

IEC/TC64 presentation

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IEC-CLC/TC64 Chairman

IEC/TC64: The Committee

■ TC64 responsibilities

- Basic Safety Publications (BSP) for protection against electric shock
 - BSPs are to be used by other IEC/TC-SC (IEC internal use)
 - Advisory Committee On Safety (ACOS) grants BSP status to standards
 - TC64 is full member of IEC/SMB/ACOS
- Low-Voltage electrical installation standards
 - Corresponds to the coordination of many electrical equipment (System aspect)
 - Forms the bridge between Public Utilities Grid and Current-Using-Equipment

IEC/TC64: The Committee

■ Scope (extract)

To prepare International Standards

- Concerning protection against electric shock arising from equipment, from installations and from systems without limit of voltage,
- For the design, erection and verification of all kind of electrical installations at supply voltage up to 1 kV a.c., 1500V d.c. except those installations covered by the following IEC committees: TC9, TC18, TC44, TC97
- In co-ordination with TC 99, concerning requirements additional to those of TC 99 for the design, erection and verification of electrical installations of buildings above 1kV up to 35kV

IEC/TC64: The Committee

■ Members of TC 64

- 35 countries are P members (AU-AT-BE-CA-CN-CU-CZ-DE-DK-ES-FI-FR-HU-ID-IE-IL-IS-IT-JP-KR-MY-MT-MX-NL-NZ-NO-PK-PL-RU-SE-SK-CH-GB-US-ZA)
- 13 countries are O members (AR-BR-BG-HR-GR-IN-IR-PT-RO-RS-SG-SI-UA)
- 20 affiliate countries are interested in TC64 work (AF-BJ-BN-CD-CI-CR-ET-GH-GM-GY-LB-MW-PE-PS-RW-SN-TZ-UG-UY-ZW)

TC64 focuses interests from a large number of countries

IEC/TC64: The Committee

■ TC64 experts

- Numbers of experts: \approx 150
- Experts provenance
 - National Committees
 - Electrical contractors
 - Laboratories
 - Universities
 - Doctors
 - Electrical Equipment Manufacturers

IEC/TC64: The Committee

■ Liaisons

- TC64 has liaisons with 20 IEC/TC-SC
- TC64 has liaison with external organizations: CIB (International Council for Building), FISUEL (Fédération Internationale pour la Sécurité des Usagers de l'Electricité), ILO (International Labor Organization), ISSA (International Social Security Association), NORMAPME (European Office of crafts, Trade and small and medium Enterprises for standardization)

TC64 focuses interests from a large number of TC-SC

IEC/TC64: Protection against electric shock

- IEC 60479 series: Effects of currents passing through the human body and livestock
 - IEC 60479-1 TS: General aspects
 - Human body impedance
 - Touch voltage
 - Skin moisture
 - Contact surface
 - ≤ 100 Hz and DC current threshold values for human body
 - Perception
 - Inability of let-go
 - Ventricular fibrillation

IEC/TC64: Protection against electric shock

- IEC 60479 series: Effects of currents passing through the human body and livestock
 - IEC 60479-2 TS: Special aspects
 - >100 Hz sinusoidal current threshold values for human body
 - Perception
 - Inability of let-go
 - Ventricular fibrillation
 - Current threshold for special waveforms for human body
 - AC with DC component
 - Alternating current with phase control
 - Alternating current with multicycle control
 - Alternating current with mixed frequencies
 - Single impulse current
 - Repeated pulses

IEC/TC64: Protection against electric shock

- IEC 60479 series: Effects of currents passing through the human body and livestock (*under revision*)
 - IEC 60479-3 TR: Livestock
 - Body impedance
 - Current path
 - ≤ 100 Hz current threshold values for livestock
 - IEC 60479-4 TR: Effects of lightning strokes
 - Interaction with different types of strokes
 - Direct strike
 - Touch voltage
 - Side flash
 - Step-voltage
 - Flashover
 - Qualitative effect of stroke on human body

IEC/TC64: Protection against electric shock

- IEC 60479 series: Effects of currents passing through the human body and livestock
 - IEC 60479-5 TR: Touch voltage thresholds for human body
 - Tables for minimum touch voltages (derived from data on Part 1)
 - AC (50 Hz) and DC
 - Startle reaction, muscular reaction, ventricular fibrillation
 - Current paths
 - Skin moisture
 - Contact area

