ISBN 978-0-626-19147-4

SANS 10089-2:2007

Edition 3

SOUTH AFRICAN NATIONAL STANDARD

The petroleum industry

Part 2: Electrical and other installations in the distribution and marketing sector

Published by Standards South Africa
1 dr lategan road groenkloof ✉ private bag x191 pretoria 0001
tel: 012 428 7911 fax: 012 344 1568 international code + 27 12
www.stansa.co.za

standards SouthAfrica (a division of SABS)

SANS 10089-2:2007
Edition 3

Table of changes

Change No.	Date	Scope

Foreword

This South African Standard was approved by National Committee StanSA TC 65, *Explosion prevention,* in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

This standard was published in January 2007. This third edition cancels and replaces edition 2.1 (SABS 089-2:2002).

Annexes A, B and C form an integral part of this standard. Annex D is for information only.

SANS 10089 consists of the following parts under the general title: *The petroleum industry*:

Part 1: Storage and distribution of petroleum products in above-ground bulk installations.

Part 2: Electrical installations in the distribution and marketing sector.

Part 3: The installation of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations.

In South Africa, control of hazardous locations is regulated in terms of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) by the Chief Inspector of Mines of the Department of Minerals and Energy (Regulator). Or in terms of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) by the Chief Inspector of Occupational Health and Safety of the Department of Labour (Regulator). Or in terms of the Explosives Act, 2003 (Act No. 15 of 2003) by the Chief Inspector of Explosives of the Department of Labour (Regulator).

The Occupational Health and Safety Act requires that a valid certificate of compliance in accordance with SANS 10142-1 be issued for any new installation work that is carried out at any facility.

NOTE The latest available editions of these acts are applicable.

Certification requirements for explosion-protected apparatus

In South Africa, it is required that all electrical equipment used in hazardous locations be certified to comply with an approved standard, carry approved markings and have the necessary test certificates. The approved test laboratories (ATL) whose certification will be accepted are listed in ARP 0108.

Any explosion-protected equipment that has repair work or modifications done to it shall be re-certified by an approved test laboratory (for example when electric motors are repaired or re-wound).

All intrinsically safe circuits (Ex i circuits) shall have system certification from an approved test laboratory (ATL) to ensure that the various devices in the circuit, with the interconnecting wiring and cabling, are compatible and suitable for the application.

The following information shall be submitted for approval:

a) a loop diagram showing all equipment and cabling or wiring;

b) information about the equipment characteristics indicated on the loop diagram and in the form of a certificate by an approved test laboratory (ATL); and

c) information about cabling and wiring indicating cable types and lengths as well as resistance, capacitance and inductance characteristics.

NOTE SANS 10086-1 gives more information about certification requirements for Ex i circuits.

Contents

The petroleum industry

Part 2:
Electrical and other installations in the distribution and marketing sector

1 Scope

1.1 This part of SANS 10089 covers the recommended safe practices in the design, construction, installation and maintenance of electrical, earthing and bonding systems intended to be used in flammable and combustible liquid storage, pumping, distribution and marketing facilities. It is not intended that this standard should apply to refineries or exploration facilities, unless any of these installations are similar to facilities listed above.

1.2 This part of SANS 10089 does not cover the requirements for flammable dust.

2 Normative references

The following referenced documents are indispensable for the application of this document. All normative documents are subject to revision and, since any reference to a normative document is deemed to be a reference to the latest edition of that document, parties to agreements based on this document are encouraged to take steps to ensure the use of the most recent editions of the normative documents indicated below. Information on currently valid national and international standards can be obtained from Standards South Africa.

API 500, *Recommended practice for classification of locations for electrical installations at petroleum facilities classified as class I, division 1 and division 2.*

API 2003, *Recommended practice for Protection against ignitions arising out of static lightning and stray currents*.

API 610, *Centrifugal pumps for petroleum, heavy duty chemical and gas industry services*.

IP Code – Part 15, *Model code of safe practice in the petroleum industry – Part 15*: *Area classification code for petroleum installations.*

IP Code – Part 21, *Model code of safe practice in the petroleum industry – Part 21: Guidelines for the control of hazards arising from static electricity*.

SANS 1020, *Power-operated dispensing devices for flammable liquids fuels*.

SANS 10086-1, *The installation, inspection and maintenance of equipment used in explosive atmospheres – Part 1: Installations including surface installations on mines*.

SANS 10089-1, *The petroleum industry – Part 1: Storage and distribution of petroleum products in above-ground bulk installations*.

SANS 10089-3 (SABS 089-3), *The petroleum industry – Part 3: The installation of underground storage tanks, pumps /dispensers and pipework at service stations and consumer installations*.

SANS 10108, *The classification of hazardous locations and the selection of apparatus for use in such locations*.

SANS 10121 (SABS 0121), *Cathodic protection of buried and submerged structures*.

SANS 10142-1, *The wiring of premises – Part 1: Low-voltage installations*.

SANS 10229-1, *Transport dangerous goods – Packaging and large packaging for road and rail transport – Part 1: Packaging.*

SANS 10313, *The protection of structures against lightning*.

SANS 60079-10/IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*.

SANS 60079-11/IEC 60079-11 (SABS IEC 60079-11), *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety "i"*.

3 Definitions

For the purposes of this part of SANS 10089, the following definitions apply.

3.1
approved standard
standard approved by the approving authority (see 3.3) in terms of the relevant statutory regulations

3.2
approved test laboratory (ATL)
test laboratory that is accredited by the government-endorsed national accreditation body and appointed by the approving authority to carry out tests specified in the appropriate standards and to issue certificates (known as IA certificates) for explosion-protected apparatus indicating that such apparatus complies with safety requirements and any other requirements of the approving authority

3.3
approving authority
body legally responsible for the relevant national statutory legislations (see foreword)

3.4
bonding
low impedance connection. Impedance shall not exceed 2 ohms

3.5
cathodic protection
electrolytic method of preventing corrosion of ferrous metal objects that stand on the ground or are buried underground such as fuel storage tanks and buried pipelines

NOTE Only trained Corrosion Prevention Technicians with a working knowledge of the principals of explosion prevention may install and work on cathodic protection systems in hazardous locations.

3.6
combustible liquid
liquid that has a closed-cup flash point at or above 38 ºC and subdivided as follows:

Class II: Liquids that have a closed-cup flash point at or above 38 ºC and below 60,5 ºC

Class IIIA: Liquids that have a closed-cup flash point at or above 60,5 ºC and below 93 ºC

Class IIIB: Liquids that have a closed-cup flash point at or above 93 ºC

NOTE If class II and class III combustible liquids are stored or handled at temperatures at or above their flash points, then special precautions should be taken in both the layout and the operation for such liquids.

3.7
encapsulated electrical apparatus
Ex m apparatus
electrical apparatus in which parts that could ignite an explosive atmosphere are so enclosed in a compound that this explosive atmosphere cannot be ignited

3.8
enclosed premises
building, a room or an enclosed space that is not substantially open to the outside air and through which there is no free and natural passage for air

NOTE Any space that has more than a roof and one solid wall or is surrounded by other buildings or structures in such a way as to obstruct quick dissipation of any released gases or vapours is considered to be enclosed.

3.9
explosion protected
electrical apparatus designed and approved for use in hazardous areas in accordance with a suitable protection method, including Ex d, Ex "ia", Ex "ib", Ex e, Ex p, Ex n, Ex s, Ex m, Ex q or a combination of these methods

3.10
flameproof apparatus
Ex d apparatus
apparatus in which parts of the apparatus that can ignite an explosive atmosphere are placed in an enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture and that prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure

3.11
flammable liquid
liquid with a flash point below 38 ºC, regardless of its temperature, or a liquid with a flash point at or above 38 ºC being handled at temperatures at or above its flash point

NOTE The classes of petroleum are defined as follows (see also SANS 10089-1):

Petroleum products are classified according to their physical properties. Product classifications vary between different codes of practice. The following classification applies to the requirements listed in this part of SANS 10089:

Class 0: Liquefied petroleum gases.

Class 1: Liquids, which are subdivided as follows:

Class 1A: Liquids that have a closed-cup flash point below 23 ºC and a boiling point below 35 ºC;

Class 1B: Liquids that have a closed-cup flash point below 23 ºC and a boiling point at or above 35 ºC; and

Class 1C: Liquids that have a closed-cup flash point at or above 23 ºC and a boiling point below 38 ºC.

3.12
grade of release of flammable gases, liquids or vapours

3.12.1
continuous release
release that is likely to occur continuously in normal operation

3.12.2
primary release
release that is likely to occur periodically or occasionally in normal operation. (As a rough rule of thumb for a continuously operating plant, a release likely to be present for more than 10 but less than 1 000 h per year should be regarded as primary.)

3.12.3
secondary release
release that is unlikely to occur in normal operation and, in any event, will occur infrequently and be of short duration. (As a rough rule of thumb, for a continuously operating plant, a release likely to be present for less than 10 h per year and for short periods only should be regarded as secondary.)

3.13
hazardous location
location determined by national regulations (see foreword) or by the risk assessment of the plant or mine, where there might be a significant risk of the ignition of gas, dust or vapour

NOTE For hazardous locations in mines, see SANS 10108.

3.14
hydraulic housing
housing which provides physical protection to the liquid or the vapour equipment (or both)

3.15
incendive
capable of causing ignition

3.16
increased safety electrical apparatus
Ex e apparatus
electrical apparatus in which measures are applied to prevent, with a minor degree of security, the possibility of excessive temperatures and of the occurrence of arcs or sparks in the interior and on the external parts of an electrical apparatus that does not produce them in normal service

3.17
intrinsically safe circuit
Ex i circuit
circuit in which any spark, arc or thermal effect, whether produced normally (i.e. by breaking or closing of the circuit) or accidentally (for example, by a short circuit or an earth fault), is incapable, under prescribed test conditions, of causing ignition of a prescribed gas or vapour

3.18
intrinsically safe electrical apparatus
Ex i apparatus
electrical apparatus that is suitable for use in a hazardous location and in which all the circuits are intrinsically safe, or electrical apparatus that is designed to form part of an intrinsically safe system

3.19
intrinsically safe electrical apparatus of categories "ia" and "ib"
electrical apparatus that, when tested in accordance with SANS 60079-11, is incapable of causing ignitions under hazardous conditions

3.20
intrinsically safe system
system that comprises electrical apparatus and interconnecting wiring in which any spark or thermal effect in any part of the system intended for use in a hazardous location is incapable, under prescribed test conditions, of causing ignition of a prescribed gas or vapour

NOTE An intrinsically safe system is also incapable of igniting atmospheres that contain prescribed flammable dusts or fibres.

3.21
non-sparking electrical apparatus
Ex n apparatus
electrical apparatus that, in normal operation and in the absence of electrical and mechanical failure, cannot, because of its construction, method of operation or its enclosure, ignite mixtures of air and prescribed flammable gases or vapours

3.22
open premises
any space that is substantially open to the outside air and offers no obstruction to the free and natural passage of air through it

NOTE Such premises may be roofed for weather protection or enclosed (for example, in wire mesh or expanded metal (or both)), provided that adequate ventilation exists and the supports for the roof and side enclosures do not at any point materially obstruct the free passage of air to or through any part of the space within.

3.23
powder-filled or sand-filled electrical apparatus
Ex q apparatus
electrical apparatus of which the enclosure is so filled with a material in a finely granulated state that any arc occurring within the enclosure will not ignite the surrounding atmosphere, and ignition will not be caused either by flame or excessive temperature of the surfaces of the enclosure

3.24
pressurised electrical apparatus
Ex p apparatus
electrical apparatus in which the entry of a surrounding atmosphere into the enclosure of the electrical apparatus is prevented by maintaining, inside the said enclosure, a protective inert gas or fresh air at a higher pressure than that of the surrounding atmosphere

NOTE The overpressure is maintained either with or without a continuous flow of the protective inert gas or fresh air.

3.25
vapour barrier
sealing system that is used to limit the passage of hazardous gases or vapours

4 Classification of hazardous locations

4.1 General

4.1.1 The basic principles of area classification owing to the presence of flammable gases or liquids are listed in 4.1.2 to 4.1.6. Reference can be made to SANS 10108, SANS 60079-10, IP Code – Part 15 or API 500 for more detailed information.

NOTE It is recommended that the extent of hazardous areas be demarcated and recorded, at least on a drawing but if possible also by floor marking. For practical purposes, only distances in the horizontal plane need to be drawn and the extent of the vertical distances can be indicated in writing.

4.1.2 Identify the sources of release of flammable gases, liquids and vapours. Identify the sources of release of class II and class IIIA combustible liquids at a temperature at or above their flash points, or released as a fine mist or spray. Such sources will give rise to a hazardous area.

NOTE Where a class IIIB combustible liquid is stored or handled, an assessment is required to determine if such a liquid will give rise to a hazardous area at the various sources of release.

4.1.3 Divide the hazardous area into zones according to the grade of release (determined by the frequency with which a flammable atmosphere occurs and its duration), (see 4.2). Ventilation could serve to reduce the extent of a hazardous area as discussed below, or could so affect the duration of the flammable atmosphere that a reduced zone can be allocated.

4.1.4 Calculate the extent of a hazard zone by reason of the rate of release and the nature of the flammable substance, which is mainly defined by the process pressure and temperature, the liquid flash point and boiling point, the density of the released vapour or gas, and the rate at which it is diluted (ventilated).

4.1.5 Allocate the appropriate equipment group and temperature class (or maximum surface temperature), pertaining to the use of explosion-protected apparatus in the hazardous area.

4.1.6 Where a mixture of flammable gases or flammable vapours (or both) occurs, the worst-case values shall be specified, unless the mixture is of controlled composition and has well-defined ignition properties.

4.1.7 Practical area classification is simplified if classification by direct example is applied. Such examples are given in annexes A and B of this part of SANS 10089. These examples apply to the petroleum industry distribution and marketing standards as given in SANS 10089-1 and SANS 10089-3, respectively, and when the examples are applied, the facility under consideration shall not differ significantly from the given example in terms of layout, type of equipment, class of petroleum product or the conditions of temperature or ventilation state.

NOTE Locations that have been classified in accordance with IP Code – Part 15 and API 500, SANS 10087-7, SANS 60079-10 or other approved standards are considered to have been classified in accordance with this part of SANS 10089.

4.2 Zone 0, zone 1 and zone 2 locations

4.2.1 General

Zone 0, zone 1 or zone 2 locations are those in which flammable gases or vapours can be present in the air in quantities sufficient to become hazardous.

4.2.2 Zone 0 locations

Zone 0 locations are those in which flammable gases or vapours are continuously or very frequently present.

NOTE 1 A continuous grade of release normally leads to a zone 0 location.

NOTE 2 Such a condition is rarely encountered and is limited mainly to confined spaces (such as the vapour space of closed process vessels, closed storage tanks, and closed containers), although it can also occur in larger rooms, such as rooms in chemical plants. Even in such spaces it is possible that the gas-air or the vapour-air mixture is normally outside the flammability range.

4.2.3 Zone 1 locations

Zone 1 locations are those in which

a) hazardous concentrations of flammable gases or vapours occur intermittently or periodically under normal operating conditions, or

b) hazardous concentrations of flammable gases or vapours can occur frequently because of repair or maintenance operations or because of leakage (which could be the result of inadequate equipment maintenance), or

c) breakdown or faulty operation of equipment or processes can occur, which might cause the release of hazardous concentrations of flammable gases or vapours, while also causing simultaneous failure of electrical equipment; or

d) channels or sumps in a zone 2 area to be classified as zone 1.

NOTE 1 A primary grade of release normally leads to a zone 1 location.

NOTE 2 This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where flammable solvents are used; locations that contain open tanks or vats of flammable liquids; oil-extraction apparatus that uses flammable solvents; portions of cleaning and drying plants where flammable liquids are used; inadequately ventilated pump rooms for flammable gases or for flammable liquids; and all other locations where hazardous concentrations of flammable vapours or gases can occur in the course of normal operations.

NOTE 3 Inadequate operating or maintenance procedures could result in the revision of the zone 1 location to zone 0 (for example a closed test measure pit with excessive product spillage).

4.2.4 Zone 2 locations

4.2.4.1 Zone 2 locations are those in which operations concerned with flammable liquid or vapours are so well controlled that an explosive or ignitable concentration is only likely to occur under abnormal conditions.

