

**UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL UTILITIES SERVICE
2002 ENGINEERING SEMINAR**

**REVISION OF THE
NATIONAL ELECTRICAL SAFETY CODE**

H. Robert Lash	-	Moderator
Harvey Bowles	-	Grounding
Jim Bohlk	-	Overhead Lines (Clearances)
Donald Heald	-	Overhead Lines (Strength and Loading)
Trung Hiu	-	Underground Lines

INTRODUCTION

As all of you should be aware, the National Electrical Safety Code C2 was revised and published August 1, 2001. This edition may have been used at any time on or after the publication date. This edition became effective 180 days following its publication date for application to new installations and extensions where both design and approval were started after the expiration of that period, unless otherwise stipulated by the administrative authority.

I don't know if you know that the revision cycle for the NESC is five years. Work on the 2007 Code has already started. RUS is lucky to have four engineers who sit on various subcommittees of the code and who have worked on the revision of the code. They are here to discuss some of the important changes to their respective sections of the code.

Harvey Bowles, who is Chairman of Technical Committee A, is a member of Subcommittee 2, Grounding Methods, Section 9. Harvey has been with RUS for well over 20 years and before joining the Grounding Methods subcommittee a few years ago, he was a member of the Underground Lines Subcommittee.

Jim Bohlk, Electrical Engineer in the Distribution Branch, is member of Subcommittee 4, Overhead Lines-Clearances, Sections 20, 21, 22 and 23. Jim has been with RUS for over 12 years and a member of these committees for over 6 years.

Donald Heald, Structural Engineer in the Transmission Branch, is a member of Subcommittee 5, Overhead Lines- Strength and Loadings, Sections 24, 25, 26 and 27. Don has been with RUS and a member of these sections for well over 20 years.

Trung Hiu, Electrical Engineer in the Distribution Branch, is a member of Subcommittee 7, Underground Lines, Sections 30 - 39. Trung has been with RUS for over 10 years and a member of this subcommittee for over a year.

Section 9 - Grounding

The first change most will notice about Section 9 is that the numbering has changed – instead of Rule 90, it is now Rule 090. This was done to match other general rule nomenclature.

Several definitions in Section 2 were added:

Multigrounded/ multiple grounded system: A system of conductors in which a neutral conductor is intentionally grounded solidly at specified intervals. A multigrounded or multiple grounded system may or may not be effectively grounded.

Compare this definition to that of “effectively grounded”:

Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to limit the buildup of voltages to levels below that which may result in undue hazard to persons or to connected equipment.

In other words, you cannot assume that because you have a multi-grounded neutral system that it is effectively grounded.

Other definitions added include:

Shield wire/conductor (also referred to as static wire or ground wire): A grounded conductor installed to shield transmission or distribution phase conductors from direct lightning strikes.

Unigrounded or single grounded system: A system of conductors in which one conductor is intentionally grounded solidly at a specific location, typically at the source.

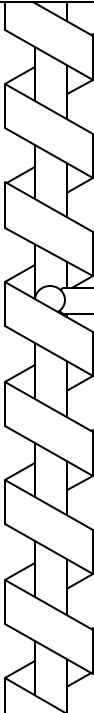
Other significant changes in Section 9 include:

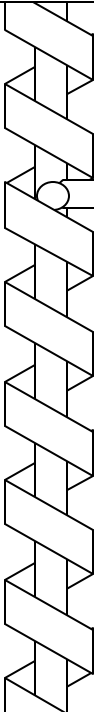
- The revision of 093A, Composition of Grounding Conductor, to allow metallic electrical equipment cases to serve as part of the grounding conductor.
- The addition of an exception to 094B2b, Grounding Electrodes, to allow other dimensions and configurations of driven rods when supported by a qualified engineering study. A similar exception already appears in 094B3a for buried wire, strips, or plates.
- Rule 096C, the four grounds per mile rule, may now be applied to overhead grounded shield wire meeting the requirements for multi-grounding. The Code previously was not clear as to whether a multi-grounded shield wire could be bonded to arrester and equipment grounds on the same structure. Also, more and

ore utilities are bonding the shield wire grounds to equipment grounds on the same structure for the safety of workers and the public.