IEC/TC64: Protection against electric shock

- IEC 61140: Protection against electric shock - Common aspects for installation and equipment (*under revision*)
 - Provisions for basic protection
 - Provisions for fault protection
 - Protective measures
 - Protection by automatic disconnection of supply
 - Protection by double or reinforced insulation
 - Protection by equipotential bonding
 - Protection by electrical separation
 - Protection by non-conducting environment
 - Protection by SELV
 - Protection by PELV
 - Protection by limitation of steady state touch current and charge
 - Coordination of electrical equipment
 - Class 0, I, II and III
 - Limitation of touch current, current through PE

IEC/TC64: Protection against electric shock

- IEC 61201 TS: Use of conventional touch voltage limits - Application guide
 - Derived from IEC 60479-5
 - Voltage threshold
 - AC (50 Hz) or DC
 - Contact area
 - Skin moisture
 - Current path
 - Conventional Safe Touch Voltage
 - Contact area
 - Physiological effect
 - Skin moisture

IEC/TC64: Protection against electric shock

- IEC 60050-195: International Electrotechnical Vocabulary – Earthing and protection against electric shock
 - Fundamental concepts
 - Electrical installation and equipment
 - Electric shock and threshold currents
 - Operation
 - Voltage and currents
 - Protective measures for electrical safety

IEC/TC64: Electrical installations

■ IEC 60364 series: Markets

- ❑ Dwellings (private villas to flats)
- ❑ Commercial (small shops to malls)
- ❑ Industry (small workshops to large factories)
- ❑ Infrastructures (railways stations to large airports)
- ❑ Special locations (marinas to hospitals)

■ IEC 60364 series: Technologies

- ❑ Mature technologies (cables to socket-outlets)
- ❑ New technologies (photovoltaic to electric vehicles)

■ IEC 60364 series: Customers

- ❑ Design companies
- ❑ Electrical contractors (several 100.000 contractors in the world)
- ❑ Controllers

IEC/TC64: Electrical installations

■ IEC 60364 series: Implementation

- Direct application
- Transposition into a regional or national standard
- In some countries the installation rules are mandatory or closely linked with national laws