4.2.4.2 The following shall be regarded as the minimum requirements for an area to be classified as a zone 2, rather than a zone 1 location:

a) the area is so well ventilated that, if abnormal conditions arise, ignitable concentrations of the gas or vapour are rapidly dispersed and their possible contact with electrical equipment is of minimal duration;

b) complete segregation from any zone 0 or zone 1 location is ensured

1) in the case of enclosed premises, by the use of a gas proof structure and the absence of doorways, ventilating ducts and trenches that communicate with such locations, and

2) in the case of open premises, by the distance between the area and the other locations being great enough to ensure safety under any atmospheric conditions, and

c) there is no point at which, under normal operating conditions, a flammable liquid, gas or vapour is in direct contact with the surrounding atmosphere.

4.2.4.3 Where inadequate construction or maintenance methods (or both) are followed, resulting in significant leakage, the classification category shall be revised from zone 2 to zone 1 (for example screwed couplings, and persistent leaks from seals and glands).

NOTE The following are examples of zone 2 locations:

a) a secondary grade release normally leads to a zone 2 location;

b) an area where equipment (such as pumps, vessels and pipework) that contains flammable liquids, gases or vapours is installed in the open air; and

c) an instrument control bay that is equipped with pipes, valves and instruments and is segregated from any zone 1 location with which it is associated. Where supervision of such a zone 1 area is involved, hermetically sealed windows of strengthened glass should be provided in the common wall.

5 Certification requirements for explosion-protected apparatus

NOTE 1 All certification requirements depend on the national statutory requirements (See foreword).

NOTE 2 See ARP 0108 for information on regulatory requirements for explosion-protected apparatus (EPA).

6 Selection of explosion-protected apparatus

6.1 Selection criteria

The two main criteria for the selection of explosion-protected apparatus are

a) choosing apparatus that is suitably explosion protected for the relevant hazard zone, as discussed in 6.2, and

b) ensuring that both the apparatus group (if applicable) and the surface temperature are suitable for worst-case flammable substances present. A list of gas groups and ignition temperatures is given in SANS 10108. In the petroleum industry, hydrocarbon type flammable vapours and liquid petroleum gas (LPG) normally require apparatus suitable for gas group IIA, temperature class T3. Hydrogen is a group IIC, temperature class T4 gas. Ethylene is a group IIB gas.

The information in (a) and (b) above can be inferred from the marking on the apparatus. The certification documents shall be examined in conjunction with the marking for detailed information on, for example, special conditions of use. Annex B of ARP 0108:2005 provides information on the acceptable marking of explosion-protected apparatus.

6.2 Selection of apparatus

Table 1 can be used to determine explosion-protection requirements of apparatus used in hazardous locations.

NOTE This table is a direct extract from SANS 10108, and further information can be obtained from that standard.

Table 1 — Explosion protection and selection of apparatus

1	2
Zone	**Equipment classification**
0	Intrinsically safe apparatus of category "ia" (Ex ia) with over voltage surge protection
1	Flameproof (Ex d) Specially protected (Ex s) Increased safety (Ex e)[a] Encapsulated (Ex m) Powder- or sand-filled (Ex q) Intrinsically safe (Ex ia or ib) Pressurized (Ex p)[b]
2	Any type suitable for zone 0 or zone 1, or Non-sparking (Ex n), or Pressurized (Ex p)[c]
NOTE Equipment ratings should be taken into account when carrying out maintenance (for example lamp replacement) so as not to cause overheating which leads to excessive surface temperatures.	
[a] Ex e motors and generators shall not be used in hazardous locations unless approved overload protective devices are used with such equipment and precautions taken to ensure that such protection cannot be rendered ineffective during use. [b] Ex p apparatus used in zone 1 locations shall have interlocks that isolate all power to it completely when the fresh-air or inert gas supply fails. [c] Ex p apparatus used in zone 2 locations shall have effective visual or audible warning systems to indicate failure of the fresh-air or inert gas supply.	

7 Installation, maintenance, inspection and repair

7.1 SANS 10086-1 is the code of practice for the installation, inspection, maintenance and repair of electrical equipment in hazardous locations.

7.2 SANS 10086-1 is a comprehensive document that forms an integral part of this part of SANS 10089 with regard to any installation, maintenance, inspection and repair work that has to be carried out in the petroleum distribution sector.

7.3 Lockout and work permit systems shall be implemented when repair and maintenance work is done. It is important that the requirements for safe isolation be complied with. Refer to SANS 10089-1 in this regard.

NOTE For more information on installation, maintenance, inspection and repair, see the foreword.

8 Cathodic protection

8.1 General

8.1.1 Impressed current cathodic protection systems are widely used in the petroleum industry to prevent corrosion and are described in more detail in SANS 10121.

The use of cathodic protection in the petroleum industry for the prevention of corrosion of tanks and, pipelines, manifolds, sea lines, jetties, etc., could introduce hazards when this method of corrosion-protection is used in hazardous locations.

Cathodic protection can be provided by a power-impressed system or by the use of sacrificial anodes, depending on the type of equipment to be protected and on soil conditions.

8.1.2 It should be appreciated that with this form of protection, the breaking of small currents can be a source of danger in hazardous locations. The apparatus or connected circuits shall therefore be used with care.

Incendive sparking might arise on cathodically protected pipelines, joints and plant in the following circumstances:

a) deliberate or accidental disconnection of pipelines, joints, plant, or any other associated equipment under protection;

b) accidental or deliberate short circuit of insulating flanges;

c) connection or disconnection of flexible conductive hoses to railcar gantry structures and associated pipework;

d) disconnection or accidental breakage of cables leading from the rectifier or other direct current (d.c.) source to the protected structure; and

e) internal breaking of the cathodic circuit, particularly with impressed current, when liquid is being drained from plant under internal protection.

8.1.3 The apparatus used and circuits employed for such systems in hazardous locations shall generally comply with the following:

a) connection to structures shall be made using an earth connection boss designed for that purpose; see figures C3 and C4 in Annex C;

b) underground cabling shall be of the double insulated type; and

c) above-ground cabling shall be of the same type provided that it is protected from mechanical damage, for example by using rigid ultraviolet stable PVC or corrosion-protected steel conduit.

8.2 Protection

In order to reduce the risks associated with incendive sparking the following practice is recommended:

a) Give consideration to the advisability of adequate bonding or resistance bonding of all neighbouring metallic bodies in the zone of cathodic protection to ensure that they are not adversely affected by the protective scheme. On completion of a protective system, tests should be conducted to establish whether and to what extent bonding or resistance bonding is required.

b) i) When maintenance or repair work is undertaken, switch off the source of power for the cathodic protection equipment, because a live system could cause incendive sparking. Because of the time factor associated with depolarization, care shall be taken to apply the necessary bonding across pipe flanges and other connections in which cathodic protection currents could flow, when disconnecting such joints during maintenance and repair operations.

ii) When turned off, a cathodic protection system in a hazardous location can take some days to depolarise and become safe. Because of this and because there might be other unknown stray currents in the region, care shall be taken to bond across the area of work when civil and mechanical repairs, maintenance and installation work is being carried out.

iii) The same bonding precautions shall be employed if stray currents are present at a site due to any other reason, for example electrified railway traction systems.

c) The insulation of insulating flanges that are incorporated in the design of the protective system should be checked by periodic testing.

d) Provide adequate bonding across non-conductive pipe joints.

e) Fit surge arresters to the low voltage DC output from the transformer or rectifier unit.

It is recommended that classified double wound safety transformers, for the power supply of impressed current cathodic protection systems be used. Use a double pole switch to control each supply circuit entering a hazardous location.

f) i) When the cathodic protection circuits that enter the hazardous locations are under test, take special precautions to prevent incendive sparking in the hazardous locations. No danger should result from the use of a high resistance voltmeter or reference electrode for test purposes.

ii) Only classified instrumentation shall be used when testing in hazardous locations. If classified instrumentation is not available the test circuits shall be so wired that the instrumentation is situated in a safe location.

g) Locate the anode ground beds associated with impressed current systems in such a way that they do not impose a hazard in hazardous locations.

9 Requirements for earthing and bonding

9.1 The equipotential earthing system

a) Electrical apparatus shall be connected to an earthing system that will provide a low earth loop impedance path for quick clearing of faults. Follow the requirements of SANS 10086-1 in this regard (see annex C).

NOTE These requirements are often stricter than those in SANS 10142-1, as SANS 10142-1 addresses only electrocution hazards and the prevention of ignition sources that are capable of igniting explosive atmospheres.

b) In addition to the electrical safety earth provided to comply with SANS 10142-1 (for example the "spare core" earth), a second earth connection should be provided to each item of electrical equipment to prevent the potential to earth of such equipment rising above spark potential (see annex C).
c) Earth all extraneous and exposed metal parts in the same manner as described in 9.1 (b).

9.2 Lightning protection

The principles given in SANS 10313 should be applied.

Vertical type steel tanks connected to piping and resting on ground have proved to be sufficiently earthed for the safe dissipation of lightning strikes. Special circumstances could arise due to the use of non-conductive secondary containment systems where additional lightning protection might be required.

9.3 Single system

A single equipotential earthing system is given in annex C. The electrical safety earth, the earth for static electrical dissipation and lightning earth conductors and earth systems are connected to this system.

9.4 Storage tanks

Storage tanks shall generally be earthed as follows:

a) Horizontal tanks and raised vertical tanks above ground: connect to the earthing system.

b) Vertical tanks installed with bottom in contact with a ground bed: these tanks can be considered inherently earthed and no further earthing is required.

c) Underground tanks and especially glass fibre coated (composite) tanks on petrol and fuel service stations shall be individually connected to the equipotential earthing system with not less than a 16 mm^2 green plastic coated conductor. One conductor may be used to connect all tanks but daisy-chain earthing is not permitted.

d) Floating roofs: A floating roof shall be bonded to the main body of the tank using a 50 mm^2 PVC insulated welding cable firmly bolted to the tank and the floating roof in a manner that will accommodate the rise and fall of the roof.

e) Floating blankets: Floating blankets are usually supplied with static bonding conductors. These shall be installed in accordance with the manufacturer's instructions.

f) Floating blankets that are not supplied with static bonding conductors shall be provided with two conductors fastened to opposite sides of the blanket and appropriate fixing points on the tank shell. These conductors should comprise 2,5 mm in diameter. PVC cable covered to 5 mm in diameter. Special care shall be taken to ensure that these cables do not foul up the rise and fall of the floating blanket.

9.5 Static electricity and bonding

9.5.1 Some of the recommendations for minimizing static electricity and hazardous practices associated with static electricity are listed below.

9.5.2 Fluids in motion generate static electricity. The rate of charge generation depends on the conductivity of the liquid, its purity and degree of agitation.

NOTE A comprehensive treatment of static electricity and its limitation as is applicable to the petroleum industry is given in recommended practice API 2003 and the IP Code – Part 21.

9.5.3 Avoid spark promoters above charged fluid. If spark promoters are present, for example level probes, they can be used inside an earthed metal tube or a metallic rod attached between them and the tank bottom.

9.5.4 Avoid turbulence. Do not allow splash loading or splash filling into containers. When filling large storage vessels limit flow velocities to 1 m/s until the product has risen to 1 m above the filling nozzle.

9.5.5 Avoid contaminants such as water that can become charged.

9.5.6 When vehicles, tanks or containers are being loaded or filled allow an adequate relaxation time (2 minutes) after the filling process has been completed before inserting a dipstick or dip tape in order to ascertain the level of the fuel.

9.5.7 Excessive flow rates shall be avoided. The following can be used as a guide:

$V D < 0{,}5$ or $V < 6$ m/s, whichever is the lower value

where

V is the flow velocity, in meters per second;

D is the pipe internal diameter, in meters.

9.5.8 Methods shall be employed to allow excessive static electricity generated by filters and strainers to dissipate by allowing adequate relaxation time before loading (for example a 30 s piping loop in the case of high purity fuels such as jet fuel.

9.5.9 Bond all metallic piping and components, together and to ground. Flange bolts are considered to provide adequate bonding across flanges, unless they are Teflon or similarly coated in which case bonding straps should be provided.

NOTE Copper straps need not be fitted over pipe flanges.

9.5.10 Rail Sidings:

9.5.10.1 Bond and earth all rail lines, metallic pipelines, gantries and component equipment.

9.5.10.2 Provide flexible clamp on bonding cables for attaching to the earth lug on rail tank vehicles.

NOTE Further comments regarding rail sidings will be found in clause 11.

9.5.11 Vehicle loading and all other container filling points:

a) Bond and earth all metallic piping and components.

b) Provide flexible clamp-on bonding cables at all road tanker and container filling and decanting points.

c) These cables shall be firmly attached to the bonding mentioned in 9.5.11a.

9.5.12 In general, above-ground metallic conductive vessels, tankers (road and rail), piping, containers and systems shall be well bonded and earthed in order to dissipate any unsuspected stray currents and accumulated static electrical charges.

9.5.13 Commercially available earth monitoring systems may be employed to verify earthing of a tank and to ensure that the bonding leads are connected before loading is allowed to commence. If such monitoring systems are not employed, special care shall be taken to implement procedures that will ensure that proper bonding does take place.

NOTE If such an earth monitoring system is used in a hazardous location it shall consist of classified explosion protected electrical equipment.

9.5.14 The practice of "switch loading", i.e. loading a class II or class III product into a tank or container that has contained a class I product and was not drained, cleaned and made vapour free, should be avoided.

9.5.15 Small (up to 250 L) portable containers could cause a hazard when they are filled. The following should be observed:

a) fixed electrical equipment shall be appropriately certified as explosion protected;

b) all conductive equipment in contact with the liquid should be earthed with a resistance path not exceeding 10 Ω for an entirely metallic path and 1 MΩ for a partly non-metallic path;

c) components should not be insulated by paint layers, in-line sight glasses, etc;

d) drum pumps should be bonded to both the container being emptied and the one being filled; hoses and nozzles should be conductive;

e) there should be an adequate relaxation time downstream of filters;

f) if switch loading is suspected, care should be taken to use long metallic nozzles, conducting chains, etc.; and

NOTE This is not only for "switch loading". Drop pipes (long metallic nozzles) shall be used for all overhead filling situations regardless of what product is being filled and regardless of switch filling or straight filling, and in the larger container situations such as rail and road vehicles the filling nozzle and the drop pipe should be bonded to the main body of the vehicle being loaded.

All hoses used should be fully conductive - i.e. low impedance from piping attachment to nozzle (not to exceed 10 ohms).

g) non-metallic containers shall not be used for transporting class 1 products, unless they are specifically approved for that purpose. Refer to SANS 10229-1 in this regard.

9.6 Stray currents and isolating flanges

The requirements for isolating flanges should be considered taking into account stray currents caused by impressed current systems, rail traction systems, or other sources.

Typically, isolating flanges should be provided at incoming supply pipelines and conditions shall be evaluated at electrified sidings.

Isolating flanges shall be tested periodically to ensure their effectiveness. (See 8.2(c).)

10 Instrumentation systems

10.1 Instrumentation systems shall comply with the installation and certification requirements for electrical installations in hazardous locations.

10.2 The correct selection of apparatus, configuration and certification of the circuits for intrinsically safe systems are important, as outlined in clauses 5 and 6.

10.3 Care shall be taken to ensure that uncertified or incorrectly certified portable equipment is not taken into hazardous locations.

The following specific examples are given:

a) two-way radios or portable/mobile/cellular telephones or pagers;

b) insulation resistance meters ("Meggers");

c) current injection devices; and

d) flash lights.

11 Sidings

11.1 The staging track, on which tank wagons stand for filling or decanting, shall be not less than 15 m from the nearest track traversed by any locomotive. Where existing installations do not permit this distance to be observed, the siding user shall ensure that conditions are safe from traversing traffic before the transferring of hazardous liquids/gases is commenced.

11.2 All rail joints at the siding, excluding insulated rail joints (block joints), shall be continuity-bonded with not less than two strands of 16 mm^2 copper or equivalent wire using a suitable method for a permanent electrical connection.

11.3 The section of continuity bonded railway lines within the siding user's enclosure shall be double bonded together and electrically interconnected employing a suitable method, with the piping system as shown on the drawings in annex C. Stranded flexible insulated conductors equivalent to a 16 mm^2 copper conductor shall be used.

11.4 Temporary flexible earth connectors may be used in addition to the permanent bonds. These temporary flexible connectors shall be attached before any valve is opened or the pipe/hose has been coupled to the tank wagon. Similarly, they shall only be detached after all transferring operations have been completed and the valve has been closed, or the pipe/hose has been disconnected from the tank wagon.

11.5 Such connections shall never be applied in such a manner that they will short-circuit an insulated flange. They shall provide a temporary connection between the tank wagons and the rail.

11.6 The temporary flexible earth connectors shall be fitted with a battery or welding earth type clamp rated at 100 A for connection to the earth lugs on the tank wagon.

