

# **Storage and Handling of Chlorinated Solvents**

**Third Edition  
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## INTRODUCTION TO THE 3<sup>rd</sup> EDITION

The chlorinated solvents Methylene Chloride, Perchloroethylene and Trichloroethylene, can, if not handled and used in the proper way, pose certain risks to human health and the environment.

This booklet, produced by the General Technical Working Group of ECSA(\*) is intended to help distributors and users of chlorinated solvents to handle those products safely and with care, thus protecting man and nature against possible negative impact.

As the main issues, this booklet deals with:

- Construction and operation of bulk storage facilities and the handling of drums.
- Precautions to be taken.
- Relevant (European and national) regulations, impacting the use of chlorinated solvents.

Since the issue of the 2<sup>nd</sup> edition of this manual, in 1988, significant changes have taken place regarding regulations on the use of chlorinated solvents in Europe, it was thought appropriate to issue this revised and updated version.

The recommendations proposed in this code are based on the understanding and experience of the chlorinated solvents producers in their respective countries and the European Union at the date of issue of this document. In some locations more stringent measures may be necessary and these recommendations are in no way intended as a substitute for the relevant national or international regulations which should be consulted and respected. This document is established in good faith and should be used as a guide to be consulted and which may be modified in the future to take technical progress into account.

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(\*) ECSA = European Chlorinated Solvent Association

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## **ABBREVIATIONS**

BS	British Standard
CHC	Chlorinated hydrocarbon solvent
C/S	Chlorinated solvent (often used instead of CHC)
DIN	Deutsche Industrie Norm
ECSA	European Chlorinated Solvent Association
FRG	Federal Republic of Germany
PTFE	Polytetrafluoroethylene

# 1. STORAGE

## 1.1. Recommended Materials for the Construction of Storage Vessels

### 1.1.1. Bulk tanks and small containers

Carbon steel of welded construction is the usual material for storage and handling of chlorinated solvents in bulk tanks. If rust contamination can not be tolerated, an appropriate grade of stainless steel may be preferred; hot-dip galvanised steel (though not steel galvanised by electroplating or spraying) should be suitable, or a coating may be applied to the steel.

Section 1.2.2.1. should be consulted for details.

### 1.1.2. Drums

Carbon steel is generally used for drums.

Product contamination can be controlled by using a special solvent-resistant coating, but a loss of integrity of the coating will give problems. Galvanised steel, in particular steel galvanised by electroplating or spraying is not recommended.

Aluminium, magnesium and their alloys should not be used in chlorinated solvents service. Plastics are not generally suitable for bulk chlorinated solvents service, but may be acceptable for very small one-way containers.

## 1.2. Bulk Storage of Chlorinated Solvents

### 1.2.1. General Requirements

The individual product quality of the chlorinated solvents (CHCs) will determine the materials of construction to be used. Freshly produced, stabilized, dry CHCs are not corrosive and require less material investments than contaminated CHCs. In case of regenerated substances, the quality of the product will determine the materials of construction to be used.

All parts of plants and protective installations have to be able to endure the projected mechanical, thermal and chemical stresses. They have to meet the following basic standards:

- Containers and pipelines must be designed to endure the static fluid pressures as well as over- and underpressures encountered during operations. They have to be resistant to external mechanical stresses. Adequate structural design and resistance qualifications are required.
- The materials must be impervious against and resistant to chlorinated hydrocarbons and their vapours.

In contact with free water some CHCs tend to hydrolyse, causing formation of acids and thus corrosion of metals. Most CHCs are stabilised against acid formation by the manufacturers today. However, depending on the use, regular analytical control may be recommended.

## **1.2.2. Storage Tanks**

### **1.2.2.1. Suitable Materials of Construction.**

#### **1.2.2.1.1. *Metals***

Reference A.1.2.1.1. (p 37) contains a useful tabulation of tested materials according to German standards.

See Appendix A.1 for further details on a national basis.

#### **1.2.2.1.2. *Non-metal Materials***

Plastics as materials for tanks are generally not suitable because they do not meet certain basic requirements, such as vapour tightness and resistance to chemicals, under continuous exposure to CHCs.

If, in special cases, plastics are proposed for installation in new constructions, the suitability has to be proved by an expert, and a qualification approval has to be obtained from the authorities.

### **1.2.2.2. Construction of Storage Tanks**

Storage facilities should be sized appropriate to requirements. The design calculation should be based on the specific gravity of the material to be stored.

Carbon steel is generally satisfactory but stainless steel can be used in special cases where high quality and purity of the product is demanded. For materials see Appendix A.1.2. For coating of the tank see 1.2.2.2.1.

Steel sheets are to be butt-welded, i.e. without overlapping.

If the tank is to be lined inside, welding should ground smooth in order to have a regular surface.

10% X-ray control of the welding [plus 100 % colour penetration test, if required] is recommended, otherwise according to design specifications.

Tanks must be hydraulically tested in accordance with the terms laid down in the design specification.

Tanks must be clean, dry, free from grease and carefully checked before being put into service.

#### 1.2.2.2.1. *Coating of the Tank*

Rust contamination of the solvent can be avoided by using a solvent-resistant coating as a tank lining. Special paints such as high baked phenolics give good results. Ease of repair should be considered when selecting the type of coating. Smaller tanks or containers can be made of hot dip-galvanised steel (steel galvanised by spraying or electro-plating is not recommended). Where available, an official certification of the suitability of the metal coating should be obtained.

For Methylene Chloride, which is a potent paint stripper, coated tanks are not recommended as the coating will be attacked by the solvent. Plain, non-phosphatised mild steel or stainless steel are materials of choice.

Heat absorption and resulting vapour losses can be minimised by using light reflecting paint on the outside of the tank.

#### 1.2.2.2.2. *Standardized Storage Tanks*

Steel tanks are often available in standard designs for the storage of flammable liquids, however their individual suitability would need to be proved if they are to be used in chlorinated solvents service. It is especially important to take into account the large density difference between chlorinated solvents and other hydrocarbons.

These storage tanks are not made to any definite design specification and are usually of very low pressure design. Since they do not provide design specifications and drawings, these types of tanks are not normally recommended for chlorinated solvents.

#### 1.2.2.3. **Location of Storage Tanks**

In order to minimise the risk of leakage, storage tanks should be sited above ground and as close as is reasonably possible to the vehicle delivery point, providing easy access for the delivery vehicle.

Tanks and vehicle delivery area must be sited to ensure containment and to avoid escape of any spill or leakage to the environment - see 1.2.3.1.

Tanks should be located away from traffic and well away from any source of heat or flames.

Provisions must be made to keep unauthorized people out of the storage area.

##### 1.2.2.3.1. *Tanks for Storage Above Ground*

Tanks for storage above ground should meet the appropriate national and local standards (see Appendix A.1.2 for further details).

##### 1.2.2.3.2. *Pressure rating of tanks*

Transfer of chlorinated solvents by air pressure requires that both receiving and delivery tanks are suitably pressure rated (to be in accordance with BS 5500 they should be designed for a pressure of 30 psig (2 bars)). As a pressure surge at the end of unloading by air pressure can cause problems of over-pressurisation and often leads to excessive atmospheric losses, discharge should preferably be completed by means of a pump.

#### 1.2.2.3.3. *Second-hand tanks*

Before a second-hand tank is purchased, detailed drawings are needed to check its suitability for the intended chlorinated solvents service.

### 1.2.3. Safety devices

A number of important safety devices are incorporated to warn of failures and to avoid damages. Their purpose is especially to prevent leakage of CHCs and they include: containment to collect drips and leaks, leakage indicators, laminations, external sealings, liquid level indicators, exhaust installations, high level trip and high and low level alarms.

#### 1.2.3.1. Containment

##### 1.2.3.1.1. *General*

In case of failure or spillage, chlorinated solvents must not be allowed to contaminate the ground or any local water course.

A bund or catchment area, capable of holding the total volume of the largest tank involved, would provide appropriate protection for the environment. For installations which can hold only minor quantities, such as drum storage and containers, drip pans should be used to contain drips or spillages. Drip pans should be tight, sufficiently resistant, water- and CHC-proof.

Containment installations must not have floor gullies or other openings discharging directly into the environment. They have to be equipped with devices for the removal of liquids. After correct identification these liquids may be removed by a pump. Design of the sump should be such as to allow safe removal and treatment of rain water whilst retaining the higher density solvent for subsequent handling.

