BUREAU OF INDIAN STANDARDS

MINUTES

Panel for Electrical Installations, CED 46:P13 : Sixth Meeting

Tuesday, 30 April 2024 : 1100 h – 1430 h

O/o Maple Engg-Design Services (India) Pvt Ltd, Maple House, 691-T, 16th Main Road, 4th T Block, Jayanagar, Bengaluru 560041.

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Convener: Shri J.N. Bhavani Prasad **Member Secretary**: Shri Arun Kumar S.
NBC Officer: Shri Shubham Chaudhary

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MEMBERS PRESENT, PHYSICALLY:

1)	Shri S. Gopa Kumar	Cape Electric Private Limited, Kancheepuram
2)	Shri Nandu Gopan	*Rep.* Cape Electric Private Limited, Kancheepuram
3)	Shri Vishnu Jayan	*Rep.* Dehn India Private Limited, Gurugram
4)	Shri M. N. Pinto	Forum of Critical Utility and Services, Bengaluru

MEMBERS PRESENT, IN ONLINE:

5)	Shri Puneet Gupta	Aeon Integrated Building Design Consultants, Noida
6)	Shri Mayankraj	*Rep.* Bureau of Energy Efficiency, New Delhi
7)	Shri Samir Shankar	Dehn India Private Limited, Gurugram
8)	Shri Deepak Kumar Gupta	Delhi Metro Rail Corporation Limited, Delhi
9)	Shri Gaurav Sharma	Engineers India Limited, Gurugram
10)	Shri P. Palani	*Rep.* Government of Tamil Nadu, Chief Electrical Inspectorate, Chennai
11)	Shri K. Arul Prakash	Obo Bettermann India Private Limited, Oragadam
12)	Dr K. Janakiraman	Obo Bettermann India Private Limited, Oragadam
13)	Smt Shruti Goel	Proion Consultants, New Delhi
14)	Shri Hemant M. Sali	Public Works Department, Government of Maharashtra, Mumbai
15)	Shri Debdas Goswami	Schneider Electric India Private Limited, Gurugram
16)	Dr G. Madhusudanan	The Institution of Engineers (India), Kolkata
17)	Dr S. Senthilkumar	The Institution of Engineers (India), Kolkata

INVITEE:

18)	Shri V. Suresh	In Personal Capacity, Thiruvananthapuram
19)	Shri B. S. Aswathnarayan	Maple Engineering Design Services, Bengaluru
20)	Shri Prasanna Kumar	Maple Engineering Design Services, Bengaluru
21)	Shri S. A. Patil	Government of Maharashtra, Industries, Energy and Labour Department, Govt. of Maharashtra
22)	Shri Ashok Ganapati Kanase	Chief Electrical Inspectorate, Industry, Energy and Labour Department, Govt. of Maharashtra

From BIS:

23) Shri Abhishek Sharma, Scientist B (Civil Engg)

Item 0 OPENING REMARKS

The Convener, Shri J. N. Bhavani Prasad extended a warm welcome to all the members to the sixth meeting of the Panel. He extended his gratitude to the National Building Code Sectional Committee for reposing faith in him and to lead the revision of the Code in 2005 and in 2016. Shri Prasad underscored the importance of this Chapter in the Building Code which provides for the requirements to be planned for and executed during building construction considering the variety of gadgets that consume electricity. He mentioned that as in the case of structural design and fire safety, a periodic audit of the building premises particularly for demand, for electrical load and the installed infrastructure be carried out towards ensuring safety from electrical shock, leakage current and even fires. Citing the instances of fires in electrical vehicles parked/being charged in buildings and the rapidly growing trend in the adoption of electric vehicles in the country, Shri Prasad highlighted the need for addressing the requirements and safety precautions for both new construction and the existing built infrastructure. The following points in particular were mentioned for consideration of the Panel in the revision exercise:

a) The dependency on electricity, and electrical gadgets, whether it is at home or in the office or a factory has increased enormously during the decade and added to the increase our dependency or the degree of dependency on power-operated devices, signal, communication and digital aids has gone up. The related need has been the need for powering these devices and the continued operation of the services by these devices despite problems. Today almost all services work on electricity from the commercial distribution system or the grid, but also have various levels of additional sources of power from storage devices like batteries, local generation from DG sets, Solar Panels & other non-conventional sources. These developments and their multitude throw up resultant issues on safety aspects and wider awareness of the users, service providers, equipment maintainers etc., who fall in the chain of the system. We also have a proliferation of systems and devices that operate on electricity to help us with giving advance warning to us of abnormalities, impending failures and emergency communication to help in the management of disasters.

b) Electricity is a great dependable servant. But if not cared for properly with due respect to the rules, it can become a bad master or even a monster.

c) We do have adequate rules. However, it is invariably noticed that the rules are often compromised or ignored. The Standards, Codes, Rules and Regulations are covered by the respective product standards. Use, installation, and maintenance aspects are in the codes including the recently updated NEC, NLC & CEA regulations. These are referred to and are followed by the qualified users, engineers, designers, technicians, etc of the respective disciplines. The NBC bridges the information across all those connected with the buildings including ultimate non-professional uses such as RWA's etc. The Rules and Regulations are compromised mostly without any bad intention, but generally with ignorance (of why a provision exists). If the reason for the provision is available then the chances of the deviation or bypassing the SCR&R would not take place. Let us try to build up the protection in this update, wherever the original code or regulation is not explicit.

Emphasizing that human beings spend maximum time in one of the nine types of building occupancies, changes that have been incorporated in the Central Electricity Authority Regulations, the National Electric Code (NEC) and the related Indian Standards, etc and various subsequent developments nationally and internationally, the Convener mentioned that this revision needs to not only incorporate the required provisions ensuring parity among these but also ensure that the provisions stand the test of time. Shri Prasad quoted examples/instances where the common man (including the Residence Welfare Associations) refers to the Building Code to satisfy himself when it comes to safety of his building edifice from electrical aspects; thereby highlighting the wide readership of the NBC apart from the building professionals. Thus, Shri Prasad highlighted the importance of suggesting all the required provisions at one place in this chapter of NBC to enable particularly the building professionals address the other related aspects on fire safety, HVAC, plumbing, sustainability and maintenance management. The following were also highlighted by Shri Prasad:

1) The vulnerability to hazards (shock on touch) from electricity has gone up due to increased use of electrical gadgets and consequent familiarity coupled with, a degree of complacency based on the fact that the system has more elaborate protection by MCBs as well as RCCBs. The complacency feeling that there is total protection from shock is most often incorrect as any circuit breaker cuts off the circuit only after the first cycle & the first cycle current may also include a doubling effect due to inductive circuit elements.
2) Our energy production and the power availability in the grid or the network have been progressively increasing. While the voltage is the same 230 V, the intensity of shock today in most places is far higher than what it would have been 40 or 50 years ago, consequent to the increased generation and distribution capacities.
3) There could be some general guidelines in distribution system design to limit fault level.

4) Multiple types of protection may also be called for in buildings with multiple sources of power such as grid, DG, Solar etc., as their fault performance characteristics would be significantly different from the load performance characteristics.
5) We have added multiple sources of electricity in our buildings, as we want some (or many) of our equipment and gadgets to continue to be working even if there is a break in the power supply. Even in the house, one would find an inverter. In larger & more technical/equipment-oriented services like hospitals, there could be a number of standby sources of power. The vulnerability or the intensity of the shock is nearly the same whether it is from the grid or from a small 200 W inverter.
6) These aspects are to be known to the users and possibly NBC ought to be the vehicle to bring out what everyone (every user) should know about electricity.
7) There are similar issues about arc flash, static electricity, surge protection, lightning protection etc., For many of these the SCR&R (Standards, Codes, Rules & Regulations) are there. The NBC may have to bring out the need, implications and objective to the forefront as this document is referred to by all concerned with buildings.
8) Study & analysis of many incidents and accidents point out deliberate and conscious decisions taken even by qualified professionals of other disciplines on the basis of personal knowledge ignoring or compromising codal provisions for small gains. Often such a compromise (or wrong decision) would not have been made if the reason for the provision was known. (Codes of some countries do provide in their National Codes the reason for many of the provisions which are often considered controversial.) The code update may include in brief an explanation or reason for typical codal provisions which are known to be often bypassed or compromised. This has particular reference to items such as clearance spaces, location choices, etc., for electrical equipment and related auxiliary systems.
9) Whenever there is a fire originated due to any cause, the insulation of the electrical wiring will get damaged due to exposure to such fire. When the insulation is damaged it is natural for the electrical system to feed energy at the point of insulation damage, literally adding fuel to the fire, till the protective device cuts off the power after some time.
10) It has become a standard practice for press/newspaper to always include a para in the report of any fire incident (or accident) to mention that “the fire is believed to be caused by a short circuit”.
11) A short circuit never causes a fire (as even the simplest level of protection provides adequate protection against short circuit). In this context it is necessary to identify and define an electrical fire, (that is a fire originating from the electrical system) in the National Building Code in the update.
12) Just as the intensity of shock received on touching a live part has increased almost by a factor of 8 to 10 over a 50 year period (say1970 and 2020), increase in system fault level also contributes to feeding more energy (to a fire, even when it is not an electrical fire) when the insulation of an electric circuit gets damaged.
13) The requirements for temporary electrical installations as provided now in the code was claimed to be inadequate in the analysis of reported accidents.

14) Construction worksites also form one area where the installations are not safe. Here again the use of power tools is on the increase, which is a necessity to enhance productivity and quality. Moreover, quite often rejected or outdated or worn out cables are commonly seen and have been responsible for dangerous developments.

He also suggested to highlight in this revision and delve more on the integrated approach within the chapter apart from the information contained in Part 0 of NBC. Thereafter, Shri Prasad concluded with the following thoughts:

i) Early-stage interaction is necessary for the electrical system to be designed to match the large loads of the HVAC systems, Fire Pumps etc and there could be a standard list of information exchange dynamically at the design.
ii) Similar requirements are to be brought out about the services which are to be operational at least for an assessed specified period to serve critical evacuation processes and identification of services as well as the protected routes for the feeders to such services. For these services, wiring (and devices) used should be capable of being in service for the specified period even under exposure to fire.
iii) Apart from these aspects which affect all those connected with buildings as users, builders, designers, O&M, there are a number of new developments such as electric vehicles, and non-conventional energy systems such as solar, taking shape at a fast rate for which the buildings have to be geared up. These will also be discussed as we progress with the formal Agenda items.

With these, it was decided to take up the Agenda, item wise.

Item 1 CONFIRMATION OF MINUTES OF THE LAST MEETING

1.1 The Panel noted the inputs received on the Minutes of the last (fifth) meeting of the Panel held on 31 May 2018 in New Delhi, and circulated vide BIS DG email letter No. CED46:P13/A-2.5 dated 28 September 2018. The Panel noted that the inputs as given at Annex 1 to the Agenda received from M/s Indelecsa India Private Limited were actually debated at length in the last meeting. The Panel noted that the inputs are only a reiteration of their points which were already considered in detail in the last meeting. Members of the Panel thereafter mentioned that these were not the comments on the minutes of the meeting but reiteration of their views, and thus decided not to make any change in the Minutes.

