RUS Revised Distribution Construction Standards

USDA Rural Development

Rural Utilities Service

Jim Bohlk
Distribution Branch
Electric Staff Division

(202) 720-1967
Jim.Bohlk@usda.gov

RUS Construction Standards Are:

- **Safe** (Lineworkers & Public)
- **Conform** to **NESC**
- **Durable** (Tested Strength)
- **Economic Designs**
- **Standard** (Same Among Systems)
- **Free, Available**
- **Defendable** (Liability Suits)
- **Required** by **RUS**

Review of New Bulletin 1728F-804

- Format, Assemblies, Drawings
- New and Re-used Assembly Numbers
- New Narrow Profile Designs
- New Specifications
  - Washers, stirrups, etc.
  - Grounding of guy wires
- New Design Parameters
  - Line angles & tables
  - Longitudinal & crossarm loading

Completion Schedule for 1728F-804

Proposed rule was published in *Federal Register:* Feb. 2004

Final Rule: ***3 – 6 Months?***

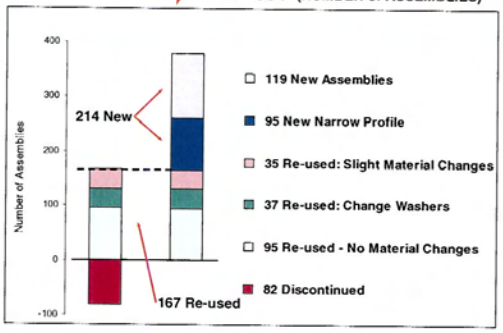
Effective: 6 months later

Bulletin 1728F-803 (25 kV)
Revisions: 2005 - 2006

Rule was approved 3-25, but has not been published. We should be under the new spec book by year's end. The spec book should be on the RUS website in 2 to 4 weeks.

Derivation of New Bulletin 1728F-804

Bulletin 50-5 ⇨ 1728F-804 (NUMBER of ASSEMBLIES)



Disposition of Guide Drawings

Old Bulletin 50-3

24 Discontinued
(~ 8 converted to assemblies)
8 Re-used in new bulletin

New Bulletin 1728F-804

8 Re-used
32 New

You May Use 166 "Old" Numbers

However,

You must make the minor 72 slight material changes

(~ half are only washers)

Good News !

Old numbers (dual numbers) shown in parentheses on drawings, in indexes, and in new Exhibit 3

New Exhibit 3 – "Conversion" Table

Disposition of Assemblies in Bulletin 50-3 (D 804)

Old Assembly Number (Bulletin 50-3)	New Assembly Number (1728F-804)	Material Changes and Comments
A1	A1.1	No material changes
A1A	A1.2	No material changes
A1-1	A2.1	No material changes
A1-1A	A2.2	No material changes
A1P	A1.1P	No material changes
A1AP	A1.2P	No material changes
A1-1AP	A2.2P	No material changes
A1-1P	A2.1P	No material changes
A2	A2.3	No material changes
A2P	A2.3P	No material changes
A3	A3.1	Replace 2 washers abutting pole
A4	A4.1	Replace 4 washers abutting pole
A5	A5.1	Replace 2 washers abutting pole
A5-1		Discontinued (*Material same as A5.1; Replaced with A5.2G*)
A5-2	A5.2	Replace 2 washers abutting pole

New Exhibit 4 – New Assemblies

Bulletin 1728F-804: New Assemblies and Guide Drawings

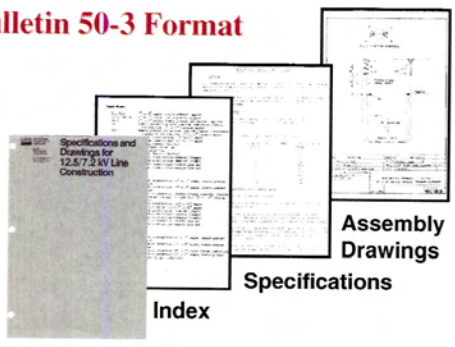
NUMBER	ASSEMBLY / GUIDE DRAWING DESCRIPTION
	NEW SINGLE-PHASE PRIMARY POLE TOP ASSEMBLIES
A1.011L	SINGLE SUPPORT - PRIMARY
A1.04N A1.04NP	SINGLE SUPPORT - NARROW PROFILE
A1.3	SINGLE SUPPORT
A1.3P	SINGLE SUPPORT (POST INSULATORS)
A1.4N A1.5N	SINGLE SUPPORT - NARROW PROFILE (TANGENT)
A1.4NP A1.5NP	SINGLE SUPPORT - NARROW PROFILE (TANGENT) (POST INSULATORS)
A1.6N	SINGLE SUPPORT - NARROW PROFILE
A1.6NP	SINGLE SUPPORT - NARROW PROFILE (POST INSULATORS)
A1.12G	SINGLE PHASE JUNCTION GUIDE

