Guidelines for the safe handling of

Phenol

Phenol and Acetone Cefic
Sector Group

Notice

The information, specification, procedures, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. No representation, guarantee or warranty is made as to the accuracy, reliability or completeness of said information, specifications, procedures, methods and recommendations or that the application or use of any of the same will avoid hazards, accidents, losses, damages or injury of any kind to persons or property or that the same will not infringe patents of others or give desired results. Readers are cautioned to satisfy themselves as to the suitability of said information, specifications, procedures, methods and recommendations for the purposes intended prior to use.

If there are national or international legal requirements on any of the recommendations set out in this document, these shall prevail.

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1 Introduction

Although phenol is a hazardous material in terms of toxicity and corrosivity, it can be distributed and handled safely provided that appropriate precautions are observed.

The transport of phenol in bulk is subject to strict regulations within most countries in Europe. In addition, the international movement of phenol by road, rail or sea is subject to international agreements laying down specific requirements concerning transport, which must be observed by all parties involved.

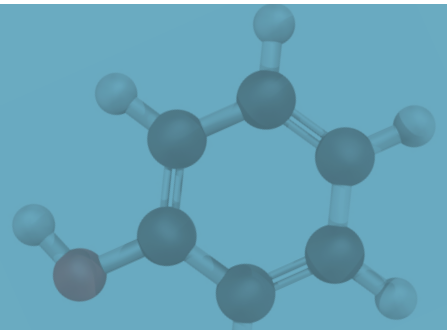
These guidelines have been prepared by the Cefic (European Chemical Industry Council) Phenol and Acetone Sector Group to establish appropriately high standards of safety for the safe handling of phenol.

These guidelines take into account the transport of phenol in bulk in road tankers, rail tank wagons and tank containers. They cover all aspects of the transport activity from loading to delivery point. Reference to existing regulatory controls is only made where this is considered necessary for the purpose of clarification.

The Cefic Phenol and Acetone Sector Group recommends that these guidelines be adopted by all parties who are involved in the distribution of phenol, and will arrange a regular review of these guidelines.

In order to facilitate effective supervision of safety in transport to destination, it is recommended that phenol producers should arrange transport themselves.

The Cefic Responsible Care Programme requires that chemical companies demonstrate their commitment to continuously improve all aspects of performance which relate to protection of health, safety and the environment. An overview of the key elements of Cefic's Distribution Responsible Care Programme is contained in appendix 1.



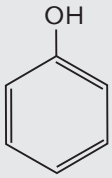
2 Product information

2.1 General data

CAS-NUMBER	EC-NUMBER	EU-NUMBER	SYNONYMS	FORM
108-95-2	203-632-7	604-001-00-2	Hydroxybenzene, Carbolic Acid, Monohydroxyben-zene, Phenyl Alcohol	Liquid

WARNING PROPERTIES
The odour of this material is adequate to warn of excessive exposure.

2.2 Physical properties

Molecular formula	C_6H_6O
Structural formula	
Appearance	Physical state: liquid (> 40.9 °C) - solid (< 40.9 °C) Colour: colourless (liquid) - white (solid)
Odour	Stinging
Odour threshold	0.022 - 22 mg/m³
pH value	At 20 °C, 10 g/L: 4 - 5
Melting point/freezing point	40.9 °C

Initial boiling point and boiling range	181.9 °C (1013 hPa, DIN 510751)
Flashing point/flash point range	81 °C (DIN EN ISO 2719)
Flammability	595 °C (VDE G1; EN T1)
Explosive properties	Product is not explosive
Explosion limits	LEL (Lower Explosion Limit): 1.30 Vol-%; UEL (Upper Explosive Limit): 9.00 Vol-%
Vapour pressure	At 20 °C: 0.2 hPa; at 50 °C: 3 hPa
Density	At 20 °C: 1.07 g/cm³; at 25 °C: 1.13 g/cm³ (DIN 51 757)
Water solubility	At 20 °C: 84 g/L; At 25 °C: 87 g/L; At 68 °C: completely miscible
Partition coefficient: n-octanol/water	1.47 log P(o/w) (CPC) Appreciable bio-accumulation is not to be expected log P(o/w): 1-3
Viscosity, dynamic	At 50 °C: 3.437 mPa*S
Explosive properties	Product is not explosive (VDE 1; EN II A)
Oxidizing characteristics	No data available
Ignition temperature	595 °C (DIN 51 794)
Additional information	Molecular weight: 94.11 g/mol Relative vapour density at 20 °C (air=1): 3.2

2.3 Reactivity hazards

Possibility of hazardous reactions

No dangerous reactions are known.

Conditions to avoid

No decomposition when used properly.
It may react to form catechol, hydroquinone, as a result of radical formation. Protect from moisture contamination.

Incompatible materials

Oxidizing agents, aldehydes, isocyanates, nitrites, nitrides, Friedel-Crafts catalysts.
Avoid ignitable vapour-air-mixtures.

Unsuitable materials

Metals, rubber, various plastics, alloys.

Hazardous decomposition products

In case of fire may be liberated: carbon monoxide and carbon dioxide.

2.4 Toxicology and occupational health hazards

The most likely route of human exposure (workers and consumers) is through inhalation or dermal contact; oral uptake may occur in accidental cases. Worker exposure can occur in the manufacturing facilities or industrial facilities where the substance is used. Since these types of activities are mainly undertaken in closed systems, exposure is low under normal conditions.

Small amounts of phenol are produced endogenously as a breakdown product of protein metabolism by the action of bacteria on normal constituents of the diet in the gut and excreted independent of external exposure to the compound.

Human Health Safety Assessment

- **Consumer:** Direct use of a significant amount of phenol is limited to specific products like salve or mouthwash. Uses in disinfectant products (with concentrations up to 5%) are no longer relevant in all European countries. Residual levels of phenol in household products are low. The main source for exposure in the environment is derived from non-industrial sources like automotive exhaust, benzene degradation, metabolism in plants and animals. Phenol is also present in food; daily intake via this route has been estimated by the European Food and Safety Agency at 0.18 µg/kg.

- **Worker:** As phenol is manufactured and handled in industrial settings in closed systems worker exposure is limited. In case of unintended exposure during maintenance, sampling, testing, or other procedures, workers should follow the recommended safety measures in the extended Safety Data Sheet (eSDS). Exposure can occur either in a phenol manufacturing facility or in the various industrial or manufacturing facilities that use phenol. Each manufac¬turing facility should have a thorough training programme for employees and appropriate work processes and safety equipment in place to limit unnecessary exposure.