With the above, the Panel decided to confirm the Minutes as circulated earlier.

Item 2 COMPOSITION

2.1 The Panel noted its present composition, as reconstituted by the National Building Code Sectional Committee, CED 46 and given at Annex 1 to the Agenda and decided/noted as follows:

1) To seek the continued interest from the following in view of their no response/nil participation in this sixth meeting of the Panel, and their revised nominations, if any:

    a) C&S Electric Limited, New Delhi
    b) Central Electricity Authority, New Delhi (Shri R. K. Verma has since superannuated)
    c) Central Public Works Department, New Delhi
    d) ITC Ltd, Gurgaon (Shri I. K. Suresh has since superannuated)
    e) Larsen & Turbo Limited, Chennai
    f) Military Engineer Services, Engineer-in-Chief's Branch, Army HQ, New Delhi
    g) Ministry of New and Renewable Energy, New Delhi
    h) Siemens Ltd, Chennai
    i) Solar Energy Corporation of India, New Delhi

2) Shri Maxim Norbet Pinto shall represent the Forum of Critical Utility and Services, Bengaluru as their principal member.

3) Shri Sandeep A. Patil, CEI and Shri Ashok Ganapati Kanase, SE shall represent the Chief Electrical Inspectorate, Industry, Energy and Labour Department, Govt. of Maharashtra as per their communication, which the Panel agreed to.

4) Shri Hemant Sali (Technical Advisor) shall represent the Public Works Department, Govt of Maharashtra.

5) To send a final reminder to M/s Tata Motors Limited, Mumbai for their nominations on the Panel considering the proposed inputs from them on the revision of the Code particularly from an EV manufacturer.

6) To co-opt a System Designer/Integrators of EV on the Panel, CED 46:P13 (*in consultation with the Convener, and members to write the suggestions to BIS*).

7) To co-opt M/s National Federation of Engineers for Electrical Safety, Tamil Nadu on the Panel considering their request.

8) To co-opt M/s Maple Engineering Design Services, Bengaluru on the Panel as recommended during the meeting.

9) To co-opt M/s International Copper Alliance on the Panel considering their request.

10) Regarding the revised nominees/names as mentioned by their organizations during the meeting, the respective organizations should send the same formally through email to ced46@bis.gov.in for BIS' records.

11) The Convener Shri J. N. Bhavani Prasad made a request to the National Building Code Sectional Committee, CED 46 for accepting his relinquishment as the Convener. However, Shri Prasad kindly agreed to the request of BIS to contribute on the Panel in his personal capacity as an individual expert. He also proposed the name of Shri N. Nagarajan, former Chief Engineer (Electrical), CPWD for consideration as the next convener of the Panel by CED 46 of BIS.

Item 3 PROJECT OF REVISION OF NBC

3.1 The Panel noted the information regarding the comprehensive exercise of revision of NBC 2016, being carried out through the 22 Panels under the National Building Code Sectional Committee, CED 46 of BIS to bring updates to the various Parts/Sections of NBC 2016 (as at Annex 3 of the Agenda) and to bring out the latest and state-of-the-art revision of the Code.

The Panel noted the existing chapter titled 'Part 8/Sec 2 Electrical and Allied Installations' and its contents as given in Annex 4 to the Agenda.

The Panel noted that the ongoing revision of the National Building Code of India (NBC) is a comprehensive document involving 33 chapters. The revision exercise aims to refine and update the contents of the Code for ease in understanding and implementation and align the chapters as far as possible with the current industry standards and practices. In this context, the Panel agreed that for harmonious revision of the Code, interconnection within the various Parts is essential including with that to Part 2 'Administration' which prescribes regarding development of detailed structural, electrical, plumbing, fire, other mechanical drawings and designs relevant to buildings which is submitted to the authority before actual construction; and for periodic renewal from structural, health, fire and electricity point of view.

3.1.1 The Panel noted the inputs/suggestions received from Shri Gopa Kumar, CAPE Electric towards revision of the Chapter as given at Annex 5 of the Agenda. The Panel was also briefed by Shri Gopa Kumar who is also member of the Electrical Installations Sectional Committee, ETD 20 which recently published the **National Electrical Code of India 2023.** Shri Gopa Kumar briefly explained the suggestions as below:

a) NBC and NEC are only complementing each other.
b) Energy Efficiency in Electrical Installation including that on low voltage may be included, taking reference from the following:

   IEC 60364-8-1:2019 *'Low-voltage electrical installations - Part 8-1: Functional aspects - Energy efficiency'*

c) Explain lucidly the concept of Residual Current Device (RCD) particularly w.r.t. shock protection and fire protection.
d) Review and align in the provisions given in the various standards formulated by the Solar Photovoltaic Energy Systems Sectional Committee, ETD 28 which includes IS 14153, IS 16230, IS 17963, IS 16960 (Parts 1, 2 & 3), IS

18124 (Parts 1 & 2) all relating to photovoltaic systems. Please see **Annex 1 (P-18)** that lists the Indian Standards formulated under ETD 28, particularly those highlighted in yellow.

e) Reference and coherence of the provisions of IS 732:2019 (on Electrical Wiring Installations) particularly classification BD4 and BE with those in Part 4 'Fire and Life Safety' of NBC.
f) Similarly, coherence of the provisions of protection against thermal effects as given in IS 18732:2023 (its Annex J) with Part 4 of NBC regarding guidance on selection of electrical requirements of buildings.

The Panel decided to consider the above aspects while comprehensively revising the provisions of the Chapter for which 3 Core Groups were constituted (*see* items **3.1.2** and **3.2**). The Panel also decided that in this revision of NBC, reference to the important clauses of NEC be made, and the requirements regarding building planning and execution w.r.t. the same be included by explaining the 'when and why' along with pictorial depictions. The Panel also decided that the ETD/NEC provide the specific changes/corrections that they would like to make.

The aspects relating to sustainability be included suitably under Clause 3 'General' and for details, reference may be made to NBC: Part 11 'Approach to Sustainability'. Some members also desired that considering the volume of content/provisions in this chapter, the same be included as a new part instead of as a Section within Part 8 'Building Services'.

3.1.2 The Panel noted the details regarding an event organized by M/s FOCUS on **EV Charging infrastructure in buildings** and particularly the suggestions for addressing the requirements in the Code. The Panel thereafter decided/noted as follows:

a) Clarity on the location of charging infrastructure particularly the floor level where such infrastructure is permissible and where it is not.
b) If the charging infrastructure is located within a closed building (having limited ventilation) consider mandating the use of battery temperature monitoring sensor and align it with the electrical distribution system as well as the fire detection and alarm system; and suitable type of sprinkler system.
c) With the growing number of electric vehicle within the same building, consider providing a separate transformer and indicate its requirements and location within a plot, particularly considering the past/recent incidences of fire during EV charging. Large number of EV under one area of basement requires consideration of the need to segregate or avoid automatic spread of fire to adjoin vehicle. Consideration has to be given to the level of IP protection for the charging system installations in buildings where the combination of sprinkler and electrical distribution with flexible leads, plugs, couplers and terminations have to co-exist.
d) Also, to consider specifying the suggestive time (of the day/night) when the EV charging infrastructure can be used to even out the overall electrical demand in a building without unnecessarily resorting to increasing the actual installed capacity. The charging circuits can be activated during the low load period at night, while the user may connect the charging on his return (which

most likely would be a period of evening peak load for the electrical system of the complex.

e) There used to be reports of frequent fires associated with charging systems & in particular Lithium batteries, which of late has reduced. While significant improvements in charging and battery temperature monitoring systems have come up, the vulnerability to vehicle/battery fires is a matter of concern and the EVs are coming up with monitoring the rise in temperature of the battery during charging. Provision for transmission of the temperature with the building fire alarm system & the protocol for automatic exchange of data would be necessary, as there would be growth of the number of vehicles. Problem of fire due to overcharging may come up as systems age and battery capacity deteriorates with age.

f) Include the relevant provisions on infrastructures, rules, principles, metering towards EV charging posts/outlets. Also, the protocol for scheduling and automatic controls to use the charging loads to fill the low load period and improve the overall load factor.

g) Separate Groups may have to be constituted for:
   a. EV, Battery charging, automatic scheduling
   b. Fire control segregation compartmentation
   c. Battery, Electricity, charging cables terminal devices and sprinkler water
   d. Ventilation smoke extraction, additional measures for Lithium fire as water/sprinkler may be inappropriate or creating more problems

h) In this context, the following Indian Standards may be suitably used/referred:

Sl No.	**IS No.**	**IS Title**	**Aspect**	**Degree of Equivalence with IEC Standards**
1	IS 17017 (Part 1) : 2018 (Active)	Electric Vehicle Conductive Charging System Part 1 General Requirements	Product Specification	Modified/Technically Equivalent
2	IS 17017 (Part 2/Sec 1) : 2020 (Active)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket-Outlets, Vehicle Connectors, and Vehicle Inlets Section 1 General requirements	Product Specification	Modified/Technically Equivalent
3	IS 17017 (Part 2/Sec 2) : 2020 (Active)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket â€“ Outlets, Vehicle Connectors and Vehicle Inlets Section 2 Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories	Dimensions	Modified/Technically Equivalent
4	IS 17017 (Part 2/Sec 3) : 2020 (Active)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket â€” Outlets, Vehicle Connectors and Vehicle Inlets Section 3 Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers	Dimensions	Modified/Technically Equivalent
5	IS 17017 (Part 2/Sec 6) : 2021 (Active)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets	Dimensions	Modified/Technically Equivalent

Sl No.	IS No.	IS Title	Aspect	Degree of Equivalence with IEC Standards
		Section 6 Dimensional compatibility requirements for DC pin and contact-tube vehicle couplers intended to be used for DC EV supply equipment where protection relies on electrical separation		
6	IS 17017 (Part 2/Sec 7) : 2023 (Active)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets Section 7 Dimensional Compatibility and Interchange Ability Requirements for a.c., d.c. and a.c./d.c. Pin and Contact-Tube Vehicle Couplers Intended to be used for a.c./d.c. EV Supply Equipment where Protection Relies on Electrical Separation	Dimensions	Indigenous
7	IS 17017 (Part 21/Sec 1) : 2019IEC 61851-21-1 : 2017 (Active)	Electric Vehicle Conductive Charging System Part 21 Electromagnetic Compatibility (EMC) Requirements Section 1 On-board chargers	Methods of tests	Identical under dual numbering
8	IS 17017 (Part 21/Sec 2) : 2019IEC 61851-21-2 : 2018 (Active)	Electric Vehicle Conductive Charging System Part 21 Electromagnetic Compatibility (EMC) Requirements Section 2 Off-board chargers	Safety Standard	Identical under dual numbering
9	IS 17017 (Part 22/Sec 1) : 2021 (Active)	Electric Vehicle Conductive Charging Systems Part 22 AC Charging Configurations Section 1 - AC Charge Point for Light Electric Vehicle	Product Specification	Indigenous
10	IS 17017 (Part 23) : 2021 (Active)	Electric Vehicle Conductive Charging Systems Part 23 dc Electric Vehicle Supply Equipment	Product Specification	Modified/Technically Equivalent
11	IS 17017 (Part 24) : 2021 (Active)	Electric Vehicle Conductive Charging System Part 24 : Digital Communication between a DC Electric Vehicle Supply Equipment and an Electric Vehicle for control of DC Charging	Code of Practice	Modified/Technically Equivalent
12	IS 17017 (Part 25) : 2021 (Active)	ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM Part 25: DC EV supply equipment where protection relies on electrical separation	Product Specification	Modified/Technically Equivalent
13	IS 17017 (Part 31) : 2024 (Active)	ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM Part 31: ac or dc EV supply equipment for where protection relies on electrical separation	Code of Practice	Indigenous

