Critical Systems Consulting Group
www.cscgcorp.com
Critical Systems Consulting Group (CSCG) Background

- *Service provider* for Mission Critical facilities such as *Communications sites* infrastructures
- Many years of experience in *Conceptual Designs, Planning and Auditing* Critical Systems sites expertise on topics, including but not limited to, *Grounding, Lightning Protection, Power Quality* and more
- In depth knowledge of many *Influential Standards and Codes* as directly related to Mission Critical areas
- Proven experience in the critical systems community assisting engineers, contractors, and facilities personnel *Implementing Critical Systems Solutions*
Sam Chreiteh
Principal and Founder of Critical Systems Consulting Group (CSCG)
Sam Chreiteh holds a BSEE degree from Louisiana State University. Has extensive involvement in many facets of the Conceptual Designs, Planning and Auditing of Mission Critical facilities such as Data Centers, 911 Emergency Operating Centers (EOC), Utilities and Communication sites' infrastructures. Service provider for Mission Critical facilities such as Communications sites infrastructures.

- Mr. Chreiteh has firsthand experience on topics covering Lightning Protection Systems and associated Grounding for Industrial, Commercial and Governmental clientele projects including extensive design work in the telecommunication industry, indoor and outdoor Distributed Antenna Systems (DAS) for both 4G and 5G networks and the Public Safety sector.

- Considered as an industry Subject Matter Expert, Sam is responsible for guiding the direction of some of the most industry challenging designs and standards addressing Electrical Power Quality, Power Distribution, Grounding, Precision Cooling, Lightning Protection and overall Management concerns for critical facilities.
SBE37.org Presentation Topics

- Bonding for Equipotential – Single Point Ground Technique
- Grounding Electrode System – Site Ground Field
- Tower Grounding
- Transmission Lines Shield Grounding
- Shield Grounding of Signal Carrying Cables
- Surge Protective Devices of Copper Based Power, Data and Communications Cables
- Questions and Answers
Purpose of Bonding and Grounding
Bonding for Equipotential
Purpose of Bonding

Bonding is required at electrical services (NEC 250.92), at enclosures (NEC 250.96), and at equipment (NEC 250.110) in order:

- To ensure that the equipment-grounding system has:
  - Continuity
  - Permanency
  - Capacity to conduct
  - Lowest impedance path

- To collapse any potential build-up between fixed metallic parts that are within 8 feet vertically or 5 feet horizontally of grounded metallic objects (NEC 250.110)
Electricity’s (Amperage) Effects on Humans

Electricity’s Effects

- 1000 Milliamperes: Will light 100-watt bulb
- 900 Milliamperes: Severe burns
- 300 Milliamperes: Breathing stops
- 200 Milliamperes: Heart stops beating
- 60 Milliamperes: Suffocation possible
- 30 Milliamperes: Muscle contraction
- 10 Milliamperes: Cannot let go
- 5 Milliamperes: GFCI will trip
- 2 Milliamperes: Mild shock
- 1 Milliamperes: Threshold of sensation

Milliamperes
Single Point Ground Technique
Single Point Ground Technique
Grounding Electrode System (GES) - Ground Field
Earth Grounding

- Earth is Ground (NEC Article 100)

- The objective is to use earth with supplemental electrodes to obtain ground earth resistance of 5Ω or less (NEC 250.53 (A)(2) requires 25Ω or less)
NEC Grounding Electrode Rod Requirements

All vertical dimensions are below the surface of earth and are the minimum required by NEC 250.53 (G)
Bonding of All Available Grounding Electrode Systems - NEC 250.50

NFPA 780 4.14
NEC 250.106

Appropriately Sized Grounding Electrode Conductors (Typical)
NEC 250.66

All Available Grounding Systems Must be Bonded Together

- Metal Water Pipe
- Building Steel
- Concrete Encased Electrode
- RF, Noise or System Grounding
- DC Grounding

GE
AC Service
Telephone Service
Lightning Protection System
Ground Ring
Tower Grounding
Communication Cables Grounding
Tower Grounding
Grounding of a Self-Supporting Tower

Exothermic Connection (Typical)

Min. 2'-0"

Concrete Pad

Earth Surface

Frost Line

Minimum #2 AWG

NFPA 780 4.13.4

Supplemental Radial (Typical)

GR

Minimum 3 Rods (8'-0"

Sugg. 10'-16"

GR

Minimum One Connection to Site Ground Ring

NEC 810.15 & 21

NEC 810.21(J)
Typical Supplemental Ground Radials

- Tower
- Concrete Pad
- Earth Surface
- Frost Line
- GR
- Minimum #2 AWG OR 2" Flat Copper Straps
- Sugg. 10' to 16'
- NFPA 780 A.4.13.5

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Grounding of a Monopole Tower
Grounding of a Guyed Tower

