INTRODUCTION

Rail transportation has grown to become the mainstream modes of transportation by providing intercity and large regional reach and shortening time for travel. It is playing a very significant role in the growth and development of nations.

To increase efficiency & reduce travel time, rail transport is constantly evolving, from coal powered engines (19th Century) to High Speed Rails, Metros, MAGLEV & Hyper-Loop technologies.

With evolving technologies, asset management & risk mitigation for Electrical and Electronic components becomes more complex and must advance accordingly. Major issues posing highest risk to this sector include:

- Electromagnetic Interferences (Inter & Intra)
- Lightning Transient
- Power Quality Issues
- Power Surges
- Dangerous Rail Potentials

During initial phase, it is essential that electrical and communication system be designed, simulated and modelled as per electrical safety and reliability parameters conforming to relevant standards. Skipping these stages will impact project cost, installations and future operations and maintenance. Efficient study and design of rail networks will avoid incidents leading to failure of traction systems and accidents causing loss of human life.

Our subject matter experts can perform ambient survey, design, modelling and simulation for new railway network. We also provide adequacy studies, design validation of existing integrated networks. Looking into the survey criteria and design output, we identify the risks in the network and provide suitable mitigation measures.

We are end to end solution provider for permanent and maintenance free earthing and lightning protection systems following IEEE 80-2013, IEEE 665, BS7430:2011, BSEN 62305 & NFC 17-102:2011 Standards. Our specialized installation, testing and commissioning of these systems are accurate and meets defined design criteria.
The railway networks consist of traction, signalling, telecommunications and radio-communication systems. Which forms a critical electromagnetic environment. For safe and intended operations, it is important to have compatibility between inter-system and intra-system component.

Inter– and Intra–systems compatibility is hindered due to high EM interference. This leads to:

- Unintended operation of protective relay
- Induced transients/surge/glitches in the signalling cable
- Electronic Card Failures
- Transmission line interferences
- Accelerated degradation of cables, pipes and structures
- Hazardous shock to human beings (Touch Potential)

Our Solutions
We provide EM Management by
- Developing Equipment Category, Cabling Philosophy, Earthing & Bonding Philosophy
- Delivering EMC Control Plan, EMI/EMC Risk Analysis with Intra & Inter System Analysis
- EMC Earthing & Cabling Rules
- Measuring & assessing site induced EMF
- Recommending special consideration to safety related systems & measures to mitigate unintended emission.

Standards Followed:
We follow BSEN 50121, BSEN 50122, BSEN 55032, CISPR 32, BSEN 61000-5-2, BSEN 50174, BSEN 50310 and RDSO standards.

Software: CDEGS, EMTP-RV and other simulation platforms.
Electrified rail systems are having challenging load for three-phase transmission lines due to load variations, reactive power, imbalance, and harmonic pollution. Good power quality is the answer for these challenging environments.

**Area of Concern**
Rail networks consist of varying traction loads, power electronic equipment along with switching operations. The presence of these non-linear loads leads to following disturbances:

- Voltage Dips
- System imbalances of traction loads
- Arcing between OHE catenary and pantograph
- Arcing between brush and rail
- Disruption/disturbances in communication signals
- Malfunction of protective systems
- Incorrect operation of transmission line control system
- Reduction in Power factor causing increased power consumption

**Our Solutions**

- Power Quality Analysis through Site Measurements
- Load Distribution Analysis
- Frequency Monitoring
- Harmonic Analysis
- Recommend suitable Mitigation Measures

**Standards Followed:**
EN 50160, IEC 61000-4-7, BSEN 61000-4-30, IEEE 519

**Software:** Power Log
Earthing and Bonding

Electrified railways need to incorporate special earthing and bonding systems to meet with their own and statutory requirements on safety, touch potentials and interfaces with other trackside electrical equipment. Inadequately maintained and aged earthing system are the principle concerns in existing network. For new network, one has to carefully design the earthing & bonding system to avoid dangerous potential rising from the limitation factor and reduce installation, operation cost by accurate design as per standards.

Area of Concern
Improper earthing & bonding results in:
- Dangerous touch potentials leading to shock hazard
- Equipment damage / Fire Hazards
- Incorrect functioning of protective equipment
- Induced voltages to underground signalling cables
- Increase cost of installation and maintenance.
The above anomalies are prominently seen in shared corridor involving track, transmission line, pipe line, etc.

