U.S.-India Virtual Standards Workshop
The Future of Electric Vehicles in India
Session II
Indian EV Power Utilities and Regulatory Issues

February 23, 2021
Opening Remarks

United States Trade and Development Agency
Tanvi Madhusudanan, Country Manager, Indo-Pacific

U.S. Department of Commerce
Geoff Parish, Principal Commercial Officer (PCO) for North India

Confederation of Indian Industry (CII)
Vipin Sahni, Executive Director
OUR MISSION

Working for A Safer World

Since 1894
Two Distinct Organizations with One Common Mission

Underwriters Laboratories (Nonprofit)
- Standards
- Research
- Education/Outreach

UL (Business Solutions)
- Testing, Inspection & Certification
- Software as a Service
- Advisory Services
Underwriters Laboratories Focus Areas

- **Battery Safety**: Investigating the limits of battery technologies to drive safer innovations and product performance.
- **Chemical Insights**: Promoting human health through research and awareness of the potential risks of chemical pollutants.
- **Data Science**: Providing analytical, statistical and predictive modeling to enhance strategy and research.
- **Education and Outreach**: Developing safety, health and sustainability education interventions to inspire behavior change, awareness and empower positive action.
- **Fire Safety**: Leading fire research and developing practical education to help firefighters stay safe and protect people and property.
- **Standards**: Delivering standards that guide the safety, performance and sustainability of products and services worldwide.
UL Standards by the numbers

OVER

1,600
CURRENT STANDARDS
On safety, security and sustainability

70+
DEDICATED
Standards Professionals
In 8 countries

Over
4,000
VOLUNTEERS
ACTIVELY PARTICIPATING IN STANDARDS DEVELOPMENT

APPROXIMATELY

50,000
REGISTERED CSDS USERS
COLLABORATIVE STANDARDS DEVELOPMENT SYSTEM

35+
COUNTRIES
REPRESENTED ON STPs AND COMMITTEES

450
ACTIVE STPs AND COMMITTEES
DEVELOPING AND MAINTAINING STANDARDS
Why Energy Storage?

Infrastructure Benefits of Energy Storage

Adding Energy Storage:

• Reduces the need for new grid construction and system upgrades

• Augments the performance of aging transmission and distribution assets:
  - **US DOE Estimates:**
    - 70% of transmission lines are more than 35 years old
    - 70% of transformers are more than 35 years old
    - 60% of circuit-breakers are more than 40 years old

• Improves grid security, reliability and resiliency

• Reduces peak demand stress on transmission and distribution lines
Enabling the Smart Grid

Peak Demand & Economics

Grid Reliability & Resiliency

Grid Balancing & Load Leveling

Supporting Renewables by Mitigating Intermittency

IMPORTANCE OF ENERGY STORAGE
What are Implementation Issues to Consider

Issues that may be associated with the Implementation:

Does the BESS provide anticipated performance?

What are the safety concerns?
Potential Hazards
Associated with ESSs

- Fire, Explosion, Temperature
- Electric Shock, Arc Flash, Burns
- Over Pressure, Noise, Moving Parts, Sharp Edges
- Exposure to toxic and hazardous substance
2012
Kahuku, Hawaii
Lead Acid Battery

2013
Port Angeles, WA
Li-ion Battery

2017
Brussel, Belgium
Li-ion Battery

2011
Tsukuba, Japan
Sodium Sulfur BAT

Video Source:
https://www.youtube.com/watch?v=IElPzxj37dw
April 2019
Surprise, Arizona
Li-ion Battery

2017~2019
South Korea
Several incidents with Li-ion Battery

International ESS Fire Accidents

Picture Source:
https://www.greentechmedia.com/articles/read/apsbattery-fire-explosion-safety-lithium-mcmickenfluence
https://biz.chosun.com/site/data/html_dir/2020/02/07/2020020700052.html
What are Implementation Issues to Consider

The incidents in South Korea and Arizona USA involved systems that were not certified to a safety standard.

There were limited installation code criteria for BESS at the time of installation.

It is important to evaluate the BESS as a system to an appropriate level of criteria for safety:

- It should be a 3rd party evaluation by an independent certification organization.

