Draft for Public comment

ZAMBIAN STANDARD

THE PETROLEUM INDUSTRY – Code of Practice

Part 2: Electrical installations in the distribution and marketing sector

This draft standard is for public enquiry only. It must not be used or referred to as a Zambian Standard.

ZAMBIA BUREAU OF STANDARDS
Amendments issued since publications

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A Zambian Standard does not purport to include all the necessary provisions of a contract. Users of Zambian Standards are responsible for their correct application.

TECHNICAL COMMITTEE RESPONSIBLE

This Zambian Standard was prepared by the Technical Committee TC 2/14 Petroleum Storage Installation upon which the following organizations were represented:

DH Engineering
Energy Regulation Board
Engineering Institution of Zambia
Indeni Petroleum Refinery Limited
Ministry of Local Government and Housing
Ministry of Mines Energy and Water Development
Mount Meru Petroleum (Z) Limited
Total Zambia Limited
Zambia Bureau of Standards
Zambia Environmental Management Agency
Zambia Weights and Measures Agency
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FOREWORD

The Zambia Bureau of Standards (ZABS) is the Statutory Organization established by an Act of Parliament. ZABS is responsible for the preparation of national standards through its various Technical committees composed of representation from government departments, the industry, academia, regulators, consumer associations and non-governmental organizations.

This National standard has been prepared in accordance with the procedures of the ZABS. All users should ensure that they have the latest edition of this publication as standards are revised from time to time.

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Compliance with a Zambian standard does not of itself confer immunity from legal obligations.

DZS 385 Part 1: 2015 was prepared by the Technical Committee TC 2/14 Petroleum Storage Installation

ZS 385 consists of the following parts under the general title the petroleum industry.

1. Part 1: Storage and distribution of petroleum products in above-ground bulk installations.
2. Part 2: Electrical installations in the distribution and marketing sector.
3. Part 3: The installation of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations.

This Part of ZS 385 was based on SANS 10089-1, The Petroleum Industry - Code of Practice - Part 1: Storage and distribution of petroleum products in above-ground bulk installations.
1. SCOPE

This part of ZS 385 covers the recommended safe practice in the design, construction, installation and maintenance of electrical and 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 code should apply to refineries or exploration facilities, unless any of these installations are similar to such facilities as those listed above.

This standard does not cover the requirements for flammable dust.

2. NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ZS 385. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this part of ZS 385 are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the Zambia Bureau of Standards.

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

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

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

**ZS IEC 60079-10**  
Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas.

**ZS IEC 60079-11**  
Electrical apparatus for explosive gas atmospheres- Part 11: Intrinsic safety "i".

**IP Code part 15**  

**IP Code part 21**  

**ZS 429**  
The handling, storage and distribution of liquefied petroleum gas in domestic, commercial and industrial installations - code of practice

**ZS IEC 60079-17**  
Explosive atmospheres - Part 17: Electrical installations inspection and maintenance

**ZS 62305**  
Lightning protection standard

**ZS 791**  
The wiring of premises.

**ZS 385-1**  
The petroleum industry – Part I: Storage and distribution of petroleum products in above-ground bulk installations.
3. DEFINITIONS

For the purpose of this part of ZS 385 the following definitions apply:

3.1 approved standard

A standard (a code of practice, a specification or a test method) that has been approved by the approving authority (see 3.3) in terms of the relevant statutory regulations

3.2 approved testing/certification body

A testing laboratory that is equipped to carry out the tests specified in the appropriate standards and whose certificates are acceptable to the appropriate approving authority (see 3.3)

3.3 approving authority

Within the scope of the Factories Act, Cap 441 of the Laws of Zambia: the Chief Inspector
Within the scope of the Energy Regulation Act, Cap 436 of the Laws of Zambia, the Board

3.4 bonding

a low impedance connection, usually less than 2 Ohm

3.5 cathodic protection

a technique for mitigating corrosion attack on a metal by making it the cathode in the electrolytic environment, by using as anode another metal that will preferentially be corroded

3.6 combustible liquid

a liquid that has a closed-cup flash point at or above 38°C. For the purpose of this part of ZS 385, combustible liquids shall be subdivided as follows:

Class II: liquids that have a closed-cup flash point at or above 38°C and below 60.5°C.
Class IIIA: liquids that have a closed-cup flash point at or above 60.5°C and below 93°C.
Class IIIB: liquids that have a closed-cup flash point at or above 93°C.