Minimum Requirements to Implement New Assemblies

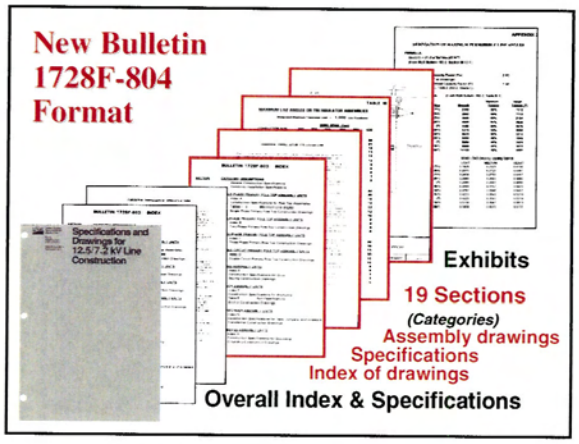
1. **Discontinue** using 82 old assemblies and 24 guides (~20 replaced with other assemblies and guide drawings)
2. Slightly **modify** material in **72** old assemblies
3. **Add** approximately **10** new assemblies

(Incorporate new numbers and assemblies as needed or when convenient)

Bulletin 50-3 Format



New Bulletin 1728F-804 Format



Assembly Drawings

Materials, dimensions and details needed to construct an assembly

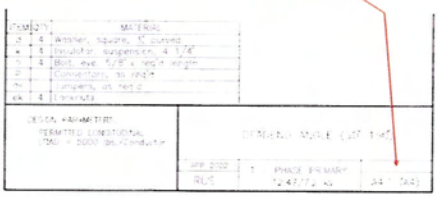
New AutoCad format

Often more than one assembly on a drawing

Dashed lines not part of the assembly

New Title Block Format

Note old and new (dual) assembly numbers

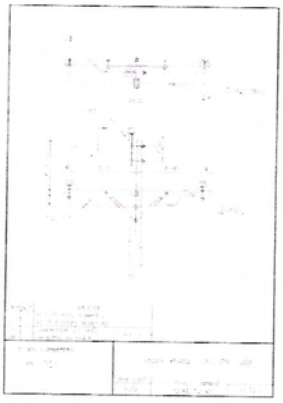


- Shorter, more descriptive drawing titles
- Standardized phase and voltage descriptions
- New "design parameters"
- New assembly numbers

Guide Drawings

Dimensions and details needed to construct one or more assembly.

- *No material*
- *Drawing number ends with "G"*
- *Not an assembly*



Why New Numbers & Format ?

- New bulletin has 119 new assemblies + 95 new narrow profile assemblies = 214 new numbers
- RUS internal "rules"
  - No provisions to modify existing numbers
  - Numbers cannot be re-used
- Too many "M" assemblies
- Old numbering system not consistent and gone awry

Standard RUS Numbering Format

Historical Format

L_1N_1 = A1

L_1N_1-N_2 = C2-1

New Standard Format

$L_1N_1.N_2$ = A1.1

$PL_1N_1.N_2S$ = VC2.52L

L_1 = **Category** of Assemblies

N_1 = **Subcategory** or Assemblies

N_2 = Assembly **Identification Number**

P = Prefix, S = Suffix

Categories of Assemblies

$L_1N_1.N_2$ = New Standard Format

A1.1

A **"Category"** is a group of assemblies that ***fulfill a similar and specific functional purpose*** (in the construction and operation of an electric line).

For example, **Category "A"** are pole top assemblies that ***support a single-phase primary conductor and usually a neutral conductor***.

19 Categories (Sections)

Assembly categories same as Bulletin 803

- A 1 - Phase
- B 2 - Phase
- C 3 – Phase
- D Double Circuit *(DC)*
- E Guying
- F Anchors
- G Transformers
- J Secondaries
- K Services

New RUS Assembly Categories
(Old REA designation in parentheses)

- H Grounding *(M2)*
- L Tying Guides *(M40-M43)*
- M Miscellaneous *(R)*
- N Neutrals *(M5)*
- P Protection *(arresters, raptor)*
- Q Metering *(M8)*
- R Reclosers *(M3)*
- S Sectionalizing *(M3,M5)*
- W Poles, Crossarms *(M5,19,20)*
- Y Voltage Alteration Equip. *(M7)*

Subcategories of Assemblies

$L_1N_1.N_2$ = New Standard Format

A1.1

A "Subcategory" is a group of assemblies that fulfills a more specific functional purpose within an assembly category ("L_1").