IEC 60364 forms the best international platform for LV installations

IEC/TC64: Electrical installations

■ IEC 60364 series: General characteristics

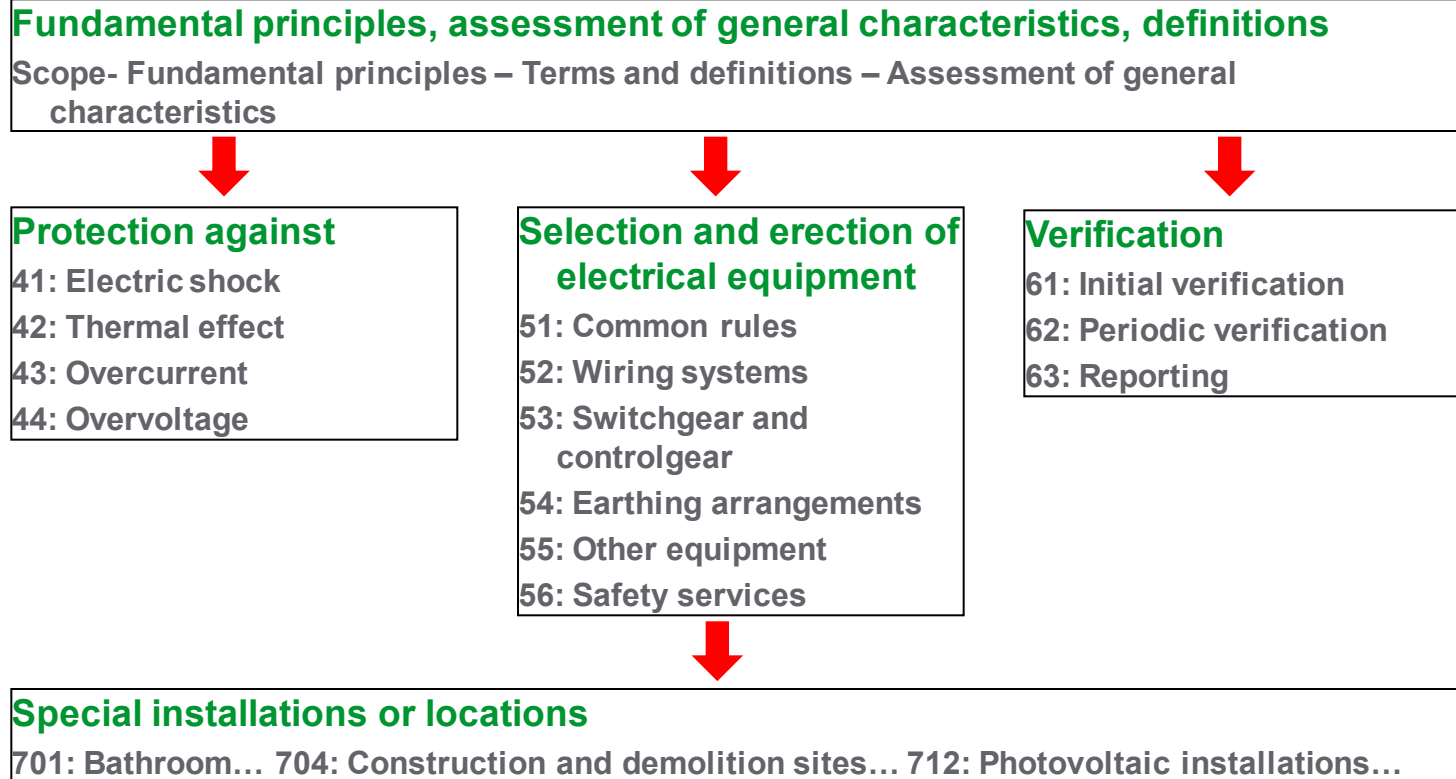
- ❑ Groups a series of 32 separate interrelated documents
- ❑ No requirements directly linked to technology should be integrated, but only final objective should be included in the document
- ❑ Flexible structure of the document for easy adaptation by countries
- ❑ Mainly devoted to safety aspects, but also considers correct operation of electrical installation

■ IEC 60364 series: Applicability

- ❑ Covers new fixed private low-voltage electrical installations
- ❑ Applicable to their modifications and their extensions
- ❑ To be used for AC up to 1000 V and to DC up to 1500 V
- ❑ May be used by Utilities

IEC/TC64: Electrical installations

■ IEC 60364 series: structure



IEC/TC64: Electrical installations

- IEC 60364-1: Fundamental principle, assessment of general characteristics, definitions
 - Scope
 - Fundamental principles
 - Structures of the document
 - General requirements
 - Main parameters
 - Demand current
 - System earthing
 - Supplies
 - External influences
 - Compatibility
 - Maintainability
 - Safety services

IEC/TC64: Electrical installations

■ IEC 60364-4-41: Protection against electric shock

- Automatic disconnection of supply
 - TN system
 - TT system
 - IT system
- Double or reinforced insulation
- Electric separation
- Extra-Low-Voltage
 - SELV
 - PELV
- Additional protection

IEC/TC64: Electrical installations

- IEC 60364-4-42: Protection against thermal effects
 - Precautions where risk of fire
 - Protection against burns

IEC/TC64: Electrical installations

■ IEC 60364-4-43: Protection against overcurrents (*under revision*)

- Protection of line and neutral conductors

- Protection against overload

- Position of protective device
- Omission of protective device
- Protection of conductors in parallel

- Protection against short-circuit

- Position of protective device
- Omission of protective device
- Protection of conductors in parallel

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- IEC 60364-4-44: Protection against voltage disturbances and electromagnetic disturbances
 - Earth fault in HV substations
 - Power frequency fault voltage (between live conductors and earth)
 - Power frequency stress voltage (between live conductors)
 - Overvoltage of atmospheric origin (*under revision*)
 - Need of Surge Protective Device (SPD)
 - External influence
 - Risk assessment
 - Determination of impulse withstand voltage for equipment
 - Electromagnetic influences
 - Mitigation for each system earthing
 - Multi source configuration
 - Earthing and equipotential bonding
 - IT installation
 - Cable management systems