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

3.7 encapsulated electrical apparatus

Ex 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

a 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 should be 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

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

NOTE Classes of petroleum are defined in ZS 385-1 as follows and apply to this part of ZS 385:

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 ZS 385:

Class 0. Liquefied Petroleum Gases (LPG)
Class I. Liquids that have flash points below 21ºC.
Class II (1). Liquids that have flash points from 21ºC up to and including 55 ºC, handled below flash point.
Class II (2). Liquids that have flash points from 21ºC up to and including 55 ºC, handled at or above flash point.
Class III (1). Liquids that have flash points above 55 ºC up to and including 100ºC, handled below flash point.
Class III (2). Liquids that have flash points above 55 ºC up to and including 100ºC, handled at or above flash point.
Unclassified. Liquids that have flash points above 100ºC.

3.12 grade of release of flammable gasses, liquids or vapours

continuous release

a release that is likely to occur continuously in normal operation

primary release

a 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 1000 hours per year should be regarded as primary.)

secondary release

a 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 hours per year and for short periods only should be regarded as secondary.)

3.13 hazardous location

area

any three-dimensional region at a facility where there could be a risk of the ignition of a flammable gas, vapour or any other explosive material

3.14 hydraulic housing

housing which provides physical protection to the liquid or the vapour equipment (or both)
3.15 **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.

3.16 **intrinsically safe circuit** Ex i circuit

A 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.

3.17 **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.

3.18 **intrinsically safe electrical apparatus of categories "ia" and "ib"**

Electrical apparatus that, when tested in accordance with ZS IEC 60079-11, is incapable of causing ignitions under hazardous conditions.

3.19 **intrinsically safe system** Ex i system

A system that is certified by an approved testing/certification body and 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.

3.20 **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.

3.21 **open premises**

Any space that is substantially open and offers no obstruction to the free and natural passage of air through it. Such premises may be roofed for weather protection or enclosed, for example, in wire mesh or expanded metal or louvres or open block construction, provided that adequate ventilation exists and the roof and side enclosures do not at any point materially obstruct the free passage of air to and through any point of the space.

3.22 **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.

3.23 **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. The overpressure is maintained either with or without a continuous flow of the protective inert gas or fresh air.
3.24 vapour barrier

A sealing system that is used to limit the passage of hazardous gasses or vapours

4. CLASSIFICATION OF HAZARDOUS LOCATIONS

4.1 General

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 ZS 402, ZS IEC 60079-10, IP Code Part 15 or API RP 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.

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.

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 clause 4.2. Ventilation could serve to reduce the extent of a hazardous area as discussed in (c) below, or could so affect the duration of the flammable atmosphere that a reduced zone can be allocated.

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).

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

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.

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 ZS 385. These examples apply to the oil industry distribution and marketing standards as given in ZS 385-1 and ZS 385-3, respectively, and when the examples are applied, the facility under consideration must 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 ZS IEC 60079-10, the British Institute of Petroleum's Model Code of Safe Practice, Part 15, the American Petroleum Institute's recommended practice 500, or other approved standards should be considered to have been classified in accordance with this standard.

4.2 Zone 0, Zone 1 And Zone 2 Locations

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.

4.2.1 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.

4.2.2 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 may 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 may result in the zone 1 location being revised to zone 0 (for example a closed test measure pit with excessive product spillage).

4.2.3 Zone 2 locations

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.

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.