11.7 If, for any reason, a pipe or conductor which is normally electrically continuous and which constitutes part of a system which is covered by these instructions, is to be made temporarily electrically discontinuous (for example for replacement of a section of a pipe), then the discontinuity shall be bridged by a flexible conductor equivalent 16 mm^2 copper conductor, before the break is made. The temporary conductor shall only be removed after the pipe/conductor has been made electrically continuous.

NOTE Refer to Spoornet GI 049 for the traction installation arrangements, which fall outside the scope of this part of SANS 10089.

Annex A
(normative)

Fuel storage depots

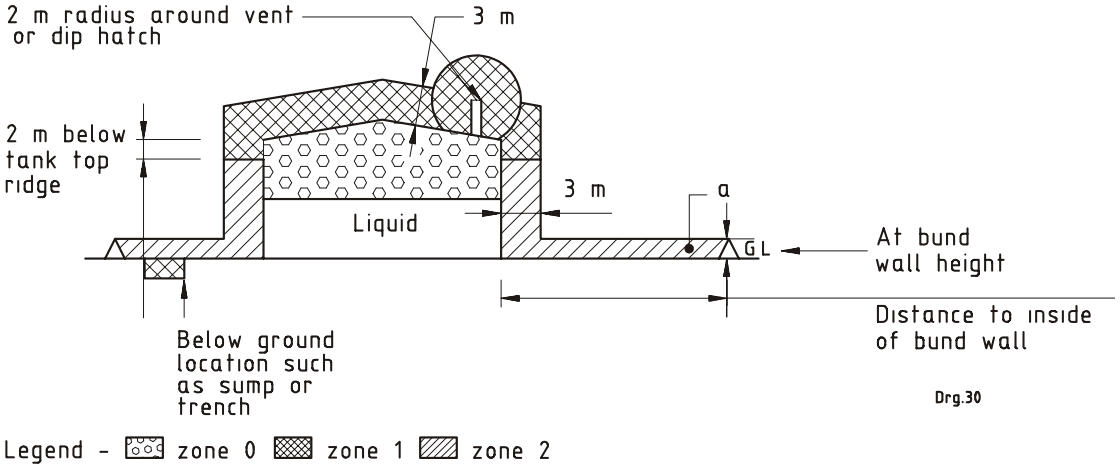
The hazardous area classification examples listed below are based on product classes as defined in SANS 10089-1 and using the principles in the IP Code – Part 15, API RP 500 and SANS 60079-10.

Examples are given for:

Flammable liquids as defined by this code (see clause 3), which includes class I liquids, as well as class II and class IIIA liquids at or above their flash points.

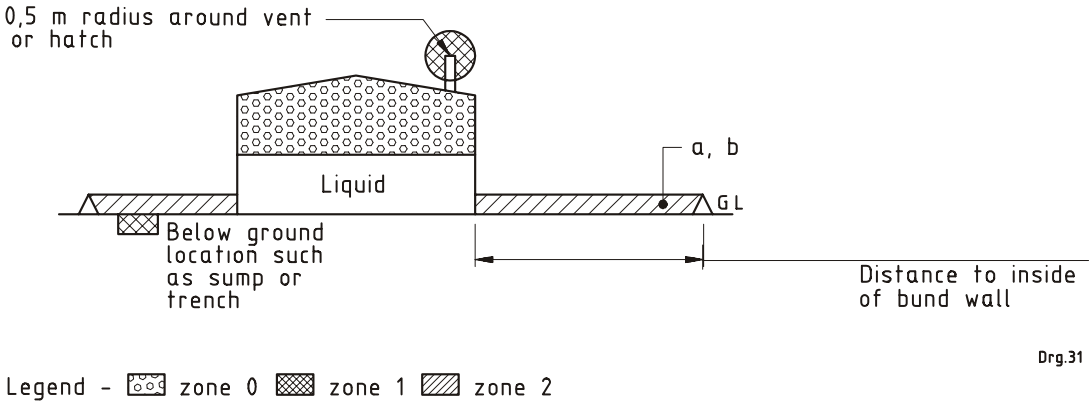
Combustible class II and class III liquids as defined by this code, stored or handled below their flash point.

Figure	Description
A.1	Cone or dome roof tank
A.2	Floating roof tank
A.3	Tank with internal pan
A.4	Horizontal tank
A.5	Underground tanks
A.6	Bottom bulk truck loading
A.7	Top and bottom bulk truck loading with canopy
A.8	Railcar, top loading
A.9	Railcar, bottom loading
A.10	Jetties, loading and discharging
A.11	Jetties, discharging
A.12	Railcar discharge
A.13	Drum filling in the open air
A.14	Pumps and piping
A.15	Separator or interceptor
A.16	Workshop



[a] If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

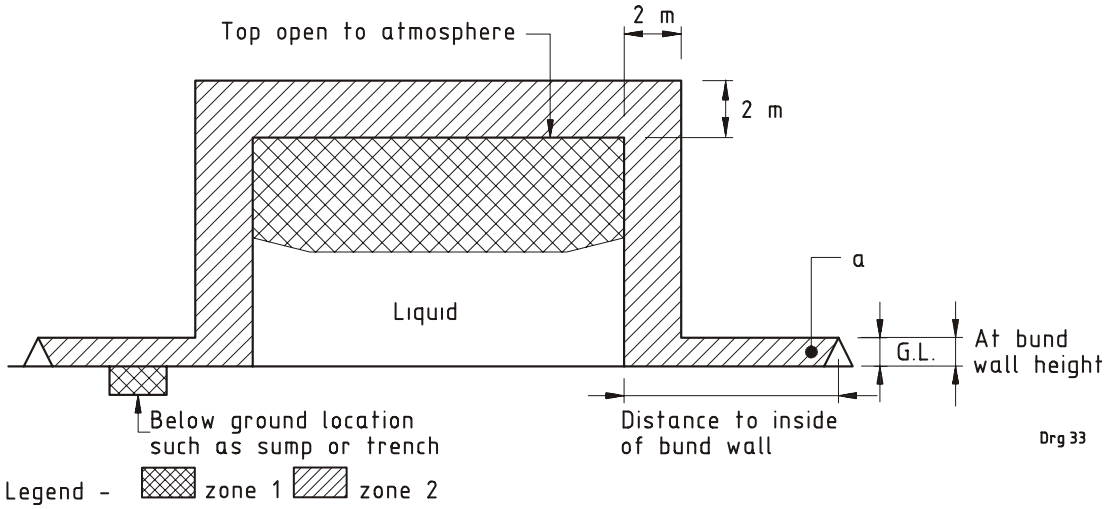
Figure A.1 (a) — Closed roof cone or dome tank with class 1 flammable liquid or class II and class III combustible liquids at temperatures at or above flash point



[a] If no tanks for class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points are present, the bund area surrounding tanks can be considered safe.

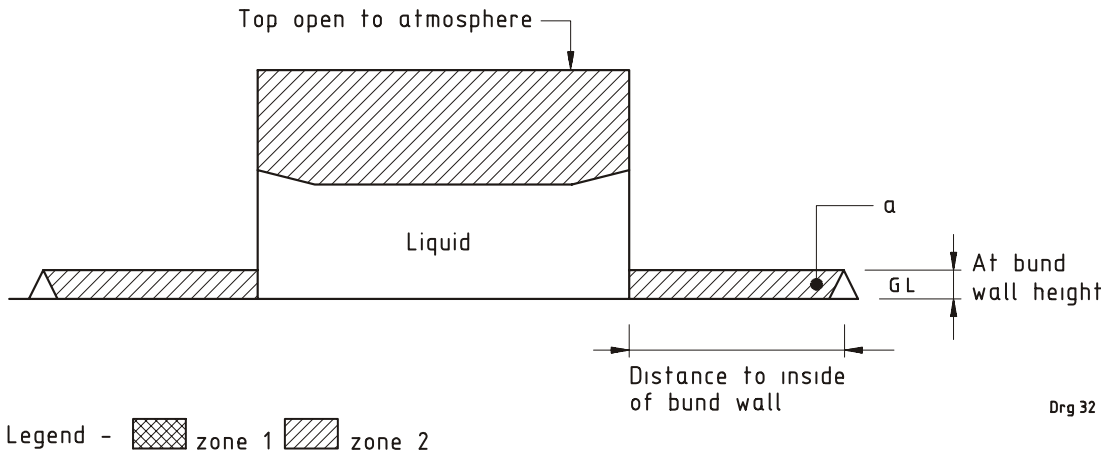
[b] If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.1 (b) — Closed roof cone or dome tank with class II and class III combustible liquids at temperatures below flash point



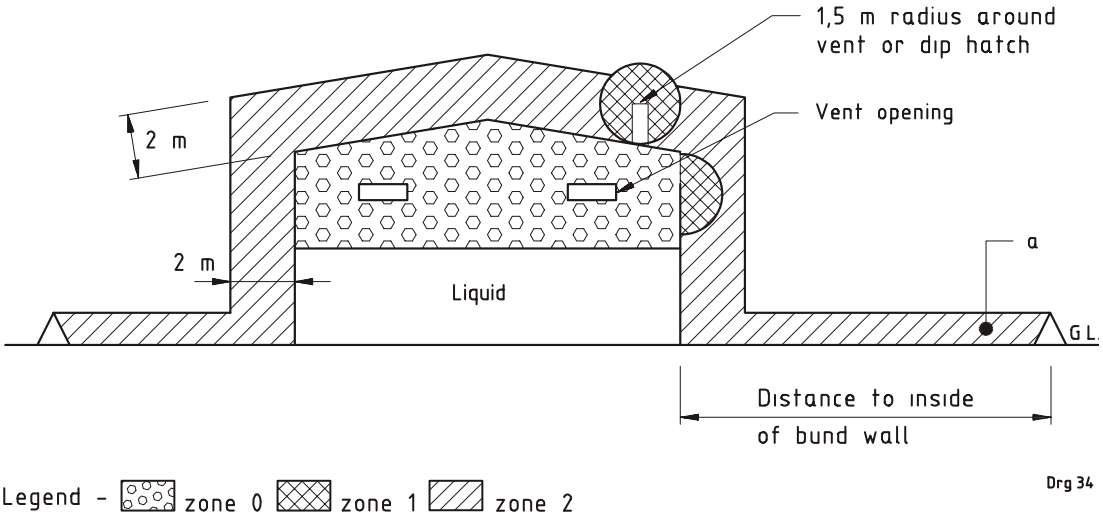
[a] If pumps or valves are located in bund areas, their grade of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.2 (a) — Floating roof tank with class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points



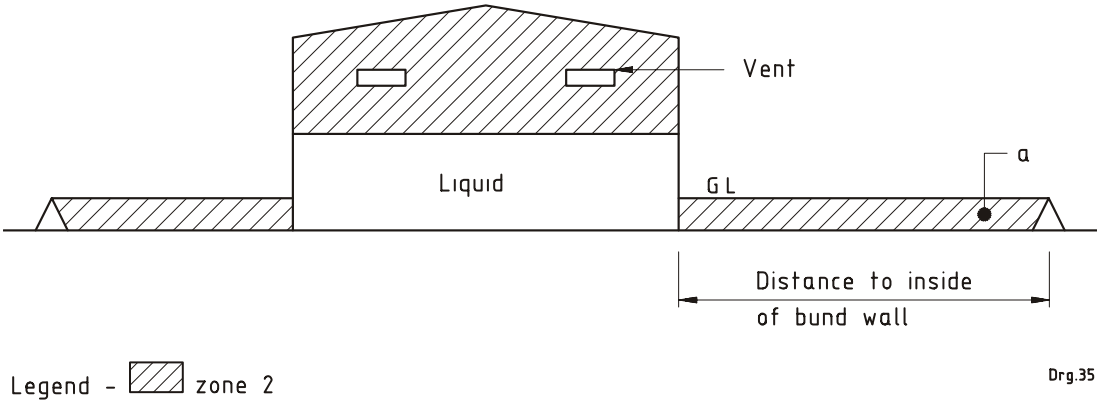
[a] If no tanks for class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points are present, the bund area surrounding tanks can be considered safe.

Figure A.2 (b) — Floating roof tank with class II and class III combustible liquids at temperatures below their flash points



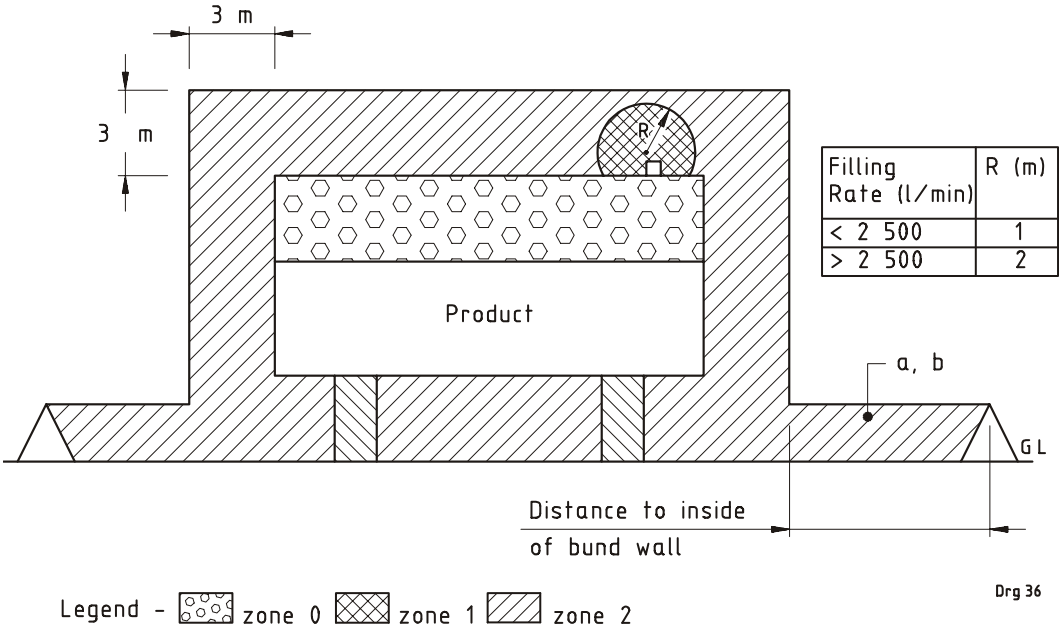
[a] If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.3 (a) — Tank with internal pan on liquid for class I flammable or class II and class III combustible liquids at temperatures at or above their flash points



[a] If no tanks for class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points are present, the bund area surrounding tanks can be considered safe.

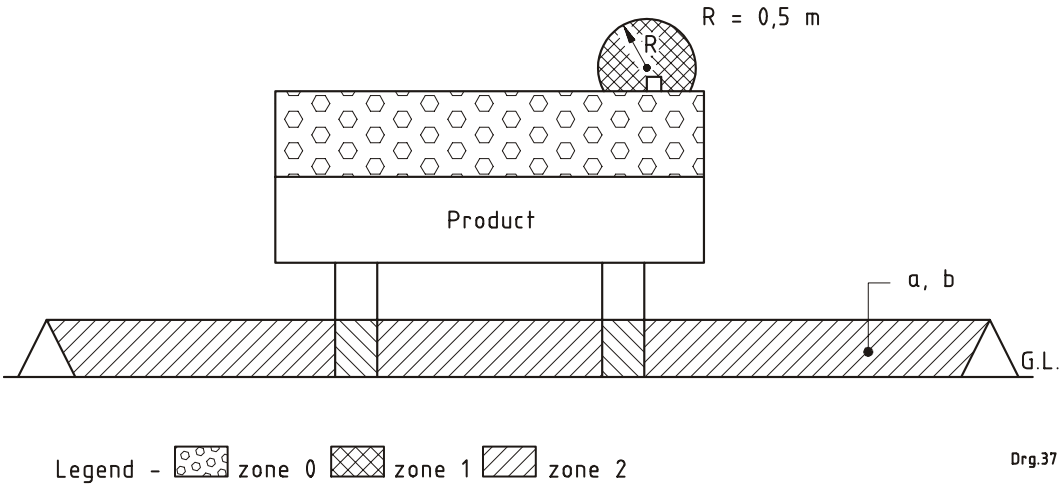
Figure A.3 (b) — Tank with internal pan for class I or class II and class IIIB flammable liquids at temperatures below their flash points



[a] If no tanks for class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points are present, the bund area surrounding tanks can be considered safe.

[b] If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.4 (a) — Horizontal tank with class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points



[a] If no tanks for class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points are present, the bund area surrounding tanks can be considered safe.