IEC/TC64: Electrical installations

■ IEC 60364-5-51: Common rules

- Compliance of equipment with product standard
- List of external influences
- Identification of equipment
 - Wiring system (conductor color)
 - One line diagram

IEC/TC64: Electrical installations

■ IEC 60364-5-52: Wiring system

- Selection of wiring system according to external influences
- Current carrying capacities of conductors
 - De-rating coefficients
- Cross sectional area of conductors
- Maximum voltage drop
- Electrical connections
- Limitation of spread of fire

IEC/TC64: Electrical installations

■ IEC 60364-5-53: Isolation, switching and control (*under revision*)

- Protective device for automatic disconnection of supply
 - Overcurrent Protective Device (OCPD)
 - Residual Protective Device (RCD)
 - Insulation Monitoring Device (IMD)
- Protective device against overcurrent (*under revision*)
- Protective device against overvoltage
 - Selection of SPD
 - Coordination of SPD with OCPD
- Coordination of various protective devices
- Device for isolation
- Device for switching
 - Mechanical maintenance
 - Emergency
 - Functional purpose

IEC/TC64: Electrical installations

■ IEC 60364-5-54: Earthing arrangements and protective conductors

- Earth electrode
 - Cross sectional area
 - Coating thickness
- Main Earthing Terminal
- Protective conductor
 - Cross sectional area
 - Type of conductors
- Protective bonding conductors

IEC/TC64: Electrical installations

■ IEC 60364-5-55: Other equipment

□ Low-voltage generating sets

- Protective measures by SELV or PELV
- Fault protection
- Overcurrent protection
- Case where stand-by source
- Case where operating in parallel with normal supply

□ Luminaires and lighting installations (*under revision*)

- Protection against thermal effects
- Specific requirements

IEC/TC64: Electrical installations

■ IEC 60364-5-56: Safety services

□ Electrical sources

- Autonomous from normal installation
- Operating in parallel with normal installation

□ Circuits

□ Lighting for emergency escape

IEC/TC64: Electrical installations

■ IEC 60364-6: Verification

□ Initial verification

- Inspection
- Testing
- Reporting

□ Periodic verification

- Frequency
- Reporting

IEC/TC64: Electrical installations

■ IEC 60364-7: Special installation or locations

- Requirements modify, supplement or supersede those from part 1, 4, 5 or 6
- Each Part 7 need to be used in conjunction with general rules (§1, 4, 5 and 6)
- Concern specific applications
 - IEC 60364-7-701: Locations containing a bath or shower
 - IEC 60364-7-702: Swimming pools and fountains
 - IEC 60364-7-703: Rooms and cabins containing sauna heaters
 - IEC 60364-7-704: Construction and demolition site installations
 - IEC 60364-7-705: Agricultural and horticultural premises
 - IEC 60364-7-706: Conducting locations with restricted movement
 - IEC 60364-7-708: Caravan parks, camping parks and similar locations
 - IEC 60364-7-709: Marinas and similar locations (*under revision*)
 - IEC 60364-7-710: Medical locations
 - IEC 60364-7-711: Exhibitions, shows and stands

IEC/TC64: Electrical installations

■ IEC 60364-7: Special installation or locations

- IEC 60364-7-712: Solar photovoltaic (PV) power supply systems (*under revision*)
- IEC 60364-7-713: Furniture (*under revision*)
- IEC 60364-7-714: External lighting installations (*under revision*)
- IEC 60364-7-715: Extra-low-voltage lighting installations (*under revision*)
- IEC 60364-7-717: Mobile or transportable units
- IEC 60364-7-718: Communal facilities and workplaces
- IEC 60364-7-721: Electrical installations in caravans and motor caravans
- IEC 60364-7-729: Operating or maintenance gangways
- IEC 60364-7-740: Temporary electrical installations
- IEC 60364-7-753: Floor and ceiling heating system

IEC/TC64: Electrical installations

■ IEC 61200 series: Electrical installation guide

- IEC 61200-413: Automatic disconnection of supply
 - Principle of protective measures
 - Application to system earthings
- IEC 61200-52: Wiring system (*under revision*)
 - Maximum temperature of terminals in normal service conditions
- IEC 61200-53: Switchgear and controlgear
 - Time/current characteristics
 - Calculation of min/max short-circuit current
 - Discrimination between Residual Current Devices (RCD)
- IEC 61200-704: Construction and demolition sites
 - Explanation for protection against electric shock
 - Selection of equipment