EFFECT ASSESSMENT	RESULT
ACUTE TOXICITY (oral/dermal/inhalation)	Toxic after oral, dermal and inhalation exposure
IRRITATION/CORROSIVITY (skin/eye/respiratory tract)	Skin: Contact with skin and mucous membranes causes burns Eye: There is a danger of serious eye damage
SENSITIZATION (skin/respiratory tract)	Not sensitizing by skin contact
REPEATED EXPOSURE	Repeated administration leads to changes of internal organs, the immune system, the central nervous system and the haematogram
MUTAGENICITY	According to EC regulation 1272/2008 phenol is classified mutagenic cat. 2.; however, scientific evidence exists for a possible threshold mechanism above 100 mg/kg bw/d (induction of micronuclei via prolonged hypothermia)
CARCINOGENICITY	Not carcinogenic
REPRODUCTIVE TOXICITY	Not reprotoxic

Based on this information the substance is legally classified. Classification is in accordance with criteria laid down in EC regulation 1272/2008.

2.5 Emissions and degradation

Based on its physical and chemical properties, if the substance is released into the environment, it would be mainly distributed in water. The substance is readily biodegradable and will not be persistent.

On the manufacturing site and for uses as intermediate of synthesis or in formulation, effluents have to be directed to a biological water treatment plant. The indirect exposure of humans via the environment is not expected to be relevant for phenol, and the risk assessment showed it will have no effect on the food chain.

EFFECT ASSESSMENT	RESULT
AQUATIC TOXICITY	Toxic to aquatic organisms on an acute basis

FATE AND BEHAVIOR	RESULT
BIODEGRADATION	Readily biodegradable
BIOACCUMULATION POTENTIAL	Not likely to accumulate in the food chain (bioconcentration potential is low)
PBT/VPVB CONCLUSION	This substance does not meet the PBT/vPvB criteria of REACH, annex XIII

Based on available data, phenol is toxic to aquatic organisms. However, phenol is readily bio-degradable and will not persist in the environment. Because the bio concentration potential is low, phenol is not expected to accumulate in the food chain.

TEST ENDPOINT	TEST RESULTS
AQUATIC ACUTE TOXICITY	Fish: $LC_{50, 96h}$ = 8.9 – 24.9 mg/L Invertebrate: EC_{50} = 3.1 mg/L Algae: EC_{50} = 61.1 mg/L
AQUATIC CHRONIC TOXICITY	Fish: NOEC = 0.077 m/L Invertebrate: NOEC = 0.16 mg/L, EC_{50} = 10 mg/L
BIODEGRADATION	Screening: 62% 100 h, 80.1% 50 d
BIOACCUMULATION POTENTIAL	BCF = 17.5

2.6 International transportation regulations

UN number

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
1671	2312

UN proper shipping name

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
UN 1671, PHENOL, SOLID	UN 2312, PHENOL, MOLTEN

Transport hazard class(es)

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
ADR/RID, AND: Class 6.1, **Code:** T2	Class 6.1, **Code:** T1
IMDG: Class 6.1, Subrisk -	Class 6.1, Subrisk -
IATA: Class 6.1	Class 6.1

Packing group

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
ADR/RID, AND, IMDG: II	II
IATA: II	

Environmental hazards

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
MARINE POLLUTANT: Yes	Yes

Special precautions for user

Land transport (ADR/RID)

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
WARNING BOARD: Kemmler-number 60, UN number 1671	Kemmler-number 60, UN number 2312
LIMITED QUANTITIES: 500 g	0
EQ: E4	E0

Fig. 1 Legend table of a phenol rail car

Inland waterway craft (ADN)

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
HAZARD LABEL: 6.1	6.1
LIMITED QUANTITIES: 500 G	0
EQ: E4	E0

Sea transport (IMDG)

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
EMS: F-A, S-A	F-A, S-A
LIMITED QUANTITIES: 500 G	0
EQ: E4	E0

Air transport (IATA)

SOLID (< 40.9 °C)	LIQUID (> 40.9 °C)
PASSENGER LTD.QTY.: Pack.Instr. Y644 - Max. Net Qty/Pkg. 1 kg	Forbidden
PASSENGER: Pack.Instr. 669 - Max. Net Qty/Pkg. 25 kg	Forbidden
CARGO: Pack.Instr. 676 - Max. Net Qty/Pkg. 100 kg	Forbidden
EQ: E4	E0

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Category Y Ship type 2.

2.7 EEC labelling/special risks/safety advice

Under the GHS (Globally Harmonized System), substances are classified according to their physical, health, and environmental hazards. The hazards are communicated via specific labels and the eSDS. GHS attempts to standardize hazard communication so that the intended audience (workers, consumers, transport workers, and emergency responders) can better understand the hazards of the chemicals in use. Substances registered for REACH are classified and labelled according EC regulation 1272/2008 (CLP/GHS).

HARMONISED CLASSIFICATION AND LABELLING OF THE SUBSTANCE ACCORDING TO REGULATION (EC) NO 1272/2008 (CLP)
Skin Corr. 1B; H314 - Causes severe skin burns and eye damage. Muta. 2; H341 - Suspected of causing genetic defects. STOT RE 2; H373 - May cause damage to organs through prolonged or repeated exposure. Acute Tox. 3; H301 - Toxic if swallowed. Acute Tox. 3; H311 - Toxic in contact with skin. Acute Tox. 3; H331 - Toxic if inhaled.

LABELLING ACCORDING TO REGULATION (EC) NO 1272/2008 (CLP)	
Pictograms	
Signal word	Danger
Hazard statements	H301: Toxic if swallowed. H311: Toxic in contact with skin. H314: Causes severe skin burns and eye damage. H331: Toxic if inhaled. H341: Suspected of causing genetic defects. H373: May cause damage to organs through prolonged or repeated exposure.
Specific concentration limit (SCL)	Skin Corr. 1B; H314: C >= 3% Skin Irrit. 2; H315: 1% <= C < 3% Eye. Irrit. 2; H319: 1% <= C < 3%

CONCLUSION

Phenol is used as a basic chemical for the production of various products. The substance has been evaluated by several national and international bodies. The identified risks are addressed by suitable risk management measures to assure that the substance can be handled safely if these measures are followed.

Additional information

Self-classified according to ATP 2 (EC 286/2011):

Aquatic Chronic 2; H41 H411: Toxic to aquatic life with long lasting effects.

Pictogram:

3 Transport and storage operations

3.1 Loading and unloading operations

The operation of loading and unloading any road tanker, tank container or rail tank car (RTC) with phenol is a potential hazard. It is therefore important that loading/unloading facilities and transport equipment are correctly designed and constructed. It is also important that the equipment is properly used and maintained. The equipment should be subject to regular checks according to maintenance and inspection standards.

The design and construction of transport equipment is described in Chapter 4 of these guidelines. Equipment, which meets the requirements of the ADR, RID and/or IMO regulations, is subject to periodic inspection and testing requirements as laid down in these regulations. The competent authorities carry out official inspection and testing.

Written operating instructions should be available covering all activities for loading of phenol into road tankers, tank containers and rail tank cars. Personnel involved should be fully trained in their implementation (involvement of fire brigades in the training is recommended). The instructions should recognize the specific hazards of phenol, and ensure the correct operation of loading equipment in both normal and emergency situations.

