Prevention of Explosions During Battery Charging in Relation to Diving Systems

International Marine
Contractors Association

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IMCA promotes improvements in quality, health, safety, environmental and technical standards through the publication of information notes, codes of practice and by other appropriate means.

Members are self-regulating through the adoption of IMCA guidelines as appropriate. They commit to act as responsible members by following relevant guidelines and being willing to be audited against compliance with them by their clients.

There are two core activities that relate to all members:

- Competence & Training
- Safety, Environment & Legislation

The Association is organised through four distinct divisions, each covering a specific area of members' interests: Diving, Marine, Offshore Survey, Remote Systems & ROV.

There are also five regional sections which facilitate work on issues affecting members in their local geographic area – Asia-Pacific, Central & South America, Europe & Africa, Middle East & India and North America.

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Introduction

Battery charging related explosions have resulted in two separate fatalities over the past four years and a number of injuries and near-misses. The two main causal factors appear to be:

- inadequate ventilation of flammable gas emitted during charging;
- faulty 'trickle charging' which generates explosive gases.

Guidance has been published in the past (e.g. the Department of Energy Diving Safety Memoranda 7/85 and 4/88). However, the most recent fatality has indicated the need for more comprehensive guidance on the subject, hence this note.

Explosive Emissions From Batteries Under Charge

'Open cell' batteries freely emit flammable explosive gases when under charge. The designation 'closed cell' or 'sealed' battery implies that gas will not be given off; this only applies, however, if charging is carried out at exactly the recommended voltage and pressure relief valves are provided for that reason. Various factors can influence the charging process such as: a faulty charger which can result in higher current levels being generated; aging batteries which can partially short themselves out resulting in a higher charge going to the remaining cells; batteries reacting to higher temperature and pressure; a cracked battery case; the fact that different chargers of the same type can produce different charging rates; and the possibility of operator error.

It must be assumed that batteries can, and given the right set of circumstances will, give off gas during charging, regardless of their type or charging arrangements. This can result in an explosion caused either by the sheer pressure of gas accumulating in a sealed battery or sealed compartment, or ignition by an additional source outwith the battery.

Hyperbaric Rescue Lifeboats – Design Considerations

An HRL by virtue of its design can constitute a gas trap. The equipment it contains such as gas cylinders, diesel fuel, electric controls etc., can give rise to the development of potentially dangerous situations viz:

- leakage of oxygen and generation of diesel fumes which can greatly increase the risk of fire or explosion;
- leakage of inert gas(es);
- production of highly flammable hydrogen during the charging process;
- ignition of gas due to sparking from electrical controls.

For the above reasons, the atmosphere inside an enclosed lifeboat which has been 'closed' for some time must be considered as suspect until it has been well ventilated.

Consideration should be given to installation of a gas analyser to permit continuous monitoring of explosive gas(es) in the atmosphere.

Ventilation of the Battery Compartment

When batteries are charged in the HRL, the battery compartment must be actively ventilated by means of vent lines to the open atmosphere outside the HRL. A safe fan (brushless type) or other appropriate means of positively venting the compartment should be used in such a way that the compartment atmosphere is expelled through one opening, while fresh air is pumped in by another route. Such a system could be activated automatically whenever the batteries are charged. (A battery compartment simply fitted with an opening may still be full of explosive gas(es), only the excess of which will drain through the opening due to the lack of positive venting).

Commercial catalytic convertors are available which can be located in the battery compartment. These operate by combining any hydrogen generated by the charging process with oxygen from the atmosphere to produce steam.

Batteries in Diving Bells

Batteries located outwith a diving bell must be contained in a pressure- and waterproof container fitted with a pressure relief valve. Pressure relief valves repeatedly exposed to sea water can malfunction and either fail to operate, or permit sea water to enter. Dry lithium batteries, often selected for their attractive power to weight ratio, can and do react to contact with seawater by releasing large volumes of gas. It should be noted that, as battery containers are built to resist sea water pressure, a considerable amount of energy can build up if the relief valve fails to operate. Accordingly, a great deal of energy would be released if the container fails, or when it is opened for servicing and operators must take appropriate precautions.

Batteries and their containers located inside a diving bell would have to contend with heliox seepage into them and consequent pressure build up. It is advisable therefore that they be located outside.

Battery Charging Procedures

For the reasons previously stated, consideration may be given to removal of batteries from an HRL for charging off site, but only if a second set, fully charged, is installed in the HRL.

When batteries are charged on site the following procedures should be adopted.

- Batteries should be located outside the HRL or physically isolated from the atmosphere inside the lifeboat by a water tight compartment;
- The charging policy to be adopted should be defined. Trickle charging should be employed only if the voltage is checked carefully and regularly to ensure that it complies with the manufacturer's specification. In the case of diving bells, trickle charging appears to be the only viable procedure;
- The lifeboat atmosphere should be ventilated;
- Appropriate ventilation arrangements for battery compartment should be made as specified above;
- Consideration should be given to installation of a gas analyser to monitor the lifeboat atmosphere.

Planned Maintenance

A maintenance policy should be adopted in line with the above and addressing the following main areas, together with any consequent requirements:

- condition of equipment, i.e. pressure relief valves, chargers, batteries and their maximum permissible age, etc.;
- ventilation of HRL and monitoring of its atmosphere;
- ventilation of battery compartment;
- induction of new crew members/technicians/personnel whether or not employed by the diving contractor, which should include: system description; dangers; and operating procedures;
- use of warning signs in accordance with national convention/ standards drawing attention to the danger of explosion during battery charging from smoking, naked lights etc., for instance:

DANGER - EXPLOSION BATTERIES UNDER CHARGE NO ACCESS TO UNAUTHORISED PERSONS NO SMOKING NO NAKED LIGHTS

Note: The above is given as an example of what might be considered suitable wording.

Conclusion

Contractors should consult with their own safety and technical advisors to ensure that their procedures are in line with the foregoing.