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(Geneva, 13-23 September 2005)

TANKS

Chapter 3.2/6.8.4 – carriage of liquefied gases in tanks with recessed valve chest

Transmitted by the Government of the United Kingdom */

SUMMARY	
Executive Summary:	The intention of this proposal is to permit the use of tanks with connections below the liquid level recessed into the shell and protected by a valve chest for carriage of UN1017.
Action to be taken:	Create a new special provision TExx to allow tank filling and discharge systems below the liquid level; to apply a new special provision TExx to CHLORINE UN1017 by adding TExx to column 13 of Table A in 3.2.
Related documents:	TRANS/WP.15/AC.1/98 paragraph 19 TRANS/WP.15/AC.1/2005/19 (United Kingdom) TRANS/WP.15/AC.1/94/Add .8, paragraph 9 TRANS/WP.15/AC.1/2003/65 (United Kingdom) TRANS/WP.15/AC.1/86 paragraph 72 TRANS/WP.15/AC.1/2001/42 (United Kingdom)

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Background

The United Kingdom submitted TRANS/WP.15/AC.1/2001/46 to the September 2001 Joint Meeting, proposing that tanks containing CHLORINE UN1017 or SULPHUR DIOXIDE UN1079 could be fitted with recessed valve chests below the liquid level. Following discussions at that meeting, the United Kingdom submitted a more detailed proposal, TRANS/WP.15/AC.1/2003/65 to the Joint Meeting session in September/October 2003.

After substantial discussion, the Tanks working group accepted that the proposal for filling and discharge openings below the surface level of the liquid but within a recessed chest, did not present a decrease in the level of safety compared with current practice. The Joint Meeting recommended that the United Kingdom should submit to a future meeting a new proposal challenging the philosophy of top opening tank valves, for discussion in the plenary session.

At the March 2005 Joint Meeting, it was noted that chlorine is carried by rail rather than road in many European countries and that the proposals should reflect carriage by both road and rail modes. The United Kingdom was asked to resubmit its proposal.

The United Kingdom believes that its proposals for CHLORINE UN1017 are ready now for adoption by the Joint Meeting, but accepts that some questions may remain on the issue of SULPHUR DIOXIDE UN1079 and will put forward proposals on this at a later date.

Justification

The United Kingdom proposal for a discharge system in a recessed chest below the liquid level does challenge the current approach of only allowing openings above the liquid level. However, as detailed in TRANS/WP.15/AC.1/2003/65, the United Kingdom believes that carriage in accordance with this proposal offers, for chlorine, equal safety, compared with other tank valve systems, a view which was supported by the Tanks working group at the September/October 2003 Joint Meeting.

The justification for having a recessed valve chest system below the level of the liquid includes:

- In a serious accident where the tank vehicle does not remain upright, the valves enclosed in a valve chest at the end of the tank remain protected from any impact during a roll-over incident.

- If it is necessary to remove the contents following a roll-over accident, the valves mounted in a valve chest in the end of the barrel will be accessible and will be in good working order.

- Valves mounted inside a valve chest with doors have a high degree of protection against other kinds of impact because they are mounted inside the shell profile of the tank, and therefore protected by position. The doors will provide further protection.

- Access to a recessed valve chest can be at a low level, thereby ensuring a safe working environment for connecting and testing hoses.

- For most liquid chemicals, a puncture of the tank above the surface of the liquid will not result in a leak of the chemical, and in many cases may be harmless. However CHLORINE UN1017 is a liquefied gas that is transported under pressure. In the unlikely event of a puncture of the tank, the chlorine would be released even if the hole were above the liquid surface.

- The tank code for CHLORINE UN1017 is given as P22DH (M) in section 3.2 Table A. A liquefied gas similar to chlorine, but unspecified in the regulations, would be classed as LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S. UN3308. This has the tank code PxBH (M). UN3308 has a the special provision TU6 in column 13 of Table A, which states that it is "*Not authorised for carriage in tanks, battery vehicles and MEGCs when having a LC50 lower than 200ppm*". The entry for CHLORINE UN1017 in Table P200 of 4.1 gives the LC50 value of 293 ppm. Hence it is difficult to justify the more severe requirements for chlorine when the less stringent requirements could be applied to a more dangerous substance transported as chemical LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S. UN3308.