All necessary protective clothing and emergency equipment should be available for loading and unloading operations (see Chapter 6). Personnel shall be trained in the correct use of this clothing and equipment.

It is not the intention of this section of the guidelines to attempt to set detailed operating instructions for loading phenol vehicles, since these of necessity will depend upon local operating conditions. However, as part of the operating instructions, the loading terminal staff shall carry out an inspection of the transport equipment before, during and after loading. This inspection does not replace or diminish the responsibility of the owner of the road tanker, tank container or rail tank car to ensure that the equipment is properly tested, maintained and fit for purpose. It is meant to ensure that the transport of phenol is conducted as safely as possible. An inspection list such as the one described in appendix 3 is recommended for use by the loader to check the condition of the phenol transport equipment, and this should be applied for all loading operations.

In addition to the routine inspection of all transport equipment prior to each loading operation, a responsible person from the loading company shall carry out a check on each road tanker, tank container or rail tank car prior to initial introduction into service, or reintroduction to service after maintenance or repair.

The conditions for discharge of phenol at a customer's premises are the customer's responsibility. If a customer requires, the consignor may provide him with technical advisory and safety service, which in principle may include safety visits. If a safety visit is made, the scheme included in appendix 5 may be used. Normally the customer himself should evaluate whether his premises, especially his reception and storage facilities, correspond with the requirements of the scheme included in appendix 5.

Appropriate systems should be in place to ensure the identification of the supplied product.

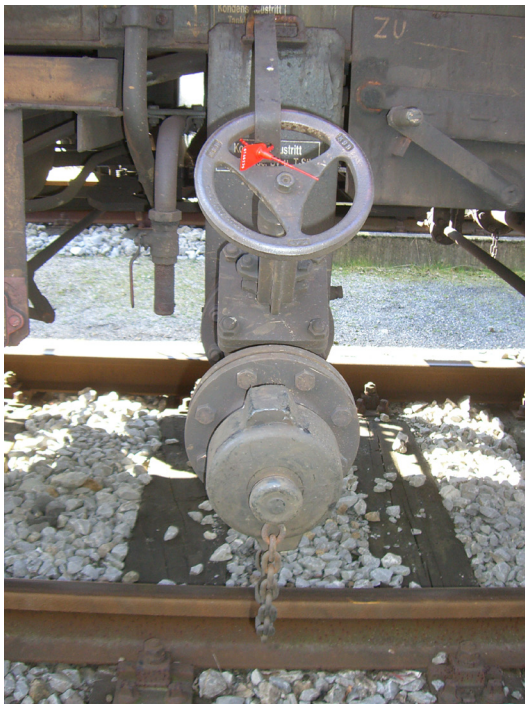


Fig.2 Phenol rail car discharge pipe with cap

Fig.3 Coupling equipment

Fig.4 Worker in protective clothing connecting a phenol rail car to discharge

3.2 Transport of phenol by road

3.2.1 General considerations

The carrier is responsible for the safe transport of phenol by road from the loading point to the discharge point. Road carriers must meet all relevant national and international regulations relating to phenol. Road carriers should preferably have a quality system (like ISO 9000) and participate in an SQAS scheme. Cefic guidelines provide a framework for the application of the principles of Behaviour Based Safety (BBS) to safe driving of road freight vehicles (see appendix 2). BBS is a programme aimed at increasing safety during transport by positively influencing the behaviour of drivers through observation, coaching and communication.

http://www.cefic.org/en/transport-and-logistics-best-practices-guidelines.html

For reasons of unwanted reactions, contamination must be avoided.
All connections should be sealed (see appendix 3).

3.2.2 Routing

The transport of phenol has to follow the ADR regulations and national regulations. Phenol should only be transported on defined routes. The route to be followed must be selected carefully and should be known to both the carrier and the consignor.

3.2.3 Severe weather conditions

When severe enough weather conditions occur during transport, for example icy roads, snow or poor visibility, it is recommended to stop the delivery at the next suitable parking place.

3.2.4 Delays or accidents

All delays during transport, whether due to severe weather conditions, breakdown or other reasons must be reported to the consignor as soon as possible.
Transport accidents must also be reported to the consignor as soon as possible.
The aid of specialist consignor's team may be required.

3.2.5 Emergency procedure

If emergency action needs to be taken by drivers when leaks, spills or fire occur during transport, then the instructions given in the "Instructions in writing" must be followed. They are available in various languages at the following website:

http://www.unece.org/trans/danger/publi/adr/adr_linguistic_e.htm

3.2.6 Customer collection

Customer collection should be avoided, except for co-producers.
However, if such collections take place, appendix 3 should be used.

3.2.7 Multimodal transport

Tank containers are often transported in a multimodal system. This is generally organized by the carrier. Management systems shall be in place to ensure quality and safety of operations by the carrier for the complete supply chain. This system should preferably be checked by means of an SQAS.

3.2.8 Subcontracting

Contractual arrangements between consignor and carrier should explicitly state that transport must not be subcontracted without prior approval of the consignor.
The subcontractor must fulfil the same requirements as the principal contracting carrier.

3.3 Transport of phenol by rail

Phenol railway transport is under RID regulations and national regulations which are obligatory and must be met in all countries.
The appropriate railway authorities are responsible for the safe transport of phenol by rail from the dispatch siding to the final reception siding.
The selection of route, intermediate stopping locations and cessation of traffic due to severe weather conditions are matters to be decided by the railway authorities or the railway company owning the rail network.

The appropriate railway authorities will normally intervene in the event of a transport emergency involving phenol rail tank cars. Railway authorities must be made aware of the information contained in these guidelines as an aid for railway hazardous cargo intervention teams.

In some cases rail wagons are transported over the public road by lorries from the final rail siding to the eventual customer by a “piggyback” arrangement, and such movements may be arranged by railway authorities as part of their overall service.
This way of transport poses additional hazards (load stability) and therefore is strongly discouraged.

In the event of derailment, leak, or other problem involving rail tank cars of phenol the railway personnel must inform the consignor immediately.
In addition under the ICE scheme, the National Emergency Centre for the country in which the accident has occurred must be contacted.
The aid of specialist consignor’s teams may be required.

3.4 Transport of phenol by sea or inland waterways

Transport of phenol by sea or inland waterways may be either:

a. By roll on/roll off ferries, or
b. Lift on/lift off shipment in tank containers, or
c. Bulk by seagoing vessels, or
d. Inland barges. Because of the nature of the transport, a number of different parties may be involved in the transport of Phenol from consignor to customer. These may include the shipping company, port, loading terminal or harbour authorities and carriers.

Prior to the commencement of each product flow; the consignor should make sure that all parties involved have adequate Safety, Health and Environment standards.