IEC/TC64: Electrical installations

- IEC 60449: Voltage bands for electrical installations of building
 - Propose voltage bands (I and II)
- IEC 62066 TR: Surge overvoltages and surge protection in low-voltage a.c. power systems - General basic information
 - Latest knowledge in various overvoltage (lightning, switching, temporary)
 - Use of Surge Protective Device (SPD)

IEC/TC64: Electrical installations

■ IEC 60050-826: International Electrotechnical Vocabulary – Electrical installations

- Characteristics of electrical installations
- Voltages and currents
- Electric shock and protective measures
- Earthing and bonding
- Electric circuit
- Wiring systems
- Other equipment
- Isolation and switching
- Capability of persons

IEC/TC64: Electrical installations

■ New projects

- IEC 60364-5-557: Auxiliary circuits
 - Characteristic of protective devices
 - Cross sectional areas
 - Connection to the main circuit
 - Functional safety
- IEC 60364-7-722: Supply of electric vehicles
 - Additional requirement due to external influences
 - Use of RCD 30 mA
 - Isolation required
 - Type of socket-outlet

IEC/TC64: Electrical installations

■ New projects

□ IEC 60364-8-1: Energy Efficiency in LV Installations

- Design of new installations
 - Determination of load demand and zones
 - Impacts on electrical installation architecture
- Improvement of existing installations
 - Methodology
- Implementation of efficiency measures
 - Current-using-equipment
 - Distribution systems
 - Monitoring systems
- Performance levels
- Installation classes and installation profiles

IEC/TC64: Electrical installations

■ Future projects

□ Smart Grid

- TC64 to identify impact of “Smart Grid” on TC64 standards
 - Safety issues when re-injecting energy through grid ?
 - System earthing if autonomous local power supply ?

□ LV-DC distribution systems

- TC64 is verifying if existing safety requirements in DC are equivalent as in AC
- To amend existing standards where relevant

CLC/TC64: The Committee

■ Scope (extract)

- Idem as in IEC

■ Members of TC 64

- 31 members as per any CLC/TC (AT-BE-BG-CH-CY-CZ-DE-DK-EE-ES-FI-FR-GR-HR-HU-IE-IS-IT-LV-LT-LU-MT-NL-NO-PL-PT-RO-SE-SK-SI-GB)

■ Liaisons

- TC64 has liaison with external organizations: FISUEL (Fédération Internationale pour la Sécurité des Usagers de l'Electricité), NORMAPME (European Office of crafts, Trade and small and medium Enterprises for standardization)

CLC/TC64: The Committee

■ Coordination with IEC

□ Parallel procedure

- Development at IEC level
- Parallel vote at CDV
- Issuing of European modifications
- Parallel vote at FDIS stage
- European vote on modifications
- Edition of consolidated document

□ CLC type of document

- European Norms (EN)
 - Have to be implemented in CLC countries
 - No modification possible at national level
- Harmonized Documents (HD)
 - Have to be implemented in CLC countries
 - Modifications possible at national level

CLC/TC64: Protection against electric shock

- BSP concept
 - Does not exist in CLC
- IEC 60479 series: Effects of currents passing through the human body and livestock
 - No counterpart in CLC
- IEC 61140: Protection against electric shock - Common aspects for installation and equipment
 - Edited as normal standard: EN 61140
 - No modification on IEC document
- IEC 61201: Use of conventional touch voltage limits - Application guide
 - No counterpart in CLC
- IEC 60364-5-54: Earthing arrangements and protective conductors
 - Edited as HD 60364-5-54

