

Electrical Safety - a perspective based on incidents

W F Bates

HM Principal Specialist Inspector (Electrical Engineering),
Health and Safety Executive,
AW House, 6-8 Stuart Street, Luton, Bedfordshire LU1 2SJ UK.

Keywords: Electrical incidents, risk management.

Abstract

An Electrical Inspector from the Health and Safety Executive (HSE) investigates many serious incidents and inspects a wide range of industrial and commercial premises. This experience gives rise to an insight into the types of incident that lead to serious injuries and death. Using this information it is possible to identify recurring types of incidents and assess them in a structured way. This will assist in managing the risks arising to prevent further serious incidents.

1 Introduction

Safety at work is as great a need today as it has ever been. We must all work hard to keep on top of the risks that can result in serious work-related incidents and deaths. There are many workers with a variety of electrical competence levels killed and seriously injured and even more who have close calls. Electricity can be very unforgiving even for the most competent workers and safety is important.

The Health and Safety Executive (HSE) enforces the Health and Safety at Work Act 1974 covering workplaces in Great Britain. An HSE Electrical Inspector inspects industrial and commercial premises and investigates many serious incidents involving electrical and control systems. These incidents involve high and low voltage installations, equipment and machinery. Sadly, many incidents have led to injury or death. These have covered a wide cross section of common types of electrical safety risks that exist today in the workplace. Knowing what the causes are, suggests ways that the risks may be managed and mitigated.

2 Electrical incident risks and consequences

Incident data over the period January 2001 to April 2009 collected from investigations of serious incidents in part of East and South East England gives evidence of the seriousness of these risks. Since 2001 the sample consists of 162 major incidents, with 38 deaths and 97 serious injuries. This data is a sample of about a fifth of the electricity-related investigations by HSE nationally. Table 1 shows a summary of the sample of incidents investigated by type, injury and cause. The injury for each type highlights significant risks. Analysis of the data highlights certain recurring types of incident having similar basic hazard, cause and consequence. Analysis of the most serious incidents has allowed the identification of recurring risks, which has been developed into a structured approach to controlling them. Overhead line strikes on construction sites and in agriculture, and shocks from fixed installations in buildings and with electrical equipment lead to fatal injuries. It is interesting to note the number flashovers leading to serious burn injuries investigated, many of which were to experienced electrical workers. Serious injuries due to electric shock to persons working on electrical equipment feature prominently. Fatal and serious injuries associated with machinery and control systems are also significant. The 'Other' category covers investigations where electricity was excluded as a cause after investigation.

Research for HSE in 2004 using 7 years of incident reports (1996/97-2002/03) found 56,597 electricity-related incidents[1]. There were 173 electricity-related fatalities, about 10% of all fatalities at work. About 5% of all reportable over-three day injury accidents were electricity-related. There were 104 fatalities involving contact with electricity, 6% of all fatalities, however non-fatal contact with electricity reports are less than 1% of all reported incidents. This may reflect serious under reporting of these incidents.

**Table 1 INVESTIGATIONS OF SERIOUS ELECTRICAL & CONTROL SYSTEMS INCIDENTS
WF BATES JAN 2001 - APR 2009**

	INJURY			CAUSE			
INCIDENT TYPE	fatal	INJURY (TOTAL NO)	dangerous occurrence	DESIGN	PROCEDURE	MAINTENANCE	TOTAL
OVERHEAD LINE CONTACT	7	4 (5)	5	0	16	0	16
SUPPLY CABLE DAMAGE	1	5 (6)	4	0	10	0	10
SUPPLY SWITCHGEAR FAILURE	1	5	6	0	1	11	12
SHOCK FROM LV FIXED INSTALLATION	7	10	2	0	12	7	19
FLASHOVER	0	18 (21)	2	1	19	0	20
EQUIPMENT FAILURE	1	4	3	2	2	4	8
MACHINERY CONTROL	9	9	5	6	9	8	23
SHOCK FROM EQUIPMENT	8	36	2	6	16	24	46
OTHER	4	1	3	0	0	0	8
TOTAL	38	92 (97)	32	15	85	54	162

3 Incident causes

The incident types fall into three broad areas,

- Electrical generation, transmission and distribution

- Low Voltage fixed installations
- Equipment and machinery

These are broad areas are shown in Table 2 with the incident types allocated to the appropriate area.

HAZARD	INCIDENT CAUSES AND CONSEQUENCES	OCCURRENCE
Electrical Supply		
Overhead line contact	Non-compliance with safe systems of work in construction, agriculture and transport leading to shock and burns	16 incidents with 7 fatal and 5 serious injuries
Cable strike	Non-compliance with approved procedures for excavation in highways, footpaths and construction sites, leading to explosions and burns	10 incidents with 1 fatal and 6 serious injuries
Switchgear disruptive failure	High Voltage or Low Voltage insulation failure, poor maintenance and equipment mal-operation, leading to explosions, fires, burns	12 incidents with 1 fatal and 5 serious injuries
Low Voltage Fixed Installations		
LV fixed installation shock	Failure to isolate, inadvertent contact with exposed conductors and poor maintenance, leading to electric shock, burns and falls	19 incidents with 7 fatal and 10 serious injuries
Switchgear and equipment flashover	Use of un-insulated tools and non-compliance with approved procedures, including isolation, leading to explosions, fire and burns	20 incidents with 21 serious injuries
Equipment and Machinery		
Equipment disruptive failure	Poor maintenance, battery failure and non-compliance with approved procedures, leading to explosions, fires, falls, serious injuries including blinding and burns	8 incidents with 1 fatal and 4 serious injuries
Machinery and control	Poor maintenance and design of safety measures, defeating of interlocks and non-compliance with procedures, leading to serious injuries	23 incidents with 9 fatal and 9 serious injuries
Equipment shock	Failure to isolate or maintain portable, transportable and permanently connected equipment and cables, leading to falls, fire, electric shock and burns	46 incidents with 8 fatal and 36 serious injuries

