2. Safety

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WARNING - a hazardous situation which if not avoided may result in injury or death

CAUTION - a situation which if not avoided may result in damage to the product, process or surroundings

2.1 Electrical Safety

The unit operates on 208 V mains voltage. Only suitably qualified personnel should attempt to disconnect, dismantle or modify the equipment.

2.1.1 Potential Electrical Hazards

Injuries caused by electricity may take any of the following forms:

- electric shock
- electric burn
- fire of electrical origin
- electric arcing
- explosion initiated or caused by electricity

Electric shock

One effect of electrical current flowing through the human body is shock. When a shock is received, the electric current may take multiple paths through the body and its intensity at any one point is difficult or impossible to predict. The passage of electric current may cause muscular contractions,

respiratory failure, fibrillation of the heart, cardiac arrest or injury from internal burns. Any of these can be fatal.

The nature and severity of injury depends upon the magnitude, duration and path of the current through the body and, in the case of alternating current, on its frequency. It is not possible to identify precise thresholds for the existence of hazard because a judgement has to be made in each case taking all the circumstances into account such as body weight, physical condition of the victim and so forth. A guide to the current magnitudes which mark the occurrence of various dangerous effects is given in the International Electrotechnical Commissions publication IEC 479. Quite low currents, of the order of only a few milliamperes, can cause fatal electric shock.

Factors influencing the likely effect of shock current are its voltage, frequency and duration and any impedance in the current path. The effects of electric shock are most acute at about the public electricity supply frequency of 60 Hertz. Susceptibility to electric shock is increased if a person is in good electrical contact with earth, such as in damp or wet conditions or in conducting locations such as inside a metal tank. Hot environments where people may become damp due to perspiration or humidity, thus reducing the insulation protection offered by clothing, may present an increased risk from electric shock.

Electric burn

Electric burns are due to the heating effect caused by the passage of electric current through body tissues. They are most commonly associated with electric shock and often occur in and on the skin layers at the point of contact with the electrical conductors which gave rise to the electric shock.

Electric burns are usually painful and very slow to heal. Permanent scarring is common.

Fires of an electrical origin

Fires may be started by electricity in a number of ways, for example:

- overheating of cables and electrical equipment due to overloading of conductors
- leakage currents due to poor or inadequate insulation
- overheating of flammable materials placed too close to electrical equipment which is otherwise operating normally and
- The ignition of flammable materials by arcing or sparking of electrical equipment

The injuries caused by fire include burns and smoke inhalation injuries.

Arcing

Arcing causes a unique type of burn injury. Arcing generates ultra violet radiation which causes damage akin to severe sunburn. Molten metal particles from the arc can penetrate, burn and lodge in the flesh. Additionally there may be radiated heat damage caused by the arc.

Ultra violet radiation can cause damage; sensitive skin and eyes are especially vulnerable to arc flash. (Arc eye is commonly encountered with electric arc welding if the proper precautions are not taken.)

Under fault flashover conditions, currents many times the nominal rating or setting of a protective device may flow before those devices operate to clear the fault. The arc may dissipate a lot of energy and continue long enough to inflict very serious arcing burns or to initiate a fire, for example within 0.25 second (which is not an untypical minimum time for fault clearance). Arc flashovers caused during work on live circuit conductors are particularly hazardous as the worker may be very near to or even enveloped by the arc. Such cases often lead to very serious, sometimes fatal, burn injuries.

Explosion

This section includes injuries caused by explosions either of an electrical nature or those whose source of ignition is electrical.

Electrical explosions include the violent and catastrophic rupture of any electrical equipment. Switchgear, motors and power cables are liable to explode if they are subjected to excessive currents, which release violent electromagnetic forces and dissipate heat energy, or if they suffer prolonged internal arcing faults.

Explosions whose source of ignition is electrical include ignition of flammable vapours, gases, liquids and dusts by electric sparks, arcs or the high surface temperature of electrical equipment.

2.1.2 Essential Precautions

All the electrical equipment supplied is provided with a protective ground. Do not remove protective grounds as this may cause an electrical safety hazard.

Do not disconnect equipment, open covers, dismantle or modify it unless you are

- Qualified to do so
- Authorised to do so

- Fully understand its operation and potential hazards or have total assurance through your local electrical permit to work the system that the equipment has been made safe.

This manual is not intended to be a service manual and should not be used as such.

2.1.3. First Aid

WARNING: Do not attempt to administer first aid to someone who may have suffered electric shock until the source of the shock has been isolated.

A course in first aid to include methods of artificial respiration is recommended for those whose work involves equipment which may produce a high voltage.

