

Aged Electrical Systems

Research Applications Symposium

National Electrical Grounding Research Project

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NEGRP- Electrical Code

NEC Article 250.52: Grounding Electrode System

Where present must use:

- **Underground Metal Water Pipe (10' minimum)**
- **Metal Frame of Building (where effectively bonded)**
- **Concrete-encased electrode**
- **Ground Ring**
- **Rod and Pipe**
- **Plate Electrodes**

NEGRP- Electrical Code

To meet NEC 250.56:

**Install one driven rod. If not 25 ohms,
install a second ground rod (electrode).**

NEC has

No testing criteria (4 point, Wenner)?

No maintenance or retesting requirements

Why do we ground?

To assure the elimination of stray voltages and to provide a safe and known path to conduct away errant electrical currents.

What is a ground electrode?

Ground electrodes complete the connection of grounded components to earth so that when stray voltage events occur the resulting current flow will be channeled into a known and safe path.

Common Problems

Engineers, inspectors contractors suppliers could not agree on the efficacy of grounding electrodes.

What is the long term performance?

Lack of data or experience, resistance values do not indicate the expected current flow (mass and soil).

Common Problems

- **Metal water services are becoming uncommon (more reliance on “made” electrodes)**
- **Evaluate new materials and electrodes**
- **Database of performances**
- **Little feedback for codes and standards**

NEGRP- IAEISNC Grounding Study

A study to determine the long term performance of differing types of commonly used grounding electrodes in diverse geographical locations and soil types.

NEGRP-History

- | | |
|-----------------|--|
| 1990 | IAEI SNC Grounding Committee |
| 1992 | Formulated plan, sought donations |
| May 1992 | First site installed |
| Dec 1992 | Fifth site installed |
| 1994 | IEEE Transaction Paper |
| 1995 | NFPA Annual Meeting |

NEGRP- IAEI/SNC Grounding Study

Five sites in Las Vegas area

Sites by Nevada Power

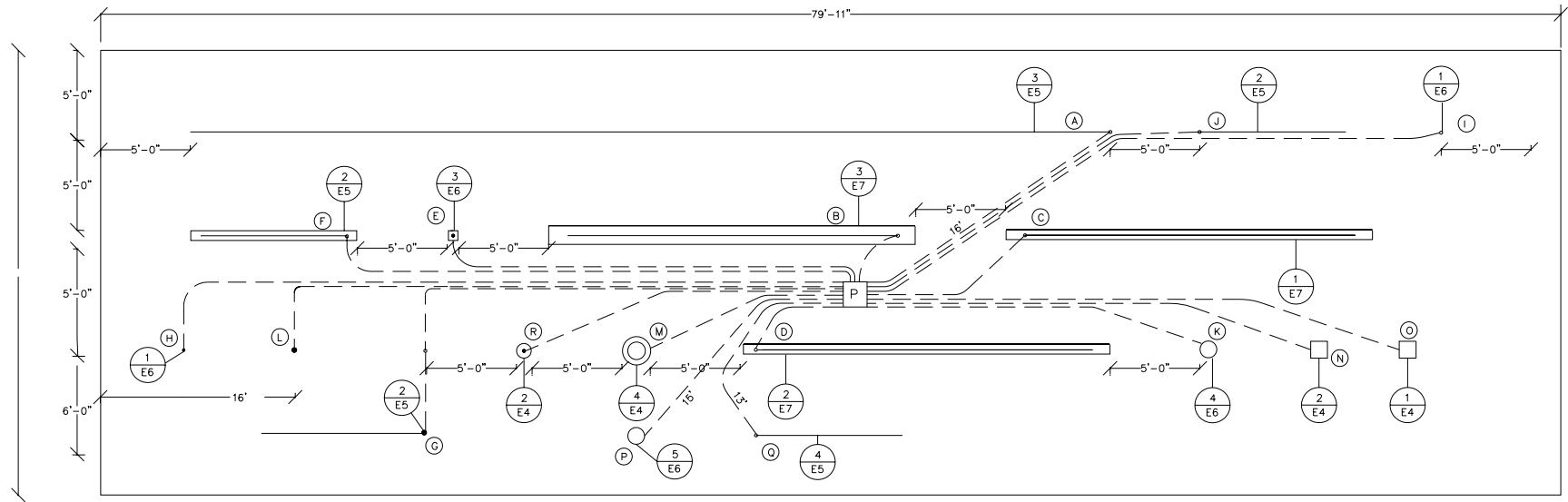
Administered by IAEI-SNC

Eighteen electrode Styles

Welded bolted and compression connections



Typical Nevada Site



1
E8

BALBOA GROUNDING SITE

SCALE: 1/4"=1'-0"

