



**Presentation
on
Electrical Safety Standard and Guidelines**

**at
CII Workshop on Managing Electrical Safety Risk
2018-04-20**

**By
BUREAU VERITAS – EAST REGION**



Move Forward with Confidence



Electrical Safety related incident



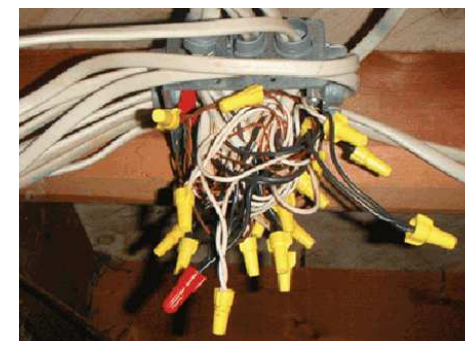
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VERITAS

| State/U.T. | Electrocution | | | | | | | Explosion | | | | | | | Falls | | | | | | |
|------------------|---------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| 1 | 77 | 78 | 79 | 80 | 81 | 81 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 86 | 87 | 88 | 89 | 90 | 91 | 91 | 91 |
| State: | | | | | | | | | | | | | | | | | | | | | |
| Andhra Pradesh | 1348 | 1182 | 970 | 880 | 1008 | 519 | 637 | 106 | 88 | 95 | 84 | 48 | 161 | 61 | 1273 | 1226 | 1251 | 1224 | 1456 | 741 | 740 |
| Assam | 51 | 84 | 99 | 61 | 58 | 73 | 35 | 33 | 3 | 0 | 5 | 5 | 14 | 1 | 28 | 37 | 38 | 20 | 27 | 47 | 17 |
| Bihar | 129 | 160 | 213 | 234 | 224 | 204 | 174 | 25 | 8 | 30 | 15 | 26 | 47 | 33 | 108 | 115 | 118 | 148 | 112 | 159 | 177 |
| Chhattisgarh | 449 | 512 | 491 | 474 | 513 | 529 | 484 | 62 | 70 | 46 | 13 | 10 | 23 | 26 | 417 | 413 | 475 | 415 | 408 | 529 | 499 |
| Gujarat | 498 | 728 | 591 | 518 | 624 | 586 | 759 | 12 | 12 | 20 | 3 | 29 | 85 | 66 | 1075 | 1344 | 1245 | 1504 | 1489 | 1788 | 2309 |
| Haryana | 343 | 373 | 346 | 370 | 426 | 411 | 302 | 27 | 12 | 11 | 10 | 11 | 19 | 35 | 247 | 277 | 290 | 311 | 329 | 411 | 343 |
| Himachal Pradesh | 19 | 18 | 15 | 16 | 17 | 11 | 25 | 3 | 0 | 0 | 1 | 5 | 9 | 1 | 327 | 339 | 341 | 360 | 350 | 468 | 464 |
| Jharkhand | 119 | 104 | 75 | 205 | 132 | 87 | 82 | 44 | 26 | 13 | 5 | 8 | 25 | 75 | 137 | 146 | 186 | 180 | 214 | 239 | 238 |
| Karnataka | 365 | 349 | 405 | 357 | 440 | 447 | 434 | 9 | 9 | 9 | 9 | 7 | 46 | 31 | 470 | 496 | 534 | 517 | 468 | 539 | 509 |
| Madhya Pradesh | 1149 | 1273 | 1348 | 1499 | 2034 | 1664 | 1545 | 42 | 30 | 36 | 26 | 42 | 49 | 131 | 936 | 852 | 928 | 968 | 1045 | 1174 | 1487 |
| Maharashtra | 1256 | 1313 | 1269 | 1235 | 1527 | 1373 | 1361 | 20 | 41 | 36 | 24 | 59 | 84 | 50 | 2177 | 2309 | 2235 | 2448 | 2075 | 2938 | 3314 |
| Manipur | 5 | 9 | 12 | 6 | 13 | 6 | 13 | 8 | 4 | 8 | 11 | 14 | 12 | 3 | 4 | 6 | 4 | 12 | 12 | 10 | 7 |
| Meghalaya | 4 | 10 | 12 | 16 | 17 | 5 | 7 | - | 0 | 4 | 4 | 0 | 0 | 0 | 13 | 28 | 21 | 28 | 18 | 19 | 47 |
| Mizoram | 4 | 7 | 2 | 7 | 5 | 5 | 8 | - | 2 | 1 | 2 | 0 | 0 | 0 | 7 | 7 | 21 | 32 | 16 | 19 | 16 |
| Nagaland | 1 | 2 | 2 | 1 | 3 | 0 | 2 | - | 0 | 0 | 0 | 0 | 0 | 8 | 1 | 3 | 4 | 4 | 3 | 3 | 1 |
| Odisha | 220 | 184 | 184 | 191 | 181 | 214 | 277 | 9 | 0 | 2 | 3 | 0 | 16 | 6 | 362 | 430 | 395 | 345 | 525 | 471 | 557 |
| Rajasthan | 631 | 748 | 723 | 836 | 894 | 995 | 1066 | 37 | 23 | 20 | 25 | 33 | 321 | 41 | 650 | 743 | 745 | 765 | 776 | 1119 | 1134 |
| Sikkim | 6 | 10 | 5 | 2 | 2 | 4 | 12 | - | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 49 | 40 | 35 | 58 | 60 | 57 |
| Tamil Nadu | 490 | 492 | 514 | 506 | 526 | 472 | 651 | 30 | 10 | 44 | 12 | 16 | 51 | 48 | 71 | 633 | 736 | 653 | 969 | 1306 | 1310 |
| Telangana | | | | | | 493 | 456 | | | | | | 45 | 3 | | | | | | 693 | 818 |
| Tripura | 35 | 30 | 14 | 34 | 21 | 31 | 41 | - | 1 | 0 | 34 | 0 | 0 | 2 | 13 | 13 | 14 | 12 | 11 | 14 | 18 |
| Uttar Pradesh | 504 | 501 | 677 | 419 | 619 | 623 | 756 | 43 | 68 | 41 | 32 | 45 | 41 | 80 | 370 | 304 | 323 | 395 | 437 | 671 | 736 |
| Uttarakhand | 43 | 35 | 34 | 45 | 63 | 4 | 43 | 8 | 1 | 7 | 8 | 9 | 1 | 1 | 87 | 90 | 103 | 85 | 80 | 69 | 116 |
| West Bengal | 99 | 93 | 156 | 144 | 177 | 199 | 155 | 62 | 42 | 37 | 24 | 35 | 35 | 45 | 151 | 166 | 146 | 199 | 165 | 247 | 276 |
| Delhi | 163 | 191 | 148 | 153 | 119 | 92 | 81 | 26 | 7 | 37 | 19 | 20 | 19 | 33 | 429 | 378 | 475 | 426 | 381 | 352 | 291 |
| Lakshadweep | - | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 1 | 0 | 0 | 0 | 1 |
| Puduchery | 38 | 25 | 26 | 23 | 25 | 13 | 10 | - | 0 | 0 | 0 | 0 | 0 | 4 | 47 | 41 | 48 | 55 | 55 | 31 | 47 |