- Shield wires of power circuits has been added to Rule 097A, Separation of Grounding Conductors.
- Revised Rule 097D to require either the primary grounding conductor or the secondary conductor must be insulated for 600 V for ungrounded or single-grounded systems. This was previously required for multi-grounded systems where neutrals not interconnected.
- Revised Rule 097G to require electric and communication systems being grounded on a joint-use structure to use a common ground, unless separation is achieved in accordance with other rules and that the communication system ground be connected to the primary neutral where primary-secondary neutral isolation is maintained.
- Added a recommendation to Rule 099C, Bonding of Electrodes, to assure that continuity is maintained if water piping is used as a bonding means.

One final note – IEEE has started a webpage called the National Electrical Safety Code Zone (<http://standards.ieee.org/nesc>). You can find links to ordering information, interpretations, tentative interim amendments, and errata sheets.

	Section 9
	Grounding

	New definitions (Section 2)
	<ul style="list-style-type: none">▪ Multigrounded/ multiple grounded system:<ul style="list-style-type: none">• A system of conductors in which a neutral conductor is intentionally grounded solidly at specified intervals. <u>A multigrounded or multiple grounded system may or may not be effectively grounded.</u>



Compare to

- Effectively grounded :
 - Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to limit the buildup of voltages to levels below that which may result in undue hazard to persons or to connected equipment.



New definitions (Section 2)

- Shield wire/conductor (also referred to as static wire or ground wire):
 - A grounded conductor installed to shield transmission or distribution phase conductors from direct lightning strikes.



New definitions (Section 2)

- Unigrounded or single grounded system:
 - A system of conductors in which one conductor is intentionally grounded solidly at a specific location, typically at the source.



Numbering change

- 090 instead of 90, to match other general rule nomenclature



093A - Composition of Grounding Conductor

- Revised to allow metallic electrical equipment cases to serve as part of the grounding conductor



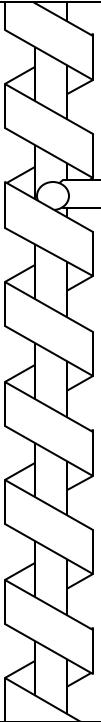
094B2b - Grounding Electrodes

- Exception added to allow other dimensions and configurations when supported by a qualified engineering study



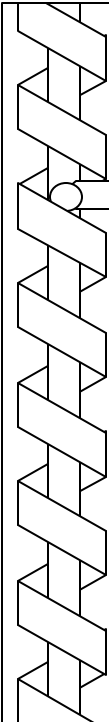
096 - Ground Resistance Measurements

- 096C (four grounds per mile rule) may now be applied to overhead grounded shield wire meeting the requirements for multi-grounding



097 - Separation of Grounding Conductors

- 097A - Added shield wires of power circuits
- 097D - Either the primary grounding conductor or the secondary conductor must be insulated for 600 V for ungrounded or single-grounded systems. (Previously required for multi-grounded systems where neutrals not interconnected)



097 - Separation of Grounding Conductors

- 097G - Now requires electric and communication systems being grounded on a joint-use structure to use a common ground, unless separation is achieved in accordance with other rules. The communication system ground shall be connected to the primary neutral where primary-secondary neutral isolation is maintained.

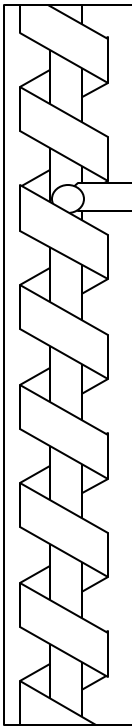


099C - Bonding of Electrodes

- Recommendation added to assure that continuity is maintained if water piping is used as a bonding means.

National Electrical Safety Code Zone

<http://standards.ieee.org/nesc>



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National ELECTRICAL Safety Code ZONE

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Welcome to the National Electrical Safety Code® Zone—a one-stop resource for National Electrical Safety Code information.

Published exclusively by the IEEE, the National Electrical Safety Code (NESC®) sets the ground rules for practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and associated

- [NESC Product Line Listing](#)
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2002 NATIONAL ELECTRICAL SAFETY CODE CHANGES IN SECTION 23 (CLEARANCES)

Section 23, Clearances, encompasses approximately 35 percent of the 2002 Edition of the National Electrical Safety Code (NESC). Since the 1997 Edition of the NESC there have been approximately 70 rule changes in Section 23. Changes have also been made to the values and footnotes of 13 tables (plus 13 metric tables) in this section of the Code. The changes made are important but overall are rather minor in nature. These changes will generally, but not always, have little impact on future electric and communication line designs.

