Formerly UIS008, July 2009

ELECTRICAL INSTALLATIONS ASSOCIATED WITH BULK LPG INSTALLATIONS

1. Introduction

This Information Sheet describes some of the principles and practices that should be used where electrical equipment is installed within the hazardous area associated with LPG installations. Typical installations include liquid installations with pumps (e.g. Autogas & FLT installations), systems using electrical power (e.g. electrically heated vaporisers) and control/instrumentation. The information sheet is only applicable to installations that include electrical equipment.

This information is intended to assist installers and operators to comply with the electrical requirements relevant to LPG installations and the duties imposed under current Regulations including the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).

The electrical installation shall be in accordance with the current version of the IEE Wiring Regulations (BS7671) (referred to as Wiring Regulations) and BS EN 60079; especially Parts 10, 14 and 17 (these documents include requirements not only for installation but also documentation, inspection & testing).

On many sites the electrical supply to the hazardous area is only a minor part of the electrical circuits.

This information only applies when low voltage (less than 1000 V AC) equipment is being used.

Under DSEAR all bulk LPG installations require assessment to establish the hazardous areas (zones) and to confirm the equipment is appropriate for the relevant zone. For the majority of installations the zoned area is often a small proportion of the total area.

- UKLPG Codes of Practice 1 part 1 and 20 give further guidance.

More information is available in a variety of documents including for:

- electrical installation standards: EEMUA Publication No. 186; “A practitioners handbook – Electrical installation, inspection & maintenance in potentially explosive atmospheres.” There is also an associated “toolbox guide”.
- specific information for electrical installations at licensed petrol filling stations EI/APEA publication “Design, construction, modification, maintenance and decommissioning of filling stations” (often referred to as the “Blue Book”).

Note: Installations using cathodic protection systems for corrosion protection of vessels or pipework require special consideration and expert advice should be sought.

2. Competence

The Provision and Use of Work Equipment Regulations require “*every employer to ensure that where work equipment is likely to involve a specific risk, the use of that equipment is restricted to those persons given the task of using it and repairs, modifications maintenance or servicing that work equipment is restricted to specifically designated persons whom the employer must ensure have received adequate related training*.” In addition Schedule 1 of the Dangerous Substances and Explosive Atmosphere Regulations (DSEAR) require suitable maintenance to be carried out by competent personnel.

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Electrical work (installation, testing, inspection or maintenance) in a zoned or hazardous area should only be undertaken by electricians who are fully competent in the type of work being carried out.

The employer of the electrician would normally be a member of an organisation providing accreditation under a third party assessment system (IEC 17024 or equivalent) and preferably be on a hazardous area approval register. Individual electricians should have completed suitable training. The current edition of BS EN60079-14 includes information on the competence of personnel.

3. New, or alterations to, electrical installations

New sections associated with existing installations must be in compliance with the 17th Edition of the Wiring Regulations.

Section 131.8, headed "Additions and alterations to an installation", states:
"No addition or alteration, temporary or permanent, shall be made to an existing installation, unless it has been ascertained that the rating and condition of any existing equipment, including that of the distributor, will be adequate for the altered circumstances. Furthermore, the earthing and bonding arrangements, if necessary for the protective measure applied for the safety of the addition or alteration, shall be adequate."

This means that the competent electrician has the responsibility to ensure that the existing site bonding is correct and that the circuits to the hazardous area have been both tested and identified all the way from the incoming supply. On a large site this is a significant responsibility, however it would not be necessary to repeat for any other circuits on the site not associated with the new installation. The extent of the work necessary should be established before the work installing the supply to the hazardous area is started. If the work is carried out concurrently then the power must not be turned on to the hazardous area until all the other work has been completed and suitable documentation issued.

4. Positioning of Installation

a) General

LPG installations differ from other fuel installations in several respects. The most important difference is that the LPG installation is a pressurised system with no venting of flammable vapours during normal operation, (e.g. storage, delivery or filling). The other releases are minimal (e.g. at the end of filling) and are controlled.

b) Installation supplies

The supply to the installation should be by underground cables (power, telecommunications etc.) suitably protected against mechanical and environmental damage and routed outside and not below the installation.