To address the above aspects, the Panel decided to constitute the following Working Group which was requested to consider the matter holistically and provide the draft clauses for inclusion in the chapter:

Working Group for Electric Vehicles; Battery Storage; Load Factor, etc.			
Organization	**Name**	**Email Id**	**Mobile No.**
In Personal Capacity, Bengaluru	Shri J. N. Bhavani Prasad *Convener*	jnb.prasad@gmail.com	9343215848
Cape Electric Private Limited, Kancheepuram	Shri S. Gopa Kumar	gk@capeindia.net	9962522244
Central Public Works Department, New Delhi	Shri Vikas Rana	delcendz4.cpwd@nic.in	9999445340
Tata Motors Limited, Pune	Shri Senthilnathan Thangavelu	stt770131@tatamotors.com	8446301663
India Energy Storage Alliance, Pune	Shri Debi Prasad Dash	ddash@ces-ltd.com	9699719818
Automotive Research Association of India, Pune	Shri A. A. Deshpande	deshpande.aed@araiindia.com	9850826640
System Designer / Integrators of EV	Representative		
Directorate of Maharashtra Fire Services, Mumbai	Shri Santosh S. Warick	santoshwarick@midcindia.org	8108077778
Indian Institute of Technology Madras, Chennai	Prof Ashok Jhunjhunwala / Centre for Battery Engineering and Electric Vehicles (CBEVV)	ashok@tenet.res.in	9444444408
In Personal Capacity, New Delhi	Shri C. K. Verma	Ck_verma@yahoo.co.in	9868603923

The above Group was authorized to invite other related professionals including experts (such as IITGN/UL India/VIT/etc.) so as to consider the matter threadbare and make its recommendations.

3.2 The Panel noted the information/decision in the last meeting regarding the need to give a holistic consideration in the matter (regarding RCCB/RCD Specification; Location for providing RCD; Use of 100 mA RCD in place of 30 mA RCD where 30 mA RCD is tripping in wet areas – indicated earlier by M/s Schneider Electric Private Limited, Gurugram) and evolve guidelines for use of protective devices coordinated with electrical products in use and their rating.

The Panel considering all the other developments in the field and in the standardization scenario in BIS and across the world, towards comprehensive revision of the chapter based on all the deliberations during the meeting, decided to reconstitute the Group as below:

Working Group for revision of the provisions in the Chapter *(Part 8/Section 2*			
Organization	**Name**	**Email Id**	**Mobile No.**
Cape Electric Private Limited, Kancheepuram	Shri S. Gopa Kumar Convener	gk@capeindia.net	9962522244
Proion Consultants, New Delhi	Smt Shruti Goel	shruti.goel@proion.net	9811355815
Central Public Works Department, New Delhi	Shri Vikas Rana	delcendz4.cpwd@nic.in	9999445340
Schneider Electric India Private Limited, Gurugram	Shri Debdas Goswami	debdas.goswami@non.se.com	9717443939
Central Electricity Authority, New Delhi	Shri Ashok Kumar Rajput	akrajput@nic.in	9868202176
Ministry of New and Renewable Energy, New Delhi	Shri A. K. Tripathi	aktripathi@nic.in	9810880378
Public Works Department, Government of Maharashtra, Mumbai	Shri Hemant M Sali	hemant.sali1@gmail.com	9422007991
Forum of Critical Utility and Services, Bengaluru	Shri M.N. Pinto	mnpinto@mapleconsultants.co.in	9845725037

Aeon Integrated Building Design Consultants, Noida	Shri Puneet Gupta	puneet.gupta@aeonconsultants.in	9910491748
Government of Tamil Nadu, Chief Electrical Inspectorate, Chennai	Shri P. Palani	eitech@tn.gov.in	94442 79283
ETD, BIS	Shri Ritwik Anand	ritwikanandbis@gmail.com, ritwikwin@bis.gov.in	9811794432

The Panel also decided that, in line with the opening remarks of the Convener and the ensuing deliberations during the day, it was suggested to introduce a new clause '**Electricity - What Everyone Should Know**' relating to power/electricity requirement for architectural, plumbing electrical load and what a building professional and even a user should know and do about to ensure safe use of electricity. In this regard, the BIS Secretariat informed about the already available Clause 13 'Protection of the man Beings from Electrical Hazards' in NBC 2016 which gives comprehensive details, and the same may be reviewed and further improved upon. Also, the electrical safety aspects be made robust by addressing the effects of increased generation and transmissions & distribution capacity and higher fault levels. This proposed clause to also introduce awareness regarding increase of shock intensity even with the use of RCCB and ELCB; particularly when the first cycle current in the case of touch has gone up and these circuit breakers does little to reduce the first cycle fault current through the touch path. To suitably make aware the users that in some cases with the use of inductive elements in the circuits there could be a doubling effect for the first cycle. The proposed clause to also cover the practical extent of protection against shock (which is really limited) by the devices like RCCB. This proposed clause to address the wide spread misconception (sometimes among the professionals as well) that a person will not receive a shock because the installation has an RCCB. Aspects such as short circuit, loose connection situations which can lead to distress to also be included in this generic clause. Topic such as 'electrical fire', distinction of electrical fire from other causes leading to failure of electrical system; tag-in & tag-out procedure to be followed by the electrical workmen; etc to also be covered. In this context, it was decided to suitably prefer/make use of the standards published by the **IEC/TC 64** 'Electrical installations and protection against electric shock'.

Special requirements and caution where power from multiple sources are fed to a building including residences; caution w.r.t devices that run on 'inverter' technology; provisions addressing automation of devices, IOT based controls and their safety, to also be address in the revision, apart from the fire caused by the electrical system due to the source of fire available in any other system in a building ultimately affecting the energy feed.

3.3 The Panel noted that the Electrotechnical Department (ETD) of BIS has since revised the **National Electrical Code of India in 2023** and released the same as **NEC 2023 (SP 30:2023)**. The Panel noted that information under the item of Agenda regarding the coverage of NEC 2023 which is available in 8 Parts and 49 Sections; and also noted the brief information about NEC as available online in the BIS Website as at: https://www.services.bis.gov.in/php/BIS_2.0/BISBlog/national-electrical-code-of-india-2023/. The Panel appreciated that NEC 2023 is also available for download (as NBC 2016) from the BIS Website in the link: https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_s

tandards/isdetails/MjgwODc.

The Panel appreciated the efforts in bringing out the BIS Talks' Video about NEC 2023 as available in the YouTube Channel of BIS which can be accessed using the link: https://youtu.be/9jlTophdJTk?si=jUMVOyTX05cbULAD .

In the absence of Officer of ETD of BIS in this meeting, Shri Gopa Kumar, member of the Electrical Installations Sectional Committee, ETD 20 (that revised NEC 2023) quickly briefed the Panel about the revision exercise that started in 2017 and in the process, aligned the requirements given in 8 Parts of IEC 60364. He also mentioned that IS 732 (on electrical wiring) was also suitably used in NEC.

3.4 The Panel noted the suggestion received from the ETD of BIS subsequent to the release of NEC 2023 as given under the item of Agenda and based on the discussions thereon, decided as follows:

a) NEC was first formulated in August 1985 and revised in February 2011 and recently in January 2023.
b) NBC in its 2016 edition had brought out the necessary updates to the provisions given in the then NEC (NEC 2011) and some publications of ETD with the understanding that ETD would update its publications.
c) There is no need to repeat the entire information that is already covered in NEC.
d) Suitably refer and include the critical extracts as annexes to NBC for the benefit and convenience of the readers, users and others who refer the NBC.
e) Typically, NEC and other ETD standards are referred by the subject specialist and related professionals while the NBC is referred by non-professionals also in the form of beneficiaries of buildings apart from the multi-disciplinary professionals including the electrical professionals involved in building planning, design, execution/construction, maintenance & demolition.

3.5 The Panel noted the information under the item of Agenda that lists the current/latest edition of the Indian Standards formulated by the ETD of BIS which were largely used in the revision of the Chapter (Part 8/Sec 2) as indicated in the foreword of NBC 2016. The Panel also noted the details contents of IS 732 : 2019 and IS 3043 : 2018 apart from the major changes in these standards as given under the item of Agenda. The Panel also noted that the earthing code (IS 3043) has once again being taken up for revision by ETD of BIS.

All the 03 Conveners and members of the Working Groups were requested to initiate the discussions among themselves on their own and share the proposed contents, first followed by the changes/revisions to the Code in the form of draft clauses in 3 months' time, i.e. end of July 2024.

Item 4 COMMENTS RECEIVED ON PART 8 'BUILDING SERVICES'/SECTION 2 'ELECTRICAL AND ALLIED INSTALLATIONS' OF SP7:2016

4.1 The Panel noted the comments received from M/s Joyeta Ghoshal APCO Worldwide on the Chapter of NBC 2016 as given in the Annex 6 to the Agenda. It

was decided to address the same through the respective Working Groups as constituted above.

4.2 The Panel noted the comments received from the Office of the Chief Electrical Inspector to Government of Kerala on the above chapter regarding "*Installation of Roof Top DG Sets in Buildings - contradiction in National Building Code, 2016 & National Electric Code, 2023"* as given in the Agenda. The Panel noted the provisions given in NEC as below:

6.3 Installation

While installing conditions mentioned under **6.3.1** to **6.3.5** below shall be considered.

6.3.1 *Indoor/Outdoor/Rooftop*

At planning stage, it is necessary to decide location so that necessary arrangements can be done related to Architectural, Structural, Civil Work requirements. Future additions, augmentation shall also be considered. Required clearances around and in between gen-sets shall be as per OEM's recommendations so that operation and serviceability of generating set shall be easy. If installation is within room, door sizes shall be of adequate size considering size of removable/replaceable parts. Necessary provisions in respect with cables, Fuel lines, breather vent, coolant/lube-oil drain, coolant, storage of consumables, spares shall be considered.

NOTES:

1 Where Gen set is meant to provide supply to critical services for which supply integrity is important, location shall be so chosen that in case of emergency like fire, functioning of the Gen-set will not get affected. This location may be at safe place away from building.

2 In case of roof top Gen-sets, OEM shall be informed in advance and the recommended pre-installation check list shall be followed.