The installation codes (e.g. fire codes, electrical codes) should adequately address the safety of the installation:

- It is important to evaluate for the potential worse case condition (a fire from the BESS) to ensure the infrastructure protections are adequate.
What are Implementation Issues to Consider

Policies impacting energy storage systems:

At the Local Level -
- Municipalities, Regional and State Governments rely upon the model codes to regulate the installation of electrical equipment
  - Examples:
    - California Fire Code based upon ICC IFC,
    - NYC Dept. of Buildings will be based upon NFPA 855
    - The model codes rely upon consensus standards for product safety
      - Examples are ANSI/CAN UL 9540, ANSI/CAN UL 9540A

At the Federal Level –
- NERC (North American Energy Reliability Corporation) regulations that impact EESS
- EPA (Environmental Protection Agency) regulations - end of life/disposal, GHG emissions (benefit)
- DOT (Department of Transportation) regulations (e.g. UN 38.3)
- OSHA (Occupational Safety and Health Administration) regulations (adoption of UL 9540 and UL 1973)
Safety Approach
In North America

Battery Safety Certification

UL 1642  Lithium Batteries
UL 1973  Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
UL 9540  Energy Storage Systems and Equipment

Installation Codes

NFPA  NFPA 1 – Fire Code
        NFPA 70 – National Electrical Code (NEC)
        NFPA 111 – Stored Electrical Energy Emergency and Standby Power Systems
        NFPA 855 – Installation of Stationary Energy Storage Systems

ICC    International Fire Code (IFC)
        International Residential Code (IRC)
        International Building Code (IBC)

Testing for Performance

UL and IEC Standards

UL 9540 Battery Requirements
  • UL 1973

IEC 62933-5-2 Battery Requirements
  • IEC 62619, IEC 63056, IEC 62485-5
  • IEC 63115-2
  • IEC 62485-2
  • IEC 62932-2-2
  • IEC 62984-2
Energy Storage Systems
Basic Construction

IEEE 1547
IEEE 1547.1
IEEE 1547A
IEEE 1547.1A

IEC/UL 62109-2
IS 16221 (Part 2)
UL 1741

IEC 62619/IEC 63056
IS 16046 / IS 16270
UL 1973

UL 9540

IEC 62933-5-1 / IEC 62933-5-2
IS 17092
UL 9540
Protective Circuit and Controls

Battery management system (BMS) shall maintain cells within the specified operating region.

Solid State Circuits
Software Controls

IEC 61508 series
IEC/UL 60730-1, Annex H
IS 17387 General Safety and Performance Requirements of Battery Management Systems
IEC 62619:2017
Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
Edition 1.0 Issued 2017-02-13

IEC 63056:2020
Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
Edition 1.0 Issued 2020-03-27

Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes — Safety Requirements for Portable Sealed Secondary Cells and for Batteries Made from Them for Use in Portable Applications Part 2 Lithium Systems

ANSI/CAN/UL 1973
Standard For Batteries For Use In Stationary, Vehicle Auxiliary Power And Light Electric Rail (LER) Applications
2nd Edition Issued 2018-02-07
IEC TS 62933-5-1:2017
Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification
Edition 1.0  Issued 2017-07-12

IEC 62933-5-2:2020
Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems
Edition 1.0  Issued 2020-04-06

IS 17092 : 2019
Electrical energy storage systems safety requirements

ANSI/CAN/UL 9540
Energy Storage Systems And Equipment
2nd Edition Issued 2020-02-27
Installation Codes
NEC, IFC, IBC, IRC, NFPA 855

National Fire Protection Association

NFPA 1
Fire Code

NFPA 111
Standard on Stored Electrical Energy Emergency and Standby Power Systems

International Code Council

NFPA 70
National Electrical Code

International Building Code

NFPA 855
Standard for the Installation of Stationary Energy Storage Systems

International Fire Code

International Residential Code
Energy Storage Systems
NFPA 70 - National Electric Code (NEC)

Scope
Section 706.1
This article applies to all energy storage systems (ESS) having a capacity greater than 3.6 MJ (1 kWh) that may be stand-alone or interactive with other electric power production sources.

> 3.6 MJ (1 kWh)

Stand-alone or Interactive
NFPA 855
Standard for the Installation of Stationary Energy Storage Systems

Min. Sprinkler Density
0.3 gpm/ft²

Spacing of Each Group
Min. 3 ft (about 1 m)

Each Group
Max. 50 kWh

Max. Stored Energy
600 kWh

The AHJ shall be permitted to approve groups with larger energy capacities or smaller group spacing based on large-scale fire testing.
What are Implementation Issues to Consider

ICC IFC 2021 / NFPA 855 Control Measures - Listing, Size, Separation, MAQ

UL 9540 Listing

Max. 50 KWh per unit

Other arrangements based on UL 9540A large scale fire testing

Max. 600 KWh aggregate/fire area

Spaced min. 3 ft. (914 mm) from other BESSs and from walls
What are Implementation Issues to Consider

**UL 9540A** - is a multi-tier test method that determines the capability of a battery technology to undergo thermal runaway (TR) and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems.