Where regular (minor) spills are difficult to avoid, e.g. at loading / unloading facilities, drumming / de-drumming stations, a full enclosure is needed to ensure that spills can be collected separately and that they will not enter the surface water drainage system.

Concepts of containment and materials of construction for containments are often described in national storage and handling regulations for CHCs.

##### 1.2.3.1.2. *Containment of metal construction*

Steel and stainless steel of types suitable for chlorinated solvents service, may be used (see Appendix A.1.2.).

The following precautions against corrosion should be considered:

- Protection from water and other liquids
- Leakage detection and control
- Suitable laminates.

CHC-resistant materials which have proved to be suitable are available for laminates (see 1.2.3.1.3). An official certificate of the suitability of any metal coating may be required.

#### 1.2.3.1.3. *Containment of concrete construction*

Unprotected concrete surfaces, including waterproof concrete, are not impervious to CHCs, therefore concrete requires, when necessary, the application of a surface protection, allowing the covering of capillary cracks, to render it impervious to CHCs. Expansion- and differential settlement-joints constitute special weak points and should be avoided as far as possible. Where they are mandatory for technical reasons, they should be constructed in such a way that deformation of joint strips and the sealing material will not impair the tightness of installation. Joints should be inspected regularly and deficiencies repaired immediately.

Suitable surface protections for concrete include:

- linings of sheet metals (see 1.2.3.1.2 and Appendix A.1.2) or plastic sheeting
- laminates (discussed below in detail).

#### *Laminates on concrete*

For CHC-proof laminates a suitable quality of concrete is required (see Appendix A.1.2, for example A.1.2.1.3).

CHC-proof laminates are based on:

- phenolic resins or;
- furan resins.

In addition, one form of epoxy resin (“Concretin”) has passed the rigorous tests for CHC-proof laminate.

Other substances are either considered not sufficiently impervious to CHCs or are suited for certain CHCs only.

Furan resin laminates may contain chemical modifiers to overcome cracking by improving their plasticity. However modifiers reduce chemical durability; this is of special importance with Methylene Chloride.

Furan resins cannot be used as sealing materials in joints due to their limited plasticity.

To obtain sufficient durability, phenolic or furan resins have to be combined with glass fiber mats. Elastic intermediate layers are required to cover and fill cracks in the concrete, e.g.

- layers of elastomers (e.g. polyisobutylene, several rubber products);
- layers on a bituminous basis;
- so-called liquid foils, which are poured on the concrete and when hardened will form an elastic layer (e.g. polyurethane)

The CHC-impervious laminate is then applied on the top of the elastic intermediate layer.

If resistance to considerable mechanical wear is required of this laminate, then a cover must be applied, e.g. of tiles in a mortar bed.

Duroplastics should be processed in coordination with the manufacturer and installed only by expert and sufficiently experienced companies.

#### *Sub-surface protection of concrete*

Concrete construction may require an additional protection from below against moisture and aggressive subsoils. This protection prevents vapours from creeping behind the laminate and detaching it from the concrete.

In cases of non-cohesive soils and low groundwater-level, a capillary moisture stop of coarse gravel will be sufficient as a base for the concrete.

The following multi-layer construction will provide improved protection: An approximately 5-10 cm thick concrete layer is placed on the soil and covered with a barrier of elastomer layers (e.g. polyiso butylene, various derivatives of rubber) or with bitumen. Then the actual concrete construction is built on these layers.

#### 1.2.3.1.4. *Containment of Plastics Construction*

In general, ECSA does not recommend the use of plastic containment for Chlorinated Solvents. Plastics considered to be suitable for chlorinated solvents packaging according to the present state of the art should have an official approval certificate and tend to be very costly.

#### 1.2.3.2. **Leakage Control Equipment for Double-walled tanks**

The following systems are state of the art for chlorinated solvents stored in double-walled tanks:

- Liquid indicator systems.

A leak in the wall of the tank is indicated by lowering of the level in the leakage indicator liquid container.

- Overpressure systems.

A leak in the tank wall is indicated by a pressure increase in the control space.

Any suitable leakage indicator may be used. The "Institut für Bautechnik" (IfBt, Institute for Construction Techniques, Reichpietschufer 72-76, D-1000 Berlin 30) will furnish information.

Leakage control equipment requires regular checks of correct functioning. The instructions of the manufacturer for installation, adjustment and maintenance have to be followed.

#### 1.2.3.3. **Leakage Sensors**

Leakage sensors may be used for bunds. They are designed to indicate a leakage of the storage tank.

#### 1.2.3.4. **High Level Alarm; Low Level Alarm/Trip**

A high level alarm linked to a "shut-off valve" will discontinue the filling process of a tank before the maximum permissible filling level is exceeded. If a pump is used to fill the tank then the high level alarm could also be set to trip the pump.

If a pump is used for the removal of solvents from a stock tank then a low flow trip could stop the pump; if an alarm is incorporated then there will be advance notice that the tank is nearly empty. These devices would prevent damage to the pump arising from dry running.

#### **1.2.3.5. Liquid Level Indicator**

Liquid level indicators are necessary for the storage tanks for CHCs.

When combined with an optic or acoustic alarm, the liquid level indicator may serve as a fill control against overfilling. The liquid level indicator should preferably not be a sight glass because of the risk of accidental breakage. In case a sight glass is in place, it has to be of a caged and impact resistant type.

#### **1.2.3.6. Sealing Material**

**Table 1** (p 13) presents a survey on the CHC-resistance of plastics for laminates and sealings:

**Table 1: Resistance to chlorinated solvents of plastics for laminates and sealings\***

Duroplastics		Thermoplastics		Natural and synthetic elastomers	
Resistant <sup>1)</sup>	Non-resistant <sup>2)</sup>	Resistant <sup>1)</sup>	Non-resistant <sup>2)</sup>	Resistant <sup>1)</sup>	Non-resistant <sup>2)</sup>
Furan resins phenol-cresol resins phenol resins cresol resins	Most EP-resins (epoxyd resins) cold/hot hardened	PTFE (poly-tetrafluoro ethylene)	PIB (polyiso-butylene)	FCM (fluoro-caoutchouc)	NR (polyisoprene)
		PFEP (poly-fluoroethylene propylene)	PVC (poly-vinylchloride)		SBR (styrene butadiene copolymer)
	PUR resins (polyurethane resins)	PVDF (poly-vinylidene fluoride)	HDPE / LDPE (high + low density polyethylene)		NBR (acrylonitrile-butadiene-copolymer)
	UP resins (unsaturated polyester resins)	Other fluoro-synthetics (copolymers)	PP (polypropylene)		CR (poly-chlorobutadiene)
			PC (polycarbonate)		IIR (isobutylene-isoprene copolymer)
Exception:	Exception:			Exception:	
vinyl-ester resins <sup>3)</sup> towards tetrachloro-ethylene	vinylester-resins <sup>3)</sup> towards dichloro-methane			thiokol (polysulphide rubber) towards tetrachloro-ethylene	CSM (chloro-sulfonated polyethylene)
trichloro-ethylene					Rubber
Range of application		Range of application		Range of application	
concrete laminates		metal laminates (containers, pumps, fittings, pipelines)		sealings (containers, pumps, fittings, pipelines)	
sealing of clay-concrete pipes		sealings,			
joint sealings		linings		joint sealings	

Notes:

<sup>1), 2)</sup> Chemical resistance/impermeability: Information is based on tests with pure solvents.

Other results in the resistance of plastics may be observed if mixtures of solvents are stored or transported.

In these cases specific user-oriented tests should be made.

<sup>3)</sup> The varying data for trichloroethylene were furnished by different manufacturers of vinylester resins.

(\* ) This information is given as an orientation for selection and based on general experience. However, it is recommended to obtain approval from the manufacturer for use of these products in contact with specific Chlorinated Solvents.

### **1.2.3.7. Other Tank Accessories**

Manholes should be fitted to larger tanks in order to facilitate inspection and cleaning; manholes should be sized for the entry of a man equipped with self-contained breathing apparatus, and should be sited in the vapour space of the tank. (See also Chapter 6).

The atmospheric vent of the tank should be fitted with an air dryer in order to prevent moisture from entering the storage tank and to minimise corrosion of exposed internal metal surfaces. An air dryer may use as a drying agent the anhydrous forms of calcium sulphate or chloride. Caustic soda flakes (sodium hydroxyde) are incompatible with, and decompose chlorinated solvents. A non-return valve in the dryer line may be helpful to prevent the dryer from becoming saturated with solvent fumes when filling the tank.