For example, **Subcategory "1"** are ***tangent or small angle*** pole top assemblies that support single-phase primary and neutral conductors (Category "A").

Subcategories of Pole Top Assemblies

SUBCATEGORY DESCRIPTION (Type or Applicable Angles)	NEW DESIGNATION (RUS 1728F-804)	HISTORICAL REA DESIGNATION
Tangent; Small Angles Single Pin or Post-type Insulators	1	1,9
Small Line Angles Double Pin or Post-type Insulators	2	1,2,9
Large Line Angles Suspension-type Insulators	3	3
Large Line Angles Double Deadends Suspension-type Insulators	4	4
Single Deadends (Taps) Suspension-type Insulators	5	5,7
Double Deadends (Tangent) Suspension-type Insulators	6	6,8

Assembly "Identification Number"

$L_1N_1.N_2$ = New Standard Format

A1.1 C1.12

The "Identification number" differentiates the similar assemblies in a subcategory (N_1).

Crossarm assemblies have a special numbering convention (from 11 to 89). (Documented in Exhibit 5).

For example, **"12"** signifies the second ("2") in a series of single, 8-foot crossarms ("1").

Prefixes to Standard Assembly Numbers

$PL_1N_1.N_2$ = New Standard Format

VA1.1

A **"Prefix"** to a standard assembly number describes the type or voltage of the assembly.

For example, **Prefix "V"** designates that the assembly is to be used for 24.9/14.4 kV distribution construction.

Standard Assembly Number "Prefixes"

PREFIX	DESIGNATED MEANING
T	Transmission Line Construction
U	Underground Distribution (URD)
V	24.9/14.4 kV Line Construction
Z	34.5/19.9 kV Line Construction

No prefix implies 12.47/7.2 kV construction

Suffixes to Standard Assembly Numbers

$L_1N_1.N_2S$ = New Standard Format

A1.1P

A "Suffix" to a standard assembly number describes the *type* the assembly.

Assemblies may have more than one suffix.

For example, Suffix "P" designates that the assembly uses post type insulators.

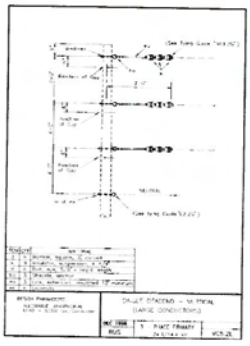
Standard Assembly Number "Suffixes"

SUFFIX	NEW DESIGNATED MEANING (RUS 1728F-804)	HISTORICAL REA DESIGNATED MEANING
A	(Not Used)	Slight variation of design or materials
B	(Not Used)	Slight variation of design or materials
C	(Not Used)	Cabled Conductors (Secondary Voltages)
G	Guide Drawing (No Materials)	
L	Large Conductors (See Note 1)	Large Conductors (See Note 1)
P	Use of post type insulators	Use of post type insulators
N	Narrow Profile Construction	

Only 4 used

Note 1: Large conductors (#2/0 ACSR and larger) have a breaking strength greater than 4,500 lbs.

Example: VC5.2L



V = 24.9/14.4 kV
C = 3-phase, pole top assembly
5 = Single deadend
2 = Second drawing in series
L = Large Conductors

Borrower Generated Assemblies & Numbers

- Only unmodified RUS assemblies are official
- Minor changes are OK
  - *(Add inventory numbers)*
  - *(Add armor rod, etc.)*
  - *(Specify bolt sizes, etc.)*
  - **Need not inform RUS**
  - **Need to modify number**
- Other changes or additions:
  - **Inform RUS for case-by-case approval**

J. Bohlk asked that we take special note of this slide, I guess because he knows we all use modified assemblies...

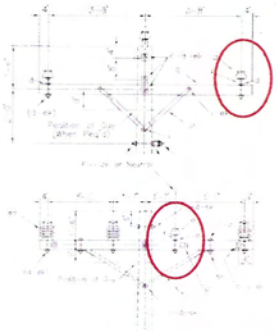
Drawings Show 4 - 1/4 inch Suspension Insulators

Drawing change only

May use:
two 6-inch
two 9-inch
one polymer deadend

(Change material quantity as required)

Use Washers Under Crossarm Pins



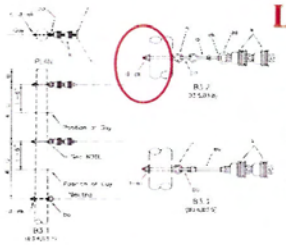
Required to:

- Minimize crushing of wood fibers
- Increase line angles
- Meet Design Parameters

(Not needed if pins have wide necks)