Where inadequate construction or maintenance methods (or both) are followed, resulting in significant leakage, the classification category must 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

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 testing/certification bodies whose certification will be acceptable to the Bureau are listed in ZS 402.

All intrinsically safe circuits (Ex i circuits) must have system certification from an approved testing/certification body 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 must 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 testing authority; and
c) information about cabling and wiring indicating cable types and lengths as well as resistance, capacitance and inductance characteristics.

NOTE: ZS IEC 60079-17 gives more information about certification requirements for Ex i circuits

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 ZS 402. In the petroleum industry, hydrocarbon type flammable vapours and Liquefied Petroleum Gas (LPG) normally require apparatus suitable for gas group II A, temperature class T3. Hydrogen is a group II C, 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 must be examined in conjunction with the marking for detailed information on, for example, special conditions of use. Annex F in ZS 402 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 an extract from ZS 402, and further information can be obtained from that standard.

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<td>Zone</td>
<td>Equipment classification</td>
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<tr>
<td>0</td>
<td>Intrinsically safe apparatus of category “ia” (Ex ia) with over voltage surge protection</td>
</tr>
<tr>
<td>1</td>
<td>Flameproof (Ex d)</td>
</tr>
<tr>
<td></td>
<td>Specially protected (Ex s)</td>
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<tr>
<td></td>
<td>Increased safety (Ex e)&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
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<td>Encapsulated (Ex m)</td>
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<td>Powder or sand filled (Ex q)</td>
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<tr>
<td></td>
<td>Intrinsically safe (Ex ia or ib)</td>
</tr>
<tr>
<td></td>
<td>Pressurised (Ex p)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>Any type suitable for Zone 0 or Zone 1, or</td>
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7. INSTALLATION, MAINTENANCE, INSPECTION AND REPAIR

Lockout and work permit systems must be implemented when repair and maintenance work is done. It is important that the requirements for safe isolation be complied with. Refer to ZS 385-1 in this regard.

This standard requires that a valid certificate of compliance in accordance with ZS 418 is issued for any new installation work that is carried out at any facility.

Any explosion-protected equipment that has repair work or modifications done to it must be re-certificated by an approving testing/certification body (for example when electric motors are repaired or re-wound).

8. CATHODIC PROTECTION

8.1 General

Impressed current cathodic protection systems are widely used in the petroleum industry to prevent corrosion.

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

Cathodic protection may 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.

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 must therefore be used with care.

Incendiary 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 tankers, barges, and rail car 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.

The apparatus used and circuits employed for such systems in hazardous locations must generally comply with the following:
a) connection to structures must be made using an earth connection boss designed for that purpose;

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

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

8.2 Protection

In order to reduce the risks associated with incendiary 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) When maintenance or repair work is undertaken, switch off the source of power for the cathodic protection equipment, because the inductance of the system may cause incendiary sparking. Because of the time factor associated with depolarisation, care must be taken to apply the necessary bonding across pipe flanges and other connections in which cathodic protection currents may flow, when disconnecting such joints during maintenance and repair operations.

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

c) Check the insulation of insulating flanges that are incorporated in the design of the protective system by periodic testing.

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

e) Fit surge arrestors on both sides of the rectifier equipment where there is a risk that voltage surges may be experienced due to switching or to lightning. It is recommended to use double wound transformers for the power supply of impressed current cathodic protection systems. Use a double pole switch to control each supply circuit entering a hazardous area.

f) When the cathodic protection system is under test, take every precaution to prevent incendiary sparking in a hazardous area. No danger should result from the use of a high resistance voltmeter or reference electrode for test purposes.

g) Locate the anode ground beds associated with impressed current systems in such a way they do not impose a hazard at fuel loading facilities.

9. REQUIREMENTS FOR EARTHING AND BONDING

9.1 Electrical Safety Earth

Electrical apparatus must be connected to an earthing system that will provide a low earth loop impedance path for quick clearing of faults. The requirements in ZS 418 should be followed in this regard. (Refer to annex C and ZS 418.)