An anhydrous calcium chloride or sulphate dryer can also be used to treat the liquid phase to maintain product quality, in case very low water content is required.

A pressure-vacuum relief valve should be fitted and should be of stainless steel, cast iron or brass to avoid oxidation. It prevents damage to the tank, should the vent become blocked. Tank design and the pressure/vacuum setting of the valve should be compatible. Consideration should be given to the provision of an emergency relief vent.

Maintenance of a dry nitrogen blanket over chlorinated hydrocarbons in the tank may be helpful to maintain product quality.

### **1.2.3.8. Vent Gas Treatment**

When unloading by gravity or pumping, chlorinated solvent vapors should be kept inside the system by connecting the vapor-phase of the tank to be filled to the vapor phase of the tank or vehicle to be emptied, i.e. a closed system operation.

If vent gases containing chlorinated solvents cannot be kept inside the system, they may be treated by:

- adsorption, e.g. on activated carbon or on resins; for big gas streams, an absorber that can be regenerated is recommended;
- the adsorbed chlorinated solvents would then be recovered and the adsorbent would be reactivated for re-use. A one-way cartridge can be used to treat the breathing of the tanks;
- incineration with adequate flue gas treatment;
- vent scrubber (if traces of aqueous hydrochloric acid need to be removed).

### **1.2.3.9. Related Equipment**

#### **1.2.3.9.1. Filters**

A filter, e.g. cartridge or basket type, of materials compatible with chlorinated solvents will be helpful in maintaining product quality.

#### **1.2.3.9.2. Pumps**

Centrifugal pumps of cast iron or steel construction are recommended, as are canned (hermetic) type pumps or pumps having mechanical seals (solvent resistant).

Pumps have to be placed inside a CHC-resistant containment - see 1.2.3.1.

#### 1.2.3.9.3. **Gaskets**

Gaskets must be solvent resistant. Suitable materials include “Viton” (A and B), “Frenzelit”, PTFE or carbon fibre.

Viton A is a copolymer of vinylidene fluoride and hexafluoro-propylene.

Viton B is a very chemically resistant terpolymer of vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene. Frenzelit is supplied by Frenzel (D) and includes a range of composites of elastomers.

Specialised gasket suppliers will be able to recommend the right product for each application.

#### 1.2.3.9.4. **Valves**

Valves can be of stainless steel, cast steel or brass. Ball valves should have a PTFE seat. Where throttling is necessary, globe valves may be used; globe valves should have a metal seat. PTFE diaphragm valves are also acceptable but not for stock tank isolation.

#### 1.2.3.9.5. **Meters**

Meters should be suitable for use with the particular solvent being handled. They should not have any aluminium, magnesium or zinc component, nor any alloys of these metals. Brass is acceptable.

### 1.2.4. **Pipelines**

Pipelines are rigid or flexible lines including elbows and fittings. Underground pipelines should be the exception and they require special precautions; they must be constructed as a jacketed pipe system with leakage alarm system for the outer space.

Pipelines should be installed with a slight fall to ensure drainage. Relief valves should be considered to prevent damage due to thermal expansion where the pipe run is long and could become full of liquid.

#### 1.2.4.1. **Steel Pipelines**

Piping may be of carbon steel or stainless steel (see Appendix A.1.2). A quality certificate will usually be required.

#### **Pipe connections**

Since pipe connections are one of the weak points of pipelines, they should be reduced to a minimum. Connections between pipe sections are usually either welded or flanged. Slip-on socket and soldered connections are not acceptable for service with CHCs.

Sealing materials for flanged connections are given in Table 1 (p 13), Section 1.2.3.6. Only bolts with quality certificates and appropriate test marks are acceptable. Suitable chemical-resistant gasketing materials shall be used (see 1.2.3.9.3).

All welding is to be carried out only by qualified welders.

All shut-off devices in these pipelines should be easily accessible and functioning; they should be supported if they would cause overloading of the pipe.

### **Fabrication and erection**

Fabrication and erection of pipelines should be in compliance with local regulations.

The external walls of the pipeline and supports shall be protected against corrosion by a priming coat followed by a coat of paint or by a suitable jacket (e.g. plastic).

If pipelines are underground they have to be double-walled. Special devices (over- or underpressure, control of inner space between pipe and jacket) are used to detect leakage.

#### **1.2.4.2. Pipelines made of Plastics**

Pipelines for CHCs made of plastics are only suitable for above-ground installation and in any case have limited durability. They should be designed for total drainage and due note should be taken of their susceptibility to mechanical damage.

Chemically resistant against CHCs are:

	max. operating temperature*	
	°C	°F
PTFE (polytetrafluoro-ethylene)	160	320
PFEP (polyfluoroethylene-propylene)	140	284
PCTFE and ECTFE (polychlorotrifluoroethylene)	120	248
PVDF (polyvinylidene fluoride)	120	248

Local regulations should be followed for the design and construction of fibre-reinforced plastic (FRP) pipelines. In general, those pipelines are not recommended for chlorinated solvents.

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(\*) *Note:*

*As plastic materials tend to lose mechanical properties at elevated temperatures, it is generally not recommended to use any sort of plastic piping for Chlorinated Solvents above ambient temperature.*

## 2. UNLOADING OF BULK SOLVENT

***Note: People involved in the unloading of Chlorinated Solvents should be trained and in the possession of written guidelines and procedures.***

Chlorinated solvents are transported in bulk, in rail and road tankers, in ISO containers or packed in drums (approximately 200 litres) or smaller packages.

There are three methods of unloading from rail and road tankers and ISO containers:

### **- Gravity**

Gravity flow is used to unload into a customer's pump or to a storage tank at a lower level. Gravity unloading is uncommon today since most storage facilities are nowadays located above ground.

### **- Pumping**

Pumping discharge includes the situation where the pump is part of the road tanker, as well as with a pump at the receiver's site. For safety reasons, the use of positive displacement pumps is not recommended for discharging chlorinated solvents. Centrifugal pumps are recommended, in particular those with magnetic transmission.

### **- Air pressure**

For safety and environmental reasons (no vapour return possible) discharging by air pressure is not recommended.

### **2.1. Solvent sampling**

Because ionic materials, moisture and other contaminants cannot always be detected by visual inspection, the chlorinated solvents should be sampled according to recommended procedures. The detailed analytical procedures for these solvents are available from the producers on request.

#### **General guidelines:**

- Sealed sampling containers should be made of brown glass with metal lined or plastic screw caps compatible with the chlorinated solvents. If clear glass bottles are used, storage should be in the dark. Aluminium in any form should not be used for storing retained sample or for the screw cap.
- Glass thief tubes or siphons are preferred as sampling devices. Those made of metals (stainless steel or other metals except light metals and their alloys) may be used but are less satisfactory. Plastic is not recommended and rubber equipment must not be used.
- All sampling material must be clean and dry.
- Underfill the container to allow for thermal expansion of the sample.
- Label the sample container properly.
- Store samples in tightly sealed containers in a cool place and away from direct sunlight.

- Sampling from tank or tank cars.  
The analysis should be done before unloading. Any pressure in the vessel should be relieved prior to opening the manhole cover. Open the dome cover cautiously and avoid breathing vapours.  
Obtain a sample by means of a lecture bottle under vacuum that sucks up the liquid via the gas phase opening (see Appendix A.4) or by immersing a clean glass container that has been securely wired to a stiff metal rod. Close the cover immediately. Samples may be also taken from a sampling point in the unloading line or pump.
- Sampling from storage tanks.  
If sampling takes place after unloading, material should be withdrawn from the center of the storage tank. Metal sample lines preferably of stainless steel may be used. Valves should have polytetrafluoroethylene packing to avoid contamination of the solvent.