- **Cell Level**
  - Establishes TR capability, vent temperature, collects & analyzes cell off gassing (lower flammability limit (LFL), burning velocity ($S_u$), max deflagration pressure ($P_{max}$))

- **Module Level**
  - Determine propagation, measures temperatures, HRR (heat release rate), SRR (smoke release rate) and off gassing data

- **Unit Level**
  - Evaluates BESS installation (without fire or deflagration protection) response to TR within the BESS and measures off gassing ($H_2$, CO, $CO_2$, THC) and measuring HRR, SRR, heat flux, and temperatures

- **Installation Level**
  - Evaluate effectiveness of BESS installation fire protection and deflagration protection during a BESS fire event
What are Implementation Issues to Consider

UL 9540A Evaluates BESS Installation Parameters
- Separation distances between units
- Separation distances between units and walls
- Potential of fire spread to overhead cabling

UL 9540A Evaluates Fire Protection (Integral or External)
- Evaluates fire protection strategies

UL 9540A Determines Installation Deflagration Requirements
- Quantifies deflagration potential
- Quantifies heat generation

UL 9540A Aids Fire Service Strategy and Tactics
- Characterizes magnitude of potential fire event
- Documents re-ignitions within a BESS unit under test
- Documents gases generated
UL 9540A Test Levels

**Cell Level**
- Thermal runaway methodology
- Cell surface temperature at gas venting
- Cell surface temperature at thermal runaway
- Gas composition and LFL (lower flammability limit)

**Module Level**
- Heat release rate
- Gas generation and composition
- External flaming and flying debris hazards
- Locations of flame venting

**Unit Level**
- Heat release rate
- Gas generation and composition
- Deflagration and flying debris hazards
- Target BESS and wall surface temperature
- Heat flux at target walls

**Installation Level**
- Fire mitigation (methods)
- Target BESS and wall surface temperature
- Gas generation and composition
- Deflagration and flying debris hazards
- Heat flux at target walls
UL 9540A – Unit Level Tests
Examples of test arrangements
ANSI/CAN/UL 9540A
Test Method For Evaluating Thermal Runaway Fire Propagation In Battery Energy Storage Systems

4th Edition  Last Revision 2019-11-12

Note: The video is for reference only. This is not an actual testing scene of UL 9540A
Video Source:
Fire Hazard of an 83 kWh Energy Storage System Comprised of Lithium Iron Phosphate Batteries
https://www.youtube.com/watch?v=uLzPSN8iaqk
UL Standards Development Process
UL Standards development process

Phases of the process

Proposal Submission
Preliminary Review
Proposal Review
Recirculation

Each phase is processed in UL’s standards development system, CSDS
STP Process Overview

- The Standards Technical Panel (STP) process is used for all consensus standards development which will be pursued for ANSI and/or SCC approval.

- An STP is a group of individuals, representing a variety of interests and representing a balanced matrix connected to the UL Standard, formed to review and vote (or ballot) on proposals for new Standards or revisions to existing Standards.

- Our procedures were approved by the Standards Council of Canada (SCC) in Canada and the American National Standards Institute (ANSI) in the US.

- Our procedures are audited by ANSI and SCC.
What are the steps in the STP process?

- **Proposal Submittal**
  - May be submitted by UL or others

- **Preliminary Review**
  - Typically 14-30 days.
  - Can be shortened or waived (as appropriate)

- **STP Meeting**
  - As needed.
  - Anyone can attend and participate in STP meetings

- **Ballot & Public Review**
  - 30-60 days
  - Ballot by STP member
  - Anyone can sign up as non-voting member to provide comment
  - All commenting and balloting done via UL’s on-line Collaborative Standards Development System (CSDS)
What are the steps in the STP process?

- **Comment Review & Response**
  - Timing depends on number and complexity of comments received.
  - Responses drafted by proposal submitter

- **Recirculation**
  - 30 or 45 days (timeframe set by ANSI)
  - 2 weeks for comment and responses (comment matrix) only

- **Publish**
  - If consensus reached.
  - If not, proposal fails
Free Digital View of UL Standards

View all current editions and revisions of UL and ULC Standards for Safety free of charge. Includes national differences to IEC/ISO based standards.