- Proper sealing is easily achieved for CHLORINE UN1017 using valves situated below the liquid level. It is likely that some external flanges on all chlorine tankers will be under the liquid surface during a journey, for example during climb or descent of moderate inclines, and when there is product movement within the tank caused by normal transport forces. This presents no significant hazard because the sealing of these joints is known to be satisfactory.

- Irrespective of the location of the opening, the piping inside the tank always presents liquid chlorine to the discharge valve, and failure of the discharge valve would allow the release of chlorine. This is common to all designs and is controlled safely by the use of the three closures already required.

- There is an exemplary safety record in several countries that already use such valve chest arrangement.

- This proposal is highly specific about the design that may be used and would continue to prohibit traditional bottom outlets that are not located in a valve chest.

- See also the Annex to this proposal, which gives more detail on the design of chlorine road tankers in the United Kingdom.

Proposal

Add "**TExx**" in column 13 of Table A in 3.2 against the entry for CHLORINE UN1017.

Add a new Special Provision TExx to 6.8.4(b).

With the agreement of the competent authority of the country of use TExx shells of tanks may have filling or discharge openings below the surface level of the liquid, provided the valves are fully recessed inside the contours of the shell protected by a valve chest. This valve chest shall be protected by doors affording protection against external damage to the valves that is at least equivalent to that afforded by the tank shell. The doors shall be capable of being securely closed during carriage.

Safety implications

Equivalent safety is assured through having a recessed valve chest, which is unlikely to be damaged in the event of an accident. The proposal is highly specific about the design that may be used and would continue to prohibit traditional bottom outlets that are not located in valve chests

Feasibility

No problems are foreseen

Enforceability

The existing designs with connections above the surface of the liquid can continue to be used. This is unchanged by this proposal. Therefore no problems are foreseen.

Annex

Carriage of chlorine in road tanks with recessed valve chest

Briefing document

Tanker design

The design of these liquefied gas road tankers is extremely robust, in line with Euro Chlor Recommendations. See drawing in Appendix 1 and photograph in Appendix 2. They have been designed with substantial external protection. During the design development of these tankers, assessment was also made of the best way to protect the valves.

Three are two significant risks associated with a road tanker valve:

(a) Leakage through the valve

It was recognised that a valve can only leak the fluid that is present on the containment side of the valve. The fluid present at the containment side is entirely dependent on what is in the pipe connected to that valve and consequently where the other end of the pipe feeds from. This is totally independent of the location of the valves. In every tanker, the gas connection must always be routed to a high point in the tanker and the liquid connection must be routed to the lowest point. See Appendix 4. There can be no difference between any possible tanker design in this respect and this is therefore common to all tankers. Hence the consequence of leakage through the valve is exactly the same for all tanker designs. The risk is minimised by use of multiple valves and sealing caps during transport, in line with Euro Chlor and ADR standards.

(b) External damage to the valves

External damage to the valves could result in significant uncontrollable loss of the contents of the tanker. It was therefore seen as critical that the valves were given the maximum protection possible. To do this, the valves needed to be highly protected. This can be achieved by positioning them within the envelope of the barrel, which in turn necessitates housing them in a valve chest. This would prevent them being damaged in any accident. The valve chest cannot be mounted inside the top of the barrel as it would then collect water leading to corrosion and consequently loss of containment. However, positioning the valve chest inside the end of the tanker (front or back) enables the valve chest to be self-draining. This places the valve connections under the surface of the liquid; however sealing a liquid chlorine joint is not difficult and very well known to the industry. The valves are located inside a valve chest inside the end of the tanker. This concept has been used in the United Kingdom for over 35 years with no failures or consequent problems of any kind.

The design for road tankers is recognised as acceptable by Euro Chlor, the European industry body for chlorine, as an appropriate design. See Appendix 6 for the relevant extract from GEST 96/221 ‘Protection of Road Tankers for the Carriage of Chlorine’, Section 3.6 Valve Protection, Subsection (a).

Valve types and connections

Filling and emptying road tankers requires two hoses or pipes to be connected to the tanker. This is the same for any tank.

- **Liquid connection** – used for the transfer of the liquid product into and out of the barrel. This is connected to an internal pipe that is routed to the lowest point at the rear of the tanker.

- **Gas connection** - used to allow gas to be removed / displaced during filling of the tank and used to apply pressurised gas (typically dry air) to drive out the liquid product during discharge of the tank. These internal pipes are shown in Appendix 1 as dashed (hidden detail) and in Appendix 4 diagrammatically.

