

Health and Safety Executive OC 270/1

Field Operations Division

To

Factory Inspectors

FCG Specialist Inspectors (Fire and Explosion)

THE FIRE AND EXPLOSION HAZARDS OF CARBON DISULPHIDE

INTRODUCTION

1 This circular describes the fire and explosion hazards of carbon disulphide (CS_2) and precautions for its carriage, storage and use. It amplifies and extends advice given in the 7th edition of a Code of Practice (CoP) published by Courtaulds plc (file 270). The general guidance in booklet HS(G)50 (file 287) on storage of flammable liquids is also relevant. Toxic hazards are not covered in this circular but are dealt with by other publications, for example, HSE Toxicity Review 3 - Carbon Disulphide (file 270).

PROPERTIES AND USES

2 CS_2 is a volatile highly flammable liquid with a flash point of -30°C , a specific gravity of 1.26, and a boiling point of 46°C . Various values are quoted for its auto-ignition temperature ranging from 80° to 120°C . CS_2 has wide flammability limits, from 1% to 50%, and a low minimum ignition energy of about 0.01 mJ. It is slightly soluble in water and the vapour is heavier than air. CS_2 is mainly used in the manufacture of mercaptans and metal sulphides.

3 The sole manufacturer in the UK is Courtaulds Fibres plc of Manchester and primary distribution in road tankers and drums is undertaken by Tankfreight Ltd. CS_2 is not imported or exported to any significant extent.

HAZARDS

4 The combination of low flashpoint and low auto-ignition temperature means that CS_2 ignites very readily. As well as normal sources of ignition, such as naked flames and unprotected electrical equipment, CS_2 can be ignited by hot surfaces (such as exposed steam pipes), by compression of vapour/air mixtures in a closed vessel, and even by the connection of a vessel containing CS_2 to a vacuum line. Fires involving CS_2 are difficult to extinguish because surfaces heated by the fire provide a ready source of re-ignition for residual vapour.

PRECAUTIONS

Storage

5 Tanks are normally constructed in accordance with BS 2654 for vertical steel welded tanks, with some modifications. The ullage space is kept completely filled with water or nitrogen, to prevent the formation of a flammable atmosphere. Water is normally chosen, using a continuous make-up and overflow system. This requires the tank design to take account of the extra stresses resulting from the tank being kept hydraulically full. Dip pipes from the tank top are used for filling and emptying, which is done by pump. Pumps should be in well ventilated locations and provided with water-sealed catch pits or bunds to retain any leakage. Bund floors should be kept well covered with 150 mm of water, with precautions taken to prevent freezing.

6 CS₂ can be stored in metal drums in a building or store room in accordance with the recommendations in booklet HS(G)51 (file 287) on storage of flammable liquids in containers. Drums should not be placed in direct sunlight or near a source of heat.

Pipework

7 Pipework should have as few joints as possible, be self-draining, routed away from sources of heat and provided with manual or automatic emergency shut-off valves. Electrical continuity and suitable marking to identify contents should be provided. Metering systems should be used for transferring CS₂, with the system duplicated if incorrect measurement could be hazardous. The flow should be controlled by 2 automatic valves in series. Where sight glasses are used, as recommended in the CoP for pipework leading from tanker connections, impact protection should be provided and shut-off valves fitted before and after the sight glass.

Process

8 Processes using CS₂ should, as far as possible, be completely enclosed, with no exposure of the reaction mixture to the open air. Nitrogen blanketing is recommended. Particular attention should be paid to eliminating sources of ignition, for example by using pneumatic rather than electrical equipment, by installing metal detectors to prevent tramp metal being fed with solid reactants into reactors, and by designing extract fans to minimise the risk of sparking from friction or static electricity. Extract ducting should be fitted with explosion relief unless strong enough to withstand an internal explosion, and fan motors should be located outside the fan casing and ducting. Ducting should be as short and as straight as possible, and where fans and ductwork can be located in a safe place in the open air, this is preferred.

9 Where sources of ignition cannot be eliminated, such as where furnaces are used or where steam-heating is necessary, extra attention should be paid to preventing the escape of CS₂ from, and the ingress of air into, items of plant. The plant as a whole should be located in the open air with no confined spaces in which vapour could accumulate. If activated carbon is used to recover CS₂, there is a risk of ignition from exotherms in the carbon bed. An additional precaution, not mentioned in the CoP, is the use of high-temperature alarms to warn of the onset of such reactions.

Carriage

10 The legal requirements for carriage of CS₂ in bulk are in the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981. Part II of Schedule 2 lays down constructional requirements for road tankers. An amendment to the Regulations (Certificate of Exemption No 1 of 1988) allows the use of the more up-to-date set of standards described in the Schedule to the Certificate, pending revision of the Regulations. These requirements and the

relatively small market restricts the number of operators who carry CS₂. The use of casual contractors, for example for the disposal of water or surplus CS₂, should be discouraged, as such firms are unlikely to have the necessary equipment or expertise.