Particular areas of interest are:

a. The shipping company
b. Loading/unloading facilities at container terminals
c. Emergency handling within hazardous cargo yards at container terminals
d. Emergency handling on board
e. Loading/unloading facilities at a bulk storage terminal
f. Emergency handling at a bulk storage terminal

The Safety, Health and Environment system should preferably be checked by means of a CDI-Marine inspection and/or consignor's own vetting system.

The consignor should issue specific instructions for the control of the operation to all parties involved and the actions to be taken in the event of an emergency.

Transport by sea and inland waterways in bulk requires a suitable ship or barge that is certified to carry Phenol. Refer to appendix 4 for details.

3.5 Incompatible materials

The material should neither react with phenol nor perform any kind of dilusion. For tank cars only materials are allowed which are in accordance with ADR/RID/IMDG/IATA tank codes. It is recommended to use equipment made of stainless steel and sealings made of PTFE or graphite.

3.6 Heat tracing and insulation

Pure phenol solidifies at 40.9 °C. All phenol containing lines and equipment with risk of solidification should be insulated and traced above solidification temperature.

4 Design and construction of transport and storage equipment

4.1 Current operation practices

Phenol manufacturers use equipment for bulk liquid transportation of phenol according to applicable regulations.

4.2 Design and construction of tank trucks (road tankers)

Tank trucks used for the carriage of phenol by road must meet the design and construction requirements of:

a. National regulations, when used for national transport.
b. International regulations depending on the mode of transportation (e.g. shortsea voyage), such as the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), when used for international transport.

In addition to the above requirements, it is recommended that tank trucks be designed and constructed in accordance with the recommendations contained in appendix 6.

Fig. 5 Phenol tank truck

4.3 Design and construction of railcars (rail tank cars)

Rail tank cars for the carriage of phenol must meet the design and construction requirements of:

a. national regulations or localrailway administration regulations, when used for national transport.
b. international regulations, such as the International Regulations concerning the Carriage of Dangerous Goods by Rail (RID), when used for international transport.

In addition, it is recommended that rail tank cars be designed and constructed in accordance with appendix 5.

4.4 Design and construction of tank containers

Tank containers may be used for the carriage of phenol by road, rail, and sea. They must meet the design and construction requirements of the appropriate national or international regulations depending upon the specific transport modes which are to be utilized.
In addition to the above requirements, it is recommended that tank containers be designed and constructed in accordance with the recommendations in appendix 6.

4.5 Design and construction of vessels and barges

Vessels used for the carriage of phenol by sea must meet the design and construction requirements of international regulations such as the International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk as produced by the International Maritime Organization (IMO).

Barges used for the carriage of phenol by inland waterways must meet the design and construction requirements of national and international regulations for the design and construction of barges such as the Regulations concerning the Transport of Dangerous Goods by Inland Waterways (ADN).

4.6. Design and construction of storage tanks

4.6.1 General consideration

Design and construction of storage tanks must meet national and international regulations.
The design of the bulk storage facility has to be accompanied by a risk analysis using methodology like HAZOP or equivalent. (For a general storage design see appendix 8)

The risk has to be controlled whenever possible by appropriate design. It also requires the implementation of appropriate procedures, operator training, maintenance and periodic controls compatible with local regulations.

The construction material used for phenol is stainless steel. Carbon steel is not recommended if not coated.

The freezing point of the phenol is the major concern. The temperature has to be kept above this freezing point. Generally the lower acceptable limit is 50 °C. This has to lead to a good insulation with an heating coil or pin and also perfectly traced pipes, pumps and vents.
The other consideration is to avoid an unnecessary overheating above 65 °C. Such temperatures accelerate a slight oxidation which provides a progressive unpleasant red coloration. Furthermore, above 81 °C the flashing point is reached, creating an additional explosive risk.
In case of indoor facility configuration, the room should be well ventilated to prevent local accumulation in case of leakage or during maintenance work. It must be noted that using fresh air for ventilation could cause freezing problems. It is suggested that adequate air change rates be ensured. Nevertheless, for special work e.g. maintenance it is recommanded that local exhaust systems be considered to supplement the general exhaust stystem.
All indoor bulk storages should have their emergency vent and regular venting system outside of the building.

4.6.2 Environment, compatibility with other feedstocks

Dikes around the storage tank are used to contain spills. The size of the diked area should hold the volume of the largest tank. Concrete is typically used as construction material. In case of multiple storages in the same diked area, it is important to check the compatibility of other feedstocks with phenol. Materials such as strong acids, strong bases, aldehydes, peroxide, nitrites, nitrates are not compatible (the list is not complete).
The draining system of a phenol workshop has to be equiped with continuous monitoring and facilities to avoid general water pollution in case of spills.
The quality of the draining water has to be checked prior to discharging to regular (rainwater) sewer retentions.

4.6.3 Precautions against fire involving phenol or fire close to phenol tank

Phenol being a combustible substance, some recommandations are provided:

- Adequate accessibilty to the phenol tank has to be considered for firemen approach.
- A foam system can be used to extinguish a phenol fire.
- The tank insulation should be specified as fire resistant, to provide better thermal protection during a pool fire.
- Separation with diked walls is useful to protect the phenol tank from pool fires caused by other chemicals or other adjacent tank fires.

4.6.4 Safety equipment

Safety shower and eye washing should be close to the storage and anywhere phenol is used. It is also recommended to have an alarm in the control room and (if present) at the fire brigade on site when the safety shower is used in order to have emergency help as fast as possible.
For small fire, water, CO_2, it is acceptable to use dry chemical extinguishers.
For large fire, foam equipement should be used.

4.6.5 Temperature control

All equipment must be insulated.
The temperature is recommended to be maintained between 50 °C to 60 °C. For example regulated hot water with a maximum of 75 °C injected on a coil or a pin is appropriate, and will limit overheating. The wall temperature of the coil or pin should not be above 75 °C.
Vent lines, safety valves, rupture disks must be heat traced to avoid any phenol build-up (electrical, steam or hot water tracing). A temperature probe with alarm on this equipment is recommended.
Deionized water should be used for hot water loop to prevent corrosion.
An electrical self regulating heater can also be used as long as wall temperature is limited to 75 °C. Nevertheless, it is not appropriate for large storage tanks.
It is important to avoid storage freezing. Therefore temperature alarms are necessary allowing alternative possibilities to counteract temperature decrease before reaching freezing point.
Thawing can be hazardous if dilatation constraints are not taken in account. Specifically, a storage rupture can occur if the bottom is unfrozen and the top is still frozen. Phenol volume is 5% more at 100 °C than at 41 °C. In addition, coloration is increased when phenol is thawed.
Electrical tracing can be used on long lines. A malfunction detection is recommended. Steam tracing is not recommended because of coloration issues.
Jacketed pipe with temperated water or electrical tracing are the best practices.
Clearing or venting a line can also minimize the problem.

When phenol is blocked in a full line, extremely high pressure occurs while reheating which can result in a dangerous line, valve or gasket failure.