Register and access the standards at www.shopulstandards.com

- Allows standards to be viewed before purchase
- Raises the awareness of what is required in the standard
- Can be accessed by anyone around the world
- Enables a variety of individuals and organizations to preview, including international stakeholders
- Benefits a wider group of stakeholders such as regulators, academia, product designers, and innovators who will look for safety certification at a future date.
- Promotes collaboration

Furthers UL’s mission and commitment to public safety.
Thank you

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Perspectives on EV
When we say Electric vehicle....

**Tesla Model 3**
Best selling EV with over 500k sales in 2020

**Electric Car from 1884 by Thomas Parker**
Lead Acid Batteries
These are also Electric vehicles

As of 2018 India has about 1.5 million lead acid battery-powered, three wheeled rickshaws on its roads with speed less than 30 km/hr

Image : Yulu Bikes
Shared Mobility
Over 10,000 on road in India

Image : Ather 450
Premium Connected Scooter, designed for Indian Roads
India: Unique market segment dominated by 2 wheelers & 3 Wheelers
Innovations to Accelerate eMobility
Technology Demands

1. 2W / 3W Chargers
2. Battery Swap Stations
3. Financing Models
4. Creating Viability

Internet of eMobility
1. 2W/3W Chargers
Making Charging Ubiquitous

- Communication module to connect charger to cloud systems
- Sensors to monitor voltage, current and other operating parameters of the charger
- Controller/Relay to enable remote control of charger operation
- RFID reader to enable card-based access
- Power backup for monitoring and control module
1. AC/DC Chargers controlled by Software

- EV: Electric Vehicle
- EVSE: EV Supply Equipment (Charger)
- OCPP: Open Charge Point Protocol
- OCHP: Open Clearing House Protocol
- OSCP: Open Smart Charging Protocol
- CPO: Charge Point Operator
- eMSP: eMobility Services Provider
- DSO: Distributed System Operator
2. Battery swap operations
Complicated Orchestration
2. Optimized energy usage

Using swap stations for energy storage

Solar renewables used for charging batteries

3. Making EVs affordable
CAPEX to OPEX business model for Drivers

Size of India’s EV financing market in 2030:
INR 3.7 lakh crore (USD 50 billion)

http://www.cleanfuture.co.in/2021/02/15/financing-electric-vehicles-risky/
4. Interface to Smart Grids

- Provide Power to Household – lighting
- Support to stabilize grid voltage and harmonics

V2H - Vehicle to Home
V2G - Vehicle to Grid
VPP - Virtual Power Plants
4. Connected ecosystem

https://www.pentasecurity.com/blog/iot-connected-car-transport-security/
Implementation Roadmap for systemic EV Adoption in India and Asia

Industry Connections Activity Initiation Document (ICAID)
Implementation Roadmap for systemic EV Adoption in India and Asia

Chair: Ravi Kiran Annaswamy, Numocity Technologies

Overview:

Electric Vehicles (EV) are emerging as the option for clean mobility across the world. The EV ecosystem brings together three industry verticals who traditionally have not worked together: EVs need the automobile industry to modify the vehicles to use batteries and new connected vehicle technologies. Power industry needs to gear up to fueling these EVs with electricity and they need to build charging infrastructure across the highways, malls and workplaces. All these equipment are IoT enabled and connected so both telecom connectivity (4G/5G) along with Digital tech like Cloud, Data and analytics become essential for accelerating EV adoption.

The goal of the IC activity is to bring all together the stakeholders (policy, business and tech) across Auto, Power and Digital technologies and create a viable, systemic and meaningful roadmap for Indian market. India is different from other world markets in mobility with over 85% being 2 and 3-wheeler vehicles. The technology and business models are frugal and designed for Indian market.
Implementation Roadmap for systemic EV Adoption in India and Asia

Chair: Ravi Kiran Annaswamy, Numocity Technologies

Expected Activities:

- EV Industry Advisory body will be created with all involved stakeholders in Indian market by January 2021.
  - In 2022, there will be additional advisory boards created in other markets of Asia, Africa, and LATAM
- Create a series of workshops also under the banner of the IC program - focused on the 3 pillars and one workshop bringing together all the elements (some teaser webinars planned for Dec 2020)
  - Three workshops one every month by May 2021.
- The IC program will identify specific deliverables - workshops, white papers and discussion papers, identification of reference use case on the grid side, all of them towards development of the final roadmap document. IC program can also include standards gap analysis for developing future standards
- Monthly meetings of the advisory board and there will be an activity (webinar or workshop) every quarter during the duration of the program
Implementation Roadmap for systemic EV Adoption in India and Asia

Chair: Ravikiran Annaswamy, Numocity Technologies

Launch:
- 25th February 2021
- 10:00 AM to 11:30 AM
- Online (WebEx) and in person at IEEE Bangalore office

Interested to contribute
Contact: rawkiran.a@numocity.com or sri.chandra@ieee.org, rawendra.desai@ieee.org
Positive side of Pandemic, During Lockdown NASA satellites have detected the lowest aerosol levels in 20 years over northern India.