11 In the design of tanker facilities, particular attention should be paid to achieving 15m separation from buildings, boundaries and sources of ignition, and satisfactory arrangements for retention of spillage. Drains should be fitted with interceptors. Unloading is normally done by nitrogen pressure, in which case a readily-operated means to shut off the nitrogen and vent the tanker should be provided. A suitable tanker earthing point should be fitted.

12 Fires have occurred at tanker stands due to CS₂ escaping from hose couplings and being ignited, probably by hot brakes or engine components. The CoP describes the need to wait 15 minutes to allow the vehicle to cool, after which the "brake drums, engine and associated parts" are tested by hand touch before driving into the unloading position. Particular attention should be paid also to turbochargers and to the various parts of the exhaust system. It may be necessary to allow a longer period for these components, testing by hand touch to ensure they have cooled below the minimum ignition temperature of 80°C (hand touch is usually possible at about 60°C). Rechecking after final positioning of the tanker may be necessary, or alternatively the tractor unit can be disconnected and removed to a safe place. Before connecting-up, couplings should be checked for damage and for missing washers, etc.

13 A feature of CS₂ tankers not mentioned in the Certificate of Exemption is spillage pipes used to convey any liquid spilt at the hose connection on top of the tanker down to the rear of the vehicle. During unloading, a container is used to catch any liquid draining from these pipes. Care should be taken in handling such containers to ensure that any CS₂ collected is safely returned to storage or otherwise disposed of.

14 To minimise the risk of sparks caused by impact, access platforms made of wood are sometimes used. This practice increases the fire load around the tank and should be discouraged. If necessary, kicking plates and similar items made of non-ferrous materials can be specified. Aluminium and light metal alloys should not be used because of the risk of initiating the thermite reaction with rust.

15 There are no longer any specific legal requirements for the carriage of CS₂ in drums or other small packages, since the revocation of the Carbon Disulphide (Conveyance by Road) Regulations 1958. The Road Traffic (Carriage of Dangerous Substances in Packages etc) Regulations 1986, however, lay down general requirements which apply to the carriage of CS₂, for example on the construction of vehicles, information on hazards, loading and stowage, and precautions against fire and explosion. In addition, the recommendations in section 7(1) of the CoP should be applied.

Electrical standards

16 Unless absolutely unavoidable, electrical equipment should not be located in areas where a vapour-air mixture is likely to be present. Where it is unavoidable, BS 5345 should be consulted and followed. Where there is any doubt about the suitability of electrical equipment, an FCG electrical inspector should be consulted. The CoP indicates that Courtaulds Group factories have been individually zoned but no guidance is given for other sites. The advice in booklets HS(G)50 and HS(G)51 can be used as a guide, modified as necessary for individual circumstances.

Fire precautions

17 A high standard of fire precautions is required at sites handling CS₂. Storage tanks and tanker loading and off-loading areas should have fixed water sprays or monitors, with a sufficient supply to provide cooling for at least 30 minutes. A pond is recommended at loading/unloading areas for the tanker to stand in, so that any spilt CS₂ is immediately covered with water. Hose reels or extinguishers (foam or dry powder) should be available for all plant handling CS₂. The advice of the fire authority should be sought.

Maintenance and modifications

18 The CoP emphasises the need for special procedures for routine maintenance and for careful consideration of proposed modifications or repairs. The occupier will need to exercise judgement on how much external consultation is required and to this end a works engineer experienced in working with CS₂ should be employed. A rigorous permit system should be in force, with all maintenance staff fully trained in the procedures.

19 The CoP recommends the use of non-ferrous tools, and these should be recommended where practicable (aluminium tools are not considered suitable however - see para 14). Where possible it is preferable to ensure that CS₂ is removed from vessels and pipework (by draining and flushing) before dismantling begins and whenever ferrous tools have to be used this precaution should always be carried out first. See FIC 431/12 on the precautions for breaking-in to chemical plant.

20 The CoP sets out a periodic inspection programme for particular items, the results of which are required to be recorded and monitored by a local factory CS₂ committee. The programme should include the examination of couplings at loading and unloading facilities, and a check on the integrity and security of screws and similar small components of reactor systems.

Emergency procedures

21 The procedures in Chapter 6 and Appendix 3 of the CoP should be incorporated into the site emergency procedures. Training in the procedures should be given and exercises should be held periodically.

References

22 para 5 BS 2654: 1984 *Specification for manufacture of vertical steel welded storage tanks with butt-welded shells for the petroleum industry.*

23 para 16 BS 5345: *Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres* (other than mining applications or explosive processing and manufacture).

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