MARITIME SAFETY AWARENESS

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Shaping Shipping for People

Electrical safety – an evaluation of electrical hazards

In this issue

Introduction

Electrical hazards can lead to deaths and injuries such as shocks and burns. They can also lead to shipboard fires, explosions and the disabling (through blackouts) of essential equipment and services on board which can compromise safety. Ensuring that the right controls and mitigation measures are in place is critical for maintaining safe operations. To be effective, control measures need to be developed at the organisational, technical and individual levels.

Incident data reported to the Australian Maritime Safety Authority (AMSA) indicates that hazards to safety and personnel resulting from the use of electrical equipment continue to be a major concern. This safety bulletin explores electrical safety through AMSA data and aims to provide further awareness and recommended actions that will promote an effective electrical safety culture on board ships.

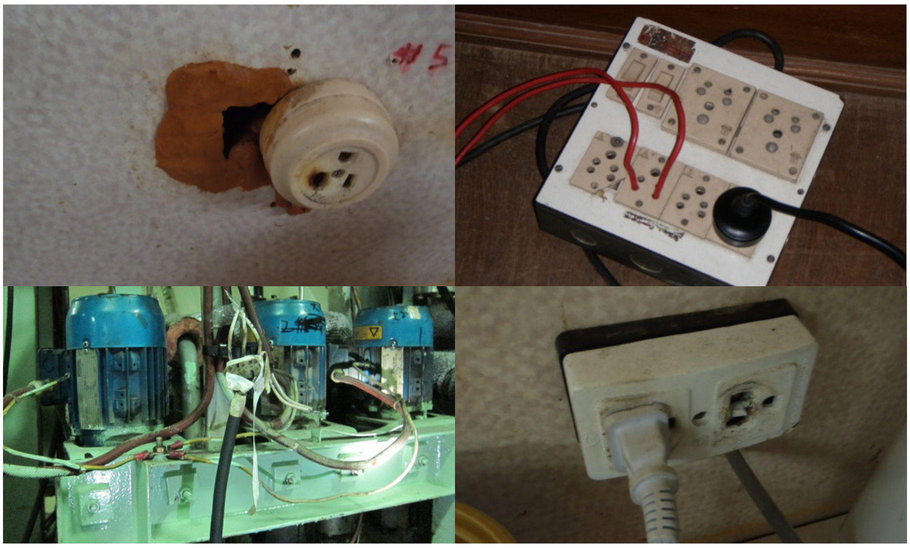

Figure 1: Electrical hazards on ships (source: AMSA)

Australian Government
Australian Maritime Safety Authority

Learning from incidents – example

In May 2005, an electrician on board a bulk carrier received an electric shock which caused him to fall between a deep frame and a parallel pipe (Figure 2). He consequently died from a heart attack believed to have been caused by the electric shock [1].

The light fitting the electrician was working on was still energised. It is possible that a qualified and experienced electrician may not have seen the need to complete an electrical work permit for a 'simple' task like repairing a light fitting. However, the electrician should have isolated and tagged the power supply prior to commencing the work.

Figure 2: Location of the electrician (source: ATSB)

In a separate incident that occurred on a passenger ship in October 2012, an engine room rating suffered serious burns from an electric shock [2]. The rating formed part of the shipboard electrical team and was assigned to trace an electrical fault on a boiler unit.

The engine room rating assumed that the system was isolated and safe to work on, so he started to disconnect the terminals. However, the system was not completely isolated and remained energised. The restricted working space meant that he had to kneel or sit to carry out the work. This provided a conduction pathway to complete an electrical circuit through his body, eliminating the protection provided by his insulated safety boots. As a result, he suffered an electric shock, which resulted in serious burns to three of his fingers.

The safety investigation concluded that poor isolation procedures, complexity of the schematic drawings and lack of familiarity with the system resulted in the engine room rating accepting risks that he did not fully understand.

> Isolation and tagging of electrical power supply are critical tasks that should be undertaken prior to commencing work

Figure 3: Safety tags on the circuit breakers (source: Transport Malta)

Figure 4: Restricted working space where the engine rating had to work (source: Transport Malta)

Electrical related incident data

Between 2011 and 2015, a total of 87 electrical related incidents were reported to AMSA. A breakdown of the outcomes from these incidents, categorised into injuries (23), fires (14), equipment/electrical failures (47) and near misses (3), is shown in Figure 5.