3 Bulk fuel oil storage should be at the ground or underground

The Panel also noted that note 3 of clause **6.3.5.1** of NEC indicates the following:

6.3.5 *Fuel*

6.3.5.1 *Diesel*

In case diesel engines, fuel tanks where they are not part of factory assembled unit, following points shall be considered:

a) Supply and return line allowable pressure, segregation, length;

NOTE — Higher pressure may lead to low power, late stopping, engine die down

b) Level of fuel tank above/below with respect to engine and fuel pump;

c) Minimum requirement of fuel by gravity if any, in respect of Gen-sets with AMF panels;

d) Arrangements shall be done for condensate drain, breather, fill neck to allow expansion;

e) Capacity; shall be to suffice requirement for continuous use for the assessed critical period but shall not exceed norms mentioned under petroleum rules; and

f) Galvanised tank, piping shall not be used for diesel.

Separate storage arrangement for fuel refilling may be done depending on need and nearby availability. Storage of fuel above 1 000 *l* requires approval from the authority. This arrangement should comply with applicable Petroleum Rules.

NOTES:

1 Diesel consumption

Fuel efficiency is an important factor for considering running cost. It is measured at 50 percent, 75 percent and 100 percent loading. Specific fuel consumption is measured in gm/bhp/hour or l/hr. Specific gravity of Diesel is 0.845 as per ISO 3046. It is always desirable to have optimal fuel consumption over broad range of loading. All manufacturers provide fuel consumption charts. It shall be noted that actual consumption may vary depending on ventilation, observance of maintenance schedule, percentage loading, and occasional overloading.

2 Diesel shall comply specifications as per IS 1460.

3 In case of Fuel Tank of Gen-sets on roof top, Specific Rules mandatory as per Local Fire Authority and Petroleum Rules shall be followed in respect of placement and capacity.

The Panel thereafter observed that the provisions related to roof top gen-sets given in NEC are not generic and only enables safe installation practice subject to the conditions indicated therein NEC.

The Panel suggested that ETD of BIS may further review and reply to the Govt. of Kerala.

The Panel decided to address any difference in the provisions among any other publication of BIS including NEC w.r.t NBC in this current revision. Further, the Panel decided to recommend the maximum capacity of such power generation sets on roof tops. Also, the Panel noted that house data centers tend to use DG sets at multiple levels and contiguous to the main building and hence the required aspects/provisions be included suitably.

Considering the various discussions and the remarks by the Convener, the following Working Group was constituted to address the electrical safety aspects including planning and design for drawing power and supplying from multiple sources such as Inverters, DG Sets, Solar PV Modules and their related protection systems and earthing requirements:

Working Group for Solar Energy and Power from Multiple Sources (Inverters, Multiple DG Sets), related protection and Earthing

Organization	Name	Email Id	Mobile No.
Proion Consultants, New Delhi	Smt Shruti Goel **Convener**	shruti.goel@proion.net	9811355815
Cape Electric Private Limited, Kancheepuram	Shri S. Gopa Kumar	gk@capeindia.net	9962522244
Forum of Critical Utility and Services, Bengaluru	Shri M.N. Pinto	mnpinto@mapleconsultants.co.in	9845725037
Public Works Department, Government of Maharashtra, Mumbai	Shri Hemant M Sali	hemant.sali1@gmail.com	9422007991
Ministry of New and Renewable Energy, New Delhi	Shri A. K. Tripathi	aktripathi@nic.in	9810880378
Obo Bettermann India Private Limited, Oragadam	Dr K Janakiraman	kjr@oboindia.com	9962501405
Solar Energy Corporation of India Limited, New Delhi	Shri C. K. Singh	cksingh@seci.gov.in	8800626613
Representative of ETD 20			
Central Public Works Department, New Delhi	Shri Vikas Rana	delcendz4.cpwd@nic.in	9999445340
Institution of Engineers (India), Kolkata	Dr S Senthilkumar	sendilkumar26@gmail.com	9176877036
Government of Tamil Nadu,	Shri P. Palani	eitech@tn.gov.in	94442 79283

Chief Electrical Inspectorate, Chennai			

4.3 The Panel noted the information under the item of Agenda relating to the matter regarding comments received on Early Streamer Emission (ESE) Lightning Protection System against the concerned provisions in Part 8/Sec 2 'Building Services, Section 2 Electrical and Allied Installations' of NBC 2016 as per which such air terminals are not acceptable as per the Code. The Panel also noted that the Hon'ble Court of Karnataka at Bengaluru vide its order dated 23 November 2022 passed in their Writ Petition No.12921 of 2020 which disposed the matter. The Panel referred to the order of the Hon'ble Court including its Para 6 as follows:

"6. point having heard the learned council for the parties and having perused the petition papers, this Court is of the view that the specific stand of the Respondent-Bureau with which the 1st Respondent - Central Government is in agreement, does substantiate that the subject Code and its provisions including what is impugned herein do not have proprio vigor enforceability, the same being 'a voluntary model code' and a 'guiding document' to use the terminology of the 2nd Respondent. Therefore, the Petitioner need not have the apprehension that in the run of its business, it has to comply with what is recommended in the Code per se and therefore, even if there is any contravention thereof, it shall not be actionable against the Petitioner, till after the same is incorporated in some statutory instrument to make it a binding rule of conduct".

Based on the deliberations during the meeting, for the consideration in the revision of this chapter by one or more of the above Groups constituted during the meeting, the commonly received queries/suggestions have been compiled and given in ***Annex 2 (P-24).***

Item 5 PROJECT OF PROMOTION OF USE OF NBC 2016 IN ALL STATES AND UTs OF INDIA

5.1 The BIS' Secretariat explained about the above Project that involved an exercise of Promotion of use of National Building Code of India 2016 in all States and UTs of India. The major deliverable namely the draft Standardized Development and Building Regulations aligned with the provisions of NBC 2016 and the other deliverables such as the State wise regulations, Pamphlets for awareness of general public, GUIDE TO USING THE NBC were explained to the members who appreciated the work done by the entire BIS team.

5.2 The Panel noted the information about the new special publication, **SP 73 : 2023 'Standardized Development and Building Regulations, 2023'** was also published and released, which is available for access (free download) from the BIS' website and from: https://standardsbis.bsbedge.com/

Item 6 DATE & PLACE OF THE NEXT MEETING

6.1 All the 03 Conveners and members of the Core Groups as constituted in the meeting were requested to initiate the discussions among themselves on their own and share the proposed contents first, followed by the changes/revisions to the Code in the form of draft clauses in 3 months' time, i.e. end of July 2024. The Groups

were also authorized to invite other interests who would be penning down the clauses in the revision exercise.

6.2 Upon receipt of the inputs from the Core Groups, it was decided to hold the next meeting of the Panel in **August 2024**.

Item 7 ANY OTHER BUSINESS

7.1 Members thanked the Convener, Shri J. N. Bhavani Prasad for ably conducting the meeting and providing leadership in the launching of the revision of this important chapter on Electrical Installations which is widely implemented in the country.

7.2 BIS Secretariat also thanked the Convener, all the members and the invitee Shri V. Suresh (Chairperson, CED 46) for taking active interest during the meeting resulting in useful deliberations.

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ANNEX 1

(*Item* **3.1.1**)

LIST OF INDIAN STANDARDS RELATING TO SOLAR PHOTOVOLTAICS

ETD28 : Solar Photovoltaic Energy Systems

Scope : To prepare standards for systems of photovoltaic conversion of solar energy into electrical energy and for all the elements in the entire photovoltaic energy systems In this context, the concept photovoltaic energy systems includes the entire field from light input to solar cell and including the interface with the electrical system(s) to which energy is supplied
Liaison : IEC TC 82 - Solar photovoltaic energy systems - Participating (P)

Sl. No.	IS No.	Title	No. of Amendments
1.	IS 12762 (Part 1) : 2010 IEC 60904_1 Reviewed In : 2020	Photovoltaic devices: Part 1 measurement of photovoltaic current - Voltage characteristics (First Revision)	-
2.	IS 12762 (Part 1/Sec 1) : 2020 IEC 60904-1-1 : 2017	Photovoltaic Devices Part 1 Measurement of Current-Voltage Characteristics Section 1 Multi-junction PV devices	-
3.	IS 12762 (Part 1/Sec 2) : 2020 IEC TS 60904-1-2 : 2019	Photovoltaic Devices Part 1 Measurement of Current-voltage Characteristics Section 2 Bi-facial photovoltaic (PV) devices	-
4.	IS 12762 (Part 2) : 2018 IEC 60904-2 : 2015	Photovoltaic devices: Part 2 Requirements for photovoltaic reference devices (Second Revision)	-
5.	IS 12762 (Part 3) : 2020 IEC 60904-3 : 2016	Photovoltaic Devices Part 3 Measurement Principles for Terrestrial Photovoltaic PV Solar Devices with Reference Spectral Irradiance Data (Third Revision)	-
6.	IS 12762 (Part 4) : 2014 IEC 60904-4 : 2009 Reviewed In : 2019	Photovoltaic devices: Part 4 reference solar devices - Procedures for establishing calibration traceability	-
7.	IS 12762 (Part 5) : 2014 IEC 60904-5 : 2011 Reviewed In : 2019	Photovoltaic devices: Part 5 determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open - Circuit voltage method (First Revision)	-
8.	IS 12762 (Part 7) : 2023 IEC 60904-7 : 2019	Photovoltaic Devices Part 7: Computation of the Spectral Mismatch Correction For Measurements of Photovoltaic Devices (First Revision)	-
9.	IS 12762 (Part 8) : 2018 IEC 60904-8 : 2014	Photovoltaic devices: Part 8 measurement of spectral responsivity of a photovoltaic (PV) device (First Revision)	-
10.	IS 12762 (Part 8/Sec 1) : 2020 IEC 60904-8-1 : 2017	Photovoltaic Devices Part 8 Measurement of Spectral Responsivity of a Photovoltaic (PV) Device Section 1 Multi-junction (PV) devices	-
11.	IS 12762 (Part 9) : 2023 IEC 60904-9 : 2020	Photovoltaic Devices Part 9: Classification of Solar Simulator Characteristicses Part 9: Solar Simulator Performance Requirements (First Revision)	-
12.	IS 12762 (Part 10) : 2023 IEC 60904-10 : 2020	Photovoltaic Devices Part 10: Methods of Linear Dependence and Linearity Measurements (Second Revision)	-
13.	IS 12762 (Part 13) : 2020	Photovoltaic Devices Part 13 Electroluminescence of	-