In addition to the electrical safety earth provided to comply with ZS 418 (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).

9.2 Lightning Protection

Prevention of direct-strike lightning is generally impossible (see API RP 2003). Vertical type steel tanks connected to underground piping and resting on ground have proved to be sufficiently earthed for the safe dissipation of lightning strikes. Special circumstances may arise due to the use of non-conductive secondary containment systems where additional lightning protection may be required.
If additional lightning protection is considered necessary, the recommendations of ZS IEC 62305 should be followed.

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 must generally be earthed as follows:

- a) horizontal tanks and some raised vertical tanks above ground: connect to the earthing system;
- b) vertical tanks installed with bottom in contact with a ground bed: these tanks may be considered inherently earthed and no further earthing is required;
- c) underground tanks: these tanks can be considered inherently earthed. Glass fibre coated metal tanks may also be considered to be sufficiently earthed for the dissipation of static charge; and
- d) floating roof tanks and floating blanket tanks: the floating roof must be bonded to the tank in an approved way.

9.5 Static electricity and bonding

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

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

Some of the recommendations for minimising static electricity and hazardous practices associated with static electricity are listed below:

- a) 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.
- b) Avoid turbulence. Do not allow splash loading. Limit flow velocities to 1 m/s until drowned flow conditions are achieved.
- c) Avoid contaminants such as water that can become charged.
- d) Allow an adequate relaxation time for charge dissipation, depending on loading method, rate and type of product.
- e) It is recommended that excessive flow rates be avoided. The following may be used as a guide:
  \[ V \times D < 0.5 \text{ or } V < 6 \text{ m/s} \]
  whichever is the lower value where
  - \( V \) is the flow velocity, in metres per second; and
  - \( D \) is the pipe internal diameter, in metres.
- f) Methods must 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 A1).
g) Provide bonding of 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 connections must be provided.

h) Bond rails at sidings to the piping flanges and provide flexible clamp-on bonding leads at road tanker top loading to bond the tank to the product piping. Tanks must be bonded before loading. In general, above ground metallic conductive vessels, tankers (road, rail and sea), piping and other vessels and systems must be well bonded and earthed in order to dissipate any accumulated electrical charge.

i) Commercially available earthing 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 must be taken to implement procedures that will ensure that proper bonding does take place.

j) 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, must be avoided.

k) Small (up to 250 litre) portable containers may cause a hazard when they are filled. The following should be observed:

1) fixed electrical equipment should be appropriately certified as explosion-protected;
2) all conductive equipment in contact with the liquid should be earthed with a resistance path not exceeding 10 $\Omega$ for an entirely metallic path and 1 M$\Omega$ for a partly non-metallic path;
3) components should not be insulated by paint layers, in-line sight glasses, etc.;
4) drum pumps should be bonded to both the container being emptied and the one being filled; hoses and nozzles should be conductive;
5) there should be an adequate relaxation time downstream of filters;
6) if switch loading is suspected, care must be taken to use long metallic nozzles, conducting chains, etc.; and
7) non-metallic containers must not be used for transporting class I products, unless they are specifically approved for that purpose.

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 must be evaluated at electrified sidings.

Isolating flanges must be tested periodically to ensure their effectiveness.

10. INSTRUMENTATION SYSTEMS

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

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

Care must be taken so that uncertified or incorrectly certified portable equipment is not taken into hazardous locations.

The following specific examples are given:
- two-way radios or portable/mobile/cellular telephones or pagers;
- insulation resistance meters ("Meggers");
- current injection devices; and
flash lights, unless they are of the two or three cell (D type, non-rechargeable 1.5 V) type with rubber outer casing.

11. SIDDING

The staging track, on which tank wagons stand for filling or decanting, must 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 must ensure that conditions are safe from traversing traffic before the transferring of hazardous liquids/gases is commenced.