The connections are mounted inside a recess (the valve chest) inside the dished end of the road tanker. The valve chest has substantial external doors that are closed when not filling or emptying the tanker. Hence the valves are protected from external impact both intrinsically by their position within the shell and by substantial protective covers. See Appendix 3.

Tankers using this principle of protecting the valve have been in use for at least 35 years and there has never been any release of chlorine from a tanker.

When filled, there is very little gas space (ullage) in the barrel and consequently the valve chests are under the level of the surface of the carried liquid.

There are multiple closures on each chlorine tanker in line with ADR and Euro Chlor requirements, two on each connecting line. See Appendix 4. Each connection has:

- An air opened, spring closed, valve assembly comprising the internal and external valves. See Appendix 5. They form the first two isolations against product leaks to atmosphere. Each internal and external valve assembly comprises two separate valves. These combination valves are manufactured in accordance with the Euro Chlor design for chlorine tanker valves. It can be seen in the diagram in Appendix 5 that the valve is connected to the vessel using a trapped joint, which is a well-proven design for sealing liquefied gasses. Each internal and external valve assembly comprises:

    - A conventional air operated globe angle-valve, which is mounted on top of…
    - An internal safety valve, which can only be opened by opening the external valve, and consequently would seal even if the outer valve were broken off.

- The free end of each connecting pipe is further fully closed during transport by a substantial cover, which provides a third seal on each line.

Hence, each connecting port is sealed by 2 valve seats and 1 sealing cover. The potential for leakage past the two valves and the final closing cover is believed negligible. Actual experience of performance agrees with this.

Safety implications

All UK chlorine distribution is by road tankers. This design of road tankers has been used for carrying bulk chlorine in the UK for over thirty-five years. There have been occasional road traffic accidents but the integrity of the containment of product has never been threatened. The United Kingdom carrier using this design is the largest carrier of bulk liquid chlorine by road in Europe and one of the largest (if not the largest) in the World. Hence this excellent experience is valid.

The most likely incident that would give rise to escape of product is believed to be one that is serious enough to result in a tanker rolling over. Incidents where the tanker remains upright are unlikely to result in failure of the containment system. When a tanker rolls-over onto its side or its back, the valves will always end up below the liquid surface irrespective of where they were when the vehicle is upright. Therefore, this design is no different to the currently permitted design in this respect.

If the valves and end cap fail to seal, their location is irrelevant. The vapour pressure would force the product through the dip pipe to atmosphere. Failure of the valves and cap to seal would result in a chemical leak no matter where the valve is located.

Flange connections have been used on chlorine manufacturing plants for over a century. Creating a proper seal on such flanges is straightforward, common practise and extremely reliable. Plant flanges are used on a wide range of temperatures, pressures, cycling duties and vibrating duties. Providing a reliable seal on a tanker is therefore not seen as difficult. Far more taxing duties have been successfully sealed for decades. Hence this should not be a reason to ban flanges below the liquid surface. Furthermore the tanker would not necessarily remain upright in a significant incident and therefore the flanges of valves in any position would be below the liquid surface at the exact time that the valves are most at risk. Nevertheless, sealing of these flanges is not difficult, even under such duress.

This proposed design was chosen because our assessment was (and remains) that this is an extremely safe arrangement for road tankers. It is believed that the chief risk to the containment integrity of the tanker valves is impact damage to them in an incident where the tanker rolls over. This was, therefore, the chief design consideration in their location and consequently the valves were positioned inside a valve chest so that they are not exposed to impact under any circumstances.

If a tanker is damaged in a serious incident, it may be prudent to empty the tanker before moving it. Transfer of product from a tanker requires access to its valves to connect to and to operate them. It is highly likely that there will be suitable access to the valves if they are mounted in a valve chest at the end of the tanker barrel.

It is most important to recognise that the valve position and arrangement used by this design is completely different to bottom outlet arrangements. It is fully accepted that normal bottom outlets that are outside the barrel profile are not appropriate for chlorine because of their vulnerability to external impact and the potential for nitrogen trichloride concentration. It is often considered that any valve connection that is not above the liquid surface of a tanker must therefore be in an external branch at the bottom. This is not the case for the proposed design of tankers, in which the valves are located inside the end and not at the bottom (or the top of the tanker).

Justification

The advantages would be as follows

1. A valve mounted inside a valve chest that is welded inside the dished end is not directly exposed to impact and therefore has a very high degree of protection from impact by virtue of its position.