	IEC TS 60904-13 : 2018	Photovoltaic Modules	
14.	IS 12762 (Part 14) : 2023 IEC TR 60904-14 : 2020	Photovoltaic devices Part 14: Guidelines for production line measurements of single-junction PV module maximum power output and reporting at standard test conditions	-
15.	IS 12763 : 2013 IEC 60891 : 2009 Reviewed In : 2018	Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I - V characteristics (First Revision)	-
16.	IS 12834 : 2023 IEC/TS 61836 : 2016	Solar Photovoltaic Energy Systems Terms Definitions and Symbols Second Revision	-
17.	IS 14153 : 1994 Reviewed In : 2019	Guide for general description of photovoltaic (PV) power generating system	-
18.	IS 14286 : 2010 61215 Reviewed In : 2020	Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval (First Revision)	-
19.	IS 14286 (Part 1) : 2019 IEC 61215-1 : 2016	Terrestrial photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements (Second Revision)	-
20.	IS 14286 (Part 1) : 2023 IEC 61215-1:2021	Terrestrial Photovoltaic PV Modules Design Qualification and Type Approval Part 1: Test Requirements Third Revision	-
21.	IS 14286 (Part 1/Sec 1) : 2019 IEC 61215-1-1 : 2016	Terrestrial photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements: Sec 1 special requirements for testing of crystalline silicon photovoltaic (Pv) modules (Second Revision)	-
22.	IS 14286 (Part 1/Sec 1) : 2023 IEC 61215-1-1:2021	Terrestrial photovoltaic PV modules Design qualification and type approval Part 1-1: Special requirements for testing of crystalline silicon photovoltaic PV modules Third Revision	-
23.	IS 14286 (Part 1/Sec 2) : 2019 IEC 61215-1-2 : 2016	Terrestrial photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements: Sec 2 special requirements for testing of thin - Film cadmium telluride (CdTe) based photovoltaic (Pv) modules (Second Revision)	-
24.	IS 14286 (Part 1/Sec 2) : 2023 IEC 61215-1-2:2021	Terrestrial photovoltaic PV modules Design qualification and type approval Part 1-2: Special requirements for testing of thin-film Cadmium Telluride CdTe based photovoltaic PV modules Third Revision	-
25.	IS 14286 (Part 1/Sec 3) : 2019 IEC 61215-1-3 : 2016	Terrestrial photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements: Sec 3 special requirements for testing of thin - Film amorphous silicon based photovoltaic (PV) modules (Second Revision)	-
26.	IS 14286 (Part 1/Sec 3) : 2023 IEC 61215-1-3:2021	Terrestrial photovoltaic PV modules Design qualification and type approval Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic PV modules Third Revision	-
27.	IS 14286 (Part 1/Sec 4) : 2019 IEC 61215-1-4 : 2016	Terrestrial photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements: Sec 4 special requirements for testing of thin - Film Cu(In,ga)(S,se)2 based photovoltaic (Pv) modules (Second Revision)	-
28.	IS 14286 (Part 1/Sec 4) : 2023 IEC 61215-1-4:2021	Terrestrial photovoltaic PV modules Design qualification and type approval Part 1-4: Special requirements for testing of thin-film CuInGASSe2 based photovoltaic PV modules Third Revision	-
29.	IS 14286 (Part 2) : 2019	Terrestrial photovoltaic (PV) modules - Design	-

	IEC 61215-2 : 2016	qualification and type approval: Part 2 test procedures (Second Revision)	
30.	IS 14286 (Part 2) : 2023 IEC 61215-2:2021	Terrestrial Photovoltaic PV Modules Design Qualification and Type Approval Part 2: Test Procedures Third Revision	-
31.	IS 16077 : 2013 IEC 61646 : 2008 Reviewed In : 2018	Thin - Film terrestrial photovoltaic (PV) modules - Design qualification and type approval	-
32.	IS 16149 : 2014 IEC 61345 : 1998 Reviewed In : 2020	UV test for photovoltaic (PV) modules	-
33.	IS 16169 : 2014 IEC 62116 : 2014	Utility - Interconnected photovoltaic inverters - Test procedure of islanding prevention measures	-
34.	IS 16169 : 2019 IEC 62116 : 2014	Utility - Interconnected photovoltaic inverters - Test procedure of islanding prevention measures (First Revision)	-
35.	IS 16170 (Part 1) : 2014 IEC 61853-1 : 2011 Reviewed In : 2019	Photovoltaic (PV) module performance testing and energy rating: Part 1 irradiance and temperature performance measurements and power rating	-
36.	IS 16170 (Part 3) : 2022 IEC 61853-3 : 2018	Photovoltaic PV Module Performance Testing and Energy Rating Part 3: Energy Rating of PV Modules	-
37.	IS 16170 (Part 4) : 2023 IEC 61853-4 : 2018	Photovoltaic PV Module Performance Testing and Energy Rating Part 4: Standard Reference Climatic Profiles	-
38.	IS 16221 (Part 1) : 2016 IEC 62109-1 : 2010	Safety of Power Converters for use in Photovoltaic Power Systems Part 1 General Requirements	-
39.	IS 16221 (Part 2) : 2015 IEC 62109 : 2011 Reviewed In : 2020	Safety of power converters for use in photovoltaic power systems: Part 2 particular requirements for inverters	-
40.	IS 16221 (Part 3) : 2023 IEC 62109-3 : 2020	Safety of Power Converters for Use in Photovoltaic Power Systems Part 3: Particular Requirements for Electronic Devices in Combination with Photovoltaic Elements	-
41.	IS 16228 : 2019 IEC 62108 : 2016	Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval (First Revision)	-
42.	IS 16229 : 2015 IEC 62093 : 2005 Reviewed In : 2020	Balance-of-System components for photovoltaic systems - Design qualification natural environments	-
43.	IS 16230 : 2017 IEC 62124 : 2004	Photovoltaic (PV) Stand-Alone Systems - Design Verification	-
44.	IS 16476 (Part 1) : 2017 Reviewed In : 2022	LED Based Solar Lantern Part 1 Specification	1
45.	IS 16476 (Part 2) : 2018	Led based solar lantern: Part 2 methods of test	-
46.	IS 16662 (Part 1) : 2017 IEC 62670-1 : 2013	Photovoltaic concentrators (CPV) - Performance testing: Part 1 standard conditions	-
47.	IS 16662 (Part 2) : 2018 IEC 62670-2 : 2015	Photovoltaic concentrators (CPV) - Performance testing: Part 2 energy measurement	-
48.	IS 16662 (Part 3) : 2018 IEC 62670-3 : 2017	Photovoltaic concentrators (CPV) - Performance testing: Part 3 performance measurements and power rating	-
49.	IS 16663 : 2018 IEC/TS 62727 : 2012	Photovoltaic systems - Specifications for solar trackers	-
50.	IS 16664 : 2018 IEC 62716 : 2013	Photovoltaic (PV) Modules- Ammonia Corrosion Testing	1

51.	IS 16781 : 2018 IEC 62852 : 2014 Reviewed In : 2023	Connectors for d.c. Application in Photovoltaic Systems Safety Requirements and Tests	1
52.	IS 16782 : 2023 IEC 62910 : 2020	Utility-Interconnected Photovoltaic Inverters Test Procedure for Under Voltage Ride-Through Measurements (First Revision)	-
53.	IS 16792 : 2023 IEC 62788-5-1: 2020	Measurement Procedures For Materials Used In Photovoltaic Modules ï¿½ Part 5: Edge Seals ï¿½ Section 1: Suggested Test Methods For Use With Edge Seal Materials	-
54.	IS 16792 (Part 1/Sec 2) : 2018 IEC 62788-1-2 : 2016	Measurement Procedures for Materials Used in Photovoltaic Modules Part 1 Encapsulants Section 2 Measurement of volume resistivity of photovoltaic encapsulants and other polymeric materials	-
55.	IS 16792 (Part 1/Sec 4) : 2023 IEC 62788-1-4 : 2020 (Ed 1.1)	Measurement Procedures for Materials Used in Photovoltaic Modules Part 1: Encapsulants Section 4 Measurement of Optical Transmittance and Calculation of the Solar-Weighted Photon Transmittance Yellowness Index and UV Cut-Off Wavelength (First Revision)	-
56.	IS 16792 (Part 1/Sec 5) : 2020 IEC 62788-1-5 : 2016	Photovoltaic Devices - Measurement Procedures for Materials Used in Photovoltaic Modules Part 1 Encapsulants Section 5 Measurement of change in linear dimensions of sheet encapsulation material resulting from applied thermal conditions	-
57.	IS 16792 (Part 1/Sec 6) : 2023 IEC 62788-1-6: 2020 (Ed 1.1)	Measurement Procedures for Materials Used in Photovoltaic Modules Part 1: Encapsulants Section 6 Test Methods for Determining the Degree of Cure in Ethylene-Vinyl Acetate (First Revision)	-
58.	IS 16792 (Part 1/Sec 7) : 2023 IEC 62788-1-7 : 2020	Measurement Procedures for Materials Used in Photovoltaic Modules Part 1-7: Encapsulates Test Procedure of Optical Durability	-
59.	IS 16792 (Part 2) : 2020 IEC TS 62788-2 : 2017	Measurement Procedures for Materials Used in Photovoltaic Modules Part 2 Polymeric Materials â€" Frontsheets and Backsheets	-
60.	IS 16792 (Part 5/Sec 2) : 2022 IEC TS 62788-5-2 : 2020	Measurement Procedures for Materials Used in Photovoltaic Modules Part 5-2: Edge Seals Durability Evaluation Guideline	-
61.	IS 16792 (Part 6/Sec 2) : 2023 IEC 62788-6-2 : 2020	Measurement Procedures for Materials Used In Photovoltaic Modules Part 6-2: General Tests Moisture Permeation Testing Of Polymeric Materials	-
62.	IS 16792 (Part 7/Sec 2) : 2020 IES TS 62788-7-2 : 2017	Measurement Procedures for Materials Used in Photovoltaic Modules Part 7 Environmental Exposures Section 2 Accelerated weathering tests of polymeric materials	-
63.	IS 16797 : 2019 IEC 62509 : 2010	Battery charge controllers for photovoltaic systems - Performance and functioning	-
64.	IS 16798 : 2018 IEC 62894 : 2014	Photovoltaic inverters - Data sheet and name plate	-
65.	IS 16911 : 2023 IEC 62790: 2020	Junction Boxes for Photovoltaic Modules Safety Requirements and Tests (First Revision)	-
66.	IS 16960 (Part 1) : 2018 IEC 62446-1 : 2016	Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance: Part 1 grid connected systems - Documentation, commissioning tests and inspection	1
67.	IS 16960 (Part 2) : 2023 IEC 62446-2: 2020	Photovoltaic PV Systems Requirements for Testing Documentation and Maintenance Part 2: Grid Connected Systems Maintenance of PV Systems	-
68.	IS 16960 (Part 3) : 2020	Photovoltaic (PV) Systems â€" Requirements for	-