Where the installation is supplied via an overhead cable, this should be terminated outside of the hazardous area or Code of Practice separation distance (whichever is the greater) and the supply continued by means of underground cable(s) or suitably supported (e.g. on cable tray) surface cable(s). The cables shall be suitably protected against mechanical and environmental damage and routed outside and not beneath the LPG installation.

c) Overhead Cables

LPG installations should not be located below un-insulated overhead cables unless protected by a suitable screen bonded to the main earth.

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As cables may swing out or drag lower than their observed position of rest under adverse weather conditions vessels should not be positioned within an area from a vertical line drawn from the cables.

- For cables operating at voltages below 1 kV the distance should not be less than 1.5 metres. For installations that require regular manual operation (e.g. LPG dispensing) this should include telephone cables.
- For cables operating at voltages of 1 kV and above, the distance should not be less than 10 metres.

These distances may need to be increased further when the overhead cable could constitute a danger to the users of the facility, LPG tankers or personnel. Further advice may need to be obtained from the electricity line owner.

Note: wherever possible at a licensed filling station it should be arranged that there are no overhead conductors (electricity or telephone lines etc.), which at their maximum horizontal swing pass within 3 m of a vertical projection upwards from the perimeter of the hazardous areas (e.g. dispensing equipment, vent pipes, tanker stands).

d) Underground Cables

To avoid risk of damage to underground electrical power cables during installation and disruption to the LPG installation in the event of subsequent work on such power cables, LPG vessels, pumps and dispensers etc. should not be located directly above electrical power cables not associated with the installation.

5. Electrical Supply

a) Provision of supply

The supply into a hazardous area should be directly from a main switch isolator and not from a ring main feeding other parts of the site. The switch isolator must isolate all live and neutral conductors.

b) Type of Supply

The form of earthing defines the types of electrical supply used on a site.

- **TT system**, a system having one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source;
- **TN system**, a system having one or more points of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to that point by protective conductors;
- **TN-C system**, a system in which neutral and protective functions are combined in a single conductor throughout the system;
- **TN-S system**, a system having separate neutral and protective conductors throughout the system;
- **TN-C-S system**, a system in which neutral and protective functions are combined in a single conductor in part of the system;
- **IT system**, a system having no direct connection between live parts and Earth, the exposed-conductive-parts of the electrical installation being earthed.

  - These are illustrated in both EEMUA publication 186 and in the “Blue Book”.

Whilst the type of supply to the main site may be any of the above for new installations the electrical supplies should be TT or TN-S subject to testing by a competent electrician.

- IT may be used but subject to restrictions – see BSEN 60079-14.

TN-C-S (PME) may only continue to be used on existing installations subject to an appropriate, documented, risk assessment being carried out **and** that the installation is then subjected to regular checks on the current on the diverted neutral current. For these installations it may be more practical to install a "derived TT system" or a local TN-S system just for the equipment in the hazardous area.

b) Cable sizing

All electrical power cables must be designed and sized by a competent electrician/designer.

The design and cable sizing needs to take into account a variety of factors including:

- Length of the cable(s),
- Proposed method of installation (e.g. underground buried, underground in duct, above ground on trays),
- Type of load (motors, heaters)
- The maximum load, (most LPG pump motors, especially single phase, take a high starting current),
- Current cable capacitance and inductance values.

Information on cable design is available from tables in the Wiring Regulations and there are also commercial programs available (e.g. AMTECH).

c) Voltage

Tests should be carried out installations to confirm there are no excessive voltage drops. (e.g. due to length of cable, connections from the incoming supply to contactors/cables, contactors/swiches.) The voltage drop to the extremity of the circuit should not exceed 5%.

- For more information see the Wiring Regulations.

The available voltage at any motor should remain within the tolerances specified by the motor manufacturer both for start up and during running.

d) Protection against Electric Shock

When a different type of supply is used for the hazardous area compared with the supply to other parts of the site there must be a suitable separation, typically in excess of 2.5 metres, between un-insulated components to prevent inadvertent contact between the two.

f) Site Earthing

Site earthing is required for all sizes of storage vessel, when the installation is fitted with electrical equipment, the primary requirement being protection against electric shock. This is not the same as the earthing required for the dissipation of static electricity; see 5 i). Earthing figures for bonding shall meet the Wiring Regulations.