[b] If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.4 (b) — Horizontal tank with class II and class IIIB flammable liquids at temperatures below their flash points

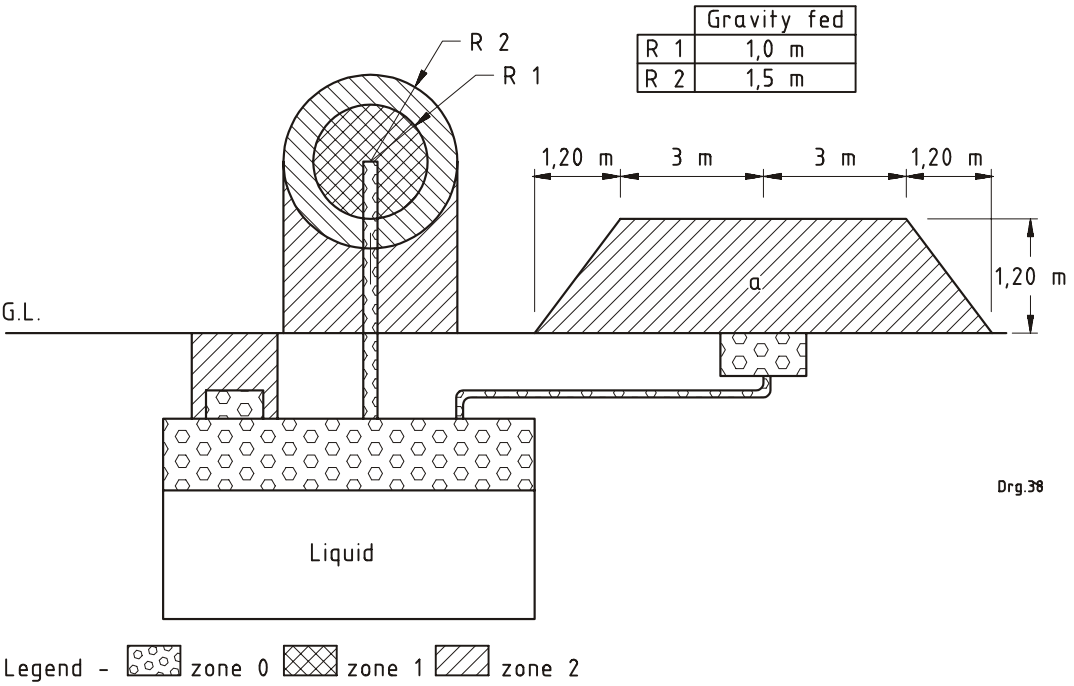


Figure A.5 (a) — Underground tank with class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points, with gravity filling

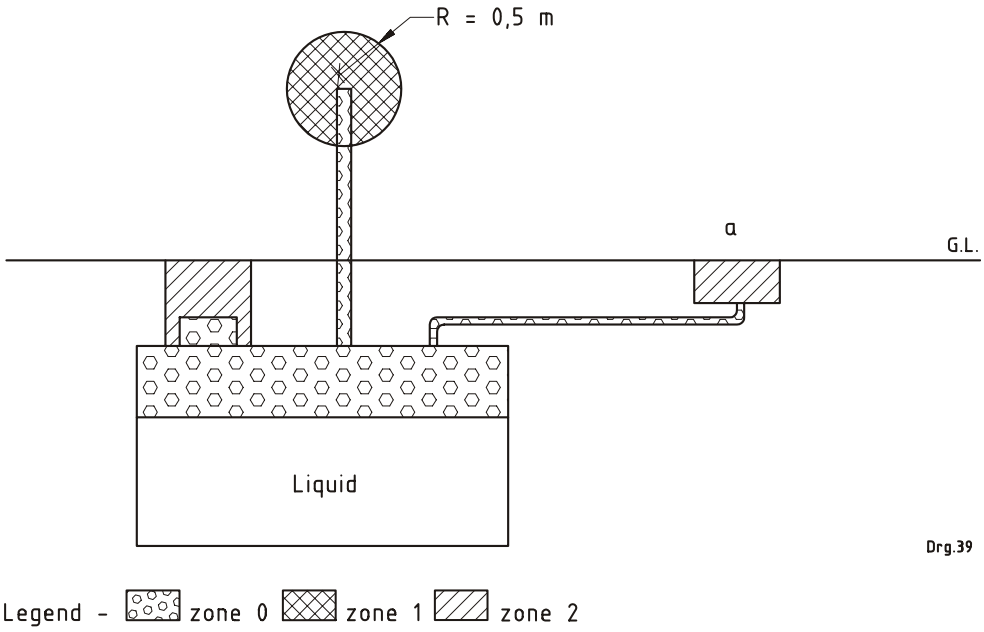
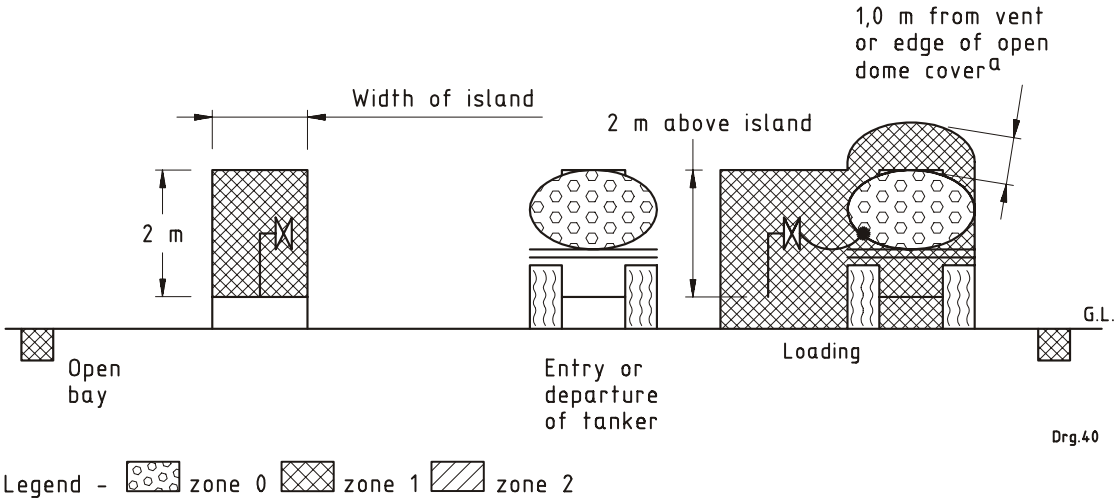


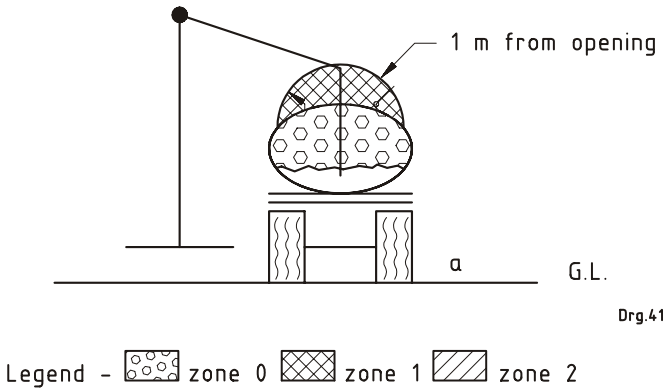
Figure A.5 (b) — Underground tank with class II and class III combustible liquids at temperatures below their flash points, with gravity filling



NOTE If a canopy is provided over loading area then all the space above the zone 1 area will be zone 2 up to the roof.

[a] Extent of zone 1 will be 1,0 m from vent if loading with closed dome covers. Extent of zone 1 will be 1,0 m from edge of open dome if loading with open domes.

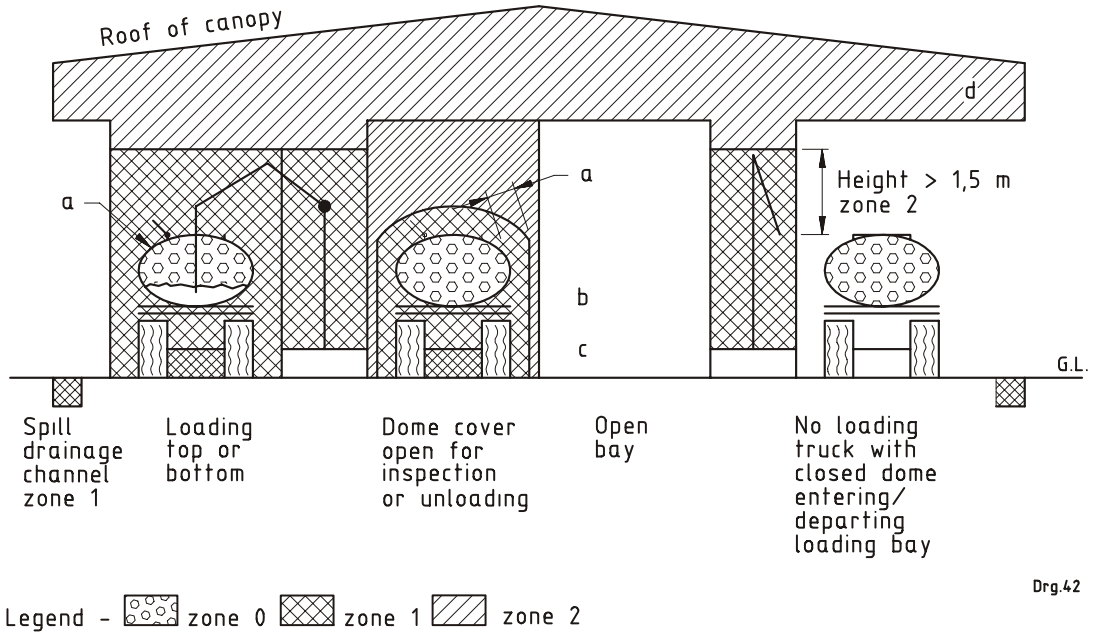
Figure A.6 (a) — Bottom loading bulk truck loading of class I flammable liquid or class II and class III combustible liquids at temperatures above their flash points, with no overhead canopy



NOTE If a canopy is provided over loading area then all the space above the zone 1 area will be zone 2 up to the roof.

[a] A transient zone 2 occurs after spillages (see figure A.7.(b)).

Figure A.6 (b) — Top or bottom bulk truck loading of class II and class III combustible liquids at temperatures below their flash points

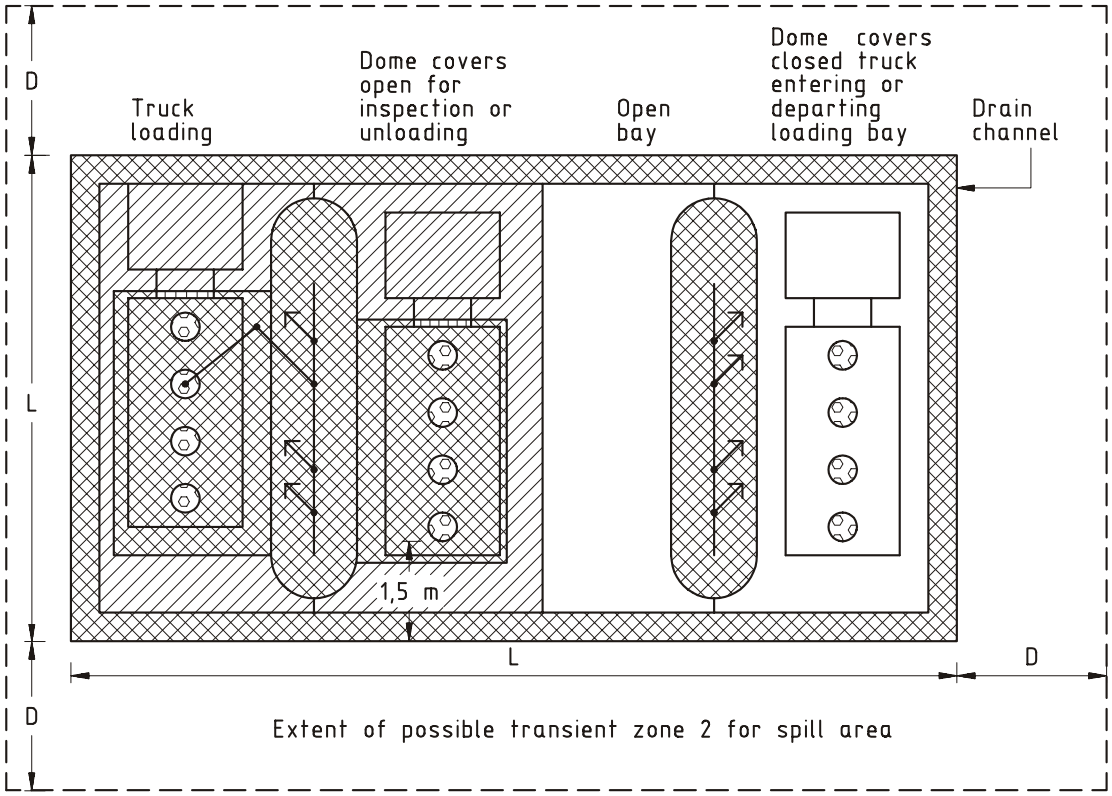


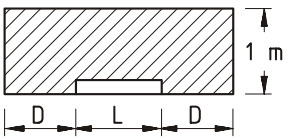
[a] Extent of zone 1 will be 1,5 m from edge of mancover opening for top loading and 1 m for bottom loading. Extent of zone 1 is 1 m from vent pipe opening with closed mancover.

[b] For class II and class III combustible liquids below their flash points, no hazardous zones are created externally to the truck tanks.

[c] A transient zone 2 occurs after spillages (see figure A.7.(b)). This applies to class II and class III combustible liquids as well.

Figure A.7 (a) — Top or bottom loading bulk truck gantry with overhead canopy for class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points





L m	D m
Less than 5	3
5 to less than 10	7,5
10 or greater	15

Drg 43

Legend - zone 0 zone 1 zone 2

NOTE 1 D is the extent of the transient hazardous area zone 2 from the edge of the spill pool area.

NOTE 2 L is the length of the spill pool (L is dependent upon the drainage design and estimated size of the spill pool).

Figure A.7 (b) — Plan view for top or bottom loading bulk truck gantry for class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points