Listed below are a few representative changes that have been made to Section 23 of the NESC:

- Clearances between a pole and a fire hydrant have been changed for 3 feet to 4 feet. (Rule 231A)
- Clearances of poles and guys from the different (now defined) types of curbs are more clearly specified. *Poles and guys must now be placed behind the curb!* (Rule 231B1)
- Ground clearances for arms, platforms and braces that extend out from a pole have been changed and better defined. (Rule 232B3 and Table 232-2)
- Ground clearances have been reduced under lines not subject to truck traffic and a method is now given to determine the required clearances for oversized vehicles. (New footnotes 13 and 26, respectively, to Table 232-1)
- Service drops are now required to be insulated or covered and have at least 3 inches of clearance when running parallel to an outside wall. (Rule 234C3)
- Clearances are now specified between a vertical riser and the face (instead of the center) of pole. (Rule 239E2a and Table 239-2)

There are now several new rules and clearances dealing with communication conductors and antennas. These new rules and revisions are found in Rules 235F, 235H, 235I and Table 238-1.

Of particular interest to rural distribution engineers are the changes in Rule 235C2b(1). This rule specifies what conductor loading assumptions must be made to determine midspan clearances. The exception that gave an extra measure of latitude for long, rural lines has been virtually eliminated. It is now assumed that, without exception, lower conductors shed their ice loads before upper conductors do. The rule and its exceptions are very complicated now because of the way they are written. We suggest that you familiarize yourself with meaning and the intent of this new rule.

It is not important that you remember these changes; it is important that you remember that several changes have been made. Whenever designing new structures and new lines, we strongly recommend that you refer to the most recent edition of the NESC to confirm that all separations and clearances are in compliance.

2002 NESC

Section 23 - Clearances

Significant Changes

0011 0010 1010 1101 0001 0100 1011

Jim Bohlk
Subcommittee 4
Overhead Lines - Clearances

Section 23 - Clearances

0011 0010 1010 1101 0001 0100 1011

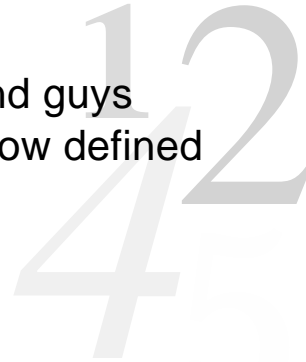
- Section 23 = 35% of NESC
- About 70 rule changes
- Changes to 13 tables and their footnotes (+ 13 metric tables)
- Nearly all changes minor

Rule 231

0011 0010 1010 1101 0001 0100 1011

231A - Clearance of pole to fire hydrant
changed from 3 ft to 4 ft

231B1 - Clearances of poles and guys
from specific types of curbs now defined
(Now they must be behind curb!)



Rule 232B3 and Table 232-2 (Clearances Above Ground)

0011 0010 1010 1101 0001 0100 1011

New ground clearances given in table
for arms, platforms, braces, etc. that
extend out from a pole.

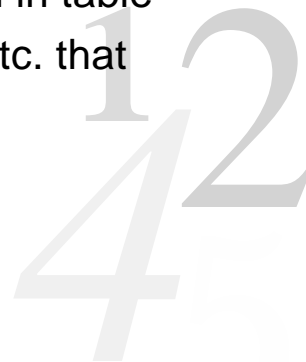


Table 232-1; New Footnotes

0011 0010 1010 1101 0001 0100 1011

(13): Limits reduced clearances not subject to truck traffic

(26): Specifies how to determine clearance for oversized vehicles.

Rule 234C3

0011 0010 1010 1101 0001 0100 1011

- (a) Now requires service drops to be insulated or covered.
- (c) Requires 3 inch clearance for service drops running along outside wall

Rule 235C2b(1)

0011 0010 1010 1101 0001 0100 1011

- Rule 235C2 (additional vertical clearances between conductors) has been rewritten with new rules.
- Exception that gave latitude for long, rural lines is now gone.
- Rules and exceptions are now long and complicated.
- *Recommend that you familiarize yourself with revised rule.*

Rule 235F, H and I

0011 0010 1010 1101 0001 0100 1011

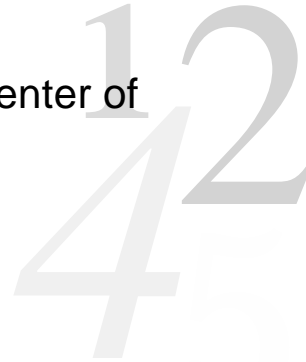
- Several new rules and clearances dealing with clearances to communication conductors and antennas.
- Also see Table 238-1 and footnote 1.