Our Solutions
- Designing of earthing & bonding system
- Specialist in installation, testing and commissioning of earthing & bonding system
- Assess and rejuvenate old earthing & bonding system

Standards Followed:
BSEN 50122-1, IEEE 80-2013, BS 7430:2011

Software: CDEGS
Lightning Protection System (LPS)

Lightning is an electrostatic discharge between cloud to cloud and cloud to ground during a thunder storm. This discharge affects following area’s in railway network:

- Metro Stations
- Complete network
- Signalling Equipment Room
- Railway Stations
- Substations
- Auto Location Huts

Lightning strikes can cause damage to the structure (stations) and to its occupants and contents, including Failure of electrical, signalling & telecom systems.

Area of Concern
Inadequate Lightning protection system causes

- Dangerous step and touch potentials
- Failure or malfunction of internal signalling & telecom systems due to LEMP
- Damage to expensive assets due to over voltage.
- Spurious trips of signalling system
- Shut down of line due to direct lightning strikes on catenary

Our solutions
We provide end-to end solutions in this field

- Health assessment of LPS and its integrity with the earthing system
- Survey, design, install, test and commission appropriate LPS for new projects.
- Audit, design-validation, recommend implementable solutions, correction, test and commission appropriate LPS for existing projects.
- Study of lightning transient
- Risk Assessment calculations to determine protection level (with reference to Isokeraunic Map)
- Validation or Calculation of protection zone

Standards followed:
BSEN 62305, NFC 17-102:2011 & IEC 61643
Software: RISCAL(INTERNAL SOFTWARE), CDEGS, EMTP-RV & other simulation platforms
Transient Study

With increasing train speed, the interactions among the train, track, and the power catenary system becomes very intense. This causes dynamic change and switching of loads. In response to these changes the system gives unprecedented responses such as:

- Unbalancing in power
- Malfunctioning of protection equipment
- Tripping of power supplies
- Overheating of equipment
- Equipment Failure
- Cable burst
- Unintended operation of control systems block

Transient study helps in analysing the nature and response of the system. If the systems response is unprecedented mitigation plan/s is formulated and designed.

Our Solutions
- Analysing potential switching problems
- Analysing lightning surges
- Ferro-resonance
- Root cause analysis of incidents and accidents.
- Recommend mitigation measures.

Standards Followed:
BSEN, IEC, IEEE, NEC, CIGRE, NFPA, ICEA

Software
CDEGS
EMTP
ETAP
Steady State Study

Area of Concern

The ability of a power system to maintain stability under continuous small disturbances is investigated under the name of Dynamic Stability (also known as small-signal stability). These small disturbances occur due to random fluctuations in loads and generation levels. In an interconnected power system, these random variations can lead catastrophic failure.

Our Solutions

The different types of analysis that can be conducted on a system are mentioned below:

- Load Flow Analysis
- Protection Coordination
- IPP - independent power producer is landing and integration
- Line and Cable Constants (Parameters) & Induction Analysis
- Cable Sizing
- Detailed Fault Current Distribution

Software: ETAP, EMTP-RV, CDEGS

Standards:
- BSEN
- IEEE
- NFPA
- IEC
- ICEA
- NEC
Substation Earthing

Area of Concern

The grounding system in substation is a necessity as it protects substation equipment from surges & lightning strikes. It protects life and assets from dangerous step and touch potential.

It is necessary to validate utilities' electrical reliability and safety philosophy to ensure deterioration of equipment health, grid health or deviation of substation health from designed parameters.

Our Solutions

New substation

- Site survey and multilayer Soil Resistivity model
- Design of substation earth grid for uniform and heterogeneous soil environment
- Survey, design, supply, installation and commissioning of earthing system
- Simulate lightning transient effects for dangerous step and touch potential

Existing substation

- Health Assessment of Existing Grounding System
- Survey, Design Validation, Audit, Supply, Installation and Commissioning of earthing system
- Simulate lightning transient effects for dangerous step and touch potential
- Substation Equipment testing using best in class multifunction substation maintenance & commissioning test systems such as STS5000

Standards Followed:

Software: CDEGS, TDMS
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Projects Snapshot

**Dedicated Freight Corridor 343 Km Survey**

- Identification of EM sensitive sites, intentional transmitters and miscellaneous assets through desktop survey.
- Measurement of Electromagnetic ambient noise at Dedicated Freight Corridor and validation of findings during site survey.
- Analysis of ambient noise with reference to permissible limits as per BS EN 50121 Part 2.
- Identification of EM prone zones and intentional emitters which can help to have specific preventive measures to avoid unintended operation of assets.

**Radiated Electro-Magnetic Measurement and Analysis**

- Electromagnetic compatibility & interference test for signalling installations as per BS EN 50121 Series.
- EMC test is done for rolling stock at different operating conditions as per BS EN 50121 Part-2
- Analysis of emission spectrum measured at site for its compatibility. Identification of frequencies exceeding the emission EM emission levels and providing suitable implementable solutions.
Manav Presence

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