## **2.2. Preparation for unloading**

- 2.2.1.** The unloading operations should be carried out only by properly trained employees under adequate supervision. The appropriate personal safety equipment, such as gloves and eye protection, must be worn.
- 2.2.2.** The unloading point should be correctly labelled with:
  - a) Type of solvent
  - b) Method of unloading
- 2.2.3.** The stock tank should also be labelled with the type of solvent stored. (Results of laboratory control should be available before unloading into storage tank in case supply contract does require analysis upon delivery).
- 2.2.4.** Check that there is sufficient capacity in the stock tank to receive the full delivery.
- 2.2.5.** Inspect the safety vent system on the storage tank to ensure that it will work properly and that it is not frozen or obstructed. To avoid vapour emissions to the atmosphere, a vapour return line should be installed between storage tank and tanker, through which the displaced air and vapour out of the storage tank is fed back into the tanker.
- 2.2.6.** Rail and road tankers should be in a position where connections can be made quickly and easily, preferably on level ground. Precautions should be taken that any spillage or leakage is contained and that there is no contamination of drains, etc. Absorption of contained spills and leakages will keep evaporation to air at a minimum.
- 2.2.7.** Emergency showers and eyewash fountains should be located in the unloading area in case of accidental skin or eye contact.

**2.2.8.** Unloading should preferably take place during daylight hours. When it is necessary to unload after dark, adequate lighting should be provided.

### **2.3. Unloading hose**

The requirements for flexible hoses are the same as for rigid pipelines, i.e. temperature and pressure ratings, as well as being chemically resistant.

Couplings and connections are weak points of flexible hoses as well as hose pipes and require a constant control.

Permanent, rigid pipelines are preferred to flexible hose because of the more secure connections. Interlocked, spiral-type hose should not be used since there will be solvent leakage through the packing. Hoses should be reinforced by steel spirals or meshed steel.

The following pipe materials are acceptable for chlorinated solvents:

- Seamless, flexible metal hose made of stainless steel (in which case it is important that moisture be excluded).
- PTFE (polytetrafluoroethylene)-lined composite hose with internal and external wire reinforcement of Monel (or of stainless steel of appropriate grade), braided with "MELINEX", and with Neoprene cotton fabric with nylon Neoprene outer cover.

Other types of linings that can be used are:

- vinyl hexafluorpropylene;
- tetrafluorethylene - fluoromethylene - vinylether;
- fluor-rubber.

Hose should be ordered in the required lengths with fittings already installed by the manufacturers.

Manufacturers' advice on chemicals resistance should be followed.

All unloading hoses should be subjected to regular inspection and testing, and when not in use should be blanked to prevent ingress of dirt and moisture.

### **2.4. Unloading from rail tankers**

**2.4.1.** Suitable stops should be placed on the rail to avoid collision between the rail wagon and other wagons which may be shunted on the discharging line. WARNING flags should be placed at appropriate points. A safety system may be installed, where possible, that closes the unloading valve in case of displacement of the rail tanker.

**2.4.2.** Set hand brake and block wheels. However the brakes must be released before unloading commences or damage to the brake mechanism could occur due to the tanker rising during unloading.

- 2.4.3. If the discharge is to be made with compressed air then it is essential that pressure of 1.3 bar (20 psig) is not exceeded. This can be accomplished by installing a pressure reducing valve and relief valve in the customer's air supply pipework.
- 2.4.4. Ensure that the internal plug valve is closed.
- 2.4.5. Open the air valve slowly on the top of the rail tanker to release any pressure or vacuum. To this valve the vapour return line should be connected now. Make sure that this valve remains open during the entire unloading period of delivery is by gravity or by pumping.
- 2.4.6. Check that the internal outlet valve is fully closed and remove the blanking cap.
- 2.4.7. Connect the flexible hose to the tanker and to either the customer's pump or intake pipework.
- 2.4.8. Check the entire system for proper valve arrangement.
- 2.4.9. Open the external outlet valve on the tanker.
- 2.4.10. Open the internal outlet valve on the tanker.
- 2.4.11. Open the customer's intake valve and feed to the stock tank. If the delivery is pumped, start the pump.
- 2.4.12. Periodically check for leaks in pipes, hoses and connections during delivery. Collect any drips in metal cans.

## **2.5. Unloading from road tankers**

- 2.5.1. Barriers and flags should be positioned to warn personnel of the unloading. Brakes should be set and the wheels chocked. The truck should be earthed.
- 2.5.2. Carry out instructions as 2.4.4. to 2.4.10.
- 2.5.3. Open the customer's intake valve and feed to the stock tank.  
If a pumped delivery is involved, start the pump.
- 2.5.4. Periodically check for leaks in pipes, hoses and connections during the delivery.

## **2.6. Procedure after unloading**

- Close the outlet valve.
- Disconnect and drain the delivery hose to a drum or other container to avoid any spillage. An unloading arm (rigid pipeline) can be left filled with solvent provided that it is properly valved and that suitable hydraulic protection is ensured. Disconnect the vapour return line.
- Close and secure the top valves and dome.
- Replace blanking caps to tanker and delivery pipework.
- Any spillage should be absorbed and disposed of properly in accordance with local regulations, to avoid contamination of water, air and ground.

### 3. TRANSFER FROM STORAGE

Transfer of chlorinated solvents from the storage to the point of use can be made in several ways depending on the transfer distance and the number of enduse points.

- Gravity
- Pumping
- Drums or portable containers.

Each unloading pipe should be labelled with the name of the product.

#### 3.1. Recommended materials

Non-returnable drums, mostly being of about 200 liters capacity, should be inspected for cleanliness before use. Bungs and plugs (1.8 cm and 5 cm) should be fitted with gaskets chemically resistant to the solvent.

Drums and portable containers must bear the appropriate safety labels (according to international and national regulations). In certain countries, especially designed safety containers respectively storage areas have to be used for storage and handling of chlorinated solvents.

#### 3.2. Repackaging

Drums or portable tanks are filled by volumetric measurement using a meter or dip stick, or by weighing.

Filling pipe must be self-draining or have provision for draining.

Transfer of solvent from rail tanker, road tanker or tank installed above ground into small tanks or drums should be done with appropriate ventilation. A closed vapour system (vapour return line) is preferred in order to prevent emissions.

Where drums are sited and filled indoors, the storage room should be well ventilated to prevent accumulation of solvent vapour displaced from the drum during filling. Adequate precautions should be taken during these operations to prevent soil and ground-water pollution. A steel retainer basin is the best way to achieve this and in some countries this is required.

Controls and switches for the pump, drum filler, etc. should be located with the convenience and safety of the operator in mind. An emergency stop of the total operation is recommended.

## **4. RECOMMENDATIONS FOR HANDLING DRUMS AND SMALL CONTAINERS**

### **4.1. Storage of drums**

Drum storage facilities for chlorinated solvents should be segregated from other types of products, e.g. flammable solvents.

Drums should be stored in cool ventilated areas and be tightly closed when not in use. Storage facilities for filled drums (also for empty drums unless new or thoroughly cleaned) need to be protected against rain and other ingress of water to prevent contamination of the surface water drainage system.

Storage for sealed drums should be out of direct sunlight and remote from sources of heat to avoid generation of pressure. Drums should be stored at ground level and measures taken to prevent corrosion of the drum base.

If stacked one upon the other, drums should not be stacked more than two high unless they are empty. Storage outside the workroom is desirable although limited storage of a working supply in the workroom should be allowed.

Adequate ventilation must be available to ensure that in case of incidental release of solvent (vapour) the vapour concentration is as low as possible, and in any event within the regulatory requirements.

In certain countries there are requirements for a drip or leak retainer basin constructed of a solvent-impervious material such as steel (see Appendix A.1. for details). Provision must be made to keep unauthorised persons out of the storage area.

### **4.2. Displacement**

Full drums should be handled with care and should not be moved without mechanical assistance. Rolling of 200-litre drums by hand with all the weight on the bottom rim is not recommended.

A portable tank on wheels or a skid is sometimes used to dispense solvent and this can be constructed of either stainless steel or mild steel, with a suitable lining if corrosion control is required. The unit should have its own permanently mounted pump, used exclusively for solvent transfers, and an adequate pressure relief valve. Any tank opening should have an attached cover to prevent accidental contamination of the unit. A drip retainer basin is recommended and may be required.

### **4.3. Unloading**

Small containers (to about 25 kg) are readily emptied by hand. Removing the contents of 200-liter drums can be achieved either by gravity or by using a pump. Under no circumstances should a drum be emptied by using air pressure as the drum may burst. To avoid soil contamination the drum to be emptied should be put on a metal grating over a metal drip pan or a collector pan of prefabricated polymer concrete.