Site Installation- Las Vegas

May 1992



Square pole plate "K"

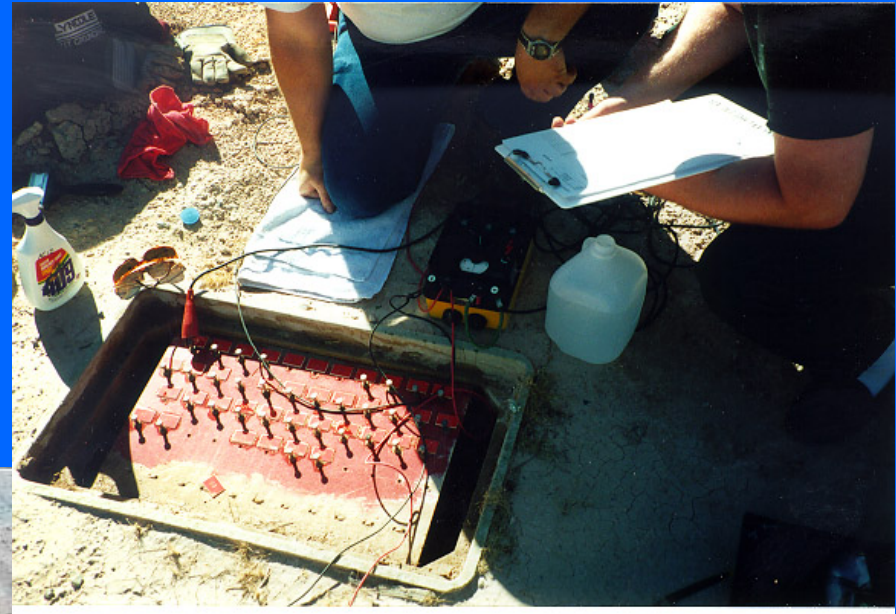


NEGRP- History

3-point

fall-of-potential

4- point soils resistivity



**Monthly
resistance
readings**

NEGRP-History

1994

IEEE paper describing the study

GROUNDING / EARTHING ELECTRODE STUDIES, 1 of 2

Conducted
by the
Southern Nevada Chapter
International Association of Electrical Inspectors
Las Vegas, NV¹

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Abstract: The paper details the effort to determine the adequacy of various methods of grounding/earthing electrodes installed in the alkaline, highly mineralized soil of the Las Vegas, Nevada area. The grounding

the electrical industry. Details of the test fields are presented and the test methods discussed. Preliminary results of the ongoing ten year test facilities are presented.

NEGRP-History

- 1995** **Donation to IAEL-SNC (CDA and IFMA) to help “nationalize” study**
- 1996** **FPRF, TAC is formed and NEGRP is created, IAEL study is adopted.**

NEGRP-History

With FPRF and TAC guidance:

- **Additional sites were added**
- **More scientific approach**
- **Temperature and moisture at varying depths
(10.5', 6.5', 2.5' depth)**
- **Electrodes in triplicate**
- **Three types of connector per electrode**

NEGRP-History

Added

- **Benign (copper cable)**
- **Dissimilar Metals (natural electrolysis)**
- **Active DC Study (galvanized, copperweld)**

NEGRP- Participants

- **Underwriters Laboratories**
- **National Fire Protection Association**
- **Lyncole XIT Grounding**
- **Harger Lightning Protection**
- **FCI / Burndy**
- **Erico Corporation...**
- **Dominion Virginia Power**
- **Copper Development Association Inc.**
- **Central Hudson Gas and Electric**

NEGRP- Past Contributors

- **NECA / IBEW Jointly**
- **Los Angeles Dept. of Water and Power**
- **Lightning Eliminators, Inc.**
- **International Facility Managers Assoc.**
- **Houston 911**
- **Clark County, NV**
- **AEMC Instruments**
- **Many Others for equipment, materials and labor**

NEGRP- History

June 1997, Staunton, VA

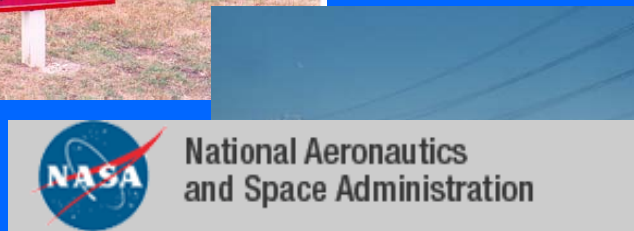
June 1998, Dallas, TX

September 1998, Poughkeepsie, NY

Sept., 1998, Northbrook, IL

July 2001, Moffett Field, CA.