J. Bohlk asked that we take special note of this slide. This was also addessed in the new 25kV specs.

Use 3-inch, Curved Washers to Hold Longitudinal Loads

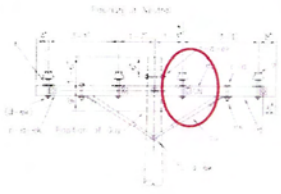


Required to:

- **Minimize crushing of wood fibers**
- **Increase permitted loads**
- **Meet Design Parameters**

Applications: Taps, Guys

Large Conductor Assemblies



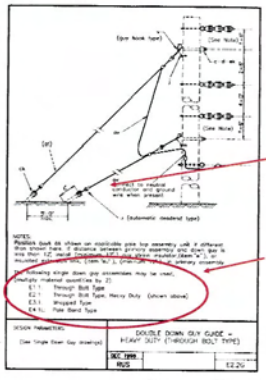
Saddle pin used on neutral support - thus, transverse loading not limited

Requires use of 60-inch crossarm brace

One Style of Double Circuit Assemblies

(Also assemblies for post type insulators and large conductors)

New Guy Assembly Guide Drawings



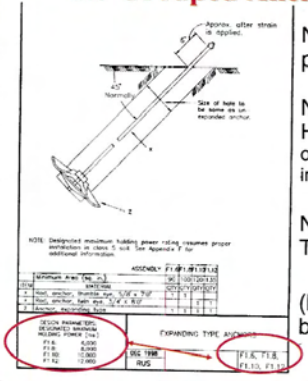
Fewer assemblies

New "Maximum Permitted Loads" (in any direction)

Guy Marker "at" (old "E3-10") now part of assembly

Multiple down guys are the sum of single down guy assemblies

Re-Grouped Anchor Drawings



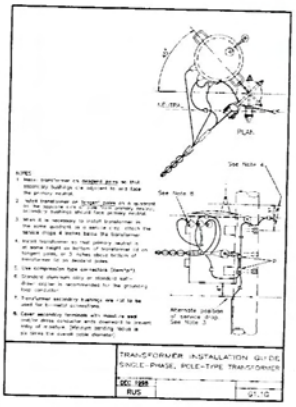
Nearly same as previous groupings

New "Maximum Holding Power" (based on proper installation in Class 5 soil)

New Soil Classification Table in specifications

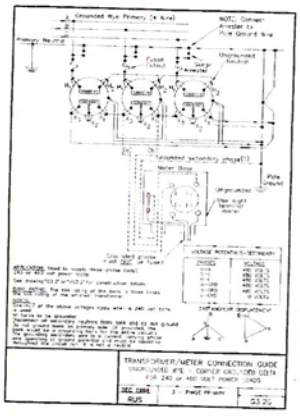
(Note: Assembly number based on holding power)

New 1-Phase Transformer Guides



- Clearer details
- Guides for quadrant installation
- Note pole top ground loop

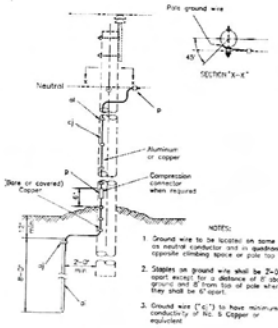
New Transformer Meter Connection Guides



Better connection details without cluttering assembly drawings

Drawings show additive polarity. (Transformers larger than 200 kVA have subtractive polarity.)

New Section H: Grounding

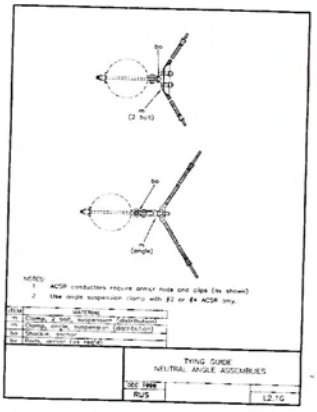


- Butt plates and pole wraps not considered "adequate" grounds by RUS.
- Install 4 driven grounds per mile
- Use arresters, not spark gaps
- No pole ground above neutral

H2.1

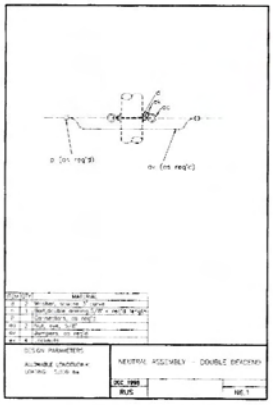
J. Bohlk asked that we take special note of this slide, but we already follow these guidelines.