Source: 'Accidental Deaths in India' Report 2016, National Crime Records Bureau, Ministry of Home Affairs.

Cause of Electrical safety incident

- Unsafe Conditions
 - Faulty Insulation
 - Improper Grounding
 - Loose Connections
 - Defective Parts
 - Ground Faults In Equipment
 - Unguarded Live Parts
 - Underrated Equipment
 - Work Environment
- Unsafe Acts (Work Practices)
- Combination



***Prevailing Mind Set
“It Won’t Happen To Me”
(Famous Last Words)***



Some more causes for Electrical Accidents



Leading Causes of Electrical Accidents:

- **Drilling and cutting through cables**
- **Using defective tools, cables and equipment**
- **Failure to maintain clearance distance of 10 feet**
- **Failure to de-energize circuits and follow Lockout/Tagout procedures**
- **Failure to guard live parts from accidental worker contact**
- **Unqualified employees working with electricity**
- **Improper installation/use of temporary electrical systems and equipment**
- **By-passing electrical protective devices**
- **Not using GFCI (ground fault circuit interrupters) devices**
- **Missing ground prongs on extension cords**

Electrical Hazard



- ▶ *Shock* – Most common and can cause electrocution or muscle contraction leading to secondary injury which includes falls
- ▶ *Fires* – Enough heat or sparks can ignite combustible materials
- ▶ *Explosions* – Electrical spark can ignite vapors in the air
- ▶ *Arc Flash* - can cause burns ranging from 14,000 degrees f. to 35,000 degrees f
- ▶ *Arc Blast* – In a short circuit event copper can expand 67,000 times. The expansion causes a pressure wave. Air also expands adding to the pressure wave

Effects of Current flow

- ▶ More than 3 milliamps (ma): **painful shock**
- ▶ More than 10 ma: **muscle contraction**
- ▶ More than 20 ma: **considered severe shock**
- ▶ More than 30 ma: **lung paralysis** - usually temporary
- ▶ More than 50 ma: **possible ventricular fibrillation** (usually fatal)
- ▶ 100 ma to 4 amps: **certain ventricular fibrillation** (fatal)
- ▶ Over 4 amps: **heart paralysis; severe burns**

Why we should take Electricity Seriously

- ▶ Electricity is the second leading cause of death
- ▶ Electrocutions make up 12% of fatalities annually.
- ▶ Over 30,000 non-fatal shocks occur each year.
- ▶ Over 600 deaths occur annually due to electrocution.