NEGRP- History



Site preparation



NEGRP

Phase 1, National Study

15 different “grounding electrode” configurations

+3 additional side studies-

- 3 passive copper cables**

- 2 sets DC studies (galvanized, copperweld)**

- 3 dissimilar metals**

'XIT' Rod in bentonite



Conduit for test leads



NEGRP

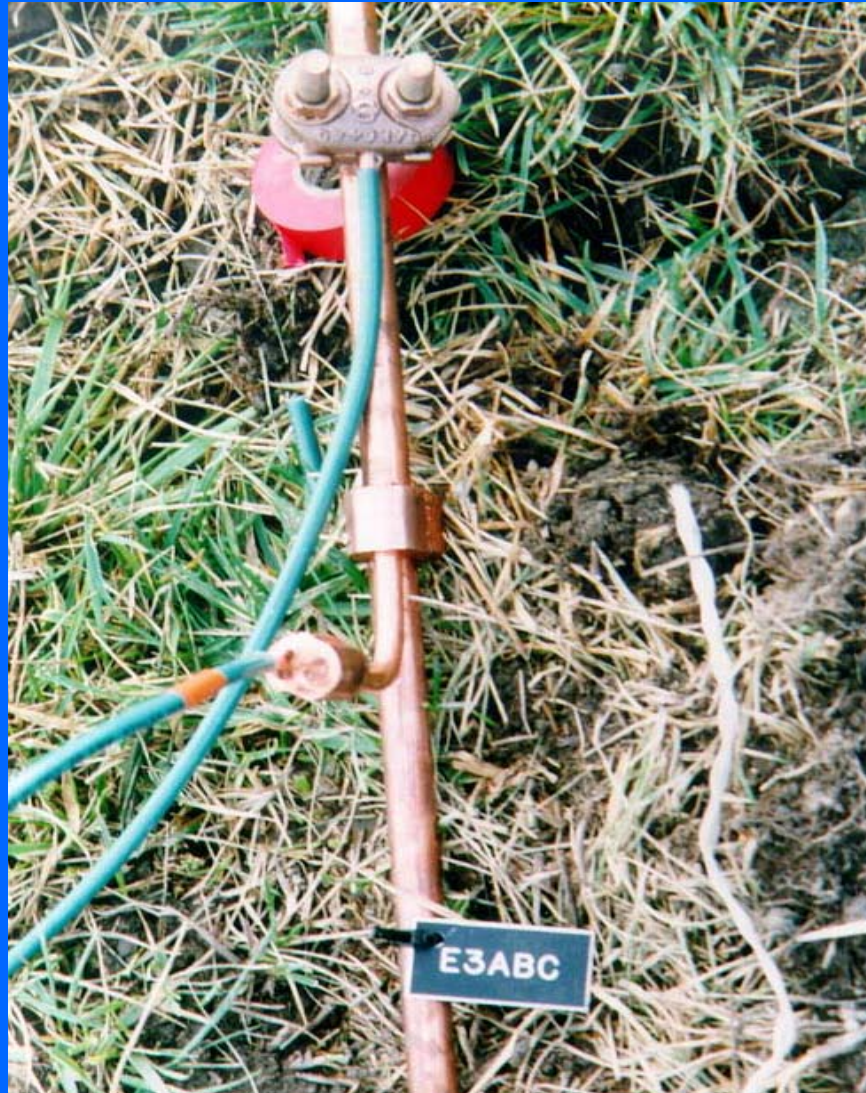
**“New”
junction
boxes**



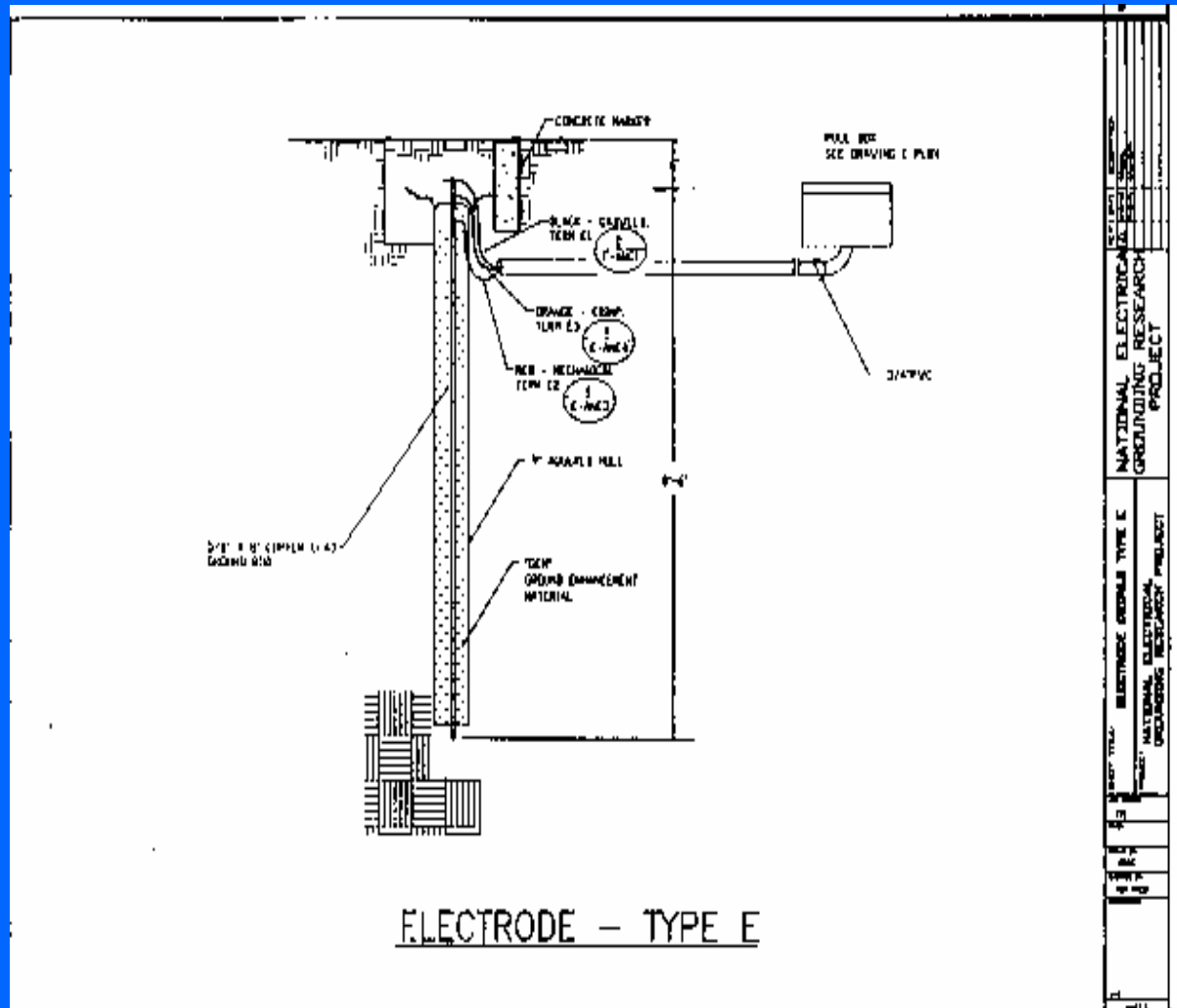
Samples weighed to 1/2 gram



Electrodes labeled and marked



Detail drawing - type E electrode



Electrodes (sample)

- **B: #4 steel reinforcing rod, 20 ft long, buried in 12" x 12" 2500psi concrete, 6ft below grade**
- **E: 8ft. X 5/8" cu. clad rod in predrilled 9" dia hole, filled with Erico GEM**
- **F: 8ft. X 5/8" cu. clad rod, horizontal in trench, encased in 6" x 6" GEM, 20" depth**
- **G: 8ft. X 5/8 cu. clad horiz. in soil, 30" depth**

Electrodes

- **H: 8ft. X 5/8" cu. clad rod driven vertically in earth**
- **K: cu. pole plate direct buried at 30" depth**
- **L: Lyncole XIT 10' vertical in drilled 9" hole**
- **R: Lightning Eliminators Chemrod, 10' vertical**
- **S; Lyncole XIT horizontal**
- **T: 8 ft. x 3/4" galv. steel pipe**