New Section "L" of Tying Assemblies



Replaces old "CE" primary & neutral assemblies

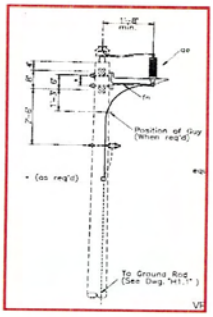
New Section "N"- Neutral Assemblies



- Allows addition or replacement of neutrals when needed
- New assembly for double deadends

  (requires offset down guy and guy strain insulator)

New Section "P"- Protection Assemblies

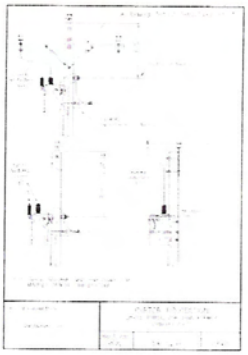


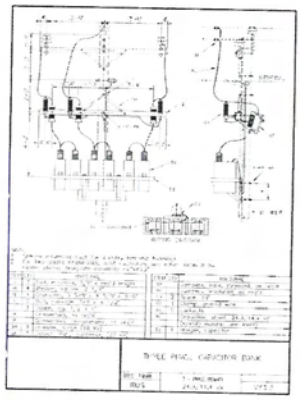
Section Includes:

- Arresters
- Pole Protection
- Raptor Protection Guide Drawings

P1.1

New Raptor Protection Guides





New Section "Y"- Voltage Alteration Assemblies

Section Includes:

- Voltage Regulators
- Autotransformers
- Capacitors

Bulletin 1728F-804 Format, Assemblies, Drawings and Numbers

Remember

- May re-use old numbers
- Minor changes are OK

Any Questions? Comments?

(Next: New Narrow Profile Designs

Design Features – Save Money

Conductor spacing and staggered brackets allow long spans *(especially tangent to vertical assemblies)*

No need for taller poles

Can convert to 3-phase using existing pole & 1-phase assembly

New Designs Incorporate RUS Recommendations

Each assembly has a minimum of 12 inches of wood spacing between conductor supports

Each assembly has a minimum 300 kV BIL

Each assembly is relatively raptor friendly

Additional Design Features

Each assembly meets NESC clearance requirements

Assemblies available for NESC Grade C and Grade B construction.

Each assembly can be constructed with material from "List of Materials"

Assemblies available for all line angles

New Narrow Profile "Standards"

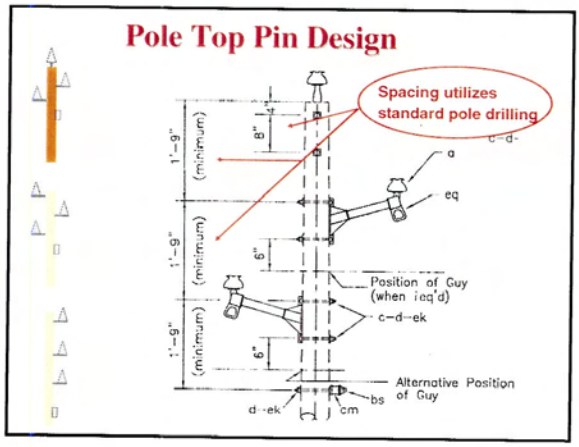
Complete sets available for both 12.47 and 24.9 kV construction