Electrical Safety Standard and Guidelines



- ▶ IS 14489
- ▶ CEA Regulation 2010, CEA Rules
- ▶ Industry Specific protocol

Electrical Safety Standard and Guidelines (Brief)



| Checkpoint | Acceptance |
|--|--|
| Are the cables laid properly and adequate supports provided to the cable trenches? | CEA Regulation, 2010 |
| The path of the underground electric and instrument cables has been marked by erecting adequately spaced separate indicators for power cables, instrumentation cables, telecom cables ,etc. | |
| The telecom cables and power cables are laid in different conduits/trenches? | |
| First aid: Is artificial respiration chart displayed at the switchgear rooms and other such electrical installation as per the CEA Regulations? | |
| Hazardous Area Classification | |
| Is hazardous area classification chart available for the plant? | e.g. Gas group Zone display (II-A, II-B) |
| Is hazardous area classification chart displayed for information of plant personnel responsible for maintenance of flame-proof equipment? | |
| Are flameproof electrical equipment and fittings are provided as per the Hazardous area classification chart? | |

Electrical Safety Standard and Guidelines (Brief)



| Checkpoint | Acceptance |
|---|-------------------------|
| Are the frame-proof fittings periodically inspected as part of preventive maintenance and records in that respect are available? | CEA Regulation, 2010 |
| Electrical Maintenance | |
| Lock Out Tag out system is in practice and being followed while working on electrical installations? | Good Industry Practices |
| Earthing Systems | |
| Major electrical equipment is provided with double and independent earth connections ? | CEA Regulation, 2010 |
| Earthing and earth pit layout diagram is available? | |
| The earth pits have been identified by painting a unique identification number on every individual earth pit? | |
| The earth pits are tested at least once in six month? | |
| The earth pits are tested in dry period (post and pre monsoon) | |
| Is the earthing symbol provided at the earthing point on the equipment and the earth pits? | |
| Are the earth pit test readings less than 5 ohm for individual pits and 1 ohm for grid in few of the installations? | |

Electrical Safety Standard and Guidelines (Brief)



| Checkpoint | Acceptance |
|---|------------|
| Lighting Arresters | |
| Lightning arrestor was found installed on the telecom tower and lighting masts? | |
| The earth pits associated with lightning arrestors are tested at least once in a year? | |
| Others | |
| Transformer oil is tested for its dielectric strength (Break Down Value) and dissolved gas analysis and the test readings are compared to the relevant Indian Standard | |
| The electrical relays are tested at least once in a year and records in that respect are maintained? | |
| The faulty relays are repaired/replaced and records in that respect are maintained? | |
| Single Line Diagram is displayed in all the sub stations? | |
| Are the name(s) of the authorized or designated person(s) for electrical installations exhibited as per CEA Regulations? | |
| Are the fire sand buckets and First Aid box provided at all sub-stations? | |
| Is the canopy provided to all the sand buckets located at outdoor? | |
| The level of oil in the transformer is well above the minimum desired level? | |

Electrical Safety Standard and Guidelines (Brief)



| Checkpoint | Acceptance |
|--|------------|
| Is the transformer oil level gauge functional? | |
| Is the transformer yard is free of dry grass and vegetation? | |
| Are the Danger Notice (skull & bones with Voltage Value) is displayed at the electrical installations in a conspicuous manner as per the Indian Electricity Rules? | |
| PPE such as rubber gloves and face masks are available in the battery rooms? | |
| Exhaust fans are available in the battery rooms? | |
| No woodwork is used for mounting off switchboards | |
| Is adequate weather protection against heat, dust, water, etc. provided for switchboards? | |
| Socket outlets of rating 30 A and above are provided with interlocked type switch? | |
| Is the fence (at least 8ft. high) provided to transformer yard to prevent unauthorized access? | |
| Are Rubber mats provided in control panels and switchgears rooms? | |
| Do the rubber mats conform to the latest Indian Standard | |
| | |

Electrical Safety Standard and Guidelines (Brief)



| Checkpoint | Acceptance |
|---|------------|
| Are the rubber mats in good condition? | |
| Are the electrical gloves available at electrical substation meant for electrical maintenance? | |
| Are the electrical gloves conforming to relevant Indian Standard or any such equivalent standard? | |
| Are overhead power lines available anywhere in the plant and cross the road/walkway? | |
| If yes, are overhead barriers erected to warn the vehicles plying on the road underneath the power lines? | |
| Are all the switchgear panels identified and marked vis-à-vis the equipment they are meant for? | |
| Are ELCB installed on electrical circuits involving major electrical equipment? | |
| Are ELCB regularly checked at periodic intervals for their functional reliability? | |
| | |
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| | |