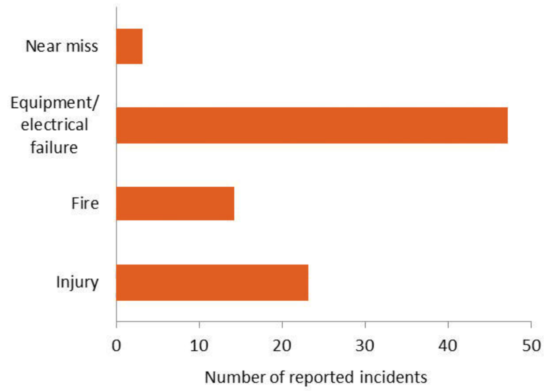

Figure 5: Primary outcomes of electrical related incidents reported, 2011-15 (source: AMSA)

AMSA also collects port State control (PSC) and flag State control (FSC) inspection data. PSC and FSC data is a reflection of normal operations and often contains information on similar precursors to accidents and incidents. This allows for the identification of control measures and the implementation of safety interventions to prevent more serious occurrences.

A comparative analysis of electrical related PSC/FSC deficiencies and reported incident data collected by AMSA during the period 2011 to 2015 is shown in Figure 6. In this period, there were a total of 1325 electrical related deficiencies issued by AMSA.

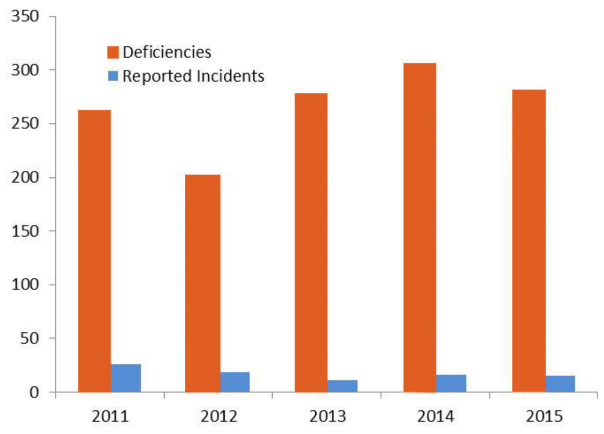

Figure 6: Electrical related PSC/FSC deficiencies and reported incident data, 2011-2015 (source: AMSA)

The PSC/FSC data displayed in Figure 6 possibly highlights a level of underreporting of electrical related deficiencies. Interestingly, a more detailed analysis of PSC/FSC data shows that most of these deficiencies point to hazards such as; low insulation (50%), earth faults (34%), unsafe wiring (11%), protection/isolation issues (3%) and power supply problems (2%).

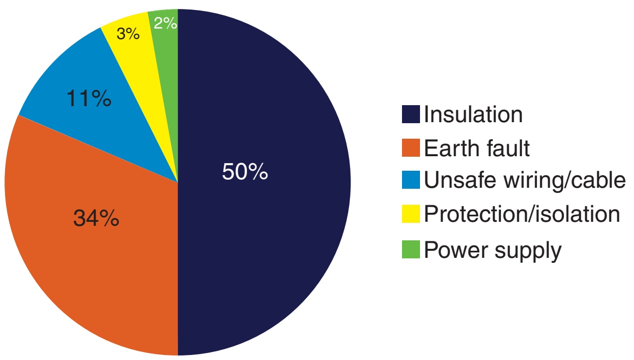

Figure 7: Electrical safety issues from PSC/FSC data, 2011-15 (source: AMSA)

Defences in depth - a risk based approach

Appropriate control measures using the 'system defences' of barriers and safeguards can be utilised to ensure electrical safety [3].

Figure 8 provides an overview of control measures that should be adopted at the organisational, technical and individual levels to ensure that the right level of 'defences' are in place to mitigate and manage the risk of electrical hazards.

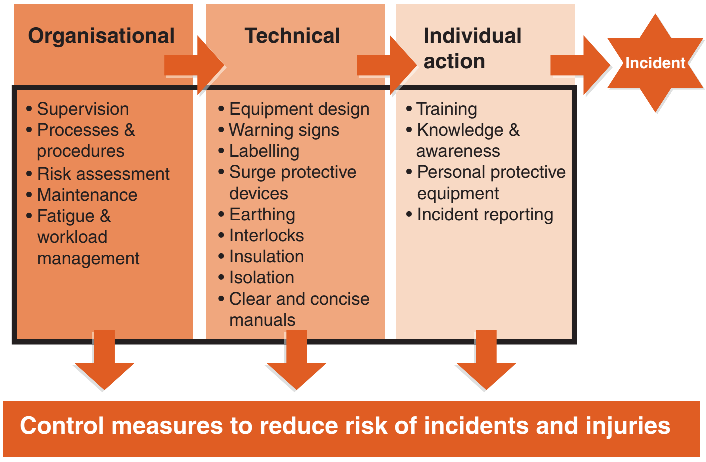

Figure 8: Defences in depth [3]

The International Safety Management (ISM) Code provides the mechanism under which the ship's safety management system operates. The ISM Code makes it clear that all identified risks to the ship, its personnel and the environment must be assessed and appropriate control measures established.