Each set has 94 assemblies plus guides for taps, cutouts and arresters

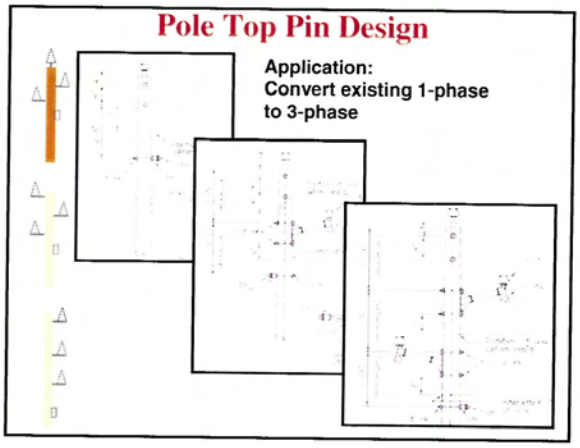
Each set includes post-type insulators

Each set has 3 fully developed designs with different bracket configurations

Pole Top Pin Design

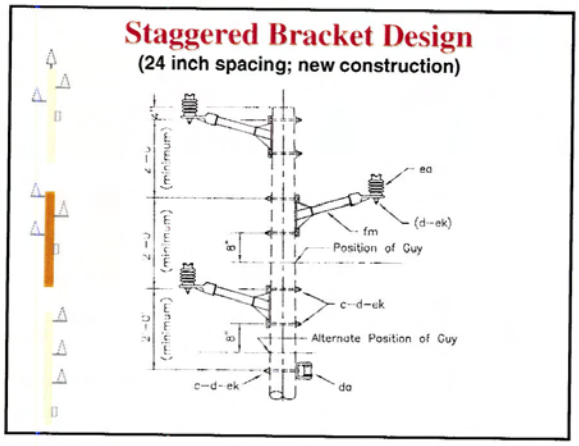


Pole Top Pin Design

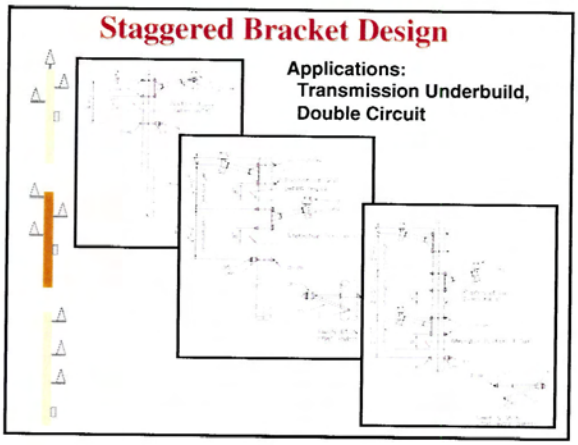


Staggered Bracket Design

(24 inch spacing; new construction)

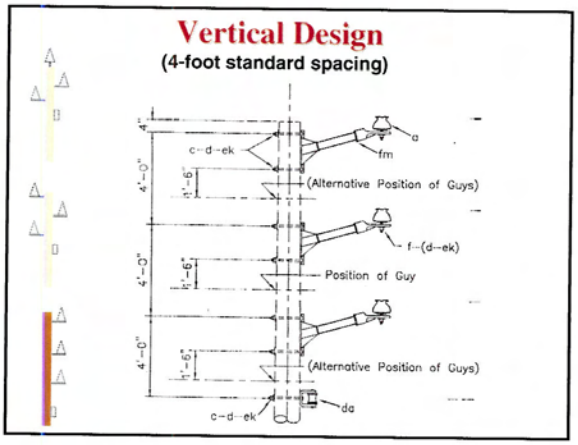


Staggered Bracket Design

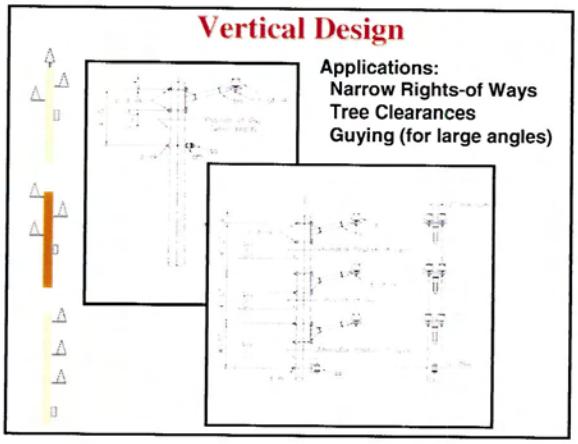


Vertical Design

(4-foot standard spacing)



Vertical Design



"Triangular" design not developed by RUS because:

- Not raptor friendly
- Limits span lengths
- Less than 12 inches of wood separation
- Less than 300 kV BIL
- Requires same pole height

Narrow Profile Brackets

- Any bracket from "List of Materials", (IP 202-1) may be used in new designs
  - "eq" = NP brackets & special arm assemblies
  - "fm" = Extension bracket for mounting apparatus
- May use fiberglass or steel
- RUS as ascertained vertical strength, (for spans well over 300 feet)
- Engineers should check for long spans

Narrow Profile Fiberglass Brackets

- RUS assumes no electrical (flashover) insulation values for fiberglass brackets
- Manufacturers test but do not publish or warranty insulation values after installation
- RUS recommends that borrowers assume no insulation (flashover) values

Availability of Narrow Profile Assemblies

- ~~Presently all narrow profile construction is "non-standard" and requires:~~
  - ~~"Case-by-case" approval for use by GFR~~
  - ~~Approval of design & material by RUS in Washington~~
- Interim step using new RUS assemblies:
  - "Case-by-case" approval for use by GFR
  - GFR will furnish new assembly designs
  - (GFR will file approval in Washington)
- After publication of 1728F-804:
  - Narrow Profile can be installed anywhere, any time.
  - (No additional approvals from RUS)

After rule is published, can use assemblies in spec book without approval. This should happen very soon.

Narrow Profile Assemblies & Designs

Remember
- 3 Designs
- Available now

(Next: New Specifications)

Lunch Time !