Managing Electrical Safety Risk



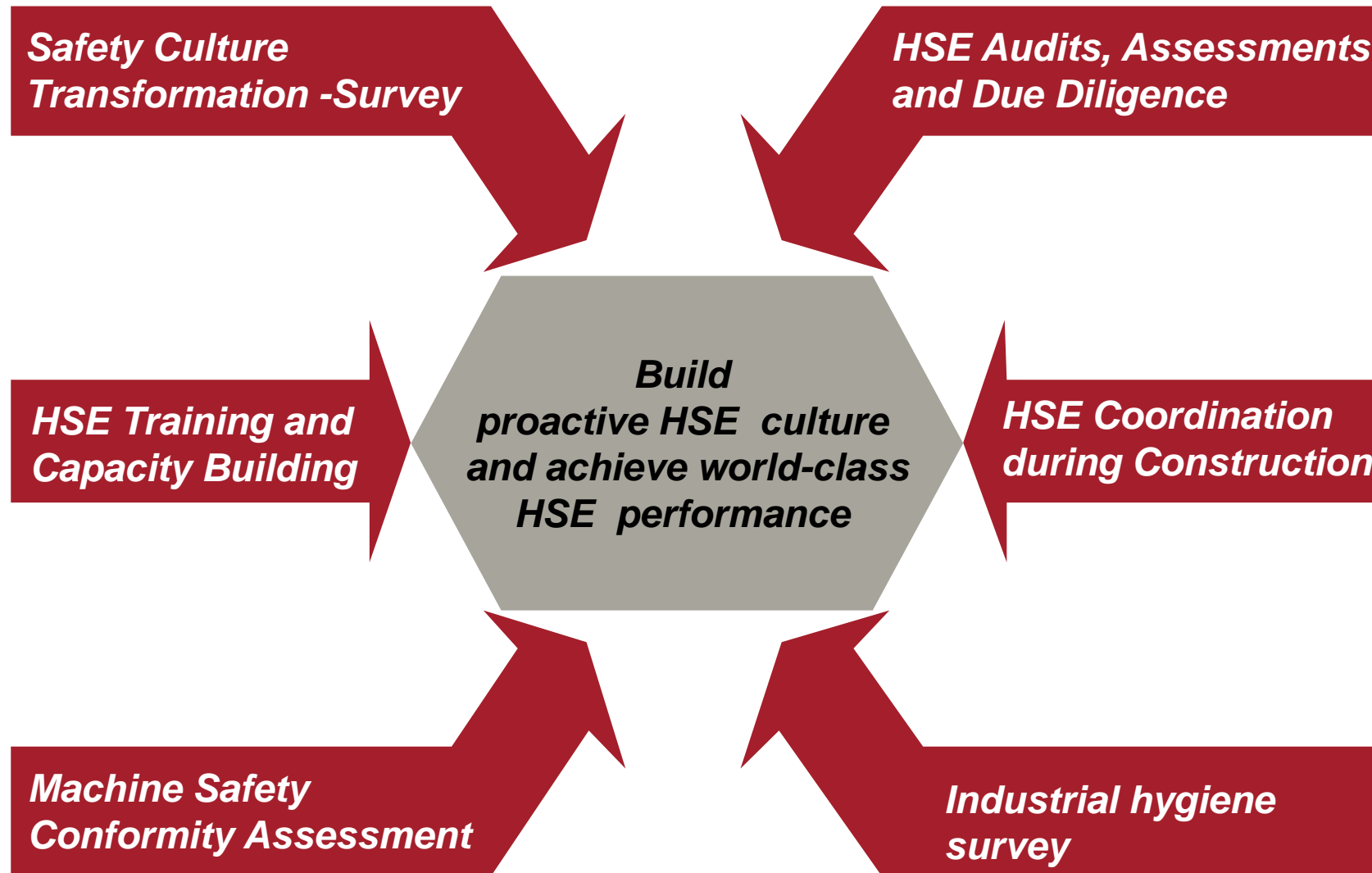
Principle steps:

- ▶ Recognition of risk – hazard identification
- ▶ Assessment of Risk
- ▶ Mitigating Risk with control
- ▶ Review effectiveness of controls

Some effective enabler for managing risk:

- ▶ Establish Company-wide safety standard, protocol/checklist, internal guidelines
- ▶ “2 Minutes safety” before start of any job
- ▶ JHA (Job Hazard Analysis)
- ▶ Application of MoC for any modification, change (process, product, system, human, technology, act/rules)
- ▶ Competence management – skill gap assessment, awareness on hazard exposure
- ▶ Safety Audit – Internal and/or external
- ▶ Effective Permit Mechanism

Steps for building Safety Excellence





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