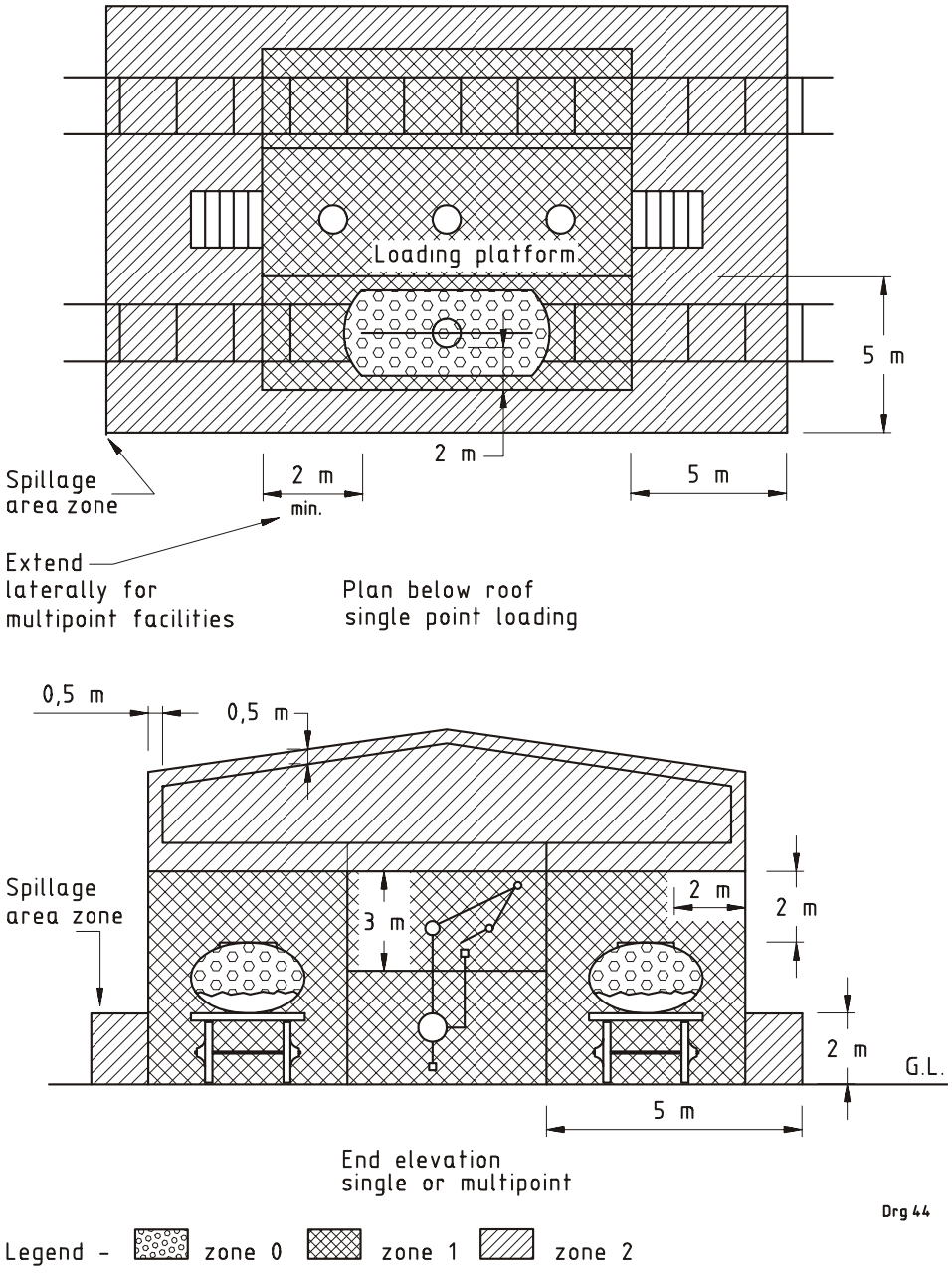
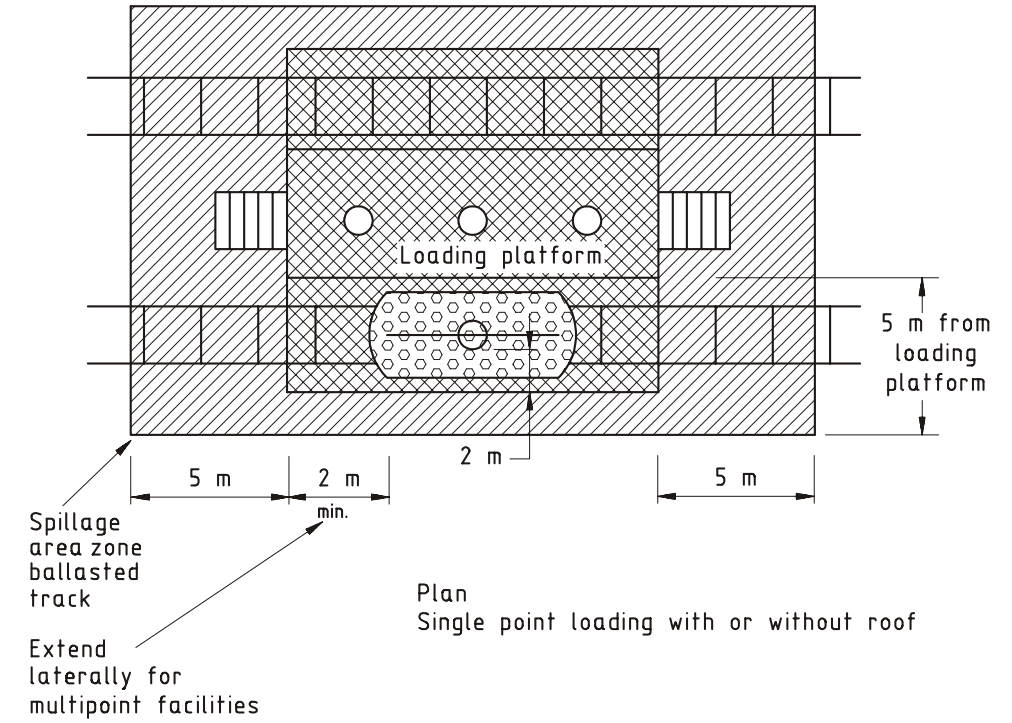


Figure A.8 — Railcar top loading for class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points



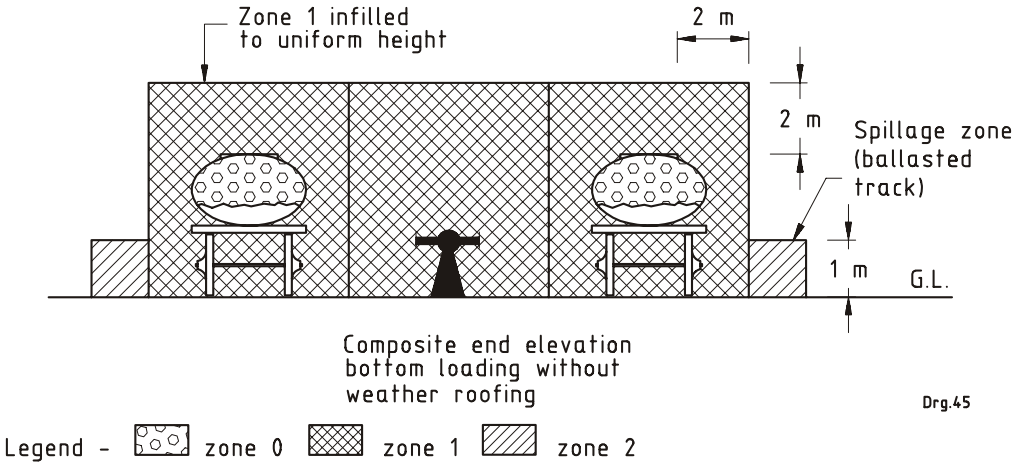
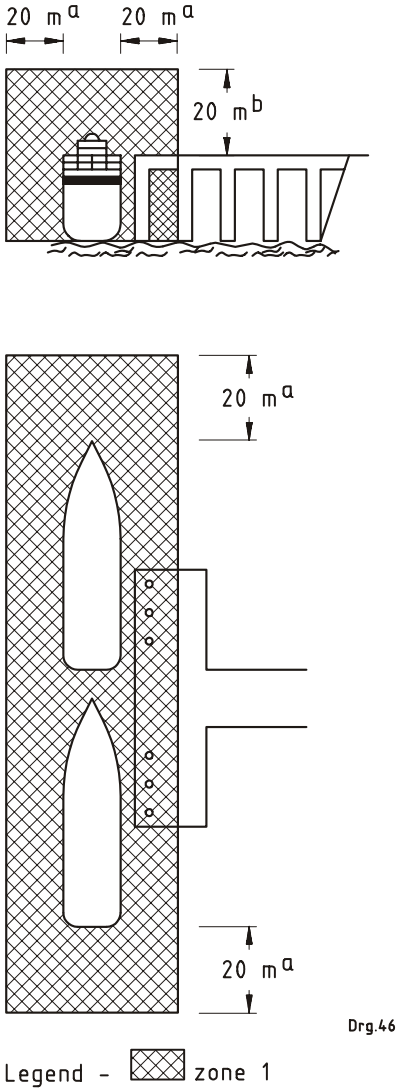


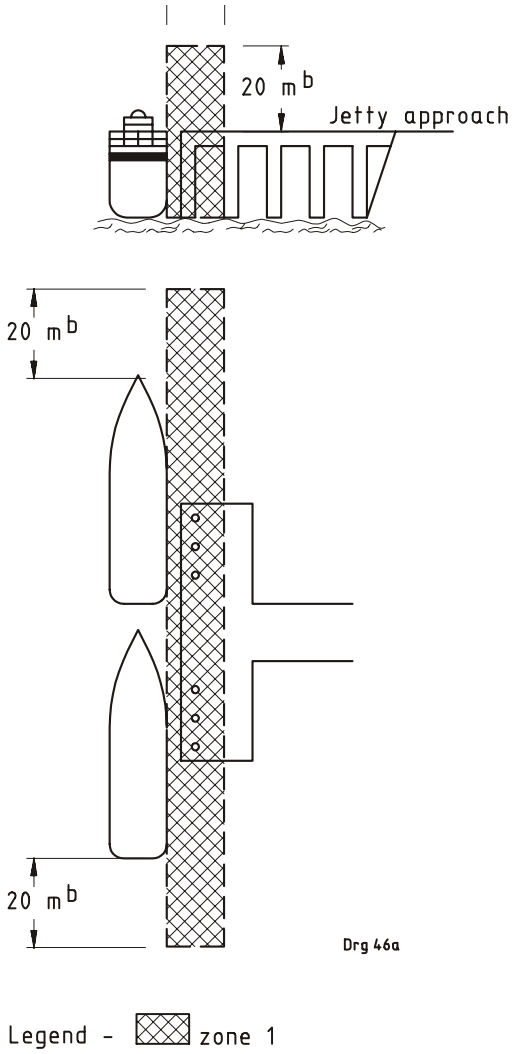
Figure A.9 — Railcar bottom loading for class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points



[a] The above zone 1 is additional to any hazardous area assessed in consequence of all other equipment on the jetty.

[b] The height of the hazardous area should be 10 m above the highest vent point. This can be reduced to 5 m for loading rates of 10 000 l/min or less.

Figure A.10 — Jetties loading and discharge facilities



NOTE Other hazardous areas or jetty should be evaluated by reference to all equipment on the jetty.

[a] If non-segregated ballasting or gas freeing is carried out, then the jetty shall be classed as for loading.

[b] Can be reduced to 10 m for vessels with discharge rates of 1 000 L/min or less.

Figure A.11 — Jetties discharge facilities only

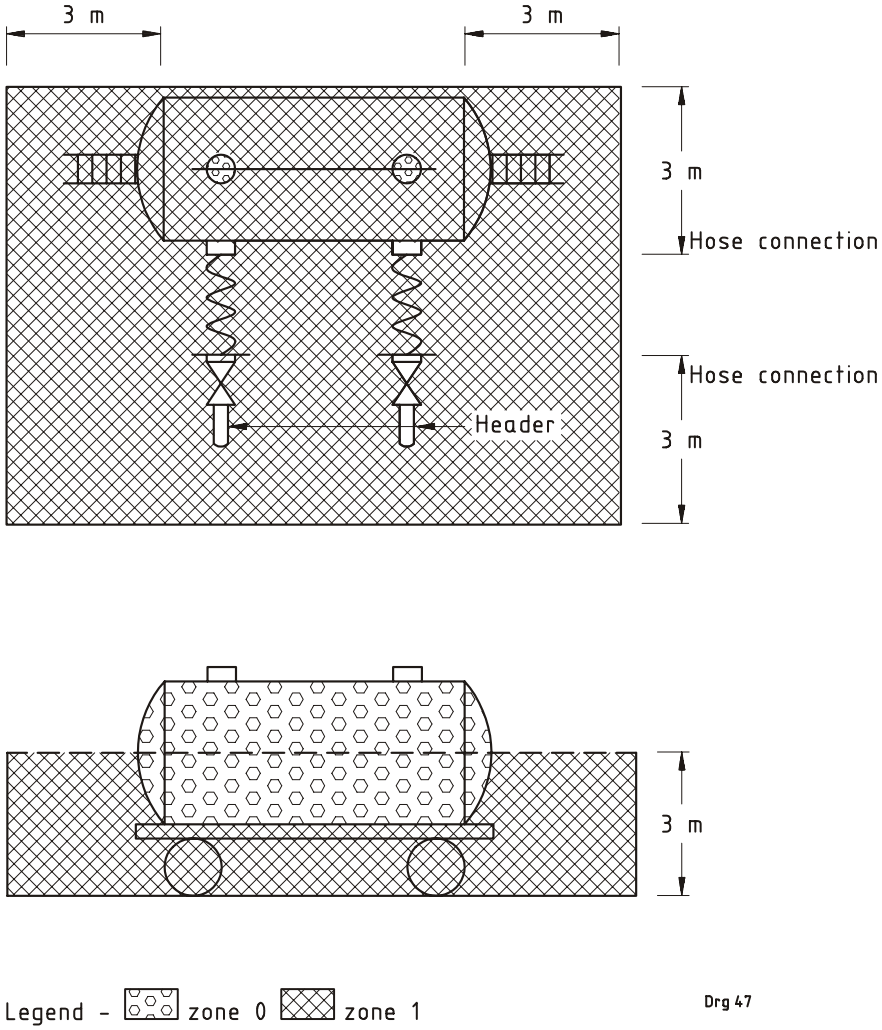


Figure A.12 — Railcar discharge via hose connection of class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points

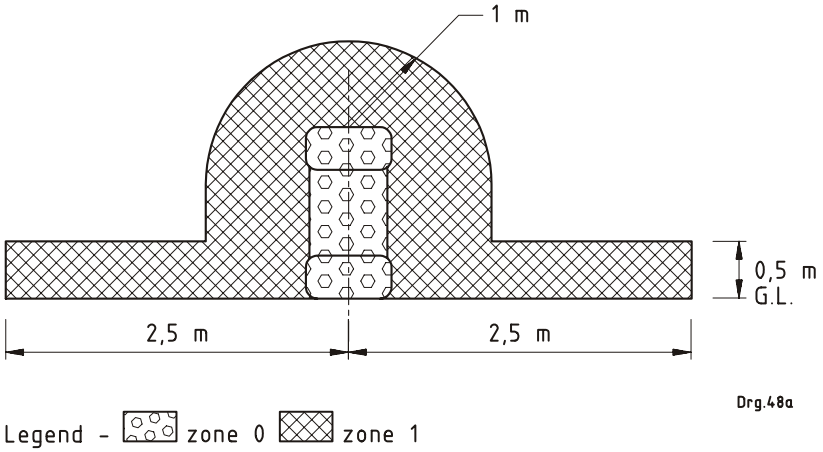


Figure A.13 (a) — Drum filling in the open air of class I flammable liquids and class II and class III combustible liquids at temperatures at or above their flash points

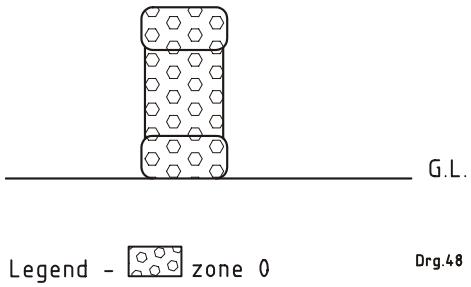
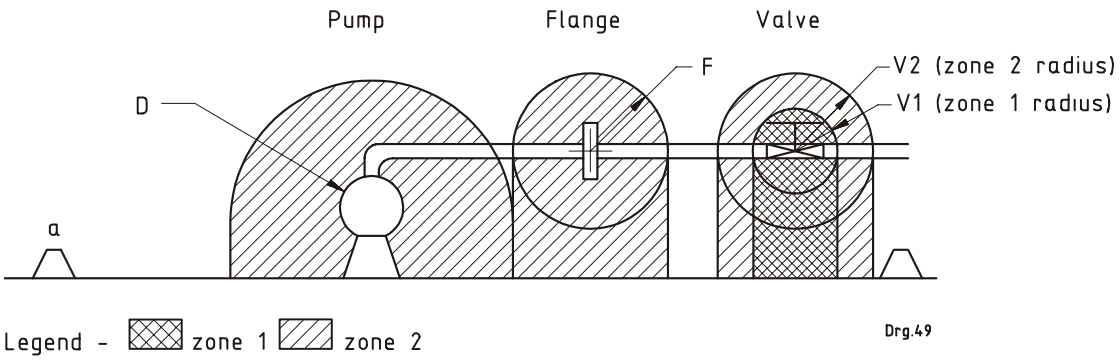


Figure A.13 (b) — Drum filling in the open air of class II and class III combustible liquids at temperatures below their flash points



Flow rate L/min	Radius m				
	D		F	V1	V2
	N	H			
< 1 700	3	3	1,5	0,3	1,5
> 1 700	7,5	3	1,5	0,3	1,5
Legend N = Normal pumps suitable for petroleum products. H = High integrity pumps (for example to API STD 610).					

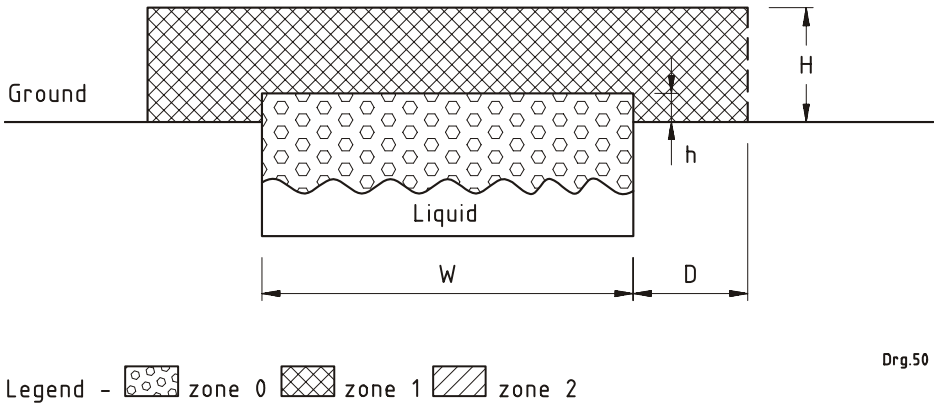
NOTE 1 The above applies for class I flammable liquids and class II and class III combustible liquids at or above their flash points.