	IEC 62446-3 : 2017	Testing, Documentation and Maintenance Part 3 Photovoltaic Modules and Plants Outdoor Infrared Thermography	
69.	IS 17210 (Part 1) : 2019 IEC TS 62804-1 : 2015	Photovoltaic (PV) Modules - Test Methods for the Detection of Potential-Induced Degradation Part 1 Crystalline Silicon	-
70.	IS 17956 : 2023 IEC 62892 : 2019	Extended Thermal Cycling of PV Modules Test Procedure	-
71.	IS 17959 : 2023 IEC TS 63126: 2020	Guidelines for Qualifying PV Modules Components and Materials for Operation at High Temperatures	-
72.	IS 17963 : 2024 IEC TR 63226: 2021	Managing Fire Risk Related to Photovoltaic PV Systems on Buildings	-
73.	IS 17977 : 2023 IEC TR 63279: 2020	Derisking Photovoltaic Modules Sequential and Combined Accelerated Stress Testing	-
74.	IS 17978 : 2022 IEC TR 63227 : 2020	Lightning and Surge Voltage Protection for Photovoltaic PV Power Supply Systems	-
75.	IS 17979 : 2022 IEC TS 63019: 2019	Photovoltaic Power Systems Pvps Information Model for Availability	-
76.	IS 17980 : 2022 IEC 62891 : 2020	Maximum Power Point Tracking Efficiency of Grid Connected Photovoltaic Inverters	-
77.	IS 17995 : 2022 IEC TR 63225 : 2019	Incompatibility of Connectors for Dc-Application in Photovoltaic Systems	-
78.	IS 18114 : 2023 IEC 62941 : 2019	Terrestrial Photovoltaic PV Modules - Quality System for PV Module Manufacturing (First Revision)	-
79.	IS 18124 (Part 1) : 2023 IEC 63092-1: 2020	Photovoltaics in Buildings Part 1: Requirements for Building-Integrated Photovoltaic Modules	-
80.	IS 18124 (Part 2) : 2023 IEC 63092-2 : 2020	Photovoltaics in Buildings Part 2: Requirements for Building-Integrated Photovoltaic Systems	-
81.	IS 18127 : 2023 IEC TS 63156: 2021	Photovoltaic Systems Power Conversion Equipment Performance Energy Evaluation Method	-
82.	IS 18128 : 2023 IEC TS 63157: 2019	Photovoltaic Systems Guidelines for Effective Quality Assurance of Power Conversion Equipment	-
83.	IS 18129 : 2023 IEC 61701 : 2020	Photovoltaic PV Modules Salt Mist Corrosion Testing (First Revision)	-
84.	IS 18160 (Part 1) : 2023 IEC TS 63106-1 : 2020	Simulators Used for Testing Of Photovoltaic Power Conversion Equipment Recommendations Part 1: AC Power Simulators	-
85.	IS/IEC 61683 : 1999 Reviewed In : 2020	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency	-
86.	IS/IEC 61701 : 2011 Reviewed In : 2019	Salt mist corrosion testing of photovoltaic (PV) modules	-
87.	IS/IEC 61724-1 : 2017 IEC 61724-1 : 2017	Photovoltaic System Performance Part 1 Monitoring (First Revision)	-
88.	IS/IEC/TS 61724-2 : 2016 IEC/TS61724-2 : 2016	Photovoltaic System Performance Part 2 Capacity Evaluation Method	-
89.	IS/IEC/TS 61724-3 : 2016 IEC TS 61724-3 : 2016 â€˜ Reviewed In : 2023	Photovoltaic System Performance Part 3 Energy Evaluation Method	1
90.	IS/IEC 61727 : 2004 IEC 61727 : 2004	Photovoltaic PV Systems â€” Characteristics of the Utility Interface	-
91.	IS/IEC 61730-1 : 2016 Reviewed In : 2020	Photovoltaic (PV) Module Safety Qualification Part 1 Requirements for Construction (First Revision)	-
92.	IS/IEC 61730-1 : 2004 Reviewed In : 2015	Photovoltaic (PV) Module Safety Qualification Part 1 Requirements for Construction	-
93.	IS/IEC 61730-1 : 2004	Photovoltaic (PV) Module Safety Qualification Part 2	-

	Reviewed In : 2015	Requirements for Testing	
94.	IS/IEC 61730-2 : 2019 IEC 61730-2 : 2016	Photovoltaic (PV) module safety qualification: Part 2 requirements for testing (First Revision)	-
95.	IS/IEC 61829 : 2015 IEC 61829 : 2015 Reviewed In : 2020	Photovoltaic Devices — Photovoltaic (PV) Array — On-Site Measurement of Current-Voltage Characteristics	-
96.	IS/IEC 62548 : 2016 IEC 62548 : 2016	Photovoltaic PV Arrays Design Requirements	-
97.	IS/IEC 62688 : 2017 IEC 62688 : 2017	Concentrator Photovoltaic CPV Modules and Assemblies Safety Qualification	-
98.	IS/IEC/TS 62738 : 2018 IEC TS 62738 : 2018	Ground-Mounted Photovoltaic Power Plants â€" Design Guidelines and Recommendations	-
99.	IS/IEC/TS 62782 : 2016 IEC TS 62782 : 2016	Photovoltaic (PV) Modules Cyclic (Dynamic) Mechanical Load Testing	-
100.	IS/IEC/TS 62789 : 2014 IEC TS 62789 : 2014	Photovoltaic Concentrator Cell Documentation	-
101.	IS/IEC 62805-1 : 2017 IEC 62805-1 : 2017	Method for Measuring Photovoltaic (PV) Glass Part 1 Measurement of Total Haze and Spectral Distribution of Haze	-
102.	IS/IEC 62805-2 : 2017 IEC 62805-2 : 2017	Method for Measuring Photovoltaic (PV) Glass Part 2 Measurement of Transmittance and Reflectance	-
103.	IS/IEC 62817 : 2017 IEC 62817:2017	PHOTOVOLTAIC SYSTEMS - DESIGN QUALIFICATION OF SOLAR TRACKERS	-
104.	IS/IEC/TS 62915 : 2018 IEC TS 62915 : 2018	Photovoltaic (PV) Modules Type Approval, Design and Safety Qualification â€" Retesting	-
105.	IS/IEC/TS 62916 : 2017 IEC TS 62916 : 2017	Photovoltaic Modules Bypass Diode Electrostatic Discharge Susceptibility Testing	-
106.	IS/IEC 62920 : 2017 IEC 62920 : 2017	Photovoltaic Power Generating Systems EMC Requirements and Test Methods for Power Conversion Equipment	1
107.	IS/IEC 62925 : 2016	Concentrator Photovoltaic (CPV) Modules Thermal Cycling Test to Differentiate Increased Thermal Fatigue Durability	-
108.	IS/IEC 62979 : 2017 IEC 62979 : 2017	Photovoltaic Modules Bypass Diode Thermal Runaway Test	-
109.	IS/IEC/TS 62989 : 2018 IEC TS 62898 : 2018	Primary Optics for Concentrator Photovoltaic Systems	-
110.	IS/IEC/TS 62994 : 2019 IEC TS 62994 : 2019	Photovoltaic PV Modules Through the Life Cycle â€" Environmental Health and Safety EHS Risk Assessment â€" General Principles and Nomenclature	-
111.	IS/IEC 63049 : 2017 IEC TS 63049 : 2017	Terrestrial Photovoltaic (PV) Systems Guidelines for Effective Quality Assurance in PV Systems Installation Operation and Maintenance	-
112.	IS/IEC 63202-1 : 2019 IEC 63202-1 : 2019	Photovoltaic Cells Part 1 Measurement of Light-Induced Degradation of Crystalline Silicon Photovoltaic Cells	-
113.	IS/IEC/TR 63228 : 2019 IEC TR 63228: 2019	Measurement Protocols for Photovoltaic Devices Based on Organic Dye-Sensitized or Perovskite Materials	-

Annex 2
(*Item 4.3*)

COMPILED QUERIES/SUGGESTIONS RELATING TO PART 8/SEC 2

Note:
The following notes are a collection of points related to Electricity and such may be considered for inclusion in an appropriate manner. There is nothing new or original in these notes and the points mentioned here appear in some form or other in published information. The information contained in these notes is something which is desirable for everyone using electricity to have an introduction to these aspects.

The importance of safety cannot be over-emphasized and some of the Electrical Transmission and Distribution Organizations and Construction Organizations have compiled these notes for training their employees, (both initial at induction and at later periodic refresher sessions). The training sessions were also as a consequence of a few undesirable incidents and accidents.

The contents are not organized. Some are based on Indian SCR&R and some are based on corresponding documents of some other countries. But all are covered by one or the other widely published code or rule or regulation.

Electrical Safety
Electricity is an excellent & highly dependable slave; but is also the worst master when due regard and respect is not given. There are four classes of accidents related to electricity:

1. Shock:

a. Use of electricity is always accompanied by the shock hazard. Due care has to be taken in proper handling of electrical system and equipment. Adequate rules and regulations exist; but they are often compromised leading to hazardous conditions.
About 30 to 40 years ago the number of electrical gadgets that we were using were very limited. Now we use a very large number, both at home and at the work place. The familiarity & regular use often leads to a presumed safety level, leading to neglect of the basic safety precautions necessary.
b. Another contributory cause for accidents has been the lack of appreciation for the regulations related to temporary installations in construction sites.
c. Training & education of the worker, which is generally inadequate is another factor.
d. Electrical shocks become more severe due to moisture and wet environment.
e. There is an increase in the use of hand held electrically operated tools. Sometimes the safety aspects are compromised and it leads to hazards.
f. Many cases of electrical shock arise out of bad work practices such as a ladder or a crane touching an overhead line.

2. Fire:

a. **L**eakage of electricity, unlike leakage of water, leads to an unintended release of energy and this release will invariably causes conversion of electrical energy into heat leading to fire. Electrical installations and equipment with bad maintenance or operated under overload form another important contributor.
b. **W**ith the increasing generation at the back of our power systems the fault levels are also increasing. Energy that is fed into a fault, before the protective device operates and isolates the faulty section, has been increasing steadily.
c. **W**ith the temporary power for construction becoming more expensive or in some cases being not available there would be local power generation. Where there is more than one source of power available additional safeguards are necessary to avoid hazardous situations likely to lead to shock as well as fire.
d. **W**ith local generation of construction power, there would be the need for storage & handling large quantities of fuel. Many safety aspects are compromised in construction site generation systems.

3. Motive power:

a. **E**lectrical motors, compressors, conveyors, lifts & hoists are common equipment necessary for productivity at the construction site. These systems generally come with safety features; But their operation and maintenance over a period of time causes changes leading to hazards.
b. A large number of incidents occur when power is restored after a short time power failure; and in our systems failures, scheduled and unscheduled load shedding are all very common. Typical situation could be that a conveyor which had stopped due to power failure starts without warning suddenly on resumption of power; or a portable welding set kept aside when power had failed makes an unintended arc on resumption as it had not been switched off.

4. Environment:

a. Lack of properly marked areas for the power distribution lines to run in a work site is one of the serious problems. In a factory where activities are regular the machine areas, clearance areas, movement areas are established and marked; But in a construction site there is a constant change in activity as the construction progresses and marking as in a factory may not be practicable; but it is a necessity, which is often ignored.
b. Lighting is an important necessity to ensure safety. Work may be ordered beyond daylight hours with either skeleton lights or ineffectual lighting creating a dangerous situation. Temporary lighting installations also may pose danger if not properly installed. Inadequate lighting or glare or hard shadows can be highly problematic.
c. Marking of hazards and illuminating them is of importance. Related Sign boards are also necessary

Problems peculiar to Construction Industry

The rapid growth in construction activity poses some peculiar problems for safety.