Table 2 Incident investigation causes and consequences by type

4 Fundamental causes

There have been many different attempts to identify causes of incidents [2, 3]. At the most straight forward level these

investigations show in table 1 that the overwhelming majority of incidents have a pre-eminent fundamental cause related to either:

Procedure (55%), or
 Maintenance (36%), or
 Design (9%)

Procedure causes were non-compliance with, and unsuitability of, procedures and systems of work.

Maintenance causes were related to how inadequate resources and lack of competence can adversely affect performance of both the individual and equipment.

Design causes go back to poor, and unsuitable, standards of design for equipment and systems.

This would direct particular effort in risk management toward particular aspects of design, systems of work and maintenance from all parts of the safety life-cycle [4].

Thus with a systematic way of identifying significant risks, risk management can be achieved [5]. There are contributions to safety made by the worker, supervisor, technical manager and executive manager. Within each organisation each hierarchical level of responsibility has a different, but complimentary, role for their contribution to mitigating these risks, and minimising the human and business costs of failure. Clarity of the challenge at each level is vital. Table 3 identifies the means of achieving this clarity. Managing the risks will allow people at all levels in an organisation to make their contribution to safety. They must understand the serious personal and other consequences of failure. A conservative approach to risk should be adopted through an organisational culture of challenging poor procedures and behaviours.

5 Risk management

TASK	PURPOSE
Analysis	identification of aims and assessment of risks, planning and providing safe ways of working, including competent staff
Communication	provision of information in an appropriate way, to ensure clear responsibility and organisation for the work
Influencing	directing and resourcing the work with clear instruction and leadership, motivating to ensure good performance
Compliance	controlling and evaluating the work to ensure the planned performance is achieved and that it meets its requirements effectively

Table 3. Risk management tasks

6 How safe is your organisation?

Experience from investigating incidents and inspecting organisations has left clear indications of key areas for management attention. A practical eight step route for helping to determine, and improve, an organisation's safety is by getting Workers, Supervisors and Managers to consider the following.

RISK AND ANALYSIS

Systematically identify any circumstances where electrical hazards might occur, the likelihood of an incident, and its effects i.e. assess the risks, using competent persons with suitable attitude, skills, knowledge and experience. This should be reviewed as circumstances change.

STANDARDS AND SYSTEMS

For identified significant risks consider whether the designs, maintenance and procedures are suitable and sufficient to prevent incidents. Adequate technical policy should ensure that safe systems of work are written and applied, using experience from the corporate memory. Safe standards and expectations should be established.

PLANNING AND ACTION

Plan using standards and systems. Implement action recognising significant risks and setting standards to mitigate and control those risks.

ROLES AND RESPONSIBILITIES

Consider the organisation's hierarchy and whether roles and responsibilities for the identified risks are clear so that the risks are managed.

COMMUNICATION AND COMPETENCE

Communication between all levels must be effective. There must be adequate information and instruction with all workers, supervisors and managers recognising their roles, limitations and responsibilities. This is essential for competent work.

LEADERSHIP AND CULTURE

Managers (leaders) should promote a strong safety culture controlling and influencing behaviours to ensure commitment to the standards set, with the workforce empowered and encouraged to challenge unsafe procedures and practices. A good corporate culture will recognise the contributions of

the various levels of responsibility. This should provide effective management, supervision and support with safety uncompromised by commercial or other workforce pressures.

REVIEW AND CORRECT

Correct any identified shortcomings in planning, records, competence, outcomes and accountability such that the risks are managed and incidents prevented.

AUDIT AND CONSTANT IMPROVEMENT

Monitoring and Auditing should be by competent persons capable of recognising technical deficiencies, with appropriate review and follow up to constantly improve performance.

All of these steps have been used to improve risk management having identified the risks and causes in electrical investigations and inspections.

7 Conclusion

Analysis of the investigations of serious incidents involving electrical and control systems does identify recurring themes of incident types and causes. The incident investigations can be categorised to indicate where significant risks are present.

Adopting a structured approach to identifying significant risks in the workplace will enable managers to manage these risks. Experience shows that failure to have adequate safe systems of work covering the significant risks can lead to real injuries and sometimes death.

References

- [1] BOMEL research report for HSE. "Identifying the incidence of electricity-related accidents in Great Britain", (2004).
- [2] "Electrical incidents in Great Britain", HSE Books, (1997).
- [3] W F Bates, "Electrical incidents in Great Britain", Towards safer electrical installations, IEE Colloquium, (1999)
- [4] "Successful health and safety management", HSE Books, (1997).
- [5] "Electricity at work, safe working practices", HSE Books, (2003).