4.6.6 Pressure control

Due to possible pluggage in case of malfuction of vent tracing or relief valve tracing, it is recommended to have a pressure probe with alarm.

4.6.7 Level control

Level monitoring instrumentation is recommanded to avoid spills when filling a storage tank. A maximum filling volume of around 90% is proposed. It is recommended that this level monitoring instrumentation include alarm device(s) which warn if the tank is filled above or emptied below a safe level. The tank should be equipped with high level switches, which shut off the feed before a potential spill.

Levels sensors can be floating or radars devices.

4.6.8 Recirculation, tank filling, sampling

Bulk storage tanks typically have a dip tube ending shortly above the tank bottom. Dip tubes are normally tack welded to the bottom to assure static grounding and have an antisiphon hole or funnel near the top.

A sampling station can be installed after the recirculation pump. A sampling system in a insulated and regulated temperature heated box is the good way for safe sampling.

4.6.9 Pumps

The pump generally in use is magnetic drive, flooded rotor or immersed centrifugal pump. The pumps have to be heat-traced as well.

Some options can be taken to prevent overheating like a power monitor that senses low and high power consumptions and activates an alarm and shuts down the pump.

4.6.10 Valves, flanges, gasket

Ball valves, plug valves and gate valves are commonly used.
When selecting gasket material for phenol, the important fact is compatibility added with other conditions such as fire protection requirement, pressure rating of the pipe, pipe size and operating temperature. Gaskets are generally in modified Teflon.

4.6.11 Tank venting system

It is recommended to hold a nitrogen blanket on the head space in order to avoid the coloration problem. Furthermore, a nitrogen atmosphere is recommended in case of accidental hot point.
The off gas from the venting system should be treated for example in a caustic soda scrubber before being released to the atmosphere. Heated and correct slope off gas line has to be guaranteed to avoid build-ups and pluggages.

It is recommended to have emergency vacuum and pressure relief valves installed. Precautions have to be taken as explained above, to avoid phenol solidification on this safety equipement. Routine inspections have to be performed.

4.6.12 Emergency venting of a bulk storage tank

It is common practice to design capacity of a tank emergency vent system based on vapours generated by a pool fire. Relief valves, weighted pallets, quick release man way covers and rupture disks can be used to vent vapour generated by a pool fire.

4.6.13 Earthing, ATEX zone

Storage must be earthed in line with national regulations.
ATEX zone must be considered. Generally, phenol is handled below its flashing point but a temperature of 81 °C can be exceeded accidentally.

4.6.14 Control systems

“Good engineering practices” should be applied in the control systems. International engineering standards giving basic design for phenol equipment such as pressure vessels, piping, fire protection, etc, are used for the design and operations. Good engineering practice, industry-wide safe design standards, safety standards and procedures and environmental criteria form the basis for the design of safe and environmentally sound operating procedures as well as control systems. It is also responsible behaviour to conform to and comply with all applicable governmental laws and regulations having effect.

5 Emergency procedures

5.1 Emergency planning

All phenol producers involved in transporting phenol in Europe should have an established Emergency Plan for receiving transport incident reports and for providing expert advice by telephone and, as necessary, at the incident scene to the emergency services on how to minimize any danger arising from an incident on road, rail or waterway. The Cefic document "Distribution Emergency Response - Guidelines for Use by the Chemical Industry" provides advice on setting up a Company Emergency Plan.

5.2 Measures in the event of a release of phenol

- Remove all sources of ignition.
- Keep upwind.
- Do not breathe vapours.
- Do not breathe dust.
- Avoid contact with the substance.
- Wear suitable protective clothing.
- Provide adequate ventilation.
- Leaks may be repaired only with full protection (tightly closing chemical protection clothing, respirator equipment independent of the ambient air).

5.3 Spill response

- Do not allow to penetrate into soil, waterbodies or drains.
- Danger to drinking water when soaking into the soil or waters.
- In case of entry into waterways, soil or drains, inform the responsible authorities.
- Allow the leaked product to solidify if this is possible without endangering people. Take up mechanically, placing in appropriate containers for disposal.

Phenol, liquid:
Collect spillage. Absorb with liquid-binding material (e.g. sand, diatomaceous earth, acid- or universal binding agents) and place in closed containers for disposal.

Final cleaning:
Collect the rinsing water when cleaning down contaminated equipment and plant components (to prevent phenol from escaping into deep soil layers).

5.4 Disposal

Product

Waste key number:
07 01 99 = Wastes from the manufacture, formulation, supply and use (MFSU) of basic organic chemicals (MFSU = manufacture, formulation, supply and use)

Possible alternatives:
ASN070108*: other still bottoms and reaction residues
ASN070101*: aqueous washing liquids and mother liquors

Incinerate according to applicable local, state and federal regulations. Discharge into the environment must be avoided.

Contaminated packaging

Dispose of waste according to applicable legislation.
Handle contaminated packages in the same way as the substance itself.
Non-contaminated packages may be recycled.

5.5 Fire fighting

Extinguishing media

Suitable extinguishing media:
Extinguishing powder, alcohol resistant foam, carbon dioxide, water fog

Extinguishing media which must not be used for safety reasons:
Full water jet.

Special hazards arising from the substance or mixture

Combustible.
Vapours are heavier than air and will spread at floor level.
In case of warming, development of explosive gases/vapours.
Hazardous vapours may form during fires.

In case of fire:
Carbon monoxide and carbon dioxide my be liberated.

Advice for firefighters

Special protective equipment for firefighters:
Wear a self-contained breathing apparatus and chemical protective clothing.

Additional information:
Hazchem-Code: 2X

Do not expose to high temperature.
Danger of bursting and explosion.
Move container away or cool with water from a protected position.
Collect contaminated fire extinguishing water separately. This must not be discharged into drains.

Fire residuals and contaminated extinguishing water must be disposed of in accordance with the regulations of the local authorities.

6 Personal protection

6.1 Personal protection

Respiratory protection

Respiratory protection must be worn whenever the WEL levels have been exceeded.
Use filter type ABEK according to EN 14387.

Hand protection

Protective gloves according to EN 374.

Glove material:
Neoprene, PVC

Breakthrough time:
140 min. (Neoprene)
75 min. (PVC)
Observe glove manufacturer's instructions concerning penetrability and breakthrough time.

Eye protecion

Goggles (DIN EN 58211) or face protection shield.

Body protection

Wear suitable protective clothing.
Material: PVC
Safety shoes according to EN 345-347.

General protection and hygiene measures

Take off immediately all contaminated clothing.
When using, do not eat, drink or smoke.
Have eye wash bottle or eye rinse ready at workplace.
Keep away from food, drink and animal feeding stuffs.

Preventive skin protection:
Wash hands before breaks and immediately after handling the product. Then apply enough skin protecting cream.

Fig. 6 Fully protected operator

6.2 First aid and medical treatment

General information

First aider: Pay attention to self-protection!
Remove the casualty into fresh air and keep him/her calm. Remove contaminated clothing.
Remove breathing equipment only after contaminated clothing has been completely removed.
If victim is at risk of losing consciousness, position and transport on their side.