Rule 239E2a & Table 239-2

0011 0010 1010 1101 0001 0100 1011

Clearances now specified between
vertical riser and face of the pole.

(Previously distance was to center of
pole.)



Sections 24, 25, 26 & 27-Strengths and Loadings

Subcommittee 5 is responsible for Sections 24, 25, 26 and 27 of the NESC. These sections deal with Strengths and Loadings for Overhead Lines. Proposed changes to these sections of the 1997 NESC were numerous and produced much debate and comment. Some of the proposed changes and what has been adopted in the 2002 NESC are summarized below:

1. There was a proposal to remove the 60-ft. height limit in Rule 250C. The present code requires one to consider extreme winds for structures over 60 feet. NESC subcommittee 5 was considering removal of this exclusion, thus requiring designers to consider extreme winds for all structures regardless of their height. If this proposal passed, distribution lines may have to be the same strength as transmission lines in situations where extreme winds control the design.
 - **Outcome**: The 60 ft. exclusion limit remains when considering extreme winds. However, all structures including those below 60 ft shall be designed to withstand, without conductors, the extreme wind load in Rule 250C applied in any direction on the structure.
2. A new combined ice and wind 50-year map was proposed to be included in section 25, Loadings for Grades B and C. This map appeared in the RUS 1998 Items of Engineering Interests. The subcommittee proposed to allow utilities to meet current requirements of Light, Medium, or Heavy Loading District loads or to meet the new combined ice and wind map.
 - **Outcome**: This new combined ice and wind map will not appear in the code at this time. Although it is in the appendix of ASCE 7, it will not be in the body of the NESC nor will it be in the appendix.
3. One proposal replaced the current 50-year extreme wind map (based on fastest mile speeds) with the new ASCE 7, 50-year wind map based on a 3-second gust wind speed.
 - **Outcome**: The new extreme wind map will replace the old map. Initially this change appears as a rather benign change. However, use of this wind information involves equations and tables, which must be used to calculate the wind pressure on an overhead line. The general equation to determine the load on a line will be

$$\text{Load} = .00256 * V^2 * k_z * G_{RF} * I * C_d * A$$

Where

V = basic wind speed, 3-second gust wind speed in miles per hour

k_z = velocity pressure exposure coefficient (Table 250-2)

G_{RF} = Gust Response Factor (Table 250-3)

I = Importance factor (1.0 for utility structures and their support facilities.)

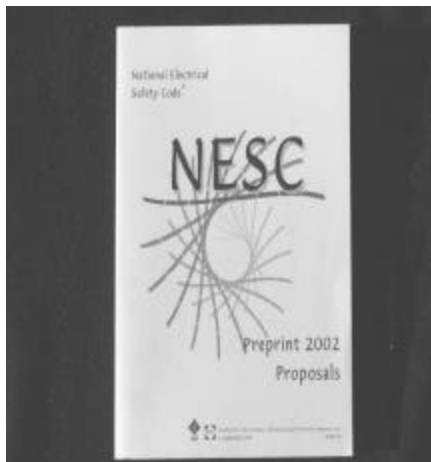
C_d = Shape Factor
 A = projected wind area (ft²)

4. Fiber reinforced composite structures and crossarms were proposed to be added to the strengths and loading sections.
 - **Outcome**: Not included for this edition of the NESC
5. One proposal concerns the Grade C transverse overload factor on steel or prestressed concrete structures. The proposal is to change the overload factor from 2.2 to 1.75.
 - **Outcome**: The transverse loads from wind are reduced to 1.75 for all structures including steel and prestressed concrete when the span being supported is **not** at a crossing. For spans at a crossing, the overload factor remains as 2.2
6. Subcommittee 5 considered a complete rewrite of sections 24,25,and 26. This proposal eliminates light, medium, and heavy loading district loads and replaces these loads with construction, extreme wind, and extreme wind and ice loads.
 - **Outcome**: The complete rewrite is deferred for consideration in the 2007 NESC.

