

- 1 **INTRO**
- 2 **COURSE GOALS**
- 3 **COURSE OVERVIEW**
- 4 **GROUNDING GOALS**
- 5 **GROUNDING TOPICS**
- 6 **NEC TOPICS**
- 7 **WHAT WE GROUND?**
- 8 **WHY DO WE GROUND?**
- 9 **SOME COMMON GROUNDING MISCONCEPTIONS**
- 10 **SOME COMMON GROUNDING MISCONCEPTIONS (Cont'd)**
- 11 **SOARES - "CLEARING GROUND FAULTS"**
- 12 **OUR DEFINITIONS**
- 13 **DEFINITIONS**
- 14 **IMPORTANCE OF INDUCTIVE REACTANCE**
- 15 **OHM'S LAW**
- 16 **ELECTRICAL CIRCUIT THEORY KNOWLEDGE BASE**
- 17 **EQUIVALENT RESISTANCE FORMULAS**
- 18 **VOLTAGE DIVIDER FORMULA**
- 19 **THEVENIN CIRCUIT REDUCTION**
- 20 **CURRENT FLOW**
- 21 **GROUNDING CONDUCTOR IN A MAGNETIC ENCLOSURE**
- 22 **IMPEDANCE INCREASE IN STEEL CONDUIT**
- 23 **PROXIMITY EFFECT ON INDUCTIVE REACTANCE AND GROUND FAULT CURRENT FLOW**
- 24 **PROXIMITY EFFECT ON INDUCTIVE REACTANCE AND GROUND FAULT CURRENT FLOW**
- 25 **THE MAGICAL 25 OHM GROUNDING ELECTRODE**
- 26 **GROUNDING ELECTRODE TYPES AND PERFORMANCE**
- 27 **SOIL RESISTIVITY**
- 28 **GROUND ELECTRODE RESISTANCE CALCS**
- 29 **TYPICAL ELECTRODE RESISTANCE FORMULAS**
- 30 **RESISTANCE GRAPHS**
- 31 **MULTIPLE GROUND ROD RESISTANCES**
- 32 **PARAMETERS AFFECTING GROUNDING ELECTRODE PERFORMANCE**
- 33 **STUDY TO DETERMINE GROUNDING ELECTRODE PERFORMANCE**
- 34 **GROUNDING ELECTRODE STUDY LOCATIONS AND SOIL**
- 35 **NATIONAL STUDY OF GROUNDING ELECTRODES - RESULTS**
- 36 **UFER TYPE GROUNDING ELECTRODES**
- 37 **UFER TYPE "D" GROUNDING ELECTRODE LONG TERM TESTS ANALYSIS**
- 38 **TOUCH AND STEP POTENTIALS (VOLTAGES)**
OR
"WHY MY EXTENSIVE GROUNDING SYSTEM IS STILL NOT SAFE"
- 39 **GROUNDING AND BONDING FOR SHOCK HAZARD AND EQUIPMENT LONGEVITY**
- 40 **EFFECTS OF CURRENT ON HUMAN BODY**
- 41 **GROUNDING MISSCONCEPTION**

- 42 **TRANSFER VOLTAGE**
- 43 **CURRENT FLOW AND VOLTAGE DROP IN SOIL OR WATER FROM AN ELECTRODE**
- 44 **TOUCH AND STEP VOLTAGE**
- 45 **EARTH VOLTAGE PROFILES
AROUND A GROUNDING ELECTRODE**
- 46 **TOUCH VOLTAGES – VERTICAL GROUND ROD – NO EQUIPMENT GROUNDING CONDUCTOR**
- 47 **TOUCH VOLTAGES – HORIZONTAL BURIED WIRE OR ROD**
- 48 **SUMMARY OF EARTH SURFACE VOLTAGES AROUND A GROUNDING ELECTRODE**
- 49 **ELECTRICAL SYSTEM GROUNDING**
- 50 **ELECTRICAL SYSTEM GROUNDING**
- 51 **UNGROUNDING SYSTEMS**
- 52 **SOLIDLY GROUNDED SYSTEMS**
- 53 **GROUNDING AN UNGROUNDED SYSTEM**
- 54 **GROUNDING ELECTRICAL SERVICES**
- 55 **NEC TABLE 250.66 ANALYSIS**
- 56 **BONDING AND SERVICE BONDING JUMPERS-Table 250102(C)(1)**
- 57 **MAIN BONDING JUMPER**
- 58 **MAIN BONDING JUMPER ADEQUACY**
- 59 **SOARES – THEORY SHORTCOMINGS**
- 60 **EQUIPMENT GROUNDING CONDUCTORS (EGC)**
- 61 **MINIMUM EQUIPMENT GROUND SIZE
TO AVOID INSULATION DAMAGE**
- 62 **MINIMUM EGC SIZE TO AVOID MELTING**
- 63 **EGC COMPENSATION FOR VOLTAGE DROP PER NEC**
- 64 **EGC SIZING – DISTRIBUTED LOADS**
- 65 **MINIMUM EGC SIZE – PARALLEL CONDUCTORS**
- 66 **TABLE 250.122 EGC SIZE WITH POWER CIRCUIT BREAKERS WILL NOT WORK!**
- 67 **IMPEDANCE OF EGC CIRCUIT
NEC vs. Soares vs. IAEI**
- 68 **IMPEDANCE OF EGC CIRCUIT
NEC vs. Soares vs. IAEI**
- 69 **“EFFECTIVE” EGC PATHS**
- 70 **SOARES - EGC vs. MAXIMUM LENGTH OF CIRCUIT**
- 71 **EFFECT OF BENDS AND LENGTH WHEN ROUTING GROUNDING CONDUCTORS**
- 72 **EFFECT OF BENDS WHEN ROUTING CONDUCTORS**
- 73 **REAL REASON FOR AVOIDING SHARP BENDS**
- 74 **EXCESSIVE LENGTH IN GROUNDING ELECTRODE CONDUCTORS**
- 75 **EXCESSIVE LOOPS IN GROUNDING ELECTRODE CONDUCTORS**
- 76 **ROUTING OF GROUNDING CONDUCTORS FOR FLEXIBLE CONDUIT**
- 77 **OBJECTIONABLE CURRENTS**
- 78 **OBJECTIONABLE CURRENT SOURCES**
- 79 **EGC FOR PARALLELED CIRCUITS**
- 80 **GROUNDING SEPARATELY DERIVED SYSTEMS**
- 81 **EMERGENCY GENERATORS – SEPARATELY DERIVED?**
- 82 **UPS AND INVERTER SYSTEMS**