Electric vehicle adoption will have a positive impact on the reduction of urban pollution

Source: https://www.space.com/india-air-pollution-drops-coronavirus-lockdowns.html
Thanks
Ravikiran.A@numocity.com
Electric Vehicle Charging

Fee Collection

John Halliwell
Senior Technical Executive
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February 23, 2021
U.S. – India Standards and Conformance Cooperation Program
Charging (₹ or $) for Charging (⚡)

- **Free**
  - Mostly AC chargers

- **Fee**
  - Some AC and Most DC
    - Parking fee
    - Session fee
    - Time fee ($/second; $/minute; $/hour)
    - Energy fee ($/kWh)
    - Combination

- **How do you pay?**
  - Credit card (contactless or magnetic stripe)
  - RFID card (issued by network provider)
  - Call phone number
  - Smart phone app
  - Plug-and-Charge (currently for DC only in U.S.)
Charge Station Populations by Network

**AC Charging**

- Network
- Circuit Electrique
- RechargeAccess
- Innogy
- Shorepower
- Sun Country
- JNCH
- OpConnect
- AeroVironment
- CarCharging
- Volta
- Greenlots
- EVgo
- GE WallStation
- SemaCharge
- Blink
- Tesla Destination
- ChargePoint
- Non-networked

**DC Charging**

- Network
- OpConnect
- AeroVironment
- Blink
- Greenlots
- ChargePoint
- Non-networked
- EVgo
- Supercharger
Key Regulatory Question – Is Fueling an Electric Vehicle an Electric Utility Function?

- In the U.S., this decision is made at the State Level
- About 1/2 of the 50 U.S. States (25) have decided that fueling an electric vehicle is not a utility function

If it is a Utility Function:
State Utility Regulatory Commission

- Usually means that third parties can’t sell kWh
- Charge for Charging by TIME

If it is not a Utility Function:
State “Weights and Measures” Regulatory Body

- Usually, part of state’s Department of Commerce or Agriculture
- Regulated as a vehicle fuel (see next slide)
- Can sell by energy units (kWh)
- Only California has started to regulate electricity as a fuel
While U.S. States Regulate Commerce – Federal Government Provides Model Language through NIST Handbooks

Handbook 44

- Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices
- See - Section 3.40 - Electric Vehicle Fueling Systems
- Focuses on technical requirements for metering of time and energy
- Still “Tentative Code”

Handbook 130

- Uniform Laws and Regulations in the Areas of Legal Metrology and Fuel Quality
- See Section 2.34 - Retail Sales of Electricity Sold as a Vehicle Fuel
- Focuses on unit of sale and labeling of stations

NIST = National Institute of Standards and Technology


Together...Shaping the Future of Electricity
A high-level look at the global EV world: 2021

John Voelcker
Auto-industry reporter + analyst

www.linkedin.com/in/jvoelcker
THEN: 2009
NOW: 2021
USA: All about trucks (and Tesla)
GLOBAL SALES: China, EU, USA

Electric transportation is a global market

Despite global pandemic, EV sales grew especially where supported by strong policy and EV supply

Europe (2020): 11.4%
- Norway (74.8%)
- Finland (18.1%)
- France (11.3%)
- Iceland (45.0%)
- Denmark (26.4%)
- Belgium (10.7%)
- Sweden (32.2%)
- Switzerland (14.3%)
- U.K. (10.7%)
- Netherlands (24.5%)
- Germany (23.5%)
- Austria (9.5%)

US EV Sales 2018–2020

Europe EV Sales 2018–2020

China EV Sales 2018–2020

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2010s: POLICY MATTERS!

2020s: Demand pull adds to regulatory push?
DC CHARGING: LEVELS RISE

But most EV charging is at 120V or 240V

Key market drivers:
- DC charging power levels increase
- Battery prices decrease

This enables larger EVs as well as lower volume market segments
Question & Answers

Submit questions in the chat box. If they are not answered then we can connect with you after the session.
Thank you!

Remember to register for our final EV webinar sessions on February 25th

Reach out to us-indiasccp2@ansi.org with any questions