NOTE 2 Care should be taken when using pumps for class I, class II and class III liquids that are adjacent to each other. This could cause pumps for class II and class III liquids to be in a hazardous location.

NOTE 3 If flanges are regularly broken (more than once per week), zone 2 changes to zone 1.

[a] If a spillage area is allowed, a transient zone 2 hazardous area shall be allowed.

Figure A.14 — Pump area in open air



W m	D m	H m
Less than 5	3	3 + h
5 to less than 10	7,5	3 + h
10 or greater	7,5	7,5

NOTE Interceptors and separators should normally be regarded as primary grade sources of release. If flammable class I liquid can only enter in exceptional cases they can be regarded as secondary sources and zone 1 will change to zone 2 and zone 0 to zone 1.

Figure A.15 — Separator or interceptor for class I, class II and class III combustible liquids

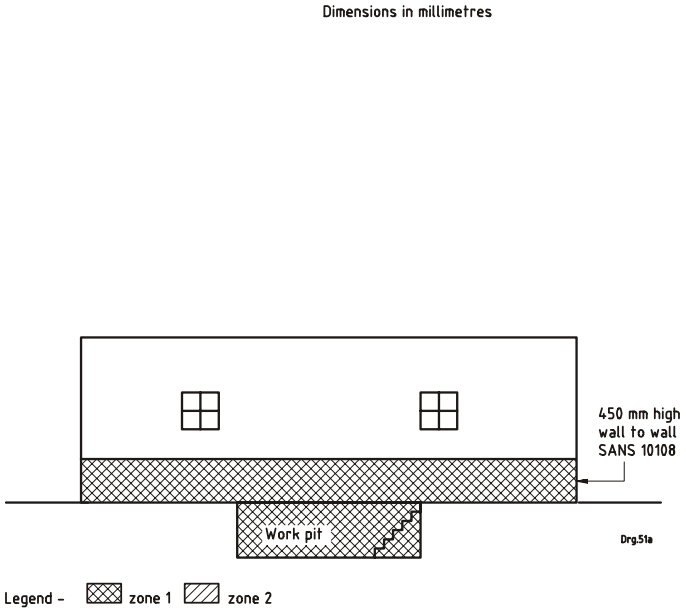


Figure A.16 — Workshop for repairing bulk fuel delivery vehicles that carry class I, class II or class III products

(a) Vehicle dip hatches shall remain closed.

(b) All the valves in the vehicle's product pipelines shall remain closed.

(b) There shall be no open product pipe work.

(d) There shall be no fuel leaks.

(e) Loaded vehicles shall not be taken into a workshop.

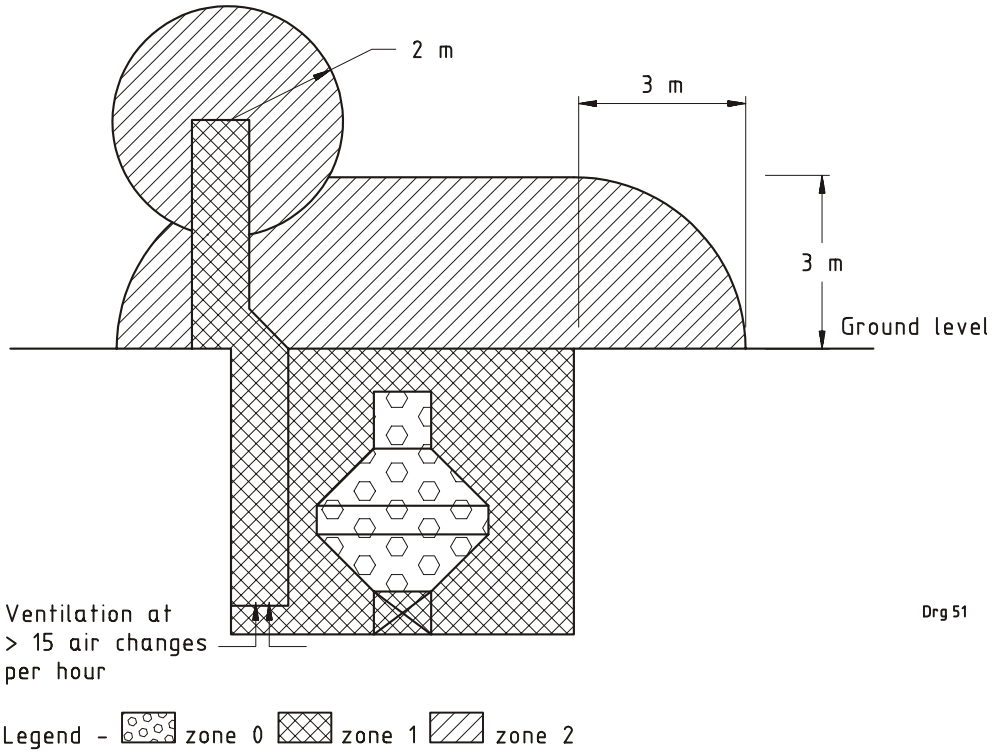


Figure A.17 — Test measure and test pit

Annex B
(normative)

Service stations

The hazardous area classification examples at service stations listed below are based on product classes as defined in SANS 10089-1 and using the principles in the IP Code – Part 15. The information is repeated in SANS 10089-3. Reference shall be made to SANS 1020 for classification of hazardous areas in dispensers or metering pumps or hazardous areas around them caused by the dispenser itself.

Figure	Description
B.1	Gravity discharge to underground tank
B.2	Low hose pump/dispenser with vapour barrier
B.3	Vehicle repair areas and workshop

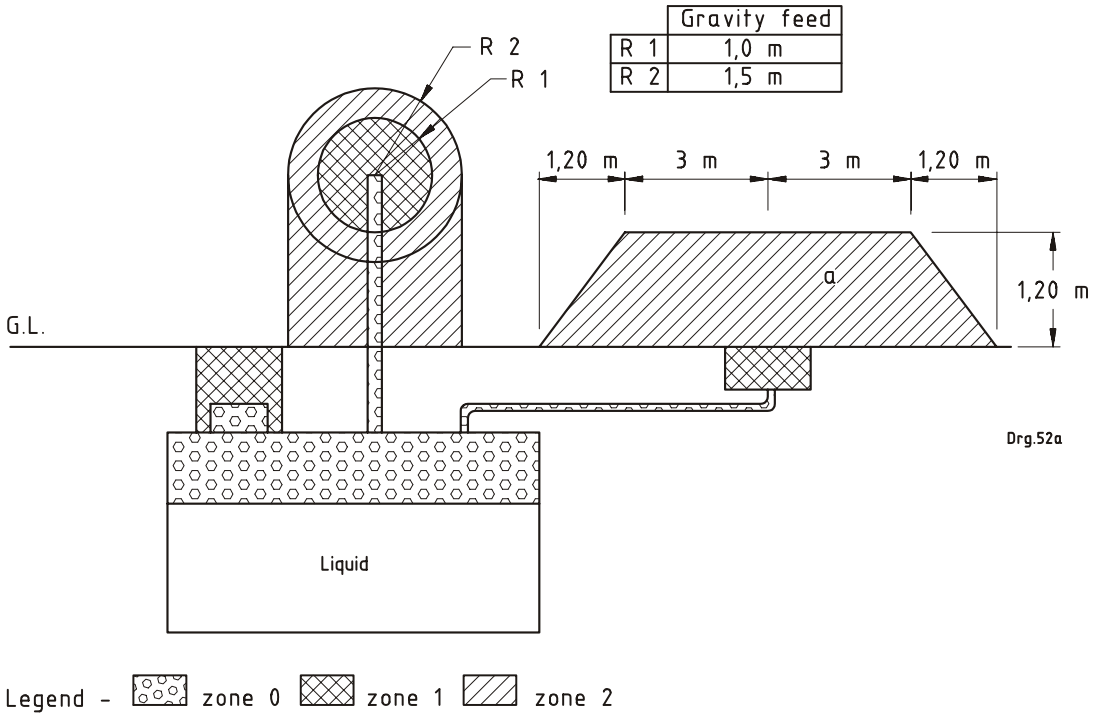


Figure B.1 (a) — Underground tank with class I flammable liquids or class II and class III combustible liquids at temperatures at or above their flash points, with gravity filling

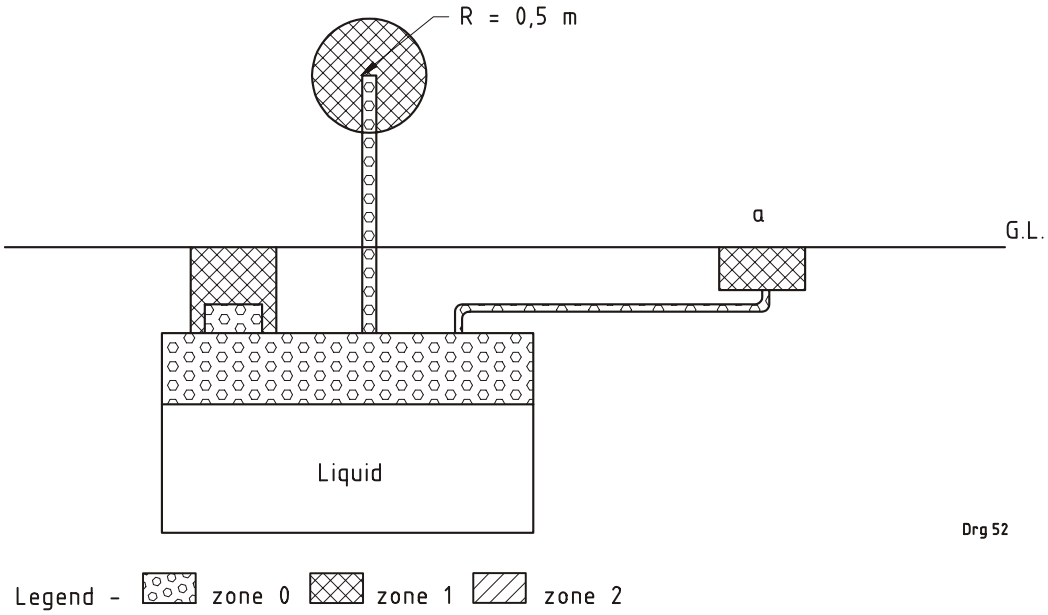
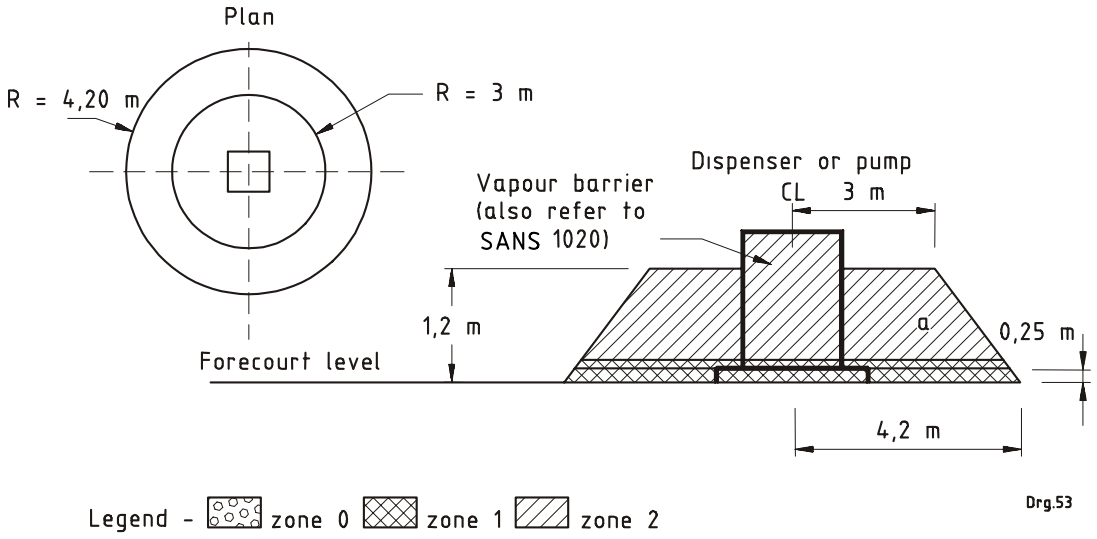


Figure B.1 (b) — Underground tank with class II and class III combustible liquids at temperatures below their flash points, with gravity filling



NOTE Refer to SANS 1020 for the dispenser or the metering pump hazardous area classification.

Figure B.2 — Low hose dispenser with vapour barrier

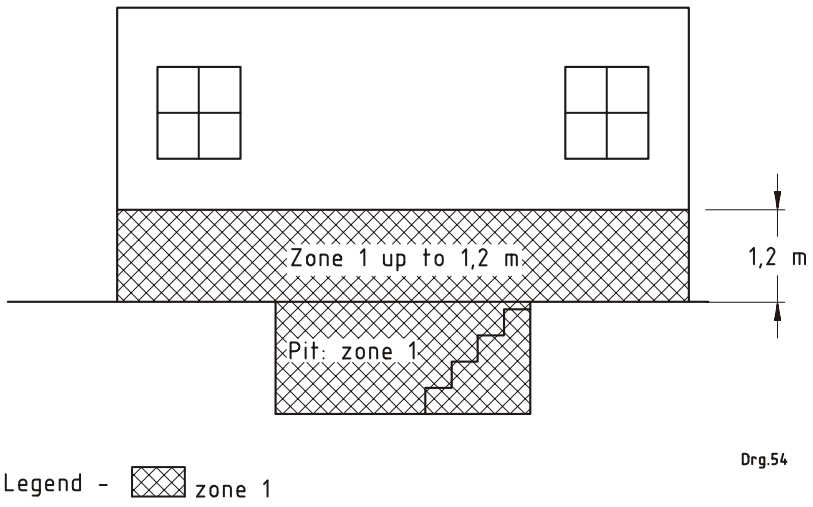


Figure B.3 — Workshop with pit

Annex C
(normative)

Earthing and bonding

The following figures illustrate earthing and bonding in various areas:

Figure	Description
C.1	Electrical safety earthing single line diagram
C.2	Earthing and bonding to prevent static build-up
C.3	Earth boss connection
C.4	Flange earth connection
C.5	Horizontal tank earthing
C.6	Road tanker bulk loading
C.7	Rail-fed depot — Bottom loading/decanting only (A)
C.8	Rail-fed depot — Bottom loading/decanting only (B)
C.9	Pipe line-fed depot — Top loading only (A)
C.10	Pipe line-fed depot — Top loading only (B)
C.11	Pipe line-fed depot — Combined top loading and decanting