In case of inhalation:
Provide for adequate fresh air. If breathing becomes irregular or ceases, apply mouth-to-mouth resuscitation or artificial respiration immediately, where required supply oxygen. Immediately get medical attention.

In case of skin contact:
Take off immediately all contaminated clothing. Immediately get medical attention. In case of contact with the skin, immediately wash alternating with polyethylene glycol and a large amount of water while waiting for an emergency team.

After eye contact:
Immediately flush eyes with plenty of flowing water for 10 to 15 minutes holding eyelids apart. Subsequently seek the immediate attention of an ophthalmologist.

After swallowing:
Rinse mouth immediately and drink plenty of water. Do not induce vomiting. Immediately get medical attention.

Most important symptoms and effects, both acute and delayed

In case of inhalation:
Mucous membrane irritation, cough, shortage of breath, damage to respiratory tract.

After contact with skin:
Strong skin absorption as main danger of phenol poisoning at the workplace with paralysis of the central nervous system (with lethal consequences in severe cases) as well as liver and kidney damage. Phenol causes chemical burns.

After eye contact:
burns

Indication of any immediate medical attention and special treatment needed

Symptoms and dangers:
No specific antidote therapy for phenol poisoning is known. So it is important to remove the phenol completely from the body surface and out of the body as quickly as possible, and in the case of inhalation prophylactic treatment to prevent pulmonary oedema is of great importance. Phenol causes strong caustic burns of the skin and mucous membranes due to its protein degenerating action. The skin initially discolours white, later red. After initial pain, local anaesthesia appears. Absorptive poisoning by large amounts of phenol is possible also through small affected skin regions and quickly leads to paralysis of the central nervous system as well as strong depression of the body temperature. Inhaling phenol vapours can lead to damage of the bronchial system and pulmonal oedema. Systemic damage to kidneys, liver and heart as well as neuropsychiatric disturbances are produced.

Treatment:
Thoroughly clean the wetted skin areas, if possible with polyethylene glycol (e.g. polyethylene glycol 300). In case of eye contact, rinse copiously with water, in case of burns rinse continuously with water as far as possible and take to an eye specialist or eye clinic. In case of inhalation, to prevent pulmonary oedema, initiate inhalative cortisone therapy as early as possible (e.g. every 10 minutes 5 strokes of a cortisone containing aerosol dosing spray); administer codeine against dry coughing. In case of commencing or manifested pulmonary oedema, systemic administration of cortisone. Caution: A low symptom or symptom-free interval is possible. If swallowed, gastric lavage after intubation, activated charcoal, saline laxative.

6.3 Exposure controls

Control parameters

OCCUPATIONAL EXPOSURE LIMIT VALUES	
Europe: IOELV: STEL	16 mg/m³; 4 ppm
Europe: IOELV: TWA	8 mg/m³; 2 ppm
Great Britain: WEL-STEL	16 mg/m³; 4 ppm
Great Britain: WEL-TWA	7.8 mg/m³; 2 ppm
Ireland: 15 minutes	16 mg/m³; 4 ppm
Ireland: 8 hours	8 mg/m³; 2 ppm

ADDITIONAL INFORMATION	
DNEL long-term, workers, inhalative:	8 mg/m³
DNEL long-term, workers, dermal:	1.23 mg/kg bw/d

PNEC water (freshwater):	0.0077 mg/L.
PNEC water (marine water):	0.00077 mg/L.
PNEC sediment (freshwater):	0.0915 mg/kg dwt.
PNEC sediment (marine water):	0.00915 mg/kg dwt.
PNEC soil:	0.136 mg/kg dwt.

Exposure controls

Execute works under fume hood. Do not inhale substance.
The substance should only be handled in closed apparatus or systems.
Process exhaust through separator/filter as needed.

Appendix 1: Cefic and Responsible Care

1. Responsible Care - a public commitment

"Chemical companies shall demonstrate their commitment to continuously improve all aspects of performance which relate to protection of health, safety and the environment."

2. Prevention of accidents

Within Responsible Care, prevention is a prerequisite to Emergency Response. The CEFIC-ICE (Intervention in Chemical Transport Emergencies) prevention programme provides a valuable tool in reducing the number of incidents during the distribution of chemicals, from the time they leave the factory gate until their arrival at the customer's premises. The objective is to minimize the possibility for incidents to happen. Since most distribution activities are subcontracted and since compliance with regulations is a necessary but not a sufficient condition to prevent accidents, there is a need for uniform safety & quality criteria against which distribution companies are regularly assessed. Unlike the ISO 9001 standards which set out the criteria for a quality management system, SQAS - Safety & Quality Assessment Systems - provide objective performance indicators, which allow the monitoring of continuous improvements. Based on detailed questionnaires, distribution contractors can be assessed by a qualified third party. Questions relate to management, equipment and operations, split by: statutory requirements, additional chemical industry requirements and desirable items. Scoring results can be presented in different ways but it is up to each individual chemical company to evaluate the results according to its own standards.

The distribution contractors will include:

- Marine transport: Vessels and barges. (Ferries)
- Road transport: Road carriers
- Storage operations: Terminals/Warehouses
- Ferry operators

3. Emergency response

Although the chemical industry has a fine record in preventing chemical transport incidents, it is committed to continuous improvement. The ICE Emergency Response scheme is a co-operative programme, set up to provide, in the event of incident information, practical help and, if necessary and possible, appropriate equipment to the competent emergency authorities by the chemical industry in order to minimize any adverse effects. National ICE schemes exist for many European countries.

http://www.cefic.org/Industry-support/Transport--logistics/Transport-Emergency-Scheme-/

The chemical industry makes its expertise available to authorities - who are normally in charge of the emergency - at three levels of assistance.
Level 1: Remote information and general advice by telephone or fax.
Level 2: Presence of an expert who will provide advice at the scene of an incident
Level 3: Actual help with equipment and personnel at the scene of an incident

For detailed information on this subject consult: the Cefic ICE - European Emergency Response Network: Operational National ICE schemes (www.cefic.org)

Appendix 2: Cefic recommendations on safe management practices in distribution (SQAS)

These recommendations conform to the principles of Responsible Care and include the following topics:

1. Safety, health and environmental policies
2. Auditing
3. Risk reduction
4. Specification of packages, tanks and other equipment
5. Incidents evaluation
6. Codes and regulations
7. Control operations
8. Training
9. Selection and monitoring of Contractors
10. Data and information
11. Emergency Response
12. Information to the public

http://www.cefic.org/Industry-support/Transport--logistics/SQAS2/

Although these guidelines for the safe handling of phenol are product specific, it is essential that policies, systems and procedures as described in the Cefic recommendations on Safe Management Practices in Distribution are in place and well maintained.

Appendix 3: Inspection of transport equipment

Inspection of road tankers and tank containers at loading terminals.