#### **4.3.1. Gravity unloading**

A drum should be fitted with a valve or draw-off faucet to facilitate unloading. Protective clothing including goggles must be worn. Cautiously loosen the 1.8 cm bung just enough to allow drum to breathe, then carefully remove the bung and replace it by a suitable valve. The drum should be placed in a horizontal position and rotated until the 5 cm plug is aligned directly above the draw-off valve. While emptying the contents, the 5 cm plug should be slightly loosened to relieve the internal vacuum.

#### **4.3.2. Pump unloading**

Pump unloading is suitable where the point of use is higher than the drum or portable container. The same precautions as in 4.3.1. apply to the opening of bungs when a drum is emptied by pumping.

Self-priming portable centrifugal pumps of adequate power (for instance having a ¼ to 1/3 h.p motor, being capable of delivering 40-120 liters per minute of 1.6 specific gravity liquid against a head of 6 m), are satisfactory. They can be placed directly on the bung head of the drum.

Either rigid piping or flexible solvent-resistant hose may be used.

### **4.4. Handling of empty containers**

Drums should not be reused without being re-conditioned. Empty drums should be thoroughly drained and then sealed with their original plugs.

Empty drums should be disposed of in accordance with local, national or international regulations wherever applicable. **TORCH CUTTING of drums that have been used with halogenated solvents is hazardous and must not be permitted.**

### **4.5. Storage of drums with solvent waste**

When storing waste solvents, it is advisable to ensure that drums should not be tightly closed so as to avoid pressure build-up should there be an uncontrolled reaction between waste products. An automatic fire extinguishing system should be installed in the waste storage area as uncontrolled reactions could cause a fire. Depending on local regulations, storage of drums with chlorinated solvent waste sometimes must be done in areas with impermeable floors and leakage containments.

## **5. MAINTENANCE**

- 5.1.** All equipment should be maintained and serviced according to the manufacturer's recommendations.
- 5.2.** The entire storage system requires careful and regular visual inspection to detect any leakage as quickly as possible.
- 5.3.** A small leak under pressure can result in solvent losses without any warning pool of liquid. A simple halide leak detector, such as is employed by refrigeration maintenance workers, can be used to check connections, valves, pump packing, and any other easily accessible parts of the system. The halide detector employs a small propane gas flame or electric element, which may make it unsuitable for use in areas containing combustibles.
- 5.4.** Be sure that all connections are painted with a material that will not be affected by the solvent. Several commonly used plant maintenance paints fall into this category.
- 5.5.** As appropriate, a maintenance program should be put in place.

## 6. SAFETY PRECAUTIONS FOR TANK CLEANING AND REPAIRS

Tank cleaning and repairs should be performed by thoroughly trained/qualified personnel who are completely familiar with the hazards, safety precautions and equipment, and with the rescue and first aid procedures appropriate to chlorinated solvents.

Depending upon the state of contamination and/or need for repair in practice, cleaning/repair is carried out either by own qualified personnel or with the assistance of specialized cleaning/repair companies.

In addition to observing any relevant local regulations, the following precautions must be taken.

- 6.1. Entry into tanks and working in them requires a work permit, to be signed by the supervisor.
- 6.2. Isolate the tank from the circuit and prepare it for the cleaning/repair operation by locking-out power feeds, etc.
- 6.3. Disconnect all in- and outgoing pipes of the tank after emptying and after closing the valves in question. Cover the ends of the pipes with a cap or a blind flange to protect against “human errors” or unsuspected leaks.
- 6.4. Empty, dry and purge the tank of all solvent vapours. Warm air purging (1 to 2 days, observing local emission regulations) is suggested until tests with a solvent detector (e.g. Dräger tube or similar) indicate that it is safe. Cleaning of the tank is carried out (after purging) by filling with water and draining. Dirt is sprayed away from the walls by means of high-pressure water. Rinsing water containing chlorinated solvents should be disposed of according to local regulations.
- 6.5. Ventilate the tank during the entire cleaning or repairing operation, with proper attention to observing local air quality standards. In practice this is done by opening the inlet at the bottom of the tank and placing the ventilator on top of the manhole above the tank; in this way air is circulated through the tank. Do not use air from compressed air systems for this purpose.
- 6.6. In case operators have to enter the tank during this **cleaning**, a qualified person has to determine that there is no oxygen deficiency. In principle, entering the tank should wait until the chlorinated solvent concentration has decreased below the national Occupational Exposure Level (OEL) value. If in exceptional situations the chlorinated solvent vapour concentration is higher than the

Occupational Exposure Level value, fresh air masks or self-contained breathing equipment (air respirator) should be used.

When carrying out repairs, every effort should be made to see that the quality of the atmosphere in the tank is not a matter for discussion and that work can be done without (obstructive) breathing protection.

To this end every 2 hours a laboratory analyst will measure the chlorinated solvent vapour concentration by means of Dräger-tubes or similar. This analysis can also be done by trained operators.

- 6.7. The people in the tank should be equipped with a rescue harness and lifeline. There must always be a qualified man outside at the manhole, who will keep the people in the tank under constant observation.
- 6.8. An air respirator or self-contained breathing apparatus of which proper operation has been checked, together with a rescue harness and air-line should always be nearby, regardless of the type of respiration equipment or air supply inside the tank.
- 6.9. Anyone entering the tank for rescue purposes should be equipped with an externally supplied air respiration.
- 6.10. More specific local regulations and laws may be applicable.

#### **EXAMPLE OF BULK UNLOADING (p 28)**

Schematical picture of a Chlorinated Solvent unloading and storage operation, showing the minimum precautions to be taken.



## APPENDICES

### A.1. Regulations and practices by country.

**Note:**

*The information below is to the best knowledge of the authors at the moment of issue of this manual. Regulations with respect to the handling and use of solvents is different from country to country and sometimes even from region to region within countries. Also are the regulations often not specific to Chlorinated Solvents but apply for solvents in general. It is strongly recommended to contact the authorities before building any installation for, or starting any operation with, Chlorinated Solvents.*

A.1.1. National regulations and requirements affecting the storage and handling of chlorinated solvents.

#### A.1.1.1. Federal Republic of Germany

Within the FRG the legal requirements for storage and transfer of water-polluting substances are stated in paragraphs 19g - 19 l of the Law on Water Economy (Wasserhaushaltsgesetz - WHG) and in subsequent regulations issued by several Länder of the FRG on the storage, transfer and transport of water-polluting substances. Detailed information is given in a brochure of the VCI with title "Innerbetrieblicher Umgang mit leichtflüchtigen chlorierten Kohlenwasserstoffen - Boden und Grundwasserschutz". This brochure can be ordered at VCI, Verband der Chemischen Industrie e.V., Abteilung Öffentlichkeitsarbeit, Karlstr. 21, D-60329 Frankfurt/Main.

#### A.1.1.2. Netherlands

For the protection of

- soil: under Law of 3 July 1986, requirements can be imposed;
- surface water: under Law of 13 Nov. 1969, no discharge without a permit; the sum of all volatile halogenated organics must be less than 5 microgram/l;  
under Law of 5 June 1975, discharge into the sea only according to regulation;
- air:  
under Law of 26 Nov. 1970, requirements can be imposed.

The Environmental Legislation (Wet Milieubeheer, Oct.15<sup>th</sup>, 1992) requires special permits for storage and handling of liquids. Those permits may contain measurements such as:

- an optical inspection of the storage system once every 4 years;
- that there should be protection against collisions;
- that investigation be initiated into soil and groundwater contamination of the area;
- that measures be taken against continuing contamination and further diffusion;
- that a direct report be made to the authorities in case of large-scale leakage.

#### A.1.1.3. **Sweden**

SFS 1991:1289 In January 1996 the professional use of methylene chloride and trichlorethylene was prohibited, but the National Chemicals Inspectorate can admit exceptions according to paragraph 3 if there are particular reasons.

KIFS 1997:3 Exceptions from prohibition in the ordinance (1991:1289) about methylene chloride and trichlorethylene: National Chemicals Inspectorate can give exemption in specific case for science, development and analysis.

AFS 1996:2	Exposure limits	OEL	STEL
	methylene chloride	35 ppm (120 mg/m <sup>3</sup> )	70 ppm (250 mg/m <sup>3</sup> )
	trichloroethylene	10 ppm(50 mg/m <sup>3</sup> )	25 ppm(140 mg/m <sup>3</sup> )

#### A.1.1.4. **Finland**

For the protection of:

air – decision on case-by-case basis after notification;

water – licensing on case-by-case basis.

