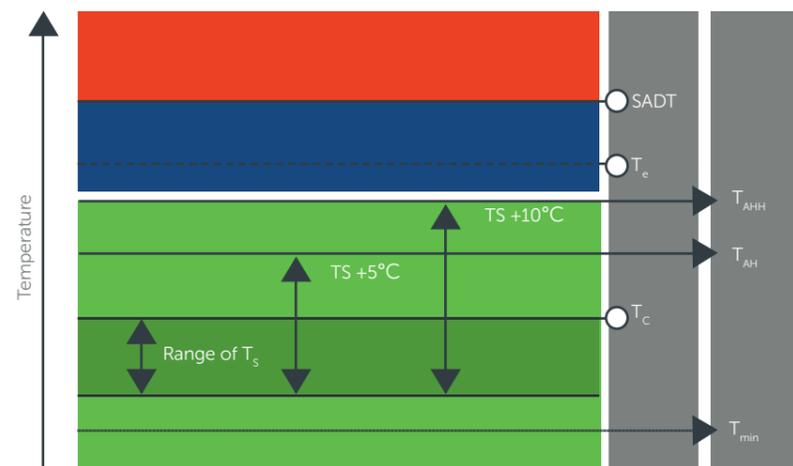


Figure 1: Schematic representation of all temperatures relevant for transport

In this case even products with higher  $T_c$  have to be pre-cooled to the lowest  $T_s$  to prevent overheating during start-up or the hand-over of the reefer container.

To ensure proper pre-cooling the temperature  $T_s$  +/- 5° centigrade has to be maintained for at least 24 hrs prior to dispatch.

For some products a  $T_{min}$  is required for quality reasons or to avoid undesirable effects to products e.g. phase separation or freezing.

A schematic representation of all relevant temperatures is given in Figure 1.

## IMDG temperatures

SADT= Self Accelerating Decomposition Temperature

$T_e$  = Emergency temperature

$T_c$  = Control temperature

## Industry temperature settings (more conservative)

$T_s$  = Transport temperature setting

$T_{AHH}$  = Temperature high-high alarm

$T_{AH}$  = Temperature high alarm

$T_{min}$  = Minimum transport temperature



## Reefer container preparation

Prior to each sea-transportation every reefer container has to pass an obligatory safety-preparation procedure. This procedure comprises:

- Successful passing and documenting the PRE-TRIP-INSPECTION (PTI) by instructed and trained personnel
- Correct temperature setting of  $T_s$ ,  $T_{AHH}$ ,  $T_{AH}$ ,  $T_{min}$  (see Figure 1)
- Test of proper working alarm function (both the visual and acoustic alarm)
- Check that temperature recorder is working properly
- Examination of all technical functions and inspection of equipment (box/framework)
- To ensure reliable functioning of all system-components; every reefer is to be tested for a reasonable time prior to shipment.



## Stowage

Stowage, based on stowage plans, is done by the shipper only. Stowage of all products within cargo-hold has to be done properly and sufficient air-ventilation has to be guaranteed (ensure air flow on all sides for instance by the use of palletised cargo only).

The product with the lowest  $T_c$  should be stowed within the reefer container in accessible position close to the doors.

The stowage shall be such that, if disposal is necessary at sea, the packages or closed cargo transport unit can be jettisoned quickly and easily.



## Manual/handbooks and reefer-connecting aboard vessel

### Manual/handbooks

The manual, which describes the basic use and features of the reefer container, is kept within each unit. It contains:

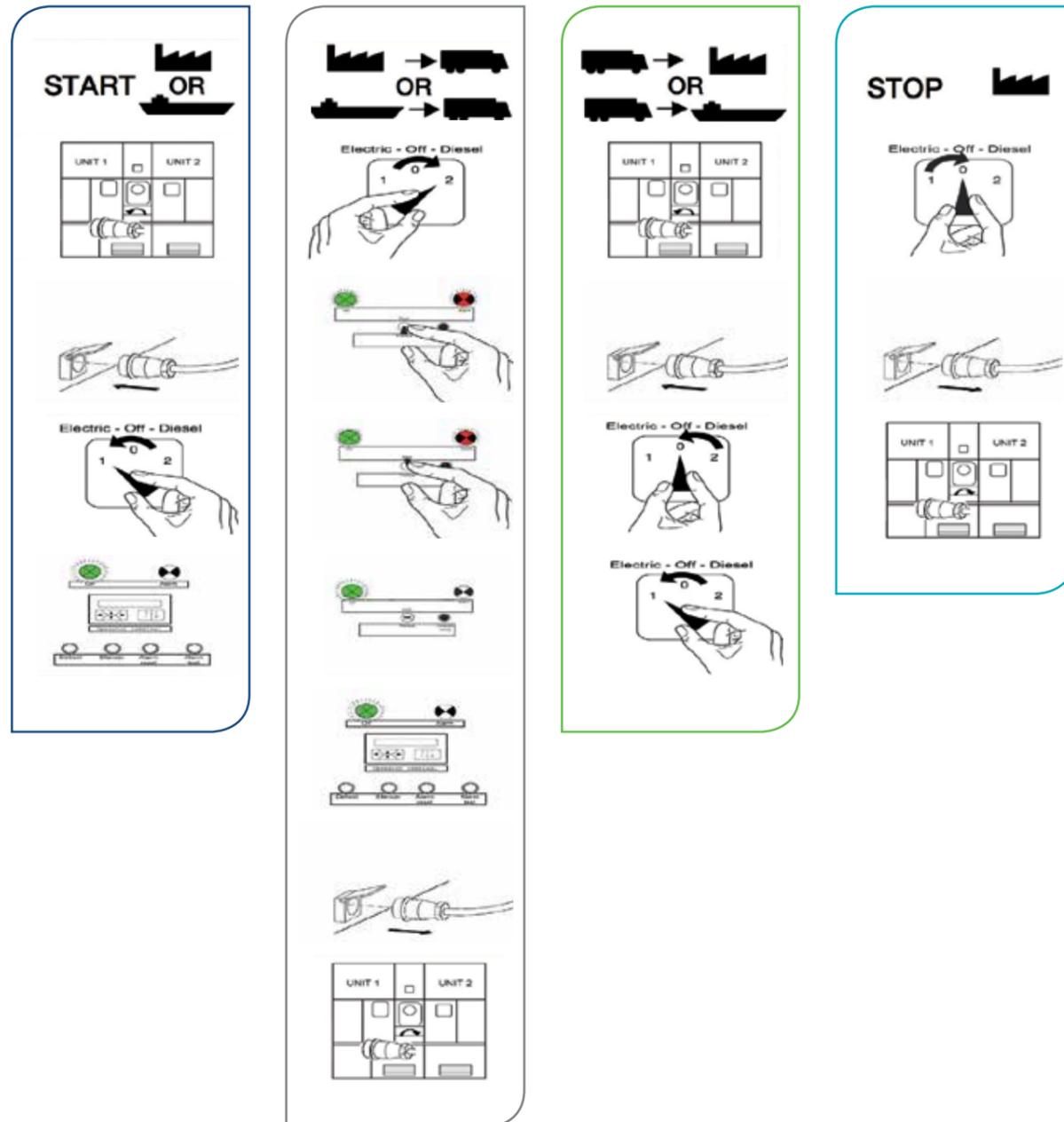
- Descriptions of special functions
- Electrical wiring-plans and schematic drawings
- A trouble shooting guide

The manual may be kept in a box outside of the reefer or handed out to the vessel's master or first engineer along with additional explanations regarding the operating-instructions of the reefer.



Spare parts

# Pictograms



# Loading on board of vessel

The exact location of the reefer on board of the vessel shall be coordinated in advance. Reefer containers with organic peroxides may only be stowed on deck in such a way that the doors, cooling units and temperature controls are easily accessible. It must be possible to open the doors easily, in case it becomes necessary to jettison the cargo. If containers are stacked on top of each other, the refrigerated container should be at the bottom of the stack standing on the deck as near as possible to the deck rail.

The container must be placed in such a way that the refrigeration units and the loading doors are easily accessible.

The actual inside temperature of the reefer container should be checked, monitored and recorded every 4-6 hours in ship's log book.

Whilst boarding at port of loading, a professional reefer service (on behalf of the shipper) should be present for:

- Support during the hand-over procedure
- Check on the connection and plugs of the electric power supply
- Check and demonstration of the cooling equipment and the diesel-generator on board of the vessel
- Giving explanations about operating and working principles of the reefer container to the captain or engineering officer
- Making sure that the container manual /handbook is handed over to captain or engineering officer



# Emergency procedures

For emergency measurements you have enough time to react if you recognize the deviation in early stages.

Any deviation of normal transport conditions must be considered potentially dangerous and treated accordingly.

Deviations could be for example:

- Abnormal rise of monitored temperature
- Any alarm
- Any spillages
- Smell, smoke or abnormal noises coming from the container

**In case of deviation you should call the emergency response number immediately indicated on the transport documents, reefer manual or reefer itself!**

The emergency response number is available 24 hours a day. You will get technical assistance and advice based on predefined emergency procedures. In case of doubts keep a safe distance to the container and prepare fire-fighting equipment.

Whenever you call the emergency response number you should have following information available:

- Name of the vessel and position
- Container id
- Product type (UN number), product name and quantity
- Nature of the incident and its development
- Corrective actions undertaken
- If available recorded temperature values
- Current temperature of the cargo
- Your contact details

See also the emergency procedures for organic peroxide (IMDG 7.8.3 and 7.8.5) but in all cases contact the emergency response number!



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## Additional information

Product Data Sheets (PDS) and Safety Data Sheets (SDS) for our polymerization initiators are available at [www.nouryon.com](http://www.nouryon.com)

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