Before loading

- Does the truck have any visual defect (e.g.structural defects, lights and tyres in good condition)?
- Is there a valid ADR equipment certificate for carriage of phenol?
- Has the driver a valid ADR licence for the bulk transport of dangerous substances of class 6?
- Are all dangerous goods labels fitted, is the identification number 60/2312 attached or the national identification plate in accordance with national regulations?
- Are the instructions in writing in all required languages on board?
- For combined ADR/IMO transport: are the IMO dangerous goods labels fitted? Is the UN number attached as per these regulations?
- Does the driver have all the necessary items of protective clothing and safety equipment as specified by the written instructions or required by the consignor?
- Determine the maximum payload based on
    i. Tare weight
    ii. Route
    iii. Country of destination
    iv. Transport mode
    v. Minimum and maximum filling degree
    vi. Volume of tank
- Are all the valves closed upon arrival?
- Can all valves be operated correctly?
- Are the loading/unloading valves leak proof?
- Is the tank placed at the correct loading position?
- Are the wheels of the truck blocked by wheel blocks or other tools?
- Is the vehicle earthed? The earthing cable should be fitted properly before loading connections are made.

After loading

- Is the maximum gross weight not exceeded?
- Are all valves closed and blinded, with all bolts in place and are all dry disconnected couplings/ metal caps in place?
- Are all openings sealed?
- Is the vehicle earhing removed?

Appendix 4: Guide for the marine chartering and handling of phenol

Ships complying with bulk chemical codes

Inspection of all marine vessels for compliance with the guidelines shall be made by a responsible and competent person prior to each loading to confirm a satisfactory condition of the vessels cargo system. Ships that have never been in the company's service will be inspected by a Marine Surveyor, under the CDI scheme (see note) or a company initiated scheme, to verify compliance with these guidelines and all applicable regulations prior to charter acceptance.

1 Certification

Phenol will only be loaded/carried on vessels meeting all currently applicable requirements and regulations of all applicable IMO codes and conventions, such as Bulk Gas Codes, Bulk Chemical Codes, SOLAS and MARPOL 73/78, and the US Coast Guard Standards.

The carriage of phenol should be permitted by the vessel's International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk, which should be valid for the expected duration of the voyage, state the carriage conditions for phenol and be suitably endorsed. Alternatively, a letter of compliance of the US Coast Guard or any other competent Flag State Authority can permit the carriage.

2 Prior cargoes

Documentation of the last cargoes as well as the cleaning certificate must be provided prior to the ship's arrival at the loading berth.

3 Inspection, segregation and loading

Proper procedures for inspection, segregation of cargo and loading should be developed and used by the loader.

4 Carriage

A copy of the carriage log recording cargo tank(s) temperature, pressure and exceptions must be available at the discharge port.

5 General information

Completion (balance) cargoes

Completion cargoes are cargoes shipped concurrent with phenol. Compounds which are reactive with or that catalyse the self-reaction of phenol are not desirable completion cargoes. Compatible cargoes are acceptable. (See US Coast Guard Compatibility Chart).

Heating

Heating is to be carried out most carefully and under continuous control, and the temperatures must be recorded daily for each tank separately and written records have to be maintained. Heating is to be carried out with appropriate medium in the heating coils of the ship's tanks. The skin temperature of the coils shall not exceed 60 °C at any time, and the tanks have to be pre-warmed prior to loading. Temperature of phenol shall never drop below 50 °C. The freezing point of phenol is 40.9 °C.

Properties

Physical properties and other useful safety and health information relating to phenol are contained in the Safety Data Sheets.

Chemical distribution institute (CDI)

This is a system that provides objective information on the quality of shipping.
CDI is an independent system to select and monitor contractors involved in shipping. The system emphasises safety performance, environmental protection, regulatory compliance, maintenance and training.
A regular review of the above- mentioned performance and necessary improvements are part of the system.
CDI accreditates inspectors and facilitates the distribution of assessment results.
Chemical companies or consignors can initiate an assessment and/or request the assessment results from the ship's owner.

Appendix 5: Design and construction of rail tank cars

Design must follow current RID or national regulations.
The following are guidelines drawn from RID regulations with specific comments for phenol application.

General recommendations

1.
The preferred material for tanks is stainless steel. If carbon steel is used, it must be rendered free from loose rust and coated. Reinforcement (backing) plates are required when the load bearing attachments are not made of a stainless steel.

2.
The filling and vapour return connections are generally on top of the tank and must incorporate an isolating valve.

3.
Depending on the specification of the tank and fittings, the tank may discharged through the bottom shut-off device (discharge valve, dry coupling) or from the top through an attached dip tube.

4.
Connections should be adequately protected against possible impact that may occur during transport.

5.
Earthing connections shall be provided to prevent dangerous differences in electrical potential arising between the carrying tank, the body of the vehicle, the piping and the ground during the filling or discharging of the vehicle.

6.
Rail tank cars are to be insulated. The insulating material shall:

- Demonstrate minimum reactivity when in contact with phenol.
- Be suitable for operating at the lowest ambient temperatures likely to be met in service.

7.
In order to permit the discharge in case of freezing of phenol, a heating coil must be fitted.

8.
The tank and fittings must be inspected, tested and certified by an inspection authority approved by the company, in accordance with the national regulations.

9. Equipment

- A new tank must be of circular cross-section and thickness of the tank shell must be designed for a pressure of not less than 10 barg.
- The tank must be able to withstand a hydraulic pressure of not less than 4 barg.
- New tank shells must be designed to take full account of additional pressure generated by liquid surge during rapid deceleration.
- Normally no baffle plates are to be fitted. Where baffle plates are fitted on existing tanks to reduce liquid surge, adequate venting and draining holes must be provided in the baffles. Baffle openings must not be less than 500 mm diameter to permit access through the baffles for inspection purposes. These openings must be staggered in locations along the tank. Baffle plates must be of the same material as the tank shell.
- The design of the rail tank car must guarantee a complete unloading of the rail tank car.
- Tanks must be designed so that there are no pockets that can trap liquid during discharge.
- Nozzles on the shell should, as much as possible, be located away from the shell main weld seams.

Appendix 6: Design and construction of tank trucks and tank containers

It is recommended that the company's technical tank truck/tank container experts will use the following list in the contractual agreement with the different road carriers.

General recommendations

1.
Stainless steel tank material is preferred, in order to avoid coloration of phenol.

2.
Baffles may need to be fitted to meet the requirements of transport regulations. However, the number of baffle plates should be kept to a minimum, as they may hinder professional cleaning operations.

3.
For top loading/unloading facilities: at least one walkway of anti-slip grating shall be provided on top of the tank to give access to the top nozzles and manway. The walkway on tank trucks should be fitted with a collapsible handrail, and be reached by an open rung access ladder.