CLC/TC64: Electrical installations

■ Correspondance IEC CLC

- IEC 60364-1 ⇒ HD 60364-1 (mod)
- IEC 60364-4-41 ⇒ HD 60364-4-41 (mod)
- IEC 60364-4-42 ⇒ HD 60364-4-42 (mod)
- IEC 60364-4-43 ⇒ HD 60364-4-43 (mod)
- IEC 60364-4-44 ⇒ HD 60364-4-443 (mod) /HD 60364-4-444 (mod)
- IEC 60364-5-51 ⇒ HD 60364-5-51 (mod)
- IEC 60364-5-52 ⇒ HD 60364-5-52 (mod)
- IEC 60364-5-53 ⇒ HD 384-5-537/HD 60364-5-534 (mod)
- IEC 60364-5-54 ⇒ HD 60364-5-54 (mod)
- IEC 60364-5-55 ⇒ HD 60364-5-551/HD 60364-5-559
- IEC 60364-5-56 ⇒ HD 60364-5-56 (idem)
- IEC 60364-6 ⇒ HD 60364-6 (mod)

CLC/TC64: Electrical installations

■ Correspondance IEC CLC

- IEC 60364-7-701 ⇒ HD 60364-7-701 (mod)
- IEC 60364-7-702 ⇒ HD 60364-7-702 (mod)
- IEC 60364-7-703 ⇒ HD 60364-7-703 (idem)
- IEC 60364-7-704 ⇒ HD 60364-7-704 (mod)
- IEC 60364-7-705 ⇒ HD 60364-7-705 (mod)
- IEC 60364-7-706 ⇒ HD 60364-7-706 (mod)
- IEC 60364-7-708 ⇒ HD 60364-7-708 (mod)
- IEC 60364-7-709 ⇒ HD 60364-7-709 (mod)
- IEC 60364-7-710
- IEC 60364-7-711 ⇒ HD 384-7-711 (mod)
- IEC 60364-7-712 ⇒ HD 60364-7-712 (idem)
- IEC 60364-7-713

CLC/TC64: Electrical installations

■ Correspondance IEC CLC

- IEC 60364-7-714 ⇒ HD 384-7-714 (mod)
- IEC 60364-7-715 ⇒ HD 60364-7-715 (mod)
- IEC 60364-7-717 ⇒ HD 60364-7-717 (mod)
- IEC 60364-7-718
- IEC 60364-7-721 ⇒ HD 60364-7-721 (mod)
- IEC 60364-7-729 ⇒ HD 60364-7-729 (mod)
- IEC 60364-7-740 ⇒ HD 60364-7-740 (mod)
- IEC 60364-7-753 ⇒ HD 384-7-753 (mod)

CLC/TC64: Electrical installations

■ Electrical installation guide

- TR 50479: Limitation of temperature rise of connecting equipment
 - Equivalent to IEC 61200-52
- TR 50480: Determination of cross sectional area of conductors and selection of protective devices
 - Provide formulas to be used by software's for calculations of electrical installations
 - Cross-sectional area of conductors
 - Estimation of sources/equipment impedances
 - Calculation of short-circuit current and fault current

CLC/TC64: Electrical installations

■ Electrical installation: other documents

- HD 193: Voltage bands for electrical installations of buildings
 - Equivalent to IEC 60449
- HD 308: Identification of cores in cables and flexible cords
 - Color for phase conductors (brown - black - Grey),
 - Color for neutral conductor (blue)
 - Color for PE conductor (green and yellow)

CLC/TC64: Electrical installations

■ Projects under the parallel procedure

- HD 60364-7-710: Medical locations
 - Text for vote is under development
 - Definition of groups
 - Requirements for IT medical system
- HD 60364-7-718: Communal facilities and workplaces
 - Modifications are under development (if needed)

CLC/TC64: Electrical installations

■ New projects

- HD 60364-5-57: Electrical devices coordination
 - Project developed only at the European level
 - Classification of types of coordination
 - Coordination characteristics
 - Between OverCurrent Protective Devices (OCPD)
 - Between OCPD and Residual Current device (RCD)
 - Between RCDs
 - Between OCPD and contactors
 - Between OCPD and Surge Protective Devices (SPD)
- HD 60364-7-719: Lighting installations for advertising signs
 - Project developed only at the European level
 - To split installation requirements from product requirements
 - Document for vote is under preparation

CLC/TC64: Electrical installations

■ New projects

- HD 60364-7-722: Supply of electric vehicles
 - Additional requirement due to external influences
 - Use of RCD 30 mA
 - Isolation required
 - Type of socket-outlet