- **Tower Supporting Plate, Bolts & Screws (Typical)**
- **Exothermic Connection (Typical)**
- **Metallic Tower**
- **Tower Foundation/Footing**
- **Earth Surface**
- **Frost Line**
- **Minimum 3 Rods (8'-0")**
- **Minimum One Connection to Site Ground Ring**
- **Supplemental Radial (Typical)**
- **GR**
- **Sugg. 10'-16'**
- **2½'**
- **Min. 2'-0'**
- **#2 AWG**
Grounding of Guy Wire Anchor

- Galvanized Guy Wire (NFPA 780-5.7)
- Exothermic Connection (Typical)
- Minimum #2AWG
- Suitable Clamps
- Guy Wire (Typical)
- Turnbuckles
- Anchor
- Frost Line
- Min. 8'-0"
Transmission Line(s) Shield Grounding
Tower Ground Bar Grounding

- Metallic Tower (Partial)
- Antenna
- Bracket
- Transmission Cable
- Ground Kit (Typical)
- Tower Ground Bar
- Bus Bar Bonded to Tower (Typical)
- To Transmission Equipment
- Minimum #2AWG
- Earth Surface
- GR
- Exothermic Connection
- Tower Ground Ring
Shield Grounding of a Tower Coax Cable

Suggested Spacing for High Lightning areas
Building External Ground Bus Grounding

- Structure
- Transmission Cables Entry Point
- Transmission Cables
- Ground Kit (Typical)
- Building Ground Bar (BGB)
- Bus Bar Mounted on Insulators
- Minimum #2AWG
- GR
- Exothermic Connection
Transmission Cables Grounding and SPD Protection
Grounding of Shielded Signal Carrying Cables
Metallic Shield Grounding of an Optical Fiber Cable
Shield Grounding of Twisted Pair Cable

- PVC Jacket
- Shield
- NEC 800.100 830.100

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C

Outside Plant Shield Grounding of Twisted Pair Cable

V\textsubscript{1} - V\textsubscript{2} = Z\textsubscript{eg} \times I \text{ (Ground Loop)}
Shield Grounding of a Coax Cable (Within a Building)
Grounding of a Shielded RS232 Cable (Within a Building)
Surge Protective Devices of Copper Based Power, Data and Communications Cables
C

Typical SPD Protection of a Communication Site

All Copper Entry Points Should be Protected with SPD's at their Point of Entry
Evolution of Surge Suppression Technology

Gas Tube  MOV  Silicon Avalanche Diodes (SASD)  Stacked SADs with leads

“The right technology, for the right application.”
Recommended Normal Mode Protection
Common Mode Protection
(Not recommended)

120VAC

Load

Hot

Neutral

Ground

S_1

S_2

S_3

Suppression Elements

S_1  S_2  S_3
Telephony, Data, Signaling, Alarm and Network Circuit Protection

The following cables/conductors entering a communications site, shelter, room, equipment area or pole/pad mounted cabinet shall be protected with suitable Surge Protective Devices (SPD):

- Telephony (NFPA 70-2017, Article 800)
- Alarm (NFPA 70-2017, Article 760)
- Broadband and Fiber Optic Cabling (ATIS-0600036.2016)
- Broadband (IEEE 802.16)
- Broadband (NFPA 70-2017, Article 830)
- Broadband and other miscellaneous communications circuits (Telcordia 1089-CORE)
- Issue 4 or higher, Class 3 and 4, IEC 60950, UL 497)
- Network (NFPA 70-2017, Article 830)
- Signaling (NFPA 70-2017, Article 725)
Data Line SPD (Normal and Common Modes)
Coax Transmission Cables SPD

- **SPD₁**: Surge Protective Device with DC Block (Typically Gas Tube/Reactive Network or Shorted Stub)
- **SPD₂**: Surge Protective Device without DC Block (Typically Gas Tube with Inductive/Reactive Network for DC Circuits)
**RF Surge Protective Devices - Summary**

All RF transmission lines, including unused spares shall have coaxial RF SPDs properly installed

- Each RF transmission line, including GPS and test lines, **shall** have center conductor surge suppression.
- All RF transmission lines, including unused spares, **shall** route through an RF SPD.
- The RF SPD **shall** be located within 2 feet of the transmission line entrance location into the equipment shelter.
- The test port cable and unused spares **shall** be terminated into a 50 ohm load if it is not terminated into a piece of equipment.
General Requirements SPD Tower Electronics

- Tower Top Amplifier
- Receive Antenna Coax with recommended ground kit
- 35 mm² CSA (#2 AWG) or larger green jacketed grounding conductor
- Main line and test line coax require coax ground kits
- Tinned plated copper ground bus bar
- Bond to tower with tinned-plated or stainless steel hardware

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Tower Lighting SPD

AC Surge Protective Device (Typically MOV or SASD)

Data Control Circuitry Device (Typically MOV or SASD)

AC Power Circuitry

For Data Control Circuitry

Tower Lighting

Control Cabinet

To Site Grounding
Questions and Answers