4.
Earthing connections shall be provided. These connections shall not be painted.

5.
Gaskets: PTFE, PTFE spiral wound or other phenol compatible material.

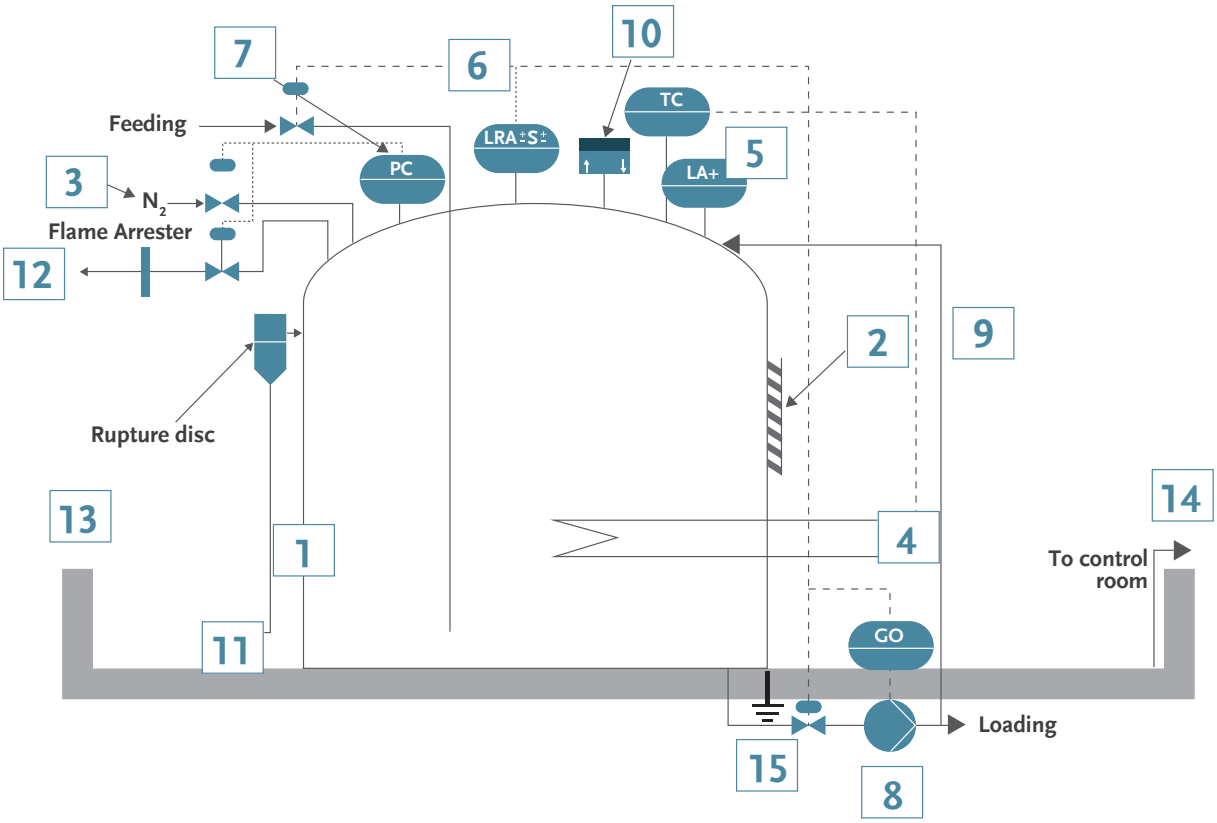
6.
UN tank instructions: T 7 or L4BH

7. Equipment

UN 2312 PHENOL, MOLTEN, 6.1, II (see ADR 3.2 table A)

- Suitability of the tank: portable tank T7-T22 or ADR tank L4BH or better (ADR 4.2.5.2.5 , 4.3.4.1)
- Material and equipment: stainless steel, heater (ADR 6.7.2.2 , 6.8.2)
- Wall (shell) thickness: minimum 6 mm reference steel when tank diameter is over 1,8 m, normally stainless steel 4.13 mm is resp. 6.0 mm reference steel (6.7.2.4)
- Design temperature: -20/+100 °C (ADR 6.7.2.5.6)
- Pressure requirements: Test pressure 4 bar (ADR 4.2.5.2.6, 6.8.2.4)
- Bottom openings: discharge outlet 3 valves/closures (ADR 6.7.2.6.3)
- Inspections and tests done as required: 2.5 years/5 years (ADR 6.8.2.4)

Appendix 7: General storage design



General design recommendations:

0. General design: vertical storage tank
1. Material: stainless steel
2. Insulation: rock wool or similar
3. Inert gas blanketing
4. Soft heating avoiding wall temperature above 75 °C.
4. Temperature control between 50 °C and 60 °C
5. Level with alarm
6. High and low level alarm interlocked with pumps shut off valves closed
7. Pressure control
8. Centrifugal pump with magnetic drive, immersed rotor or equivalent to avoid leakages
9. Recirculating (with sampling system)
10. Safety valve low and high pressure protection
11. Foam connection for firemen to internal sprinkling
12. To vent treatment
13. Retention pit
14. Leakage monitoring
15. Earthing

Appendix 8: Member Companies of the Phenol & Acetone Sector Group

COMPANY	COUNTRY
BOREALIS POLYMERS Oy	Finland
CEPSA QUIMICA S.A.	Spain
DOMO CAPROLEUNA GmbH	Germany
DOW EUROPE GmbH	Switzerland
INEOS PHENOL GmbH	Germany
NOVAPEX S.A.S.	France
RÜTGERS GERMANY GmbH	Germany
VERSALIS S.p.A.	Italy

Appendix 9: Glossary of Abbreviations

ADR	Accord européen relatif au transport des marchandises dangereuses par route. European agreement concerning the international carriage of dangerous goods by road
ADN	Accord européen relatif au transport des marchandises dangereuses par voie de navigation intérieure. Regulations concerning the transport of dangerous substances in barges on inland waterways
CAS	Chemical Abstract System
CDI	Chemical Distribution Institute
Cefic	Conseil Européen de L'Industrie Chimique
DIN	German Industry Standard (Deutsche Industrie Norm)
DNEL	Derived no effect level
EEC	European Economic Community
IATA	International Air Transport Association
IBC	Intermediate Bulk Container
IBC Code	International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk
ICE	Intervention in Chemical Transport Emergencies (Cefic)
IMO	International Maritime Organization
ISO	International Standard Organization
LC50	Lethal Concentration (50%)
LD50	Lethal Dose (50%)

MARPOL	Marine Pollution Act
PTFE	Polytetrafluorethylene
PNEC	Predicted No Effect Concentration
RID	Règlement International concernant le transport de marchandises dangereuses par chemin de fer Regulations concerning the international carriage of dangerous goods by rail
RTC	Rail Tank Car
SOLAS	Safety of Life at Sea
SQAS	Safety and Quality Assessment System (Cefic)
STEL	Short Term Exposure Limit
TWA	Time Weight Average
UN	United Nations

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