Some of the issues are related to the workmen & training:

1. Safety requires not only the commitment, effort and related practices, but also training, education and retraining of the worker, supervisor and the engineers.
2. Rapid growth is causing an acute shortage of skilled workmen. Untrained, inadequately skilled persons are engaged in activities involving sensitive activities requiring an understanding of the tools that the worker has to use and the knowledge of abnormal conditions that can arise while using the tool or equipment.
3. Turnover of workmen has been at a very high rate. This gets combined with the increased use of electrical tools & equipment causes problem. The worker may have the skill to do the expected job by hand tools, but may not have been introduced to the power tool; but he would be able to work with the power tool, by his common sense and knowledge of the job; but at the same time he could be working in a manner unsafe for himself and for others in the vicinity if he is not properly trained and acquainted with the tool that he is handling.
4. We are now getting equipment & tools from various countries, manufactured to suit the requirements of various counties, their standards and practices. Quite often the associated manual for the tool may not be studied properly. There could be critical differences between similar tools from different origin, which can lead to serious problems.
5. Floating or constantly changing workmen and constantly changing work place and quite often frequently changing activity type assigned to the workman causes problems.

Some of the issues are related to the standards & operating practices:

1. We have the rules and regulations through a number of document, laws and regulations & codes of practice in addition to the recommendations for safe use of equipment & tools by the manufacturer.
2. Some of the primary acts, rules, codes in this context for electrical safety are:
o Indian Electricity Act,
o National Building Code,

3. Use of personal protective equipment

Use of PPE is neither enforced nor practiced. The managers and supervisors have to promote the use of PPE strictly. No doubt there is a problem with some of the PPE; some of them cause discomfort in the hot & humid weather; but that should not be the reason for not using them.
4. Standard operating practice for electrical installation maintenance calls for ensuring that the installation is properly switched off, isolated & tagged or/and locked. Tagging/locking is to ensure that someone else does not switch on the section which has been taken for maintenance.

5. Declaration of authorized person is a requirement under the rules. This ensures that for each section of the electrical installation there is a competent trained electrician designated to attend to the operation problems and maintenance. But this rarely followed at a construction site.

Lack of Earth Leakage Circuit breaker in the feeders for portable tools & equipment.

Portable Electrical Tools, Equipment, and Instruments

Portable electrical equipment or tools shall always be inspected to identify defects; defective equipment hall be removed from service immediately. Portable electrical equipment shall be connected to a portable GFCI (or a circuit that contains a GFCI) when used outdoors, in damp locations, in any unsafe environment, or for indoor or outdoor construction. Ordinarily, the casings for portable electrical equipment are grounded. If it is necessary to operate this type of equipment with other than grounded equipment casing, suitable barriers, guards, or shields shall be installed to protect personnel while working on or near the equipment. In addition, a safety procedure shall be written describing the controls for safe operation of the equipment. Receptacles and flexible cords can be used to connect electrical appliances and equipment (e.g., fans, machine tools, and pumps) to power sources. Receptacles used on a two-wire, single-phase portable generator (or vehicle-mounted generator) with a rating of not more than 5 kW (where the circuit conductors are insulated from the frame and all other grounded surfaces) do not need to be GFCI protected.
5. Path to ground either missing or not provided at all.

Equipment Grounding

All electrical apparatus, equipment, and systems shall be grounded in accordance with NEC Article 250 (Grounding) and ANSI standards. The conductor used for grounding shall meet the following criteria:

a. • Be permanent and continuous.
b. • Facilitate operation of the circuit’s protective devices.
c. • Have sufficiently low impedance to limit the voltage to ground to a safe level at all frequencies and fault-current conditions anticipated.
d. • Have the capacity (size and rating) to safely conduct any fault current that may be imposed on it for the time required for protective device operation.
6. Equipment or power tool not used in the prescribed manner.Employee training shall be documented with respect to the specific equipment and tasks for which the employee is qualified. Much of the experience required for an employee to be considered qualified is specific to the equipment and tasks involved. On-the-job training is always a necessary component of a qualification program. Classroom training, including courses offered by the Hazards Control Department, is a useful way to ensure that employees share a common level of basic knowledge on which to build specific on-the-job training. Additionally, employees can gain knowledge and experience about how to perform their jobs safely and properly by taking courses offered by universities and trade schools or through apprenticeships, on-the-job training (OJT), or other formalized training. The depth of training and how training is provided shall be determined by the hazards and environmental aspects associated with the employee’s respective tasks.
7. Improper use of Extension and Flexible Cords.

Extension Cords.

Observe the following precautions when using extension cords. Note that extension cords for normal office use do not require a temporary wiring tag.
a. • Use only three-wire extension cords and cables that conform to the rating, grounding, and non-interchangeability stated in NEC Article 210-7 (Receptacles and Cord Connectors).
b. • Check extension cords before use to ensure they are adequate for the intended purpose. Plug high-current equipment (e.g., space heaters, hot plates, and coffee pots) directly into a wall receptacle whenever possible.
c. • Use only one extension cord for lamps, appliances, or other equipment in conjunction with the power supply cord. Laboratory practice prohibits the use of multiple extension cords (daisy chaining) that will increase resistance in an electrical circuit, which in turn will increase heating of conductors, receptacles, and plugs.
d. • Inspect extension cords for damage before placing them in service and daily during use.
e. Only qualified and authorized persons can repair extension cords; this shall be done in a manner approved by the manufacturer. Replace damaged cords with new cords immediately.

For receptacles connected to circuits with different voltages, frequencies, or current (ac or dc) on the same premises, use a design such that the attachment plugs on the circuits are not interchangeable (see Section 3.7 for details). All extension cords shall be listed or labelled properly.
g. Only high-visibility orange or yellow extension cord integral ground-fault circuit interrupters (GFCIs).

8. Multiple Outlet Boxes

a. • Each multiple outlet box shall be plugged into a wall receptacle. Use of one outlet box to provide power to one or more outlet boxes is not permitted.
b. • Outlet boxes shall not be used to provide power to space heaters, hot plates, coffee pots, or other high-current loads. These types of appliances have caused outlet boxes to burn up.

9. Flexible Cords and Cables.

They shall not be • Used as a substitute for fixed wiring of a structure.
• Attached to building surfaces.
• Routed through holes in walls, ceilings, or floors; or through doorways, windows, or similar openings.
• Concealed behind building walls, ceilings, or floors.
• Wired with a plug or connector that does not have dead-front construction or strain relief. “Dead-front construction” is defined as electrical equipment built so that it is “without live parts exposed to a person on the operations side of the equipment.”
• Placed where they could present a trip or fall hazard.
• Used when the cord insulation is damaged, cracked, or spliced; or when the ground pin is missing from the end of the male cord plug.

• Installed in raceways,

Basic regulations related to electrical safety:

1. No employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by de-energizing the circuit and grounding it or by guarding it effectively by insulation or other means.
2. In work areas where the exact location of underground electric power-lines is unknown, employees using jack-hammers, bars, or other hand tools which may contact a line shall be provided with insulated protective gloves.
3. Before work is begun the employer shall ascertain by inquiry or direct observation, or by instruments, whether any part of an energized electric power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact with the electric power circuit.
4. The employer shall post and maintain proper warning signs where such a circuit exists.
5. The employer shall advise employees of the location of such lines, the hazards involved, and the protective measures to be taken.
6. Barriers or other means of guarding shall be provided to ensure that workspace for electrical equipment will not be used as a passageway during periods when energized parts of electrical equipment are exposed.
7. Working spaces, walkways, and similar locations shall be kept clear of cords so as not to create a hazard to employees.
8. Load ratings. In existing installations, no changes in circuit protection shall be made to increase the load in excess of the load rating of the circuit wiring.
9. Fuses. When fuses are installed or removed with one or both terminals energized, special tools insulated for the voltage shall be used.
10. Worn or frayed electric cords or cables shall not be used.
11. Extension cords shall not be fastened with staples, hung from nails, or suspended by wire.
12. Controls. Controls that are to be deactivated during the course of work on energized or deenergized equipment or circuits shall be tagged.
13. Equipment and circuits. Equipment or circuits that are de-energized shall be rendered inoperative and shall have tags attached at all points where such equipment or circuits can be energized.
14. Tags. Tags shall be placed to identify plainly the equipment or circuits being worked on.
15. Equipment (or tools) which require to be used in an area subject to water spray or require the operator to stand in a wet surface shall be protected by a ELCB set for 30mA and the equipment shall be fed by an earth loop monitored cable.

Analysis of Electrical Incidents

Serious and potentially lethal incidents, including near misses that could result in a serious or potentially lethal shock, shall undergo an incident analysis should be made. As of now no formal procedure exists and possibly cannot be enforced by the inspector.

"Incidents—Notification, Analysis, and Reporting,"
This analysis shall be determined by facility or program management and the responsible ES&H Team.
• Properly secure the area once the victim is under care, leaving items and equipment in the same position as much as possible. Try to remember the original position of items that may have been moved during response to the accident.
• Record the time, date, and location of the accident; the name of the victim and any witnesses; who was notified; the voltage and current; the contact parts of the body; what equipment or system was being serviced; and the shock reaction and duration of the shock.
Often victims of shock may develop unusual symptoms after a day of the incident even if they appear to be alright or show-off that they have satisfactorily faced the accident or incident without any damage. Often there is a tendency to show-off that a person is strong enough & nothing has happened.
At the same time there could be an opposite reaction also, wherein there may be no damage physical or physiological, but the person may show serious incapacity, dizziness and fear.
This requires that person(s) who has faced an incident has to be watched for at least 36 hours. In a case of apparent "no damage" a person developed serious cold-feet on the next day, which caused another accident as most activities are team dependent activities.

Responsibilities of different groups:

Employees
• Only perform the tasks for which you are qualified.
• Understand the basic principles of electricity and electrical safety.
• Follow applicable OSHA requirements.
• Use the proper tools and required PPE.
• Request additional training to avoid working beyond your level of qualification or comfort.

Work Supervisors

• Ensure employees
— Comply with the requirements set forth by the DOE, OSHA, LLNL, and other regulatory agencies.
— Have the appropriate PPE available and use them properly.
— Are adequately qualified to perform their jobs.
• Determine the work each employee is qualified to perform and make work assignments accordingly.

Management

• Provide support primarily through the ES&H Teams, which are the initial point-of-contact for all ES&H issues raised by Programs or individuals.
• Identify electrical ES&H hazards and make recommendations for resolution.
• Provide support to program line management responsible for analyzing electrical accidents and incidents.

• Evaluate electrical accidents and incidents to determine trends.
• Develop, review, and approve electrical safety training programs.
• Interact on a continual basis with groups (e.g., ES&H Working Group and subcommittees,
Directorate safety committees and councils, the ES&H Teams) charged with providing a safe work environment for employees.
This interaction may include conducting electrical safety presentations and providing a forum (e.g., written or electronic communication or meetings) for the exchange of ideas and information.
• Inform management and employees of lessons learned from electrical accidents and incidents.
• Participate in electrical safety programs & exchange information; Failure & accident (or incident) information documentation will avoid another person committing the same mistake that caused a problem.

ELECTRICAL MAINTENANCE OR REPAIRS

Only qualified persons shall perform electrical repairs. It is dangerous for an unqualified worker to attempt electrical repair. Before any electrical maintenance or troubleshooting is performed, sources of electrical energy (and for this it is a pre-requisite to know where the standby sources are and whether there is any automatic switching on is built-in) shall be de-energized, except where it is necessary for troubleshooting, testing, or areas that are not feasible to deenergize.
All energy sources shall be brought to a safe state. For example, capacitors shall be discharged and high capacitance elements shall be short-circuited and grounded.