2. The proposed design also ensures that the valves cannot be exposed to the direct weight of the tank or its inertial forces because the weight of the tank cannot be brought to bear on the valves.

3. In a serious accident, a tanker will not normally remain upright and, as a result, the valves of all tanker designs will consequently be below the liquid surface. Hence, when the valve system is most exposed to damage risk, the valves on all tankers are below the surface of the liquid. In this respect, following a significant incident there is absolutely no difference between this proposal and the existing ADR design; in both cases the valves are both below the liquid surface.

4. Following a serious incident in which a tanker rolls onto its side or upside down, it is likely to be desirable to empty the tanker before it is moved or rolled back upright. This is done by transferring the contents to another tanker or absorption system. If the tanker has valves mounted in a valve chest at the end of the tanker, they will be immediately accessible and undamaged (hence operable).

5. Access is at a low level and therefore allows a safe working environment for connection and testing of hoses. Slips and falls are a significant cause of injury to personnel involved with the delivery and transfer of product. With the access at a low level, any fall generally results in a minor injury. Whilst endeavours are made to minimize the risk of falls from any tanker, they do occur and it is therefore appropriate to do all that is possible to minimize the injury from any fall.

6. Chlorine is not difficult to seal. Extensive experienced of performance in both transport and static applications show that proper sealing is easily achievable. There is no case for prohibition of joints below the liquid level on these grounds.

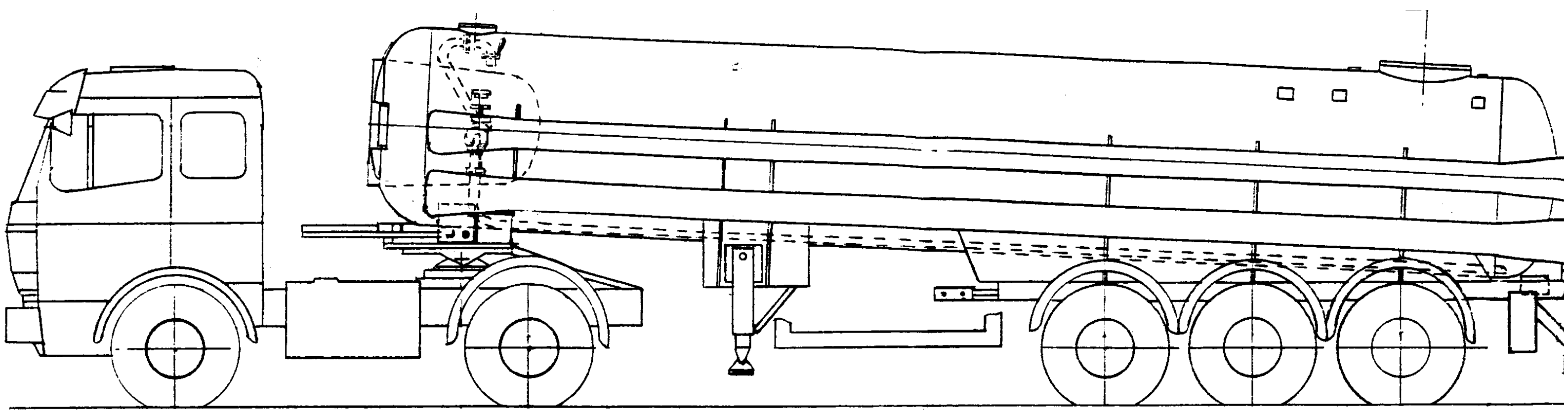
7. Historically tankers have been regarded as either having discharge points at the top or the bottom. Any tanker not fitted with connections at the top has been assumed to have connections

at the bottom and external to the barrel. The proposed design is different to both of these arrangements and is as safe as the current ADR design and far safer than a traditional bottom discharge vehicle for chlorine.

8. The valve chest arrangement has been used for decades and has an exemplary safety record. The volume of chlorine transported by road by in the United Kingdom is a very high proportion of all European chlorine road transport; consequently the good experience is statistically valid.