Miscellaneous General Specifications

- Depicted materials meant to be generic
- Explanation of washers, locknuts and studs for crossarm pins and post type insulators
- When and how borrowers may modify assemblies
- Explanation of when NESC strength and overload factors applied by RUS

Specifications: Lowering Neutral

1. Neutral may be lowered 2 feet for (cutout) clearance requirements
2. Neutral may be lowered, up to an additional 6 feet, for bucket truck installation and maintenance

No additional RUS approval is required

Specifications: Use of Washers

- Install 3-inch (minimum), square curved washer abutting pole
  - at all taps and guy attachments
  - to increase permitted longitudinal loads
- Install 2-1/4 inch square washer under crossarm pins
  - unless pins have wide necks
  - to increase designated load and line angles

Both needed to minimize crushing of wood fibers and meet Design Parameters

Specifications: Pole Top BIL

RUS specifies a minimum of 12 inches of insulating material (preferably wood), excluding insulators, between all phase-to-phase and phase-to-ground conductors.

Thus, many assemblies require a fiberglass extension link (item "eu") or a guy strain insulator (item"w").

RUS recommends, but does not require, 300 kV Basic Insulation Impulse (BIL) for all pole top assemblies, especially at deadends.

New Stirrup Specifications

- Ampacity: Jumper Wire or #2 Copper
- Material: Copper or Bronze
- Install according to manufacturers' specifications

- Not Allowed:
  - With all-purpose or aluminum clamps
  - In areas of aeolian vibration "U-shaped"
  - To connect main lines or heavy loaded taps
  - For sectionalizing or operational purposes

- Not recommended for reclosers and line regulators

Large Conductor Installations

Large Conductors: RBS: 4,500 - 10,000 lbs. (# 2/0 to 336.4)
Extra Large Conductors: RBS > 10,000 lbs. (336.4 +)

Use "large conductor" ("L") assemblies or other assemblies within Design Parameters

Use "C" neck insulators for conductors up through 477 kcmil; "J" neck up to 795 kcmil

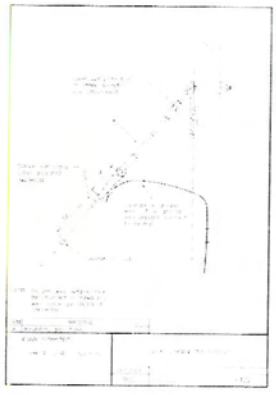
Note: the C and J were reversed.

Misc. Pole Top Assembly Specifications

- Neutral to be installed on same side (roadside) of all tangent poles
- Single crossarms to be installed away from roads and away from top of hills
- Explanation of when NESC strength factors (Table 261-1A) and NESC overload factors (Table 253-1) applied to assemblies by RUS

Guy Assembly Specifications ("E")

- Written RUS permission required for sidewalk guys and push poles
- NESC Grade of construction equal to highest grade of other installations on pole
- NESC strength factors have been applied; NESC overload factors need to be applied
- Reduce permitted loads by 25% for NESC Grade B construction



New Guy Strain Insulator Assembly

- Used to improve pole top BIL and raptor protection
- Note: Down guy still needs to be bonded to pole ground and/or neutral

Grounding of Guy Wires

- RUS specifies and recommends that all down guys be effectively grounded
  - "Exception" for insulating guy wires in NESC
  - RUS advocates that grounded down guys are safer
  - Improves overall system grounding (decreases impedance)
  - Improves performance of protection devices
- RUS now allows insulating of down guys to mitigate corrosion of anchors and anchor rods. No approval needed from RUS if:
  - Documented history or study of anchor (rod) corrosion
  - Only fiberglass strain insulators installed at top of guy wire
  - Insulators inspected and tested "periodically"

Note that insulating down guys does not always solve the corrosion problem. It may shift if elsewhere.

J. Bohlk asked that we take special note of this slide. If you have any issue concerning grounding of guys, I suggest you get with Kevin or Richard.

Anchor Assembly Specifications (F)

- Includes Soil Classification Tables
- Specifies to derate anchors in poor soils
- "Transmission" log anchors are acceptable
- Other specifications same a previous

Note new "Holding Power" (in any direction) given in Design Parameters on assembly drawings

Transformer Specifications ("G")

Arresters may be mounted on transformers (preferred by RUS), on arm or bracket, or in combination with cutout.