WORK ON ENERGIZED/DEENERGIZED ELECTRICAL EQUIPMENT

The first consideration for working on any electrical system is to have the circuit positively de-energized. All circuits and equipment must be considered energized until opened, tagged and/or locked according to an approved procedure and should be proven de-energized by testing with an approved testing device known to be in proper working order. Review system drawings and/or perform system walk-downs. Where the possibility exists that the circuit can become energized by another source or where capacitive devices (including cables) may retain or build up a charge, the circuit should be grounded and shorted. The grounding and shorting device should be selected and installed in accordance with appropriate standards. Whenever work is to be performed on a positively de-energized system, the worker must also identify and protect against any accidental contact with any exposed energized parts in the vicinity of the work.

CONSIDERATIONS FOR WORKING ON ENERGIZED SYSTEMS AND EQUIPMENT

Qualified employees performing such tasks as electrical repairs, modifications, and tests on energized electrical systems, parts, and equipment need to comply with the following:
1. Live parts to which an employee may be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-

energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

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2. Work on energized electrical systems and equipment may be performed only if a supervisor and/or competent safety professional and the personnel performing the work determine that it can be done safely.

Explicit approval on record should be given for each job along with restrictions & lockout/tag out lists.

Approval for the same job performed repeatedly may be given through the use of an approved procedure or job safety analysis.

3. Personnel shall not work on energized circuits unless they are qualified to do so, or, for training purposes, unless they work under the direct supervision of a qualified person.

4. Sufficient protection in the form of insulated tools and insulated protective equipment, such as gloves, blankets, sleeves, mats, etc., shall be used while working on energized circuits.

Other work, independent of voltage, that presents a significant shock or arc blast hazard to employees, needs to be evaluated as to the number of employees involved. At least two employees [See 29CFR 1910.269(l)(1)(i)] shall be present while the following types of work are being performed:

(A) Installation, removal, or repair of lines that are energized at more than 600 volts.

(B) Installation, removal, or repair of de-energized lines if an employee is exposed to contact with other parts energized at more than 600 volts,

(C) Installation, removal, or repair of equipment, such as transformers, capacitors, and regulators, if an employee is exposed to contact with parts energized at more than 600 volts.

(D) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and

(E) Other work that exposes an employee to electrical hazards greater than or equal to those listed above.

Exceptions to the items listed above are:

(A) Routine switching of circuits, if the employer can demonstrate that conditions at the site allow this work to be performed safely,

(B) Work performed with live-line tools if the employee is positioned so that he or she is neither within reach of nor otherwise exposed to contact with energized parts, and

(C) Emergency repairs to the extent necessary to safeguard the general public.

Even trained & competent personnel, who are likely to contact exposed energized parts, shall use the appropriate protective equipment for the voltage levels involved.

Safety Rules that everyone has to keep in mind (whether at home or at the work-spot).

Here are some safety rules which should be kept in mind by the Manager, Engineer, Supervisor, Worker & the Assistant.

Applying these safety rules consistently at your job site can save your life and the lives of your co-workers:

Always assume power lines are live. This applies to power lines on utility poles as well as those near homes and buildings. Assume that the cable can become live if the feeding switch or switches are not locked-out or tagged-out.
Even though you may notice a covering on a line, never assume it is safe to touch. The covering may not be an insulation of adequate value. Even momentary contact with power lines can cause injury or death.
Never stand ladders near power lines. When working on or near ladders, keep the ladder, tools and anything else you may be carrying at least 10 feet from power lines.
Keep all cranes, scaffolding and high reach equipment away from power lines. Contact with a power line can cause serious burns or electrocution. Remember to work a safe distance from all power lines. When performing construction activities, keep equipment at least 10 feet from power lines and 7 meters from transmission tower lines. Use a spotter to ensure compliance with the line clearance. If clearance cannot be obtained, request that the utility de-energize the lines.
Keep yourself and others away from any fallen power lines. Because it is difficult to know whether a fallen power line is live or not, it is imperative that you call your local utility right away and report the location of the down wires. If a line falls on your car, stay in your car. If you must get out of the car, be sure to jump clear, being careful not to touch any part of the car and the ground at the same time, while staying clear of the fallen line.
Do not climb or trim trees near power lines. Hire a qualified contractor to trim trees near power lines. If you have any questions about removing limbs or trees near power lines, call the local utility.
Call your local Underground Utility Locating Service. Assume that all cables are live until it is tested and confirmed to be not energized. Assume that the cable can become live if the feeding switch or switches are not locked-out or tagged-out. By law, most states require you call your local utility to identify any gas, electric, telephone and other utility facilities before you dig. Whether you are planting a tree, building a fence or laying foundation, contacting a line with a shovel, pick or other piece of equipment can result in injury or death.

Safety Practice of Tags

When work is taken up the section on which the work is to be done is switched off. To ensure that someone else will not switch it on the section has to be tagged & locked.

LOCKOUT/TAGOUT PROCEDURE
Each employer shall document and implement lockout/tag-out procedures to safeguard employees from injury while they are working on or near de-energized electric circuits and equipment. The lockout/tag-out procedures should be clearly defined and all employees should be made aware of. Particular emphasis should be on the explicit record of the authorized group or team leader or supervisor who is authorized to remove the lockout or the tag-out.
VERIFICATION OF DEENERGIZED CONDITION
Verification shall be made that all live circuits, parts, and other sources of electrical energy, including any mechanical energy, have been disconnected, released, or restrained. A qualified worker shall operate the equipment operating controls,

perform voltage verification, inspect open switches and draw-out breakers etc. to assure the isolation of energy sources.

VOLTAGE VERIFICATION TEST

A qualified worker shall use the appropriate test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are de-energized. The test shall also determine if a hazardous energized condition exists as a result of induced voltage or voltage back feed after specific parts of the circuit have been de-energized. If the circuit to be tested is over 600 V nominal, the test equipment shall be checked for proper operation immediately before and immediately after this test. This test is also recommended for systems of 600 V or less. Testing shall be performed as if the circuit is energized. The voltage verification device used shall be rated for the application. Proximity testers and solenoid-type devices should not be used to test for the absence of any voltage.

REMOVING LOCK AND TAG

Each lock and tag shall be removed by applying the following:

1. Each lockout or tag-out device shall be removed from each energy-isolating device by the authorized employee who applied the lockout or tag-out device, or under their direct supervision, or as stated below.
2. Exception: When the authorized employee who applied the lockout or tag-out device is not available to remove it, that device may be removed under the direction of his or her supervisor. Extreme care shall be taken and specific procedures shall be followed. The specific procedure shall include at least the following elements:

a. Verification by the supervisor that the authorized employee who applied the device is not at the affected facility

b. Making all reasonable efforts to contact the authorized employee to inform him or her that the lockout or tag-out device has been removed

c. Ensuring that the authorized employee has this knowledge before he or she resumes work at the affected facility.

COMMON CAUSES OF ELECTRICAL FIRES.-

The more frequent causes of electrical fires are arcs, sparks, overheating, and over loading a circuit. When a current-carrying circuit is interrupted, intentionally or otherwise, an arc is produced such as that formed when a knife switch carrying load is opened. Such arcs have temperatures high enough to ignite any combustible material that may be in the vicinity, as well as through hot metal from the fused conductor. The amount of heat generated in a conductor is in direct proportion to the resistance of the conductor and to the square of the current. For this reason, conductors used to carry power to electrical equipment should be large enough (of low resistance) to carry the load without overheating. Metals such as copper and aluminum are used for this purpose. In many instances, electrical fires are caused by temporary or inadequate wiring jobs which are in violation of the National Electrical Code, which limits the current a conductor shall carry and the type of insulating covering.

Some of the major causes of electrical fires are:

(1) Use of fuses too large for the circuit they are protecting, or a circuit breaker with too high a setting.

(2) Adjustable-type circuit breakers with a blocked tripping element.

(3) Packing by washer inserted behind plug fuses.

(4) Nails or bolts substituted in place of cartridge fuses.

(5) Refillable fuses in which additional strips have been placed.

(6) Corrosion of fuses, circuit breakers, or conductors.

(7) Insulation of conductors deteriorated from age or mechanical injury and exposure to heat, moisture, or vapors.

(8) Joints not properly soldered and taped. (or even joints by twisted wires.)

(9) Burned and pitted contacts.

(10) Overheating due to poor contactor overload.

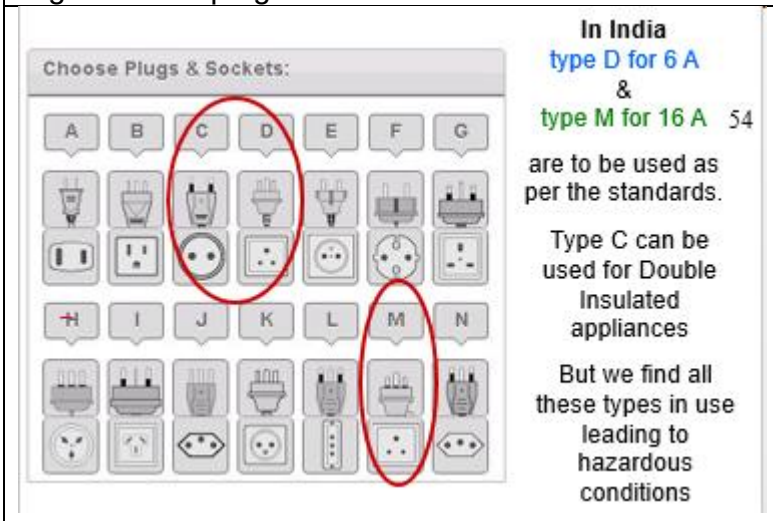
People using electricity should also be made aware of the types of fire extinguishers that can be used at an electrical installation. A water spray or foam spray may give a shock to the person holding the jet nozzle or the extinguisher (foam type) canister.

COMMON CONFUSION BETWEEN TYPE OF FIRE & CAUSE OR ORIGIN OF FIRE.

Types of fire classification goes for the main content which is burning in a fire and is classified in to Types, A, B, C, D & E. The type of extinguisher used (or to be used and also the type which should not be used) goes with the type.

The cause/origin of fire would be the method or the source from which the fire started. The fire could have been started by a careless match stick thrown about or by ignition of an inflammable material (stored or leaking) or by overheating of an equipment or part of an equipment due to abnormal operation or due to electrical arc or a overheated portion of an equipment coming in contact with an inflammable material..

For a fire to be called an electrical fire, the fire ought to have started from electricity. After a fire incident, whatever be the cause, the electrical system would have been exposed to fire and would have got damaged due to fire from other causes. But it has become the general practice to call it as electrical fire, leading various other incorrect steps. An electrical short circuit is always taken care of by the protection system and the affected portion is isolated by the protective devices.

Nightmare of plugs and sockets.	
	Plugs and sockets are an essential necessity of flexibility of using many types portable gadgets and equipment in the nature of semi-permanent installation. Use of the wrong combination may allow the gadget to work; but with great risk of fire due to mismatched contact leading to heating & arcing.

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