Appendix 1

Chlorine Tanker Design



Appendix 2

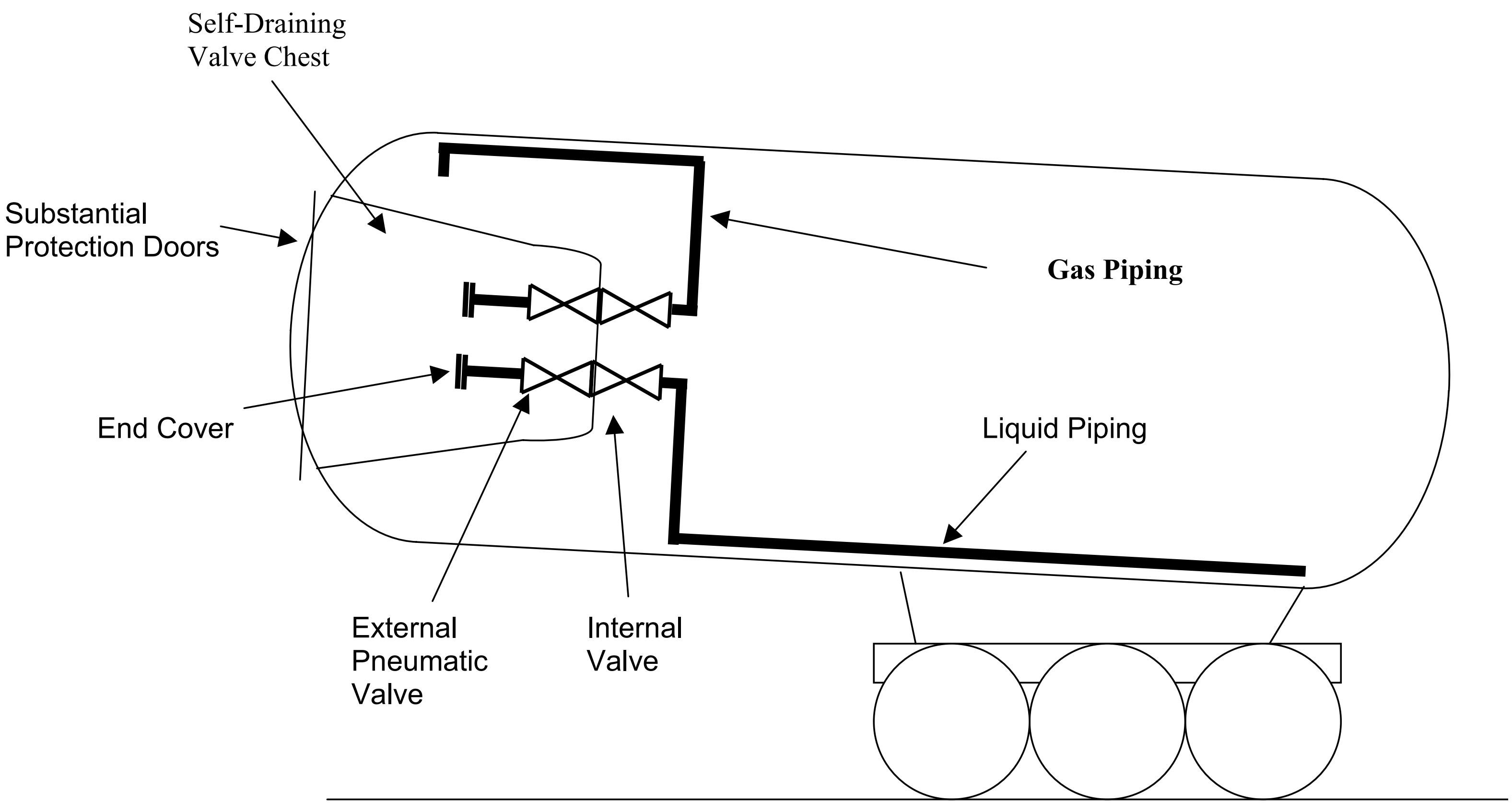
Chlorine Tanker Photograph

Appendix 3

Valve Chest Doors on Tanker

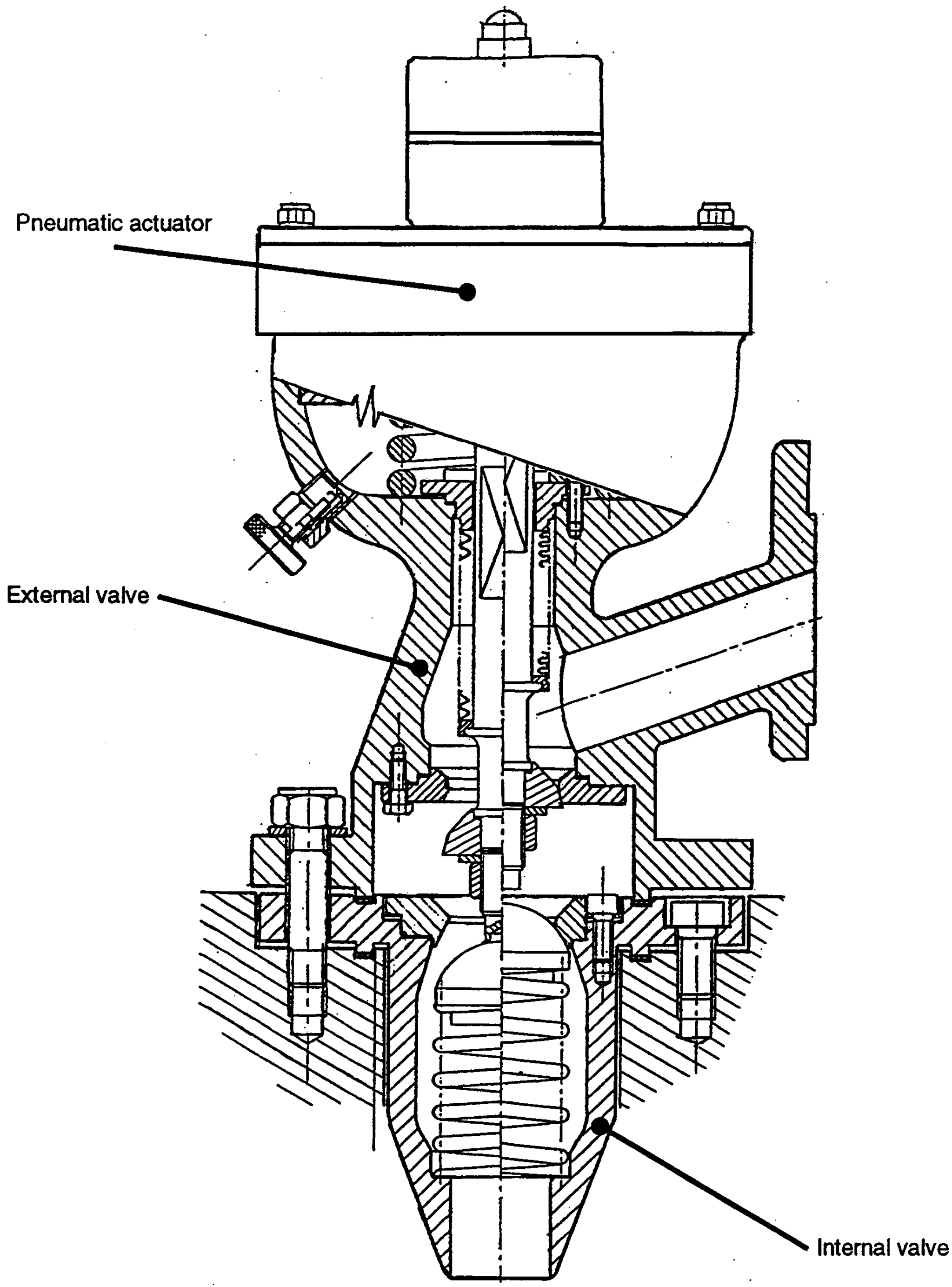
Appendix 4

Diagram of Tanker Barrel Valves and Internal Piping – this is not to scale and **diagrammatic only**



Appendix 5

Internal and External Valve Assembly



Appendix 6

Extract from Euro Chlor document GEST 96/221 – Protection of Road Tankers for the Carriage of Chlorine

3.6 VALVE PROTECTION

The tanker chlorine filling/discharge valves should be protected from damage during road incidents by one of two methods.

(a) Valve protection is provided by a valve chest whereby the valves are recessed inside the tanker barrel. This is ideally located at the front, behind the cab unit. The valve chest should be covered by a suitable substantial access door, which can be secured closed during transport.

(b) The valves are mounted external to the barrel shell and are protected by a substantial cover dome, which can be secured closed during transportation. The attachment of the cover to the tanker should be sufficiently secure to ensure that it will not open or detach during any accident. This is particularly important in designs where the valves are mounted externally to the barrel, and could be broken off if the dome were to open or detach.

The cover system should be designed in such a way that it will not damage the barrel when subjected to the forces generated in an accident.