2.2 Safe Mechanical Practice

In normal use personnel are not required to undertake mechanical work. However, servicing or repair may necessitate access to any part of the system. Only suitably qualified personnel should attempt to dismantle, modify or repair equipment.

2.3. Safe Cryogenic Practice

There are a number of potential safety risks to operators of cryogenic equipment if the accepted procedures are not followed. The following list of hazards and recommended procedures provides general guidelines for safe cryogenic practice. If in any doubt with regard to a specific procedure, the user is advised to contact Oxford Instruments.

Liquid nitrogen has a boiling point of 77.3 K (-196°C). Even when kept in insulated storage vessels (dewars), the liquid will remain at its boiling temperature and will boil off gas with the gas increasing in volume to approximately 694 times its liquid volume as it warms to room temperature.

2.3.1. Handling Cryogens

When handling cryogens the following hazards may be encountered.

Extreme cold.

Exposed skin will stick and subsequently be torn on removal from contact with cold surfaces. Cold burns can result from contact with a jet of cold gas or liquid.

Mechanical Strength

Flexible or soft materials become hard and brittle, and may break easily if they are strained. Polythene tubing is more suitable than rubber tubing for transferring liquid nitrogen but is still likely to fracture if moved. All metal transfer lines are preferred, except for temporary installations where experienced technicians are responsible. Cryogens spilt on vacuum equipment may freeze O-rings and thus cause loss of insulating vacuum.

Asphyxiation.

Most common cryogens are not poisonous, but there is a risk of asphyxiation if a large amount of gas is released into a confined space displacing atmospheric oxygen. There is no sensation of breathlessness to warn the victim of the danger. It is dangerous to be with storage or transport dewars in confined spaces.

Precautions

As a precaution, when handling liquid cryogens:

- Wear loose fitting protective gloves (impervious to liquid) which you can remove quickly if cryogens are spilt inside the gloves.
- Wear eye protecting goggles.
- Wear sensible shoes with trousers over the top of them so that spilt fluids do not collect inside them.
- Keep cryogens away from areas where they may spill on cables. Cryogens spilt on electrical cables may freeze and fracture the insulating layer. Moisture from the atmosphere may cause short circuiting or electrical hazards to personnel.

First Aid

If any cryogen comes into contact with the eyes or skin, flood the area with large quantities of cold or tepid water immediately. Apply a cold compress. Never use hot water or dry heat.MEDICAL ADVICE SHOULD BE SOUGHT IMMEDIATELY.

2.3.2. Storage Dewar And Cryostat Hazards

Condensation of contaminates

The cryogens or cold surfaces in a cryostat may condense contaminates from the atmosphere. Frozen water or air may block up narrow tubes preventing the venting of natural boil off from the system and leading to a build up of pressure in the vessel. When attempting to clear a blockage wear thick gloves as there is a danger that a jet of cold gas or liquid may result.

Fire hazards.

Most commonly used cryogens are not themselves flammable however liquid oxygen may condense onto cold surfaces. The presence of any oil or grease in this oxygen rich environment will result in a severe fire hazard.

Risk of explosion.

In general cryostats are fitted with pressure relief valves to prevent the risk of damage if a high pressure accidentally occurs. High pressure might occur where a cryogenic liquid is trapped in a pipeline . The liquid can boil which may cause a dangerously high pressure. In the event of a vacuum failure cryogenic fluids will boil vigorously and lead to pressure build ups.

Warming up of a system.

When warming up a system take care that no enclosed volumes are trapped. Open all valves to allow the gas boiled off to escape. Frozen air can exist in vacuum spaces, so take care to avoid pressure build up due to this air vaporising.

2.4. Safe Gas Handling

WARNING: Nitrogen gas is supplied compressed to around 200 bar in gas cylinders. Care should be taken when connecting and disconnecting from these gas cylinders.

2.4.1. Health Hazards

Refer to safety data sheets supplied by the gas supplier. Oxford Instruments can except no liability for accidents arising from gas use.

2.4.2. Essential Precautions

- Avoid rough handling of cylinders and overheating.
- Avoid flames or welding in vicinity.
- Treat every cylinder as full, handle carefully, always use a carrier.
- Use cylinders in an upright position and fixed so that they cannot fall.
- Avoid cylinders coming into contact with oil or grease. Regulators and valves must NEVER come in contact with oil or grease.
- Do not use cylinders as work supports.
- Store compressed gas cylinders in designated areas
- Take great care when removing compressed gas lines. Ensure that they are vented or may be vented without risk to personnel.
- When dealing with cryogenic vessels or lines refer to section on safe cryogenic practice.
- Fuel gas and oxygen gas leaks are highly dangerous.

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