An earth-bonding conductor should be run back to a primary earthing point at the source of energy. For a TN-S system this is where all metallic parts will ultimately be bonded.

The electrical supply must have a suitable effective earth. A "split" earth bar and test socket should be installed for each installation to allow testing of the earthing efficiency.

Bonding to other services must be connected to earth and comply with Wiring Regulations.

Notes:

- The armour of SWA cable should not be used as an earth conductor although it must be bonded to earth.
- Installations using cathodic protection systems for corrosion protection of vessels or pipework require special consideration and expert advice should be sought.

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g) MCB's

Miniature circuit breakers (MCB's) should disconnect all poles of the supply (i.e. all phase(s) and neutral). Consideration should be given, when sizing MCB's, to the current rating of the type, the type of load (e.g. motor, heater etc), its short circuit capability and earthing impedance values, which need to be evaluated on site to ensure compliance with Wiring Regulations.

h) RCD's

Every power circuit into hazardous areas should be protected by a Residual Current Device (RCD) being capable of disconnecting all poles including neutral of the circuit having a disconnection time of not more than 30ms.

i) Generators

Special precautions are required when a generator is to be used either during normal operations or more importantly in emergencies.

- For more information see the Wiring Regulations.

6. Installation of Equipment

a) Motor overload/low voltage protection

The Wiring Regulations require that every electric motor having a rating exceeding 0.37 kW be provided with control equipment incorporating means of protection against overload of the motor.

Every motor needs to be provided with means to prevent automatic restarting after a stoppage due to a drop in voltage or failure of supply.

b) Cables

Cable conductors should only be of copper.

Power cables with integral mechanical protection are preferred, non-armoured cables can only be used providing the cable is protected by another method against mechanical damage.

Earthing cable sizes need to be assessed for each site prior to installation. 25mm^2 should be adequate for most installations, should a smaller cable be considered then the appropriate calculations need to be carried out before installation is carried out.

c) Glands

Cable glands should be suitable for the relevant zone or area, the type of equipment being connected, the connection thread and for the cable being used. They should also maintain the Ingress Protection of the equipment.

d) Auxiliary equipment

Auxiliary electrical equipment (e.g. solenoid valves) should be protected using an adequately sized fuse or MCB, in the event of failure of the equipment. This protection should not be incorporated into hazardous area enclosures unless written approval is received from the manufacturer of the enclosure.

e) Enclosures of equipment for use in hazardous Areas

Unauthorised modification of any enclosures will invalidate the electrical certification for use in hazardous areas and must not be carried out.

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f) Emergency Switch

Suitable switching device(s) for emergency use should be fitted outside the hazardous areas or separation distance (whichever is greater). When operated this would disconnect all electrical supplies (live and neutral conductors) to the associated equipment. It may be preferable to leave some auxiliary circuits live; e.g. lighting for the area, gas detection systems etc.

Except where failure to start after a brief interruption would be likely to cause greater danger; the installation should incorporate a system so that following the loss of power (e.g. power cut) power is not restored automatically but needs to be reset manually by an authorised person. This may be incorporated with the switching device as above.

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g) Isolation

Where required by Wiring Regulations and BSEN60079–14 a means to secure the isolation in the off position shall be provided for the equipment in the hazardous areas.

h) Switching off for mechanical maintenance

A means of locking off and isolating the power supply for mechanical maintenance should be provided for any electrical equipment in accordance with Wiring Regulations and BSEN60079-14.

i) Earthing

Earthing arrangements should be assessed for each site prior to installation. Metallic sections of an installation should be designed, installed and tested to confirm they are electrically connected. For equipment not mounted on common steelwork each component may need to be electrically connected, using an appropriately sized conductor, back to a single point.

The use of electrical connections across mechanical joints is not necessary providing, after installation, electrical conductivity is checked and confirmed to be acceptable. This should be checked periodically at intervals not exceeding 2 years.