The toxic substances regulations require that construction materials for tanks and containments shall withstand the substances contained.

#### A.1.1.5. **Norway**

Tanks larger than 3 m<sup>3</sup> have to be notified to the local fire authority. Tanks larger than 100 m<sup>3</sup> have to be approved by the “National Board for Fire and Explosion Protection”.

A.1.1.6. **France**

Health and Safety Regulation:

- Professional diseases:  
  
Social security code: L461-1 to 8 articles:  
obligation to declare the employees
- Special Medical Care:  
  
“Arrêté du 11/07/77” and “circulaire n° 10 du 29/04/80”  
(list of activities requiring special medical check-up)
- Work Safety:  
  
“code du travail” art. 4232-5 to 5-14  
Minimization of emissions, aerosols and solid particles from emission sources

Classified Plants Regulation:

- “Loi N° 76-663 du 19/07/76”  
“Décrets du 07/07/92” and “N° 93-1412 du 29/12/93” and “N° 96-197” du  
11/03/96”
- “Loi N° 1175”: organohalogenes (liquid usages)  
Solvents, extraction, surface treatment except dry cleaning and metal  
degreasing.
- “Arrêté du 02/02/98” Water sampling, water consumption and all types of  
emissions from classified installations requiring an authorization.

Wastes:

- “Loi N° 75-663 du 15/07/75” and “Décret N° 77-974 du 19/08/77”:  
hazardous wastes.
- Technical recommendations (22/1/80) on industrial wastes.
- “Loi N° 76-663 du 19/07/76” and “Arrêté du 02/02/98”.

Domestic Usages (Trichloroethylene):

- “Arrêté du 12/03/1981” Restrictions concerning Trichloroethylene being sold  
for domestic usages.
- “Arrêté du 04/05/1989” Trichloroethylene sales forbidden to all persons under  
the age of 18.

#### A.1.1.7. Spain

##### Storage:

- Instrucción Técnica Complementaria MIE-APQ-007: “Almacenamiento de Líquidos Tóxicos”: Draft; expected to be issued end 1998). Applies to storage in tanks, drums; loading, unloading and transfer of liquids classified T and Xn.

##### Transport:

- TPC (Transporte por Carretera). (Draft; expected to be issued end 1998).

##### Waste:

- Ley 10/98 de 21 de abril, de Residuos. New; transfers directive 91/156/CEE, regulation 259/93, decision 96/350/CEE. Has to be developed by further regulations on specific issues, until then still valid:
  - Real Decreto 833/1988 de 20 de julio de 1988. Residuos Tóxicos y Peligrosos. Reglamento para la ejecución de la Ley 20/1986, modified by Real Decreto 952/1997 de 20 de junio.
- Orden de 12 de marzo de 1990. Transboundary transport of hazardous waste. Transfers directives: 84/631, 86/279, 86/121, 85/469 and 87/112.
- Ley 11/1997, de 24 de abril, de Envases y Residuos de Envases. Transfers directive 94/62/CE on packaging Real Decreto 782/1998, de 30 de abril, Reglamento para el desarrollo y ejecución de la Ley 11/1997. Transfers decisions 97/129/CE and 97/138/CE.

##### Workplace:

- Ley 31/1995, de 8 de noviembre, de Prevención de Riesgos Laborales. Transfers directive 89/391/CEE to Spanish law. It has to be developed by further regulations.
- In terms of solvent vapour in workplace TLV values (ACGIH) are considered as reference by authorities and industry.

##### Emissions to Air:

- Ley 38/1972 de 22 de diciembre, de Protección del Ambiente Atmosférico. Decreto 83/1975.
- Some autonomies (with competencies in environmental issues) are handling the Draft of VOC Directive as a reference for recommendation.

Disposal to Water:

- Ley 29/1985, de 2 de agosto, de Aguas. General law of use and protection of public water.
- Real Decreto 849/1986, de 11 de abril. Reglamento del Dominio Público Hidráulico. Implementation of Ley 29/1985, regulates authorization for water discharges.
- Orden del 12 de noviembre de 1987. Discharge limits to continental water. Transfers Directives 76/464, 86/280.
- Orden de 13 de marzo de 1989. Transfers directive 88/347, addition of Chloroform and other substances.
- Orden de 28 de junio de 1991. Transfers directive 90/415, addition of Tric, Perc, EDC and TBC.
- Ley 22/1988, de 28 de julio, de Costas. Discharges to sea water.
- The discharges to sea water through undersea discharge outlets are still regulated by Orden de 29 de abril de 1997.
- Real Decreto 258/1989 de 10 de marzo. General regulation on discharge of hazardous substances to sea water. Transfers directives: 76/464 and 86/280.
- Orden de 31 de octubre de 1989. Discharge limits to sea water. Transfers directives 76/464, 86/280, 88/347.
- Orden de 28 de octubre de 1992. Addition of Tric, Perc, EDC and TBC. Transfers directive 90/415.

A.1.1.8. **Portugal.**

Transport:

- RPE (Regulamento Nacional do Transporte de Mercadorias Perigosas por Estrada).

### Waste:

- Decree-Law 310/95 of 20 November 1995. General regulation on waste managing. Transfers directives 91/156 and 91/689. Modifies waste and hazardous waste definitions on DL 121/90. To be developed by further regulations. Until then, still valid the existing Portuaria 374/87 of 4 May related to licences for waste managing operations.
- Decree-Law 121/90 of 9 April 1990. Transboundary transport of hazardous waste. Transfers directives: 84/631, 85/469, 86/279 and 87/112.
- Portuaria 335/97 of 16 May 1997. (Domestic transport of waste).
- Decree-Law 366-A/97. Embalagens e gestao de residuos de embalagen. Transfers directive 94/62 on packaging.

### Health & Safety:

In Portugal special regulations do not exist for chlorinated solvents. The legislation is general for the majority of dangerous chemical products. However, we can find some peculiar specifications (e.g.: gas, explosives).

- Norm I-1796 from 1982. Establishes threshold limit values for hazardous substances in workplace. Values are based on TLV from ACGIH.
- Decree 109/91 of 15 March 1991 establishes the legal procedures for setting up an industrial activity, focusing on prevention of safety hazards to operators and the population in general.
- Decree 204/93 of 3 June 1993 determines the procedures that must be taken with certain new chemicals industries and when serious industrial accident occurs, as well the governmental authority in charge of these matters.
- Decree-Law 264/98 of 19 August 1998 poses restrictions to the commercialization and uses of dangerous chemical preparations. Indicates the substances and preparations subject to these restrictions.
- Official Diploma 732A/96 of 11 November 1996 establishes the rules for notification of new chemical products, as well as classification, packaging and labelling of dangerous chemical products.

#### A.1.1.9. **Belgium.**

Belgium is divided in three separate regions (Flanders, Wallonia and Brussels). Each region has its specific regulations.

##### Regulations per region:

##### **Flanders:**

###### a) Licences:

Vlarem I (Vlaams Reglement betreffende de milieuvergunningen 26.09.91) contains general rules about obtaining an environmental permit including HAZOP-study and MER-report, environmental audit and year report. In the list of activities for which a permit is required, the following sections are mentioned:

- 2.2.5 Waste - Storage and physical treatment of organic chemicals, with or without mechanical treatment.
- 17 Dangerous substances (storage facilities).
- 17.2 Industrial activities and storage facilities with risks for severe incidents (Directive 82/501/EC) revision under progress. Paragraphs specify nature of danger and quantity.
- 20 Industrial categories mentioned in Directive 84/360/33G, concerning the abatement of air pollution caused by industrial sites.

###### b) Conditions for specific sectors

Vlarem II (Vlaams Reglement inzake milieuhygiëne)

- Part 5: Environmental conditions per sector for indicated activities.
- Chapter 5.7 - section 5.7.7: products from organic chemicals or solvents.

##### **Wallonia:**

###### a) Licences:

Regulated via RGPT (Règlement Général pour la Protection du Travail), chapter 1 - Establishments under specific surveillance of the Minister of Labour.

- Number 340/58 Chlorinated solvents: carbon tetrachloride, perchloroethylene, trichloroethylene, etc. (fabrication of... workplaces where... are used).

Sector conditions for the discharge of waste water:

- AR 30.03.87: Petrochemicals, organic chemicals and derivatives.
- AR 23.04.97: Determining conditions per sector: carbon tetrachloride, chloroform, 1,2-dichloroethane, trichloroethylene, perchloroethylene.