Sections 24,25,26 & 27

Subcommittee 5
Overhead Lines—Strengths
and Loadings

Preprint for 2002



60-foot exclusion (250C)

- **PROPOSED** –
 - *Remove 60 ft Exclusion Limit.*
- **OUTCOME** –
 - *Rejected*
 - *Revisit for the 2007 Code*

New Combined Ice/Wind Map

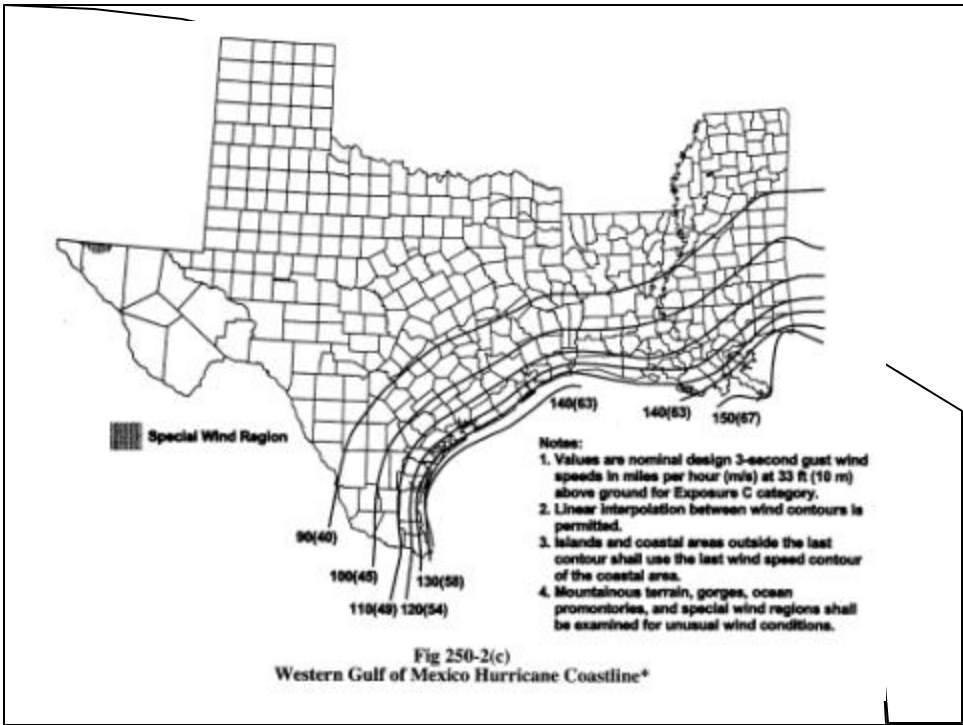
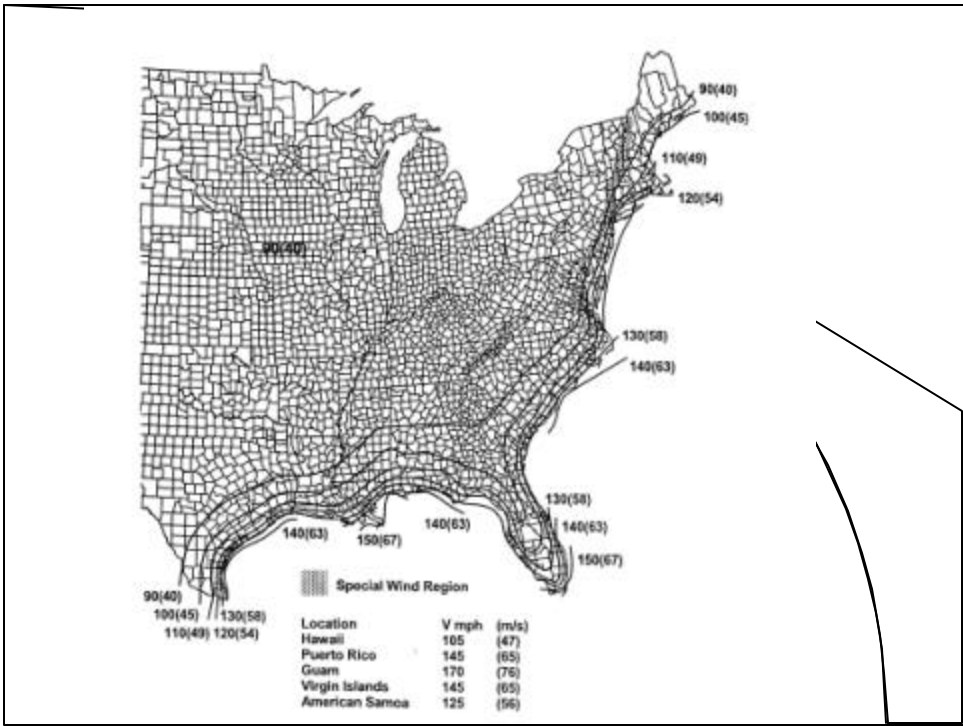
- **PROPOSED** –
 - *New combined ice and wind map; retain current requirements of Light, Medium, and Heavy Loading Zones.*
- **OUTCOME** –
 - *Rejected*
 - *Revisit for the 2007 Code*