Consideration should be given as to whether earthing of metallic items within a distance of 2.5 metres is also required. e.g. adjacent metallic fencing. Care should be taken to ensure that surface features (e.g. powder coating) do not render surfaces insulating.

For installation the incorporate Cathodic Protection systems suitable measures will need to be taken to ensure the parts of the installation protected by the CP system are not connected to the electrical system earth. Electrical isolators (with static build up protection) may need to be incorporated into the installation.

j) Static earthing

Before connecting a vessel to a local earth rod an assessment is required to see if this would affect the protection of the entireinstallation.

It may be necessary to supply a separate "clean" earth for a delivery tanker earth connection.

k) Sodium lamps

Due to the potential hazard of ignition if a lamp is dropped or falls sodium lamps should not be installed within or above zone 0 or 1 areas. Before changing such lamps above zone 2 areas the area should be checked to confirm there is no flammable atmosphere present.

l) Redundant cables or cores

Any redundant cables/cores should either be removed or terminated to earth or adequately insulated at the "hazardous end" in a suitable enclosure.

m) Multi-strand conductors

To prevent separation of strands the terminations of multi-stranded and fine stranded conductors should be fitted with crimped or similar ends.

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6. Testing/documentation

a) Initial inspection

All new installations and equipment should be subject to a detailed inspection as part of the commissioning. An electrical installation certificate based upon the model in the Wiring Regulations should also be issued for every new installation on completion of satisfactory testing. Typical information is given in Appendix 1.

On completion, DSEAR requires a register of the electrical components, their relevant zone of installation and the equipment approvals. Typical register layout is given in Appendix 2 (by courtesy of NICEIC).

b) Periodic Inspection

This is the routine inspection of all equipment, systems and installations and information is given in BS EN 60079-17. An assessment should be made, and recorded, at the time of issuing the initial inspection of:

- The type of inspections required usually visual or close
- The period between inspections.
  (For LPG installations these are normally 12 months but must not exceed 3 years)

Visual and close inspections can be carried out without removing any covers or isolating the power.

The results of all inspections should be recorded.

c) Detailed inspection

In addition to any other periodic inspections a detailed inspection should be carried out at intervals to be determined by the competent electrician (usually not exceeding 5 years) or after any modifications to equipment and/or wiring. Modifications being defined as any change to the wiring, circuits or the replacement of items that are not identical to the one removed.

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Appendix 1 Completion Test Certificate

SUMMARY COMPLETION REPORT FOR LPG INSTALLATIONS

Site:_____ Date of completion_____
Address_____
_____ Post Code_____

Summary of installation: _____
_____
Test socket fitted Yes/No Split earth bar fitted Yes/No

Supply type: (Delete those not applicable) TT TN-S IT TN-C TN-CS
Notes:_____

Bonding: Size: _____ Material:_____ Notes:_____
Confirm suitable connections including to other services:

Main switch: Type_____ No. poles _____ Size_____ BS_____

Method of protection: Type _____ Rating _____ BS _____
Cable size _____ Type_____ No cores _____

Insulation resistance: Lowest reading_____ $R_1 + R_2$ _____
Earth loop: At test socket _____ At distribution board _____

Summary of installation including details of electrical components
(if necessary continue on back of sheet)

We confirm that the installation has been tested and is suitable for operation in hazardous areas.

The next electrical survey will be due no later than_____/ 12 months from the date of this document. (Delete as applicable.)

Signed: _____Name: _____ Date:_____

Qualification for hazardous area work: _____

This Schedule relates only to Certificate/Report Reference

Installation Details	Address/Location		Extent covered by this schedule	
Area Classification	Zone	Gas Group	T Class	T_{amb}

Tag or Cable No.	Item Description	Manufacturer	Certificate Number	ATEX Group and Category	Certificate Code	EPL	Gas Group	Temp Class	I P Rating	Cable type	Gland type	Correct

Cable type

A	B	C	D	E	F	G	H	Other
PVC/PVC cables	PVC cables in metal conduit	PVC cables in non-metal conduit	PVC cables in metal trunking	PVC cables in non-metal trunking	PVC/SWA cables	XLPE/SWA cables	Mineral Insulated cables	