Electrodes

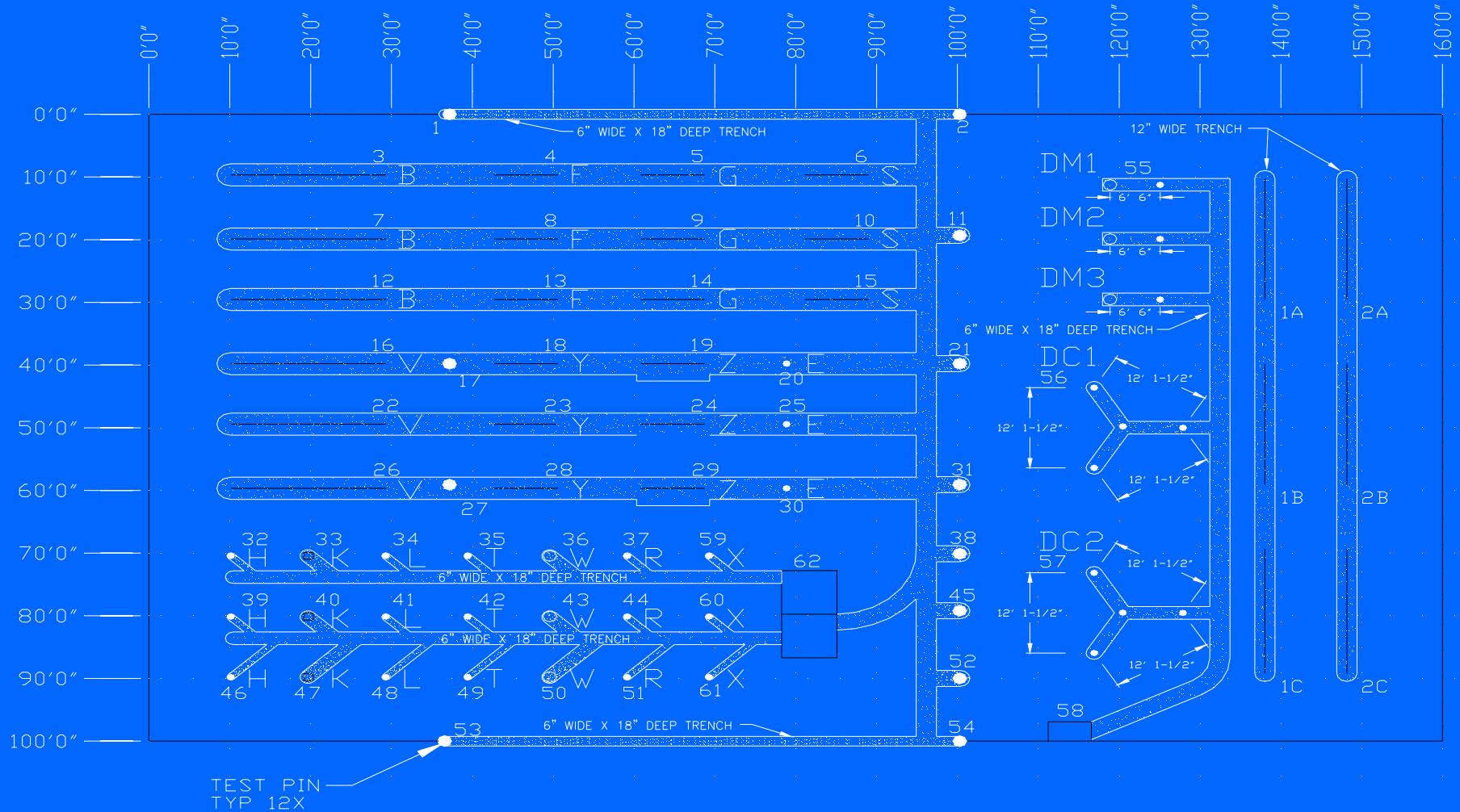
- **Each electrode installed in triplicate**
- **Every electrode has welded and bolted connections**
- **Every electrode weighed to 1/2 gram before installing**
- **Every connector is weighed to 1/2 gram before installing**

Site analysis

Each site has 3 to 6 soil samples taken

**Each site has temperature and moisture sensors
buried at 3 depths (2.5, 6.5, 10.5 ft.)**

New York Site



TRENCHING & AUGERING DETAIL

SCALE: 1/16" = 1' (TRENCH WIDTH N.T.S.)

NEGRP

- **2001 Balboa removed**
- **2003 Pawnee removed**
- **2004 Pecos and Lone Mountain removed**
- **2005 Corrosion analysis LV Sites**
- **2006 New York site removed**
- **2006 December close project**

NEGRP- Data

Spot Readings

Horizontal and Vertical Electrodes

SPOT COMPARISON

One Reading Late 2005