- On transformer: Best equipment protection
- With cutout: Minimizes nuisance operations

Note that connection guide drawings show additive polarity. (Transformers larger than 200 kVA have subtractive polarity)

Grounding Specifications ("H")

- RUS specifies driven ground rods to meet NESC requirement of 4 effective grounds per mile.
- Old pole top protection units discontinued
  - **No grounds above neutral for lineperson safety and BIL**
- 2 ground connections required for all equipment
- Specifies shortest path from neutral to ground rod **(and requires above ground splices, if required)**
- Bond of all conductors and equipment per NESC

New Bulletin Specifications

Remember
- Proper use of washers
- Rules for insulating guys
- 4 driven grounds / mile

(Next: Permitted Loading and Line Angles)

Permitted Loads

- "Permitted Loads" (strengths required to sustain loads or tensions) are RUS designated loads times the strength factors of NESC Table 261-1A
  - NESC Grade C construction = 0.85
  - NESC Grade B construction = 0.65
- RUS "designated" loads based on "Items Requirements" specifications and manufacturers' certified test results
- Wherever appropriate, RUS has applied strength factor
- ***All applied loads must be multiplied by NESC overload factors found in Table 253-1***

J. Bohlk asked that we take special note of this slide, especially engineers, warning not to "double dip" the strength factors.

Maximum Line Angles - Pole Top Assemblies

Previous specifications typically were "30 degrees within line limits."

- **What are "line limits?"**
- **How are they calculated?**

Many staking engineers simply applied the 30 degrees as the maximum line limit.

Maximum Line Angles

Calculations are a function of:

- **Designated strength of pin and insulator**
- **Conductor tension**
- **Wind span (1/2 span length in both directions)**
- **Wind load on conductor**
- **NESC wind overload factor**
- **NESC wire tension overload factor**

Exhibit 1, Bulletin 1728F-804

Calculation of Maximum Line Angles

The following formula and the data tabulated below was used to calculate the maximum line angles on pin and spool insulator assemblies:

$$Sin(\theta/2) = \frac{P - (Fw \times Sw \times Ww)}{2 \times Ft \times T} \qquad \theta = 2 \times Arc\sin\left[\frac{P - (Fw \times Sw \times Ww)}{2 \times Ft \times T}\right]$$

Where:

θ = Maximum Line Angle (calculated): [Degrees]
P = Designated Maximum Transverse Load (allowed on pin or insulator): [lbs
Fw = Wind Overload Factor for Transverse Loads
Ft = Wire Tension Overload Factor for Transverse Loads
Sw = Wind Span (equals ½ sum of adjacent spans): [ft]
Ww = Wind Load on Conductor: [lbs/ft] *(See Table Below)*
T = Design Tension of Conductor: [lbs] *(See Table Below)*

From Table 253-1 of the 2002 Edition of the National Electrical Safety Code (NESC) for Grade C Construction:

Fw = 1.75 for non-crossing spans (Footnote 4 to Table 253-1)
= 2.20 for crossing spans
Ft = 1.30

Exhibit 1, Bulletin 1728F-804

CONDUCTOR DATA:

Conductor Size	Strength	Maximum Tension	Design Tension (T
4 ACSR (7/1)	2360	60%	1416
2 ACSR (6/1)	2850	60%	1710
2 ACSR (7/1)	3540	60%	2184
1/0 ACSR (6/1)	4380	60%	2628
123.3 AAC (7)	4460	60%	2676
2/0 ACSR (6/1)	5310	50%	2655
3/0 ACSR (6/1)	6620	50%	3310
4/0 ACSR (6/1)	6350	40%	3349
246.9 AAC (7)	8560	40%	3424
336.4 ACSR (18/1)	8680	40%	3472
336.4 ACSR (26/7)	14100	35%	4935

	WIND LOAD (Ww) by Loading District		
	LIGHT	MEDIUM	HEAVY
4 ACSR (7/1)	0.1928	0.2523	0.4190
2 ACSR (6/1)	0.2370	0.2720	0.4387
2 ACSR (7/1)	0.2438	0.2750	0.4417
1/0 ACSR (6/1)	0.2985	0.2993	0.4660
123.3 AAC (7)	0.2985	0.2993	0.4660
2/0 ACSR (6/1)	0.3353	0.3157	0.4823
3/0 ACSR (6/1)	0.3767	0.3348	0.5007
4/0 ACSR (6/1)	0.4223	0.3543	0.5210
246.9 AAC (7)	0.4223	0.3543	0.5210
336.4 ACSR (18/1)	0.5130	0.3947	0.5613
336.4 ACSR (26/7)	0.5408	0.4070	0.5737

Maximum Line Angle Tables

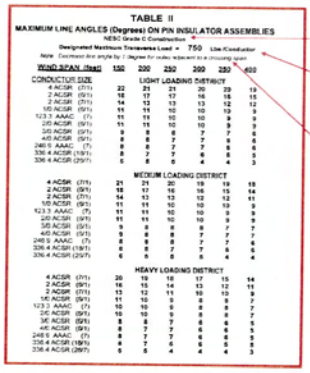


TABLE II
MAXIMUM LINE ANGLES (Degrees) ON PIN INSULATOR ASSEMBLIES
NESC Grade C Construction