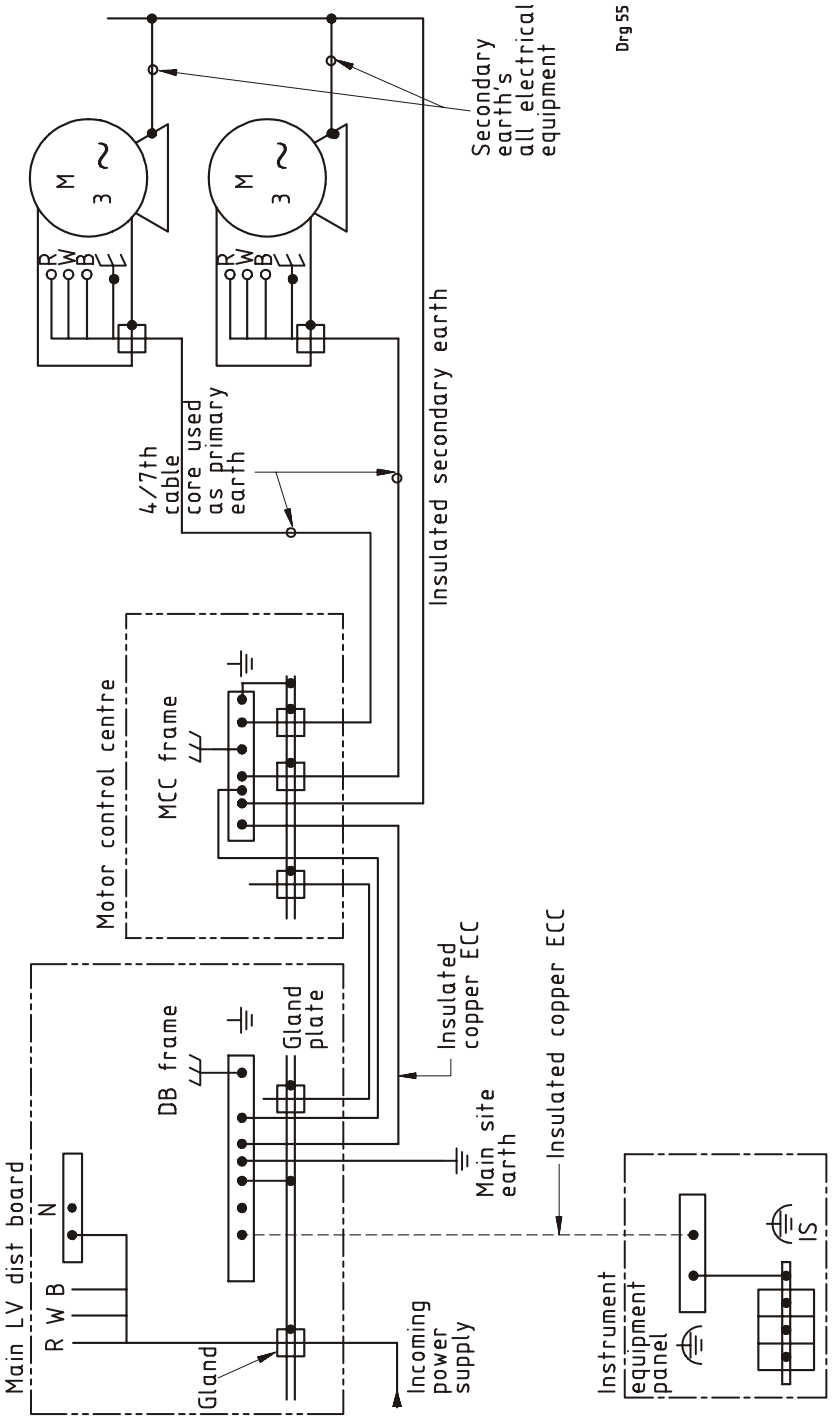


Figure C.1 — Earthing and bonding of electrical circuits

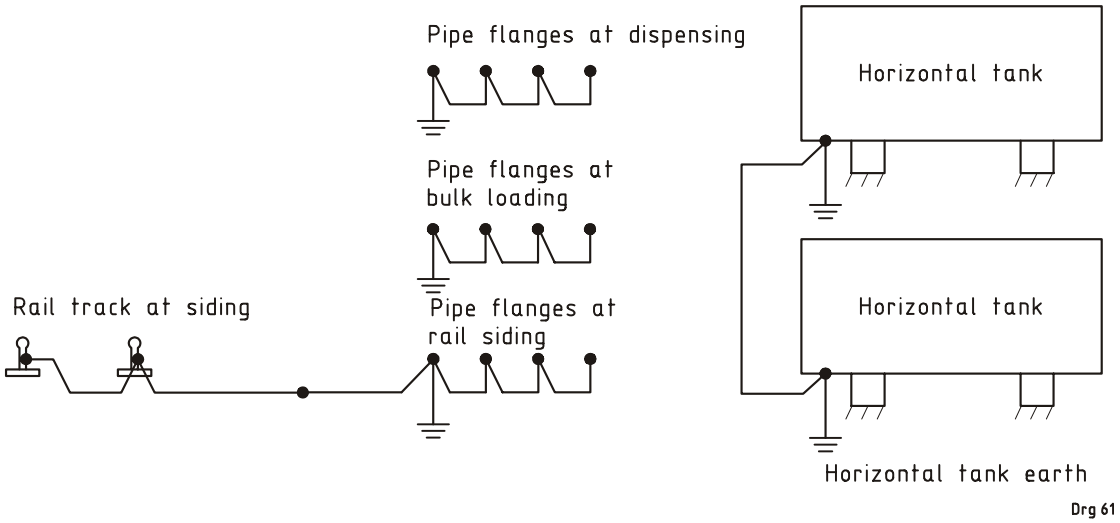


Figure C.2 — Earthing and bonding to prevent static build-up

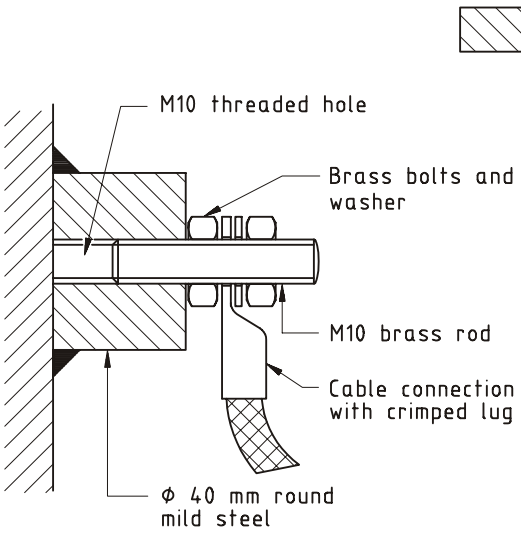


Figure C.3 — Typical earth boss connection on tanks and other equipment

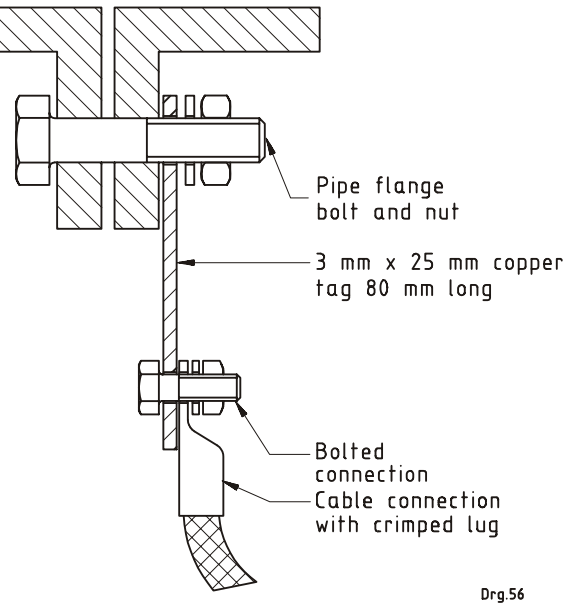


Figure C.4 — Typical pipe flange earth bond

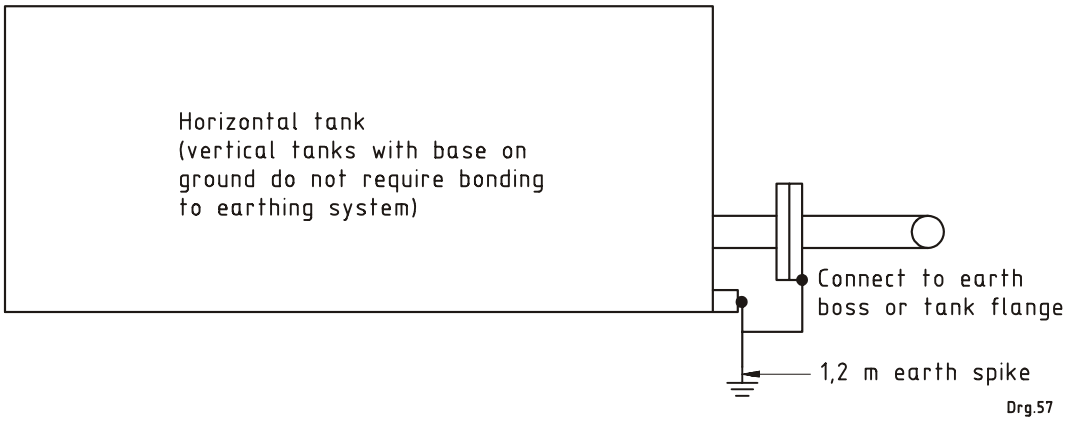


Figure C.5 — Horizontal tank and raised vertical tank earthing

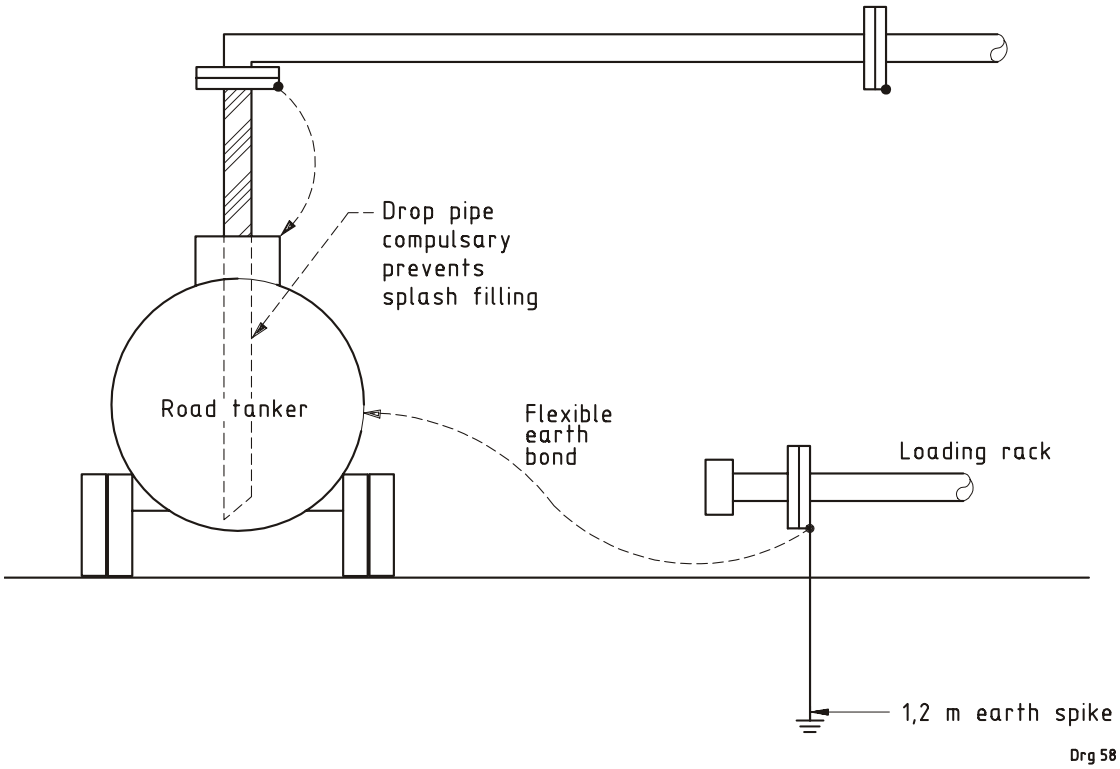


Figure C.6 — Road tanker bulk loading (top loading shown)

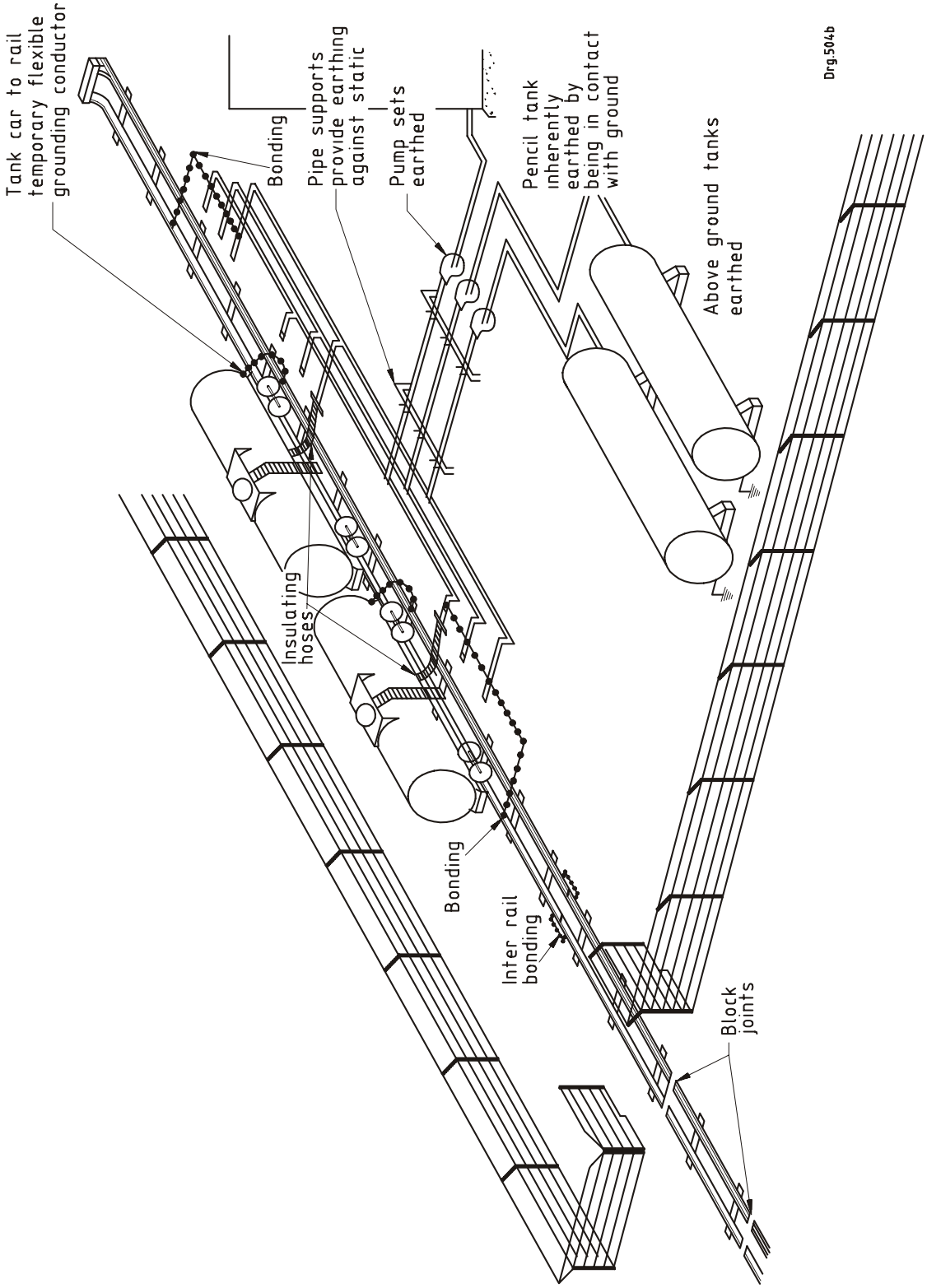


Figure C.7 — Rail-fed depot — Bottom loading/decanting only (A)

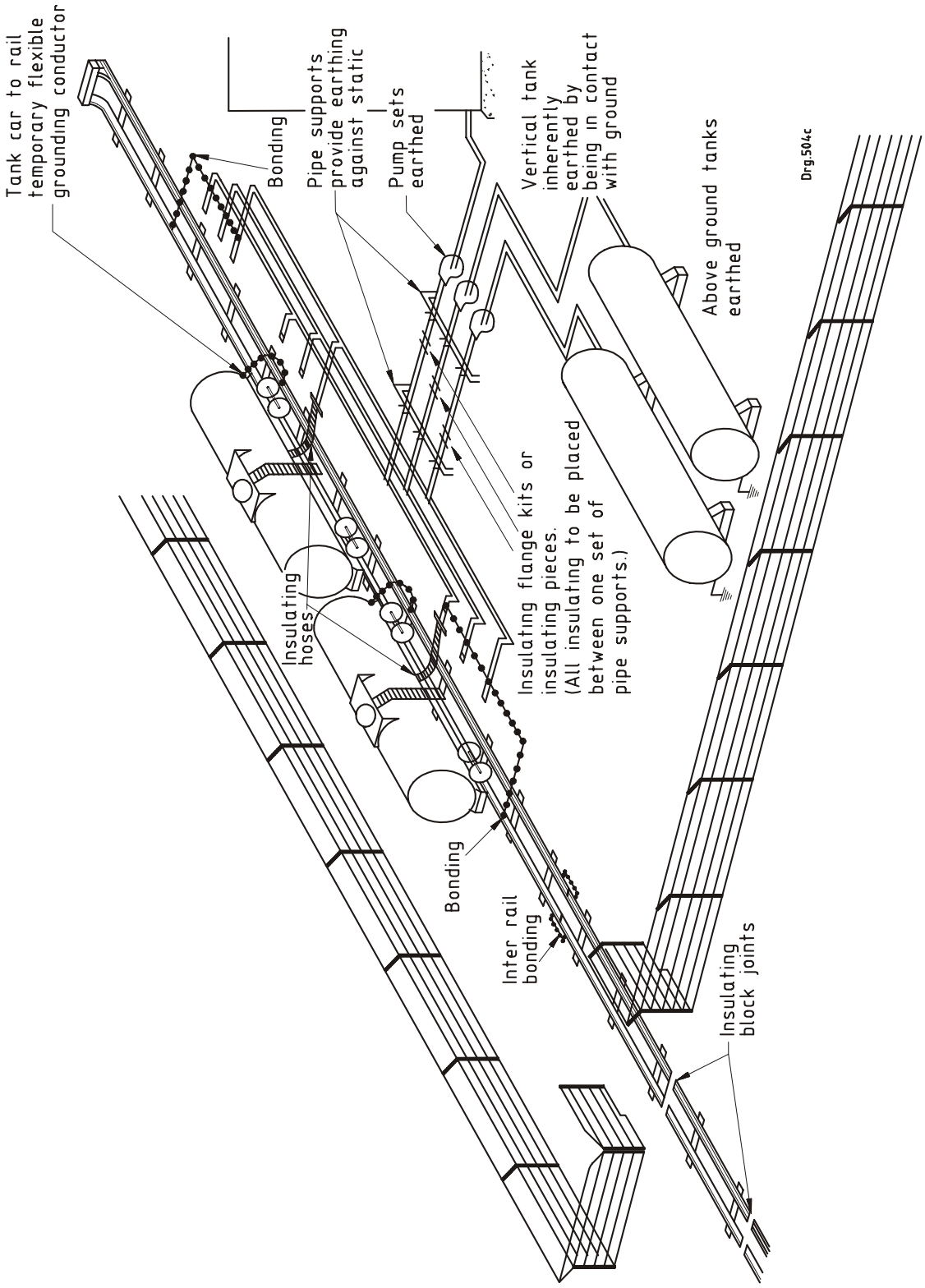


Figure C.8 — Rail-fed depot — Bottom loading/decanting only (B)