**Region Brussels-Capital:**

- Environmental and Building Permit - Ordonnance of 30.07.92. Heading 141: Industrial installations not mentioned in other headings, for the production, transformation or the treatment of organic chemicals and chlorinated solvents.
- Discharge permit for waste water: Sectorial conditions (21.05.92) for discharge into normal surface water and into the public sewer system of waste water coming from the production, transformation and use of trichloroethylene, perchloroethylene.

A.1.1.10. **Switzerland**

The legislation for storage and handling of chlorinated solvents is given in the Gewässerschutzgesetz (GschG) and the following directives:

- a) Verordnung über den Schutz der Gewässer vor wassergefährdenden Flüssigkeiten (VWF) of July 1<sup>st</sup>, 1998, regulating tanks, storage units and the classification of substances (two groups of water endangering substances as listed by BUWAL).
- b) Gewässerschutzverordnung (GschV) of Oct.28, 1998, regulation emissions into water and the classification of protected areas.
- c) Altlastenverordnung (AltV) of Oct.1<sup>st</sup>, 1998, regulating remediation criteria.

A.1.1.11. **United Kingdom**

- Implementation of 96/55/EC under COSHH 98; Prohibition of use of 8 specific Chlorinated Solvents (Chloroform; CTC; 1,1,2-Trichloroethane; 1,1,2,2-Tetrachloroethane; 1,1,1,2-Tetrachloroethane, Pentachloroethane; Vinylidene Chloride; 1,1,1-Trichloroethane) in diffusive applications like, for instance, surface and textile cleaning.
- Environmental protection Act 1990; Part 1: Secretary of State's Guidance – Coating of Metal and Plastic PG 6/23(97) (Revision).

**A.1.2.** Construction – Some National Practices and Standards.

**A.1.2.1. Federal Republic of Germany.**

Recommendations according to the “Informationsblatt zum innerbetrieblichen Umgang mit leichtflüchtigen chlorierten Kohlenwasserstoffen”, Verband der Chemischen Industrie und Verband des Deutschen Chemikalien Gross- und Aussenhandels, 1985.

**A.1.2.1.1. Metals for Construction of Storage Tanks.**

Materials		Nature of sample	Quality Standard according to EN 10204	Identifications Products
General purpose construction steels acc.to EN 10027-1	S235JRG1 S235JRG2	Melt	test certificate 2	steel grade manufacturer composition nr.
	S235JRG2/G3 SW355JO/J2G3	Melt	acceptance certificate B	steel grade. manufacturer composition nr.
Weather-resistant construction steels according to Stahl-Eisen-Werkstoffblatt 087	WTSt 37.2. WTSt 37.3. WTSt 52-3	Melt	acceptance certificate B	composition nr. sample nr. tester's initials
Boiler steel sheets acc.to EN 10028T2	P235GH P255GH	Rolled plate	acceptance certificate B	steel-making process
	P295GH	rolled plate	acceptance certificate A/B	
Close-grained steel according to EN 10028-3 and VdTÜV Merkblatt	StE 255 StE 285	Rolled plate	acceptance certificate A	steel grade
	StE 315 StE 355	Rolled plate	for tanks without intern. overpressure: acceptance certificate A/B	manufacturer composition nr. sample nr. tester's initials
			for tanks without internal overpressure: acceptance certificate A	
Stainless austenitic steel acc. to DIN 17440 (EN 10088-3)	Material Nr. WkSt 1.4541 WkSt 1.4571 (WkSt 1.4306 WkSt 1.4404 also acceptable)	DIN 17440 Nr. 8.2	acceptance certificate B/A (depends on wall thickness)	steel grade manufacturer composition nr. sample nr. tester's initials

#### A.1.2.1.2. **Tanks for Storage Above Ground**

##### **Without Containment**

Double-walled storage tanks with leakage indicator:

- DIN 6616 Horizontal tanks of steel – double-walled – for storage above ground of flammable liquids
- DIN 6623 Teil 2 Vertical tanks of steel with less than 1000 ltr. capacity for storage above ground of flammable liquids – double-walled
- DIN 6624 Teil 2 Horizontal tanks of steel 1000 to 5000 ltr. capacity – double-walled – for storage above ground of flammable liquids of “Gefahrenklasse A III” (hazard rating A III)

##### **With Containment**

Single-walled tanks:

- DIN 6616 Horizontal tanks of steel – single-walled- for storage above ground of flammable liquids
- DIN 6618 Teil 1 Vertical tanks of steel – single-walled – for storage above ground of flammable liquids
- DIN 6623 Teil 1 Vertical tanks of steel, capacity less than 1000 ltr. for storage above ground of flammable liquids – single-walled.
- DIN 6624 Teil 1 Horizontal tanks of steel, capacity 1000 to 5000 ltr. – single-walled – for storage above ground of flammable liquids “Gefahrenklasse A III”
- DIN 4119 Tank constructions above ground in cylindrical forms with flat bottoms of metal-containing materials.

Note:

Flat-bottom tanks according to DIN 4119 should have a double bottom together with a leak detector. Flat bottom tanks without double bottoms should be erected in a way (e.g. lifting on steel members) that leaks at the bottom may be detected by a visual inspection. (Remark: this note depends on requirements of different local country codes).

#### A.1.2.1.3. **Containment**

Metals suitable for construction of containment in chlorinated solvents service are steel, according to DIN 17100 respectively 17155 and stainless steel, according to DIN 17440.

For containment of concrete construction, a concrete of minimum BII quality according to DIN 1045 and local codes is needed. Local regulations and requirements will govern the choice of surface protection for the concrete.

#### A.1.2.1.4. Steel pipelines

Steel types suitable for pipelines are:

	DIN / EN	Steel types
Seamless pipes	DIN 1626 EN 10028 T2  EN 10088-3 Teil 1	St 37.0; St 44.0, ST52.0 P235 61 TH P255 61 TH 1.4541 1.4571
Welded pipes  für geschweisste Rohrwerkstoffe sind z.Zt. auch EN-Normen in Vorbereitung	DIN 1626  DIN 17 177  DIN 2463 Teil 1  <i>Remark: DIN will change into EN Codes</i>	St 37.0; St 44.0; St 52.0  St 37.8; St 42.8  1.4541 1.4571  <i>Remark: Material name will change into EN-Type</i>

The following types of steel may be used for adaptors and prefabricated parts:

- same as in Table above
- made of sheet steel  
e.g. material P255GH EN 10028T2 with APZ 3.1 B,  
EN 10204
- cast steel  
e.g. material GS-C 25, DIN 17 245 with APZ 3.1  
EN 10204

#### A.1.2.1.5. General Remark.

For design, fabrication, testing and service of tanks including accessories the requirements of legal regulations for flammable liquids (TRbF) and legal regulations for water contaminating media (VAwS) have to be considered.

### **A.1.2.2. United Kingdom**

#### **A.1.2.2.1. Metals for Construction of Storage Tanks**

For tanks constructed to BS 5500:1997

BS 1501-151 Grades 360 A or 400 A or 430 A

For tanks constructed to BS 2654:1989 or BS 2594:1975

BS 1501-151 Grades 360 A or 400 A or 430 A

BS EN 10025:1993 Fe430A

#### **A.1.2.2.2. Tanks for Storage Above Ground**

Double-walled tanks are not required. BS 5500:1997 applies to pressure vessels and BS 2594:1975 is for low pressure tanks. BS 2654:1989 would be used for large capacity storage tanks and requires full support of flat-bottomed tanks which precludes inspection underneath (cf. A.1.2.1.2., DIN 4119)

#### **A.1.2.2.3. Steel pipelines**

Steels suitable for seamless and electric welded pipes are

API 5L Grade "B"

BS 3602 Part 1:1987 (1993)

A 106 Grade "B" (seamless only)

### **A.1.2.3. Netherlands**

#### **A.1.2.3.1. Metals for Construction of Storage Tanks**

Material must comply with Normblad" G 0801 which is derived from BS 2654, and with requirements according to the M-sheet of "Steam Engineering Authority" (notch value).

#### **A.1.2.3.2. Tanks for Storage Above Ground**

Double-walled storage tanks are not normally used.