These control measures at the organisational level (Figure 8) should include:

- ensuring appropriate supervision is provided;
- putting in place safe operating processes and procedures;
- carrying out risk assessments for all electrical work;
- adequate maintenance, including inspection and testing; and
- ensuring that fatigue and workload is managed appropriately.

Companies must ensure that control measures, work practices and procedures are in place to eliminate electrical hazards. Although policies and procedures provide for safe working practices, it is the culture within the organisation and on board each ship that must support the desired behaviours.

At the technical level (Figure 8), control measures should include:

- equipment design (ensuring safe design);
- appropriate warning signs are in place including proper labelling for tag/lockouts;
- appropriate use of surge protective devices;
- ensuring electrical systems are properly isolated when required;
- carrying out regular insulation testing; and
- ensuring there are clear and concise manuals for use of electrical equipment.

At the individual level (Figure 8), control measures should include:

- appropriate training, knowledge and awareness of electrical hazards;
- appropriate use of Personal Protective Equipment (PPE); and
- reporting of electrical safety related incidents and near misses.

Historically, we have tended to focus only at the individual level of controls. While this has provided improvements in safety outcomes, it is nowhere near as effective as a holistic approach in combination with technical and organisational defences. This holistic approach provides for a more robust approach to hazard and risk management.

Figure 9: Wasted cable trays on main navigation mast (source: AMSA)

Electrical hazards on board ships - a case study

An AMSA ISM Auditor was conducting a Safety Management Certificate (SMC) audit on board an Australian-flagged vessel. During the audit, the auditor noticed two shore-based contractors going in and out of the engine room with electrical testing equipment. On investigation, the auditor determined that they were conducting testing on a range of motors, including 440 volt equipment. He also established that the work was not being conducted under electrical isolation or work permit and no risk assessment or toolbox meeting had been carried out for this work.

When looking into this matter further, the auditor requested records of previous electrical isolation permits. However, none could be provided. The vessel's crew were also unable to provide any safety management system procedures that related to electrical safety.

It was apparent that the vessel had been operating without specific, documented procedures for electrical safety despite the fact that electrical work had been rated as 'severe' in the vessels' risk register. Furthermore, the occupational health and safety (OHS) obligation to provide a safe workplace had not been met.

> Always remember – electricity is the invisible and silent killer. You won't see it, you won't hear it and you won't feel it until it is too late. Just don't risk it.

Take-away message

Working with electricity is inherently dangerous and it is critical to ensure that safe working conditions are in place. Both the seafarer and the company have a responsibility to make safety their top priority.

From an organisational perspective, the following should be considered:

- regular communication, education, training and safety meetings;
- ensure thorough risk assessments are in place;
- ensure a thorough verification of electrical equipment has been conducted, particularly with regard to quality, labelling, design and location on board;
- reinforce the positive behaviour of reporting all incidents, near misses and unsafe conditions;
- ensure routine checks of switchboard and distribution systems are carried out; and
- ensure robust isolation processes and procedures are in place and adhered to.

From an individual perspective, the following should be considered:

- stop the job if you feel unsafe;
- always ensure a detailed risk assessment is in place and you are familiar with the risk controls required for the task;
- always check and confirm tag/lockout is in place;
- use appropriate Personal Protective Equipment (PPE) such as insulated mats, safety shoes and tools;
- establish clear lines of communication with other personnel;
- inspect and test tools prior to use – do not use equipment if it has been modified or damaged; and
- report all incidents and near misses.

References

1. Australian Transport Safety Bureau (ATSB), Marine safety investigations and reports, https://www.atsb.gov.au/publications/safety-investigation-reports.aspx?Mode=Marine
2. Malta Transport (MT), Safety investigations, https://mti.gov.mt/en/Pages/MSIU/Safety-Investigations-2012.aspx
3. Reason, J. (1997), Managing the Risks of Organizational Accidents. Ashgate: Manchester, UK.

Useful resources

- MarineSafe Forum, Marine Safety Flash, http://marinesafeaustralasia.ifap.asn.au/Incident%202015.aspx
  - (2012), Electrical Shock Incident, A12-15.
  - (2013), Surge Protective Devices Onboard Vessels, A13-16.
  - (2016), Marine Vessel Electrical Incident, A16-03.
- Safe Work Australia (2015), Model Code of Practice – Managing Electrical Risks in the workplace