SEPARATELY DERIVED?

- 83 SEPARATELY DERIVED – EQUALITY?
- 84 USE OF EGC AS A GEC FOR A SEPARATELY DERIVED SYSTEM, ARTICLE 250.121
- 85 EGC NOT USED AS A GEC FOR A SEPARATELY DERIVED SYSTEM – JUSTIFICATION ANALYSIS
- 86 GROUNDING BUILDINGS FED FROM ANOTHER BUILDING
- 87 RECREATIONAL VEHICLE AND MOBILE HOME PARKS
- 88 GROUNDING IN RV AND MOBILE HOME PARKS
- 89 GROUNDING AND BONDING SPECIAL LOCATIONS
- 90 GROUNDING AND BONDING FOR HAZARDOUS AREAS
- 91 BONDING IN HAZARDOUS AREAS
- 92 HEALTH CARE FACILITIES
- 93 AGRICULTURE
- 94 ALTERNATE ENERGY SYSTEM GROUNDING AND BONDING
- 95 PHOTOVOLTAIC SOLAR ARRAY SYSTEMS
- 96 LARGE PV SYSTEM GROUNDING
- 97 SWIMMING POOLS
- 98 STRAY VOLTAGES AROUND POOLS
- 99 ARTICLES 553 AND 555 – FLOATING BUILDINGS, MARINAS, AND BOATYARDS
- 100 ELECTRONIC AND DIGITAL EQUIPMENT GROUNDING AND BONDING
- 101 LOW VOLTAGE INTERSYSTEM GROUNDING
- 102 SURGE ARRESTERS, SURGE PROTECTIVE DEVICES, TVSS, SPD's
- 103 SURGE PROTECTIVE DEVICE INSTALLATION
- 104 CASE STUDY- BATTLE OF THE GROUNDING ELECTRODES
- 105 THE BATTLE OF THE GROUNDING ELECTRODES
"My ohm is better than your ohm."
- 106 THE BATTLE OF THE GROUNDING ELECTRODES – SYSTEM MODEL 277V
- 107 THE BATTLE OF THE ELECTRODES – SITUATION 1
- 108 THE BATTLE OF THE ELECTRODES – SITUATIONS 2 and 3
- 109 THE BATTLE OF THE ELECTRODES – SITUATION 1 REVERSED
- 110 SITUATION 4 – EGC SMALLER THAN PHASE CONDUCTORS
- 111 THE BATTLE OF THE GROUNDING ELECTRODES - SUMMARY
- 112 SAFE EQUIPMENT GROUNDING SYSTEM
- 113 3-POLE AND 4-POLE TRANSFER SWITCH
SAMPLE PROBLEM
- 114 3-POLE TRANSFER SWITCH
SYSTEM WITH GROUND FAULT PROTECTION
- 115 OHM's LAW – SOME THOUGHTS
- 116 LAB EXAMPLES
- 117 COURSE SUMMARY
- 118 COURSE SUMMARY
- 119 REFERENCES
- 120 SUPPLEMENTARY MATERIAL
- 121 GROUNDING ELECTRODE CONDUCTOR LENGTH