All block joints within the siding user’s enclosure must be continuity bonded with not less than two strands of 16 mm² copper equivalent wire using a suitable method for a good electrical connection.

The section of continuity bonded railway lines within the siding user’s enclosure must 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 mm² copper conductor shall be used.

Temporary flexible earth connectors may be used in addition to the permanent bonds. These temporary flexible connectors must be attached before any valve is opened or the pipe/hose has been coupled to the tank wagon. Similarly, they must 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.

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.

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

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 must be bridged by a flexible conductor equivalent 16 mm² 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 that fall outside the scope of this standard and that is provided and maintained by Spoornet.
ANNEX A
(normative)
Fuel storage depots

The hazardous area classification examples listed below are based on product classes as defined in ZS 385-1 and using the principles in the IP Code part 15, API RP 500 and ZS IEC 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 flashpoints.
- Combustible class II and class III liquids as defined by this code, stored or handled below their flash point.

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

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

NOTE 1 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 may be considered safe.

NOTE 2 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.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

Legend — □ □ zone 1 □ □ zone 2

NOTE 1 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 may be considered safe.

NOTE 2 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.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

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

NOTE 1 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 may be considered safe.

NOTE 2 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

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

NOTE 1 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 may be considered safe.

NOTE 2 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.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

Legend - zone 0  zone 1  zone 2

Figure A.5(b) — Underground tank with class II and class III combustible liquids at temperatures below their flash points, with gravity filling
Notes for Figures 3.7 (a) and (b):
1. Transient spillage zone areas normally free from hazard when no spillage is present, or for Class II(1) and III(1) materials.
2. If weather roofing is provided, all space above the Zone 1 area will be Zone 2 up to the roof (see 3.3.4.5).
3. For height of Zone 1 area see 3.3.4.1.

Figure A. 6 Bottom bulk truck loading
NOTE 1  Extent of zone 1 will be 1.5 m from edge of manoeuvre opening for top loading and 1 m for bottom loading. Extent of zone 1 is 1 m from vent pipe opening with closed manoeuvre.

NOTE 2  For class II and class III combustible liquids below their flashpoints, no hazardous zones are created externally to the truck tanks.

NOTE 3  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
Note: For rail cars with permanent loading and vapour recovery connections, the Zone 1 area may be downgraded to a

Figure A. 8 Railcar, top loading
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 flashpoints.
Notes:
1. The hazardous area for each piece of equipment on the jetty should be evaluated.
2. If non-segregated ballasting or gas freeing is carried out, then the jetty must be classed as for loading.
3. For Category A fluids, reference should be made to the methodology given in Chapter 5.
4. The height of the hazardous area should be 20 m above the coupling point. For a Category C material, this is equivalent to a 5 mm diameter hole in the coupling. If larger hole sizes are possible reference should be made to Table C9(a) for the equivalent hazard radius.

Figure A. 11 Jetties, Discharging
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.

Legend - ☐ ☐ zone 0 ☐ ☐ zone 1

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

Legend - ☐ ☐ zone 0
### Table: Flow Rate and Radius

<table>
<thead>
<tr>
<th>Flow rate (l/min)</th>
<th>Radius (m)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
</tr>
<tr>
<td>&lt; 1700</td>
<td>3</td>
</tr>
<tr>
<td>&gt; 1700</td>
<td>7.5</td>
</tr>
</tbody>
</table>

**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 III combustible liquids at or above their flash points.

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

**NOTE 3** If a spillage area is allowed, a transient zone 2 hazardous area must be allowed.

**NOTE 4** If flanges are regularly broken (> once per week), zone 2 changes to zone 1.

**Figure A.14** — Pump area in open air
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 may 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
NOTE  Loaded tankers leaking class 1 products should not be allowed in a workshop.

Figure A.16 — Workshop
X = The greater of 1.2 m or top of the dispenser or pump hydraulic housing. (Refer to SABS 1020)

Legend - zone 0 zone 1 zone 2

NOTE Refer to SABS 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