Figure 10-2. 50-year mean recurrence interval uniform ice thicknesses due to freezing rain with concurrent 3-second gust wind speeds: contiguous 48 states.



New Extreme Wind Map

- **PROPOSED** –
 - *New wind map based on a 3 second gust (old map based on fastest mph).*
- **OUTCOME** –
 - *Accepted*
 - *New equations*



$$P = .00256 * V^2 * k_z * G_{RF} * I * C_d * A$$

V = 3-second gust wind speed, mph

k_z = velocity pressure exposure coefficient. (Table 250-2)

G_{RF} = Gust Response Factor
(Table 250-3)

I = Importance factor (1.0)

C_d = Shape Factor

A = projected wind area, ft²

Fiber Reinforced Composite Structures and Crossarms

- **PROPOSED** –

- *Overload factors and strength factors*

- **OUTCOME** –

- *Rejected*

- *Revisit in 2007*

Grade C Transverse OLF

- **PROPOSED** –
 - *Grade C Transverse Overload Factor reduced from 2.2 to 1.75 for prestressed concrete poles and steel structures*
- **OUTCOME** –
 - *Accepted*

Complete Rewrite of Sections 24, 25, and 26

- **PROPOSED** –
 - *Rewrite eliminates L,M,and H Loading Districts and replaces these with construction, extreme wind, and extreme wind and ice loads.*
- **OUTCOME** –
 - *Deferred for the 2007 NESC*

Sections 24,25,26 & 27

- *2002 --- New extreme wind map*
- *2007 --- Many proposed changes to the 2002 have been deferred for the 2007 NESC.*

On the Road of Life.....

*Some days you are the bug, some days you
are the windshield.*

~~~~~

*If at first you don't succeed, sky diving is  
not for you.*

~~~~~

Don't squat with your spurs on.

Important Updates to the Safety Rules for Underground Lines in the 2002 NESC

New Rules:

Rule 323. Manholes, Handholes, and Vaults

323.C.5 – Any manhole greater than 1.25 m (4 ft.) in depth shall be designed so it can be entered by means of a ladder or other suitable climbing device. Equipment, cable, and hangers are not suitable climbing devices.

Rule 354. Random Separation

354.A.2 – Radial separation of supply and communications cables or conductors from steam lines, gas, and other fuel lines shall be not less than 300 mm (12 in).

Revised Rules:

Rule 320. Location

320.B.5 – Gas and Other Fuel Lines – Conduit should have sufficient separation from gas and other fuel lines to permit the use of pipe maintenance equipment. Conduit shall not enter the same manhole, handhole, or vault with gas or other fuel lines.

Rule 323. Manholes, Handholes & Vaults

323.E.3 – Where accessible to the public, access doors to utility tunnels and vaults shall be locked unless qualified persons are in attendance to restrict entry by unqualified persons. When vaults and utility tunnels contain exposed live parts, a prominent safety sign shall be visibly posted before entering the vault. NOTE: ANSI Z535 contain information regarding safety signs.

NESC Changes

by

Trung Hiu
Rural Utilities Service

A Very Important Change in the 2002 NESC

Rule 354 - Random Separation

New Rule 354.A.2 prohibits radial separation of less than 300 mm (12 in) between supply and communications cables or conductors from steam lines, gas, and other fuel lines.

Safety Signs

*“Caution” Sign is obsolete and has been replaced by “Warning” Sign.

*RUS will no longer specify the design of safety signs.

*RUS requires the ANSI Z535 on Safety Signs be used as the standard specification.