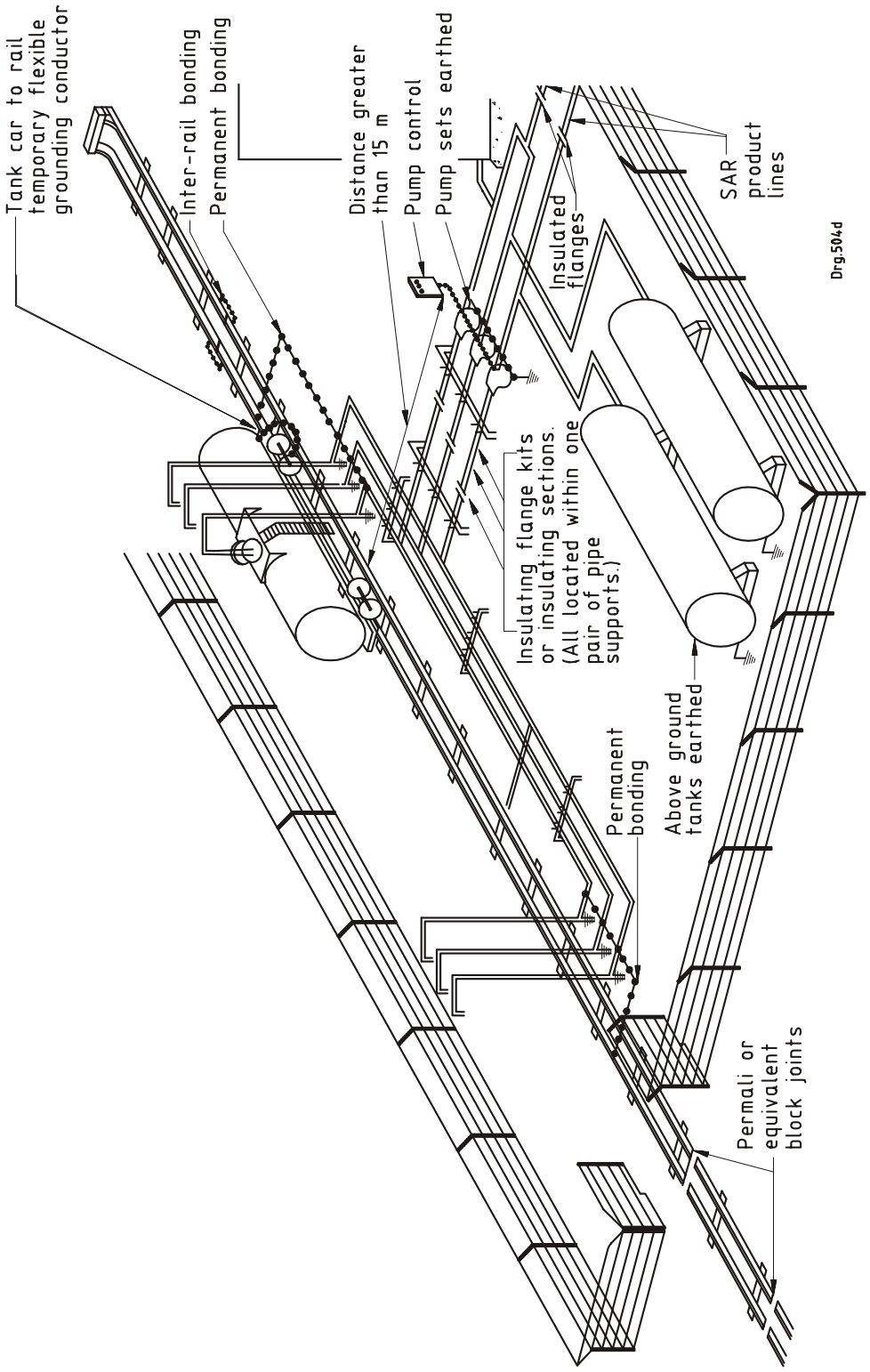


Figure C.9 — Pipe line-fed depot — Top loading only (A)

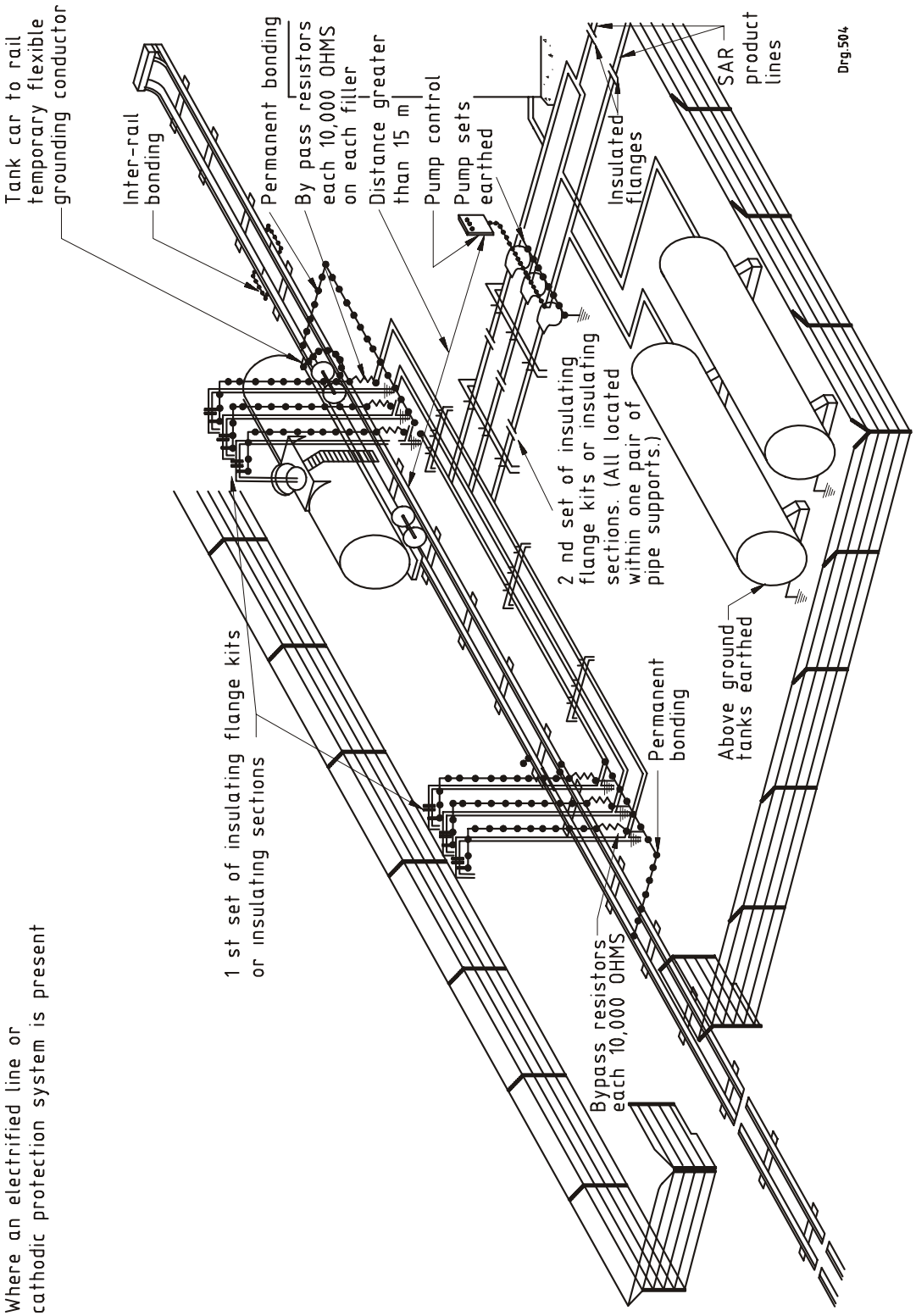


Figure C.10 — Pipe line-fed depot — Top loading only (B)

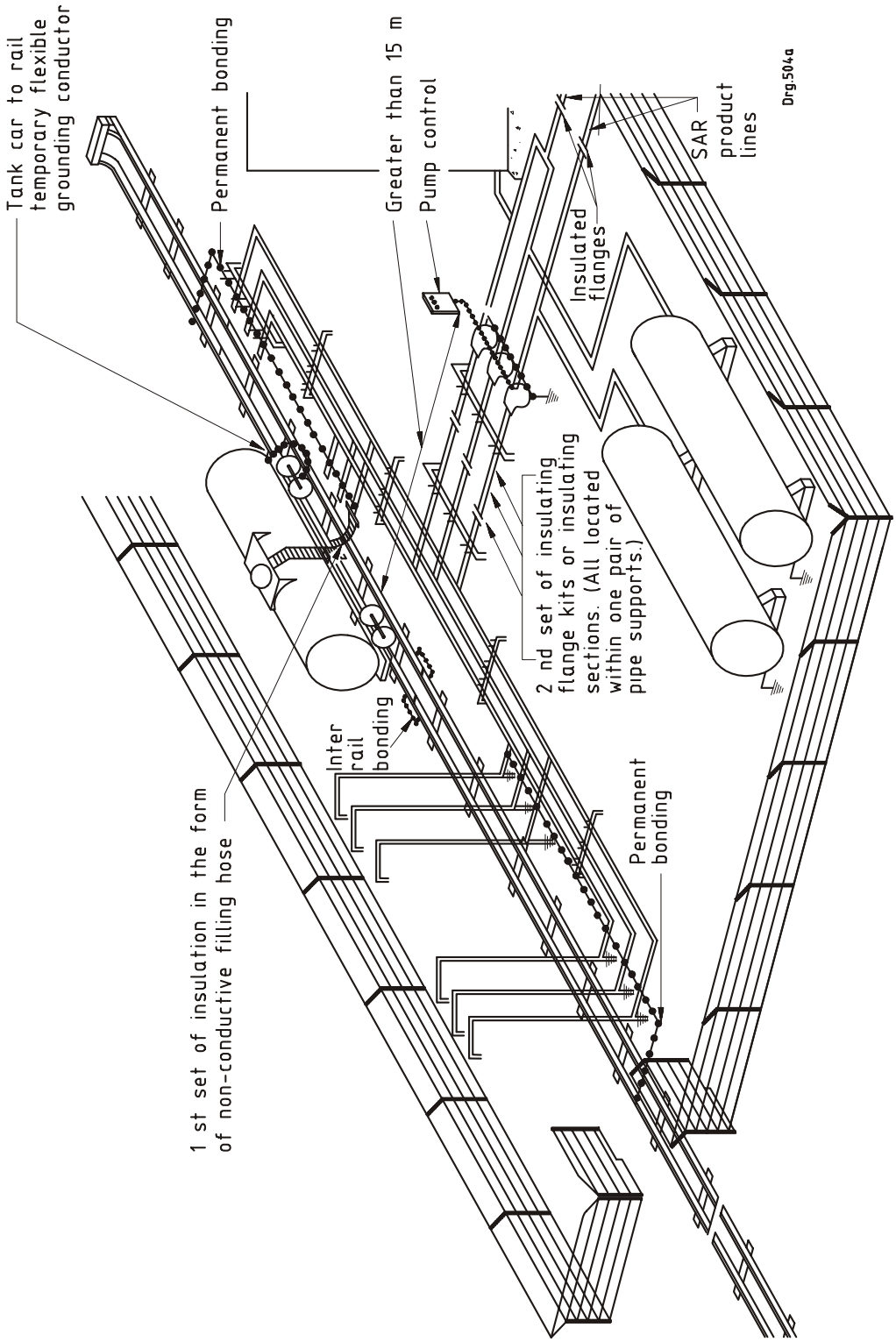


Figure C.11 — Pipe line-fed depot — Combined top loading and decanting

Annex D
(informative)

Other requirements

The following is a checklist of items that have to be complied with or are recommended as good practice, and is included for information only:

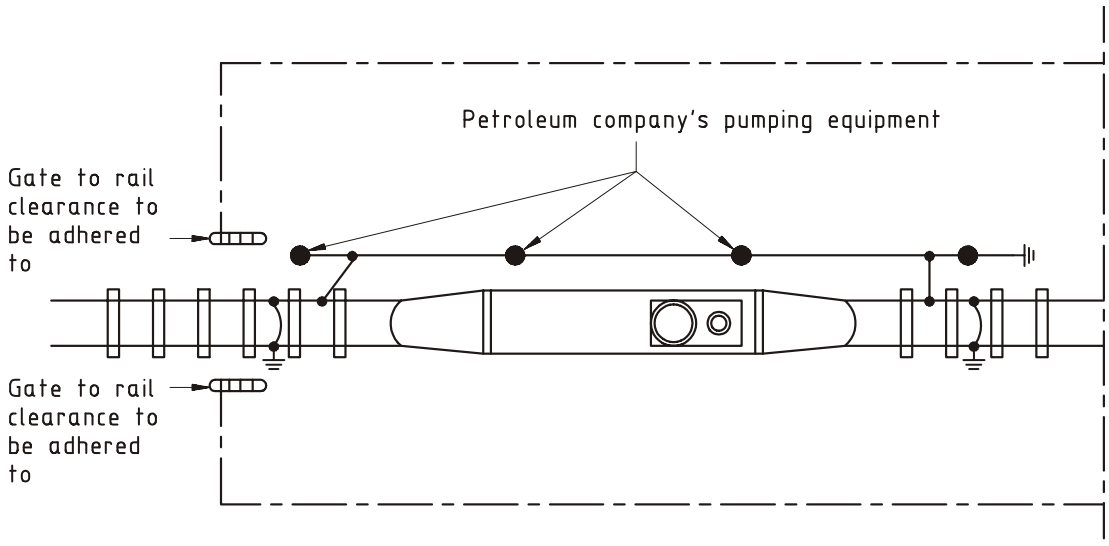
a) the OHS Act (Act No. 85 of 1993) requires electrical installations in hazardous locations to be inspected at least every 24 months (refer to Electrical Machinery Regulation 8);

b) the OHS Act also requires that a valid Certificate of Compliance be available for any electrical work carried out (refer to the Electrical Installation Regulations);

c) all equipment used in hazardous locations should carry the required certification referred to in this part of SANS 10089. Any such certified equipment that is repaired should be re-certified and marked by a repair facility that is authorized to do so by a recognized certifying authority. It is recommended that the equivalent equipment inspection certificates be kept on record as well to confirm certification; and

d) all intrinsically safe circuits should have system certification from an approved authority.

All work carried out at installations should be regulated by a work permit system which incorporates safe isolation procedures as per the requirements of SANS 10089-1.



Bibliography

ARP 0108, *Regulatory requirements for explosion-protected apparatus.*

SANS 10087-7 (SABS 087-7), *The handling, storage and distribution of liquefied petroleum gas in domestic, commercial and industrial installations – Part 7: Storage filling sites for refillable liquefied petroleum gas (LPG) containers of capacity not exceeding 9 kg*.

Spoornet Engineering Instruction GI 049 – *Earthing and bonding arrangements in rail sidings handling petrol, oil as explosive commodities* – Spoornet Infrastructure, Electrical.