IEC/TC64 Strategic Business Plan

■ Background

□ History

● 1st rules

- 1882 in UK by IEE (Institution of Electrical Engineers)
- 1896 in DE by VDE (Verband Deutscher Elektrotechniker)
- 1897 in US by NFPA (National Fire Protection Association)
- 1911 in FR by UTE (Union Technique de l'Electricité)

● TC64 setting up

- 1965 IEC/CA set up a WG for unification of wiring rules
- 1967 IEC council set up TC64

IEC/TC64 Strategic Business Plan

■ Background

□ Scope

To prepare International Standards

- Concerning protection against electric shock arising from equipment, from installations and from systems without limit of voltage,
- For the design, erection and verification of all kind of electrical installations at supply voltage up to 1 kV a.c., 1500V d.c. except those installations covered by the following IEC committees: TC9, TC18, TC44, TC97
- In co-ordination with TC 99, concerning requirements additional to those of TC 99 for the design, erection and verification of electrical installations of buildings above 1kV up to 35kV

IEC/TC64 Strategic Business Plan

■ Business environment

□ General

- Publications on Low-voltage electrical installations
 - Application: dwelling, commercial, industry, infrastructure...
 - Market indicators: worldwide electricity consumption
- Publications under pilot function: Protection against electric shock
 - List of standards: current effects on human body, common rules...
 - Market indicators: list of TC using TC64/BSP

□ Market demand

- Basic needs
 - Installation of standardized installation equipment
 - Safe use of standardized current-using-equipment
- Implementation
 - Direct implementation of IEC 60364
 - Adaptation of IEC 60364
 - Use of principles proposed by IEC 60364

IEC/TC64 Strategic Business Plan

■ Business environment

□ Trend in technology

- Proximity of signal cables and power cables (EMC problems)
- Increasing presence of harmonic currents
- New technologies of renewable power supplies (PV solar power supplies)
- “Smart Grid” impact on LV electrical installations
- Installations in “DC” or using mix DC and AC
- Installations in AC with other frequencies than 50/60 Hz ?
- Up dating existing installations

□ Market trends

- To ease safe use of electricity for those who have not yet access to it
- Energy efficiency of installations for reducing energy consumption
- Power supply for electric vehicles
- Autonomous electrical installations (not connected to the Grid)

IEC/TC64 Strategic Business Plan

■ Business environment

□ Ecological environment

- Reduction of Electromagnetic disturbances

■ System approach aspects

□ Combination of 2 aspects

- Safe use of electricity
- Selection, erection and verification of electrical equipment

□ Electrical installations

- To incorporate various equipment in one system
 - Power supplies
 - Wiring systems
 - Protective devices
 - Control devices
 - Current-using-equipment

IEC/TC64 Strategic Business Plan

■ System approach aspects

□ Component committees

- TC64 as a customer
 - 31 IEC/TC or SC

□ System committee

- TC64 as a supplier
 - 45 IEC/TC or SC

□ Liaisons

- External liaisons
 - 4 external organizations
- Internal liaisons
 - 20 IEC/TC or SC

IEC/TC64 Strategic Business Plan

■ Objectives and strategies (3 to 5 years)

□ Maintenance cycles

- To give time for national implementation by NC (\approx 10 years stability)

□ Collaboration with TC

- To convince products TC that IEC 60364 is the best platform to promote the use of their equipment
- To introduce some of their needs in the IEC 60364

□ Countries needs

- To better consider needs of countries not participating to TC64 works
- To encourage all countries to participate to TC64 works

□ BSP adaptation

- To introduce new TC needs in our BSP

IEC/TC64 Strategic Business Plan

■ Actions plan

□ Current work

- Maintenance of existing standards
 - In accordance with work program
 - See standards under revision
- New items to be introduced
 - Short-circuit and earth fault proof installations
 - Restriction of PE conductor current under normal operating conditions, including harmonics
 - Introduction of report to be proposed after verification of the electrical installation

IEC/TC64 Strategic Business Plan

■ Actions plan

□ Future work

- Energy efficiency within electrical installation
- DC installations
- Renewable energy power supply
- Renovation of existing installations in terms of safety
- Supply of electric vehicles
- Installations supplied by independent micro grid
- Installations to be adapted if supplied by smart grids
- Incorporation of systems for energy storage
- Installations using industrial frequencies other than 50/60 Hz

Thank you

Questions?