#### **A.1.2.3.3. Containments**

New regulations are expected to require, for new construction,

- concrete containment around the storage area, with a chlorinated solvent-resistant coating.
- sump with pumping facility
- sump provided with valve and water-drainage facilities

#### **A.1.2.4. Sweden**

The Department for Environmental Control at the County Administrative Board, must approve the constructions drawings and choice of materials. And these matters are decided on a case-by-case basis.

##### **A.1.2.4.1. Metals for Construction of Storage Tanks**

Recommended material is boiler plate SS 1330 (C max. 0.17%, Mn 0.4-1.00%, P max. 0.035%, S max. 0.030%).

#### **A.1.2.5. Finland**

##### **A.1.2.5.1. Containments**

Containments are a common practice and they are obligatory when the stored volume exceeds 15 m<sup>3</sup>. (When located in a ground water area: 5 m<sup>3</sup>).

#### **A.1.2.6. Norway**

##### **A.1.2.6.1. Metals for Construction of Storage Tanks**

Construction steels NS 1540, NS 1541 are used.

##### **A.1.2.6.2. Containments**

Containments are obligatory and must have a volume that is more than 50% of the tank capacity.

#### **A.1.2.7. Portugal.**

##### **A.1.2.7.1. Tanks for Storage**

- Decree 131/92 of 6 July 1992: Regulation for steady and mobile tanks, designed for operation under elevated pressure ( $\geq 0,5$  Bar).
- Official Diploma 1152/92 of 9 December 1992: Procedures for the model acceptance, verification and import of tanks with working pressure  $\geq 0,5$  Bar.

## A.2. Flammability of chlorinated solvents

Experience shows that there is usually no danger of fire or explosion when the chlorinated solvents are used under normal conditions.

The chlorinated solvents discussed here exhibit neither flash point nor fire point by standard methods though, with stabilized solvents under certain conditions and test procedures, a flash point can be demonstrated (consult manufacturers for details). These solvents, except for perchloroethylene, DO however have flammable limits in air (FLA), so that at certain concentrations of vapours of chlorinated solvents in air, these vapours might burn in contact with a source of high energy such as electric arc or oxyacetylene welding flame. For this reason electrical equipment approved for use in hazardous locations is recommended for work in closed tanks, in accident situations or in locations where high concentrations of solvent vapour may accumulate. In addition: all tanks should be grounded (earthed).

The flammable limits in air (FLA) at atmospheric pressure are:

SOLVENT \ FLA CONDITIONS	% OF SOLVENT IN AIR AT 25°C	
	LOWER LIMIT	UPPER LIMIT
METHYLENE CHLORIDE	13	23
TRICHLOROETHYLENE	8	10.5
PERCHLOROETHYLENE	NONE	NONE

Note: the flammable limits in air will be different under pressure.

When solvent vapours are exposed to extreme heat, they tend to decompose yielding hydrogen chloride, carbon dioxide, carbon monoxide, chlorine and water.

By a secondary reaction carbon monoxide and chlorine can combine to form phosgene. These thermal breakdown products may create greater hazards than the solvent itself. They can be extremely toxic as well as corrosive to metals in the workplace.

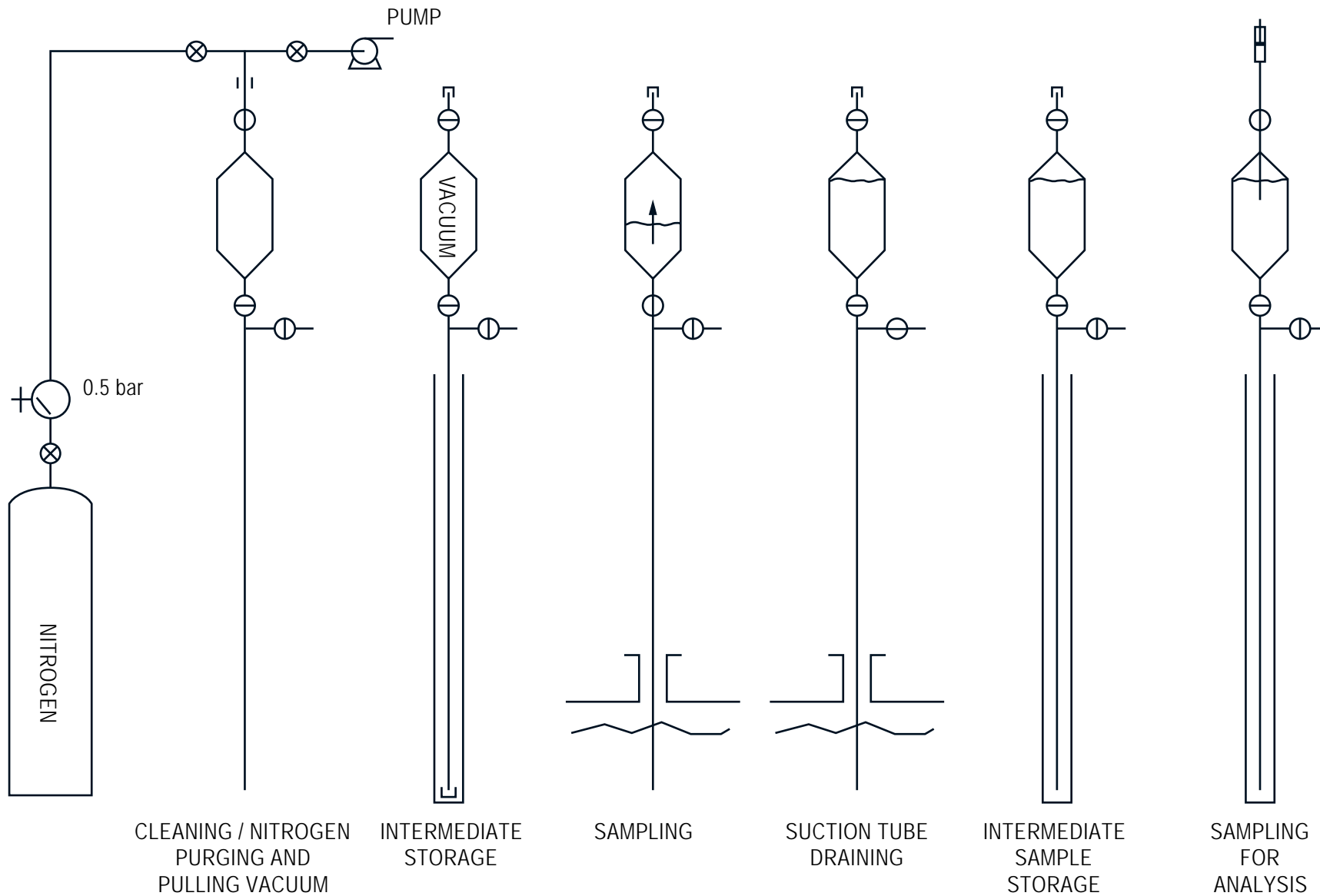
No operation of welding arc or cutting torch should be allowed in an area where chlorinated solvent vapours may be emitted.

These specific operations require observance of the safety precautions given in section 6 (6.1. to 6.10.) for one or both of the following reasons:

- open flame or excessive heat due to potential hazard associated with thermal decomposition of solvent
- if the vapour concentration of chlorinated solvent in the air is within the flammable range.

### A.3. Typical properties of Chlorinated Solvents

<b>Solvent</b> <b>Properties</b>	<b>Methylene Chloride</b>	<b>Trichloroethylene</b>	<b>Perchloroethylene</b>
Chemical Formula	CH <sub>2</sub> Cl <sub>2</sub>	C <sub>2</sub> HCl <sub>3</sub>	C <sub>2</sub> Cl <sub>4</sub>
Boiling Pt @ 1013,25 hPa	39.7°C (103.5°F)	87°C (189°F)	121.1°C (250°F)
Freezing Pt	-95°C (-139°F)	-87.6°C (-124°F)	-22.8°C (-9°F)
Specific Gravity @ 25/25°C	1.32	1.456	1.619
Vapor Density (air = 1.00)	2.93	4.53	5.76
Heat of Vaporization @ Boiling Pt cal/g J/g	78.9 330	56.4 236	50.1 209
Viscosity @ 25°C m.Pa.s	0.41	0.54	0.75
Solubility (g/100g) @ 25°C H <sub>2</sub> O in solvent Solvent in H <sub>2</sub> O	0.17 1.70	0.02-0.03 0.10	0.007 0.015



**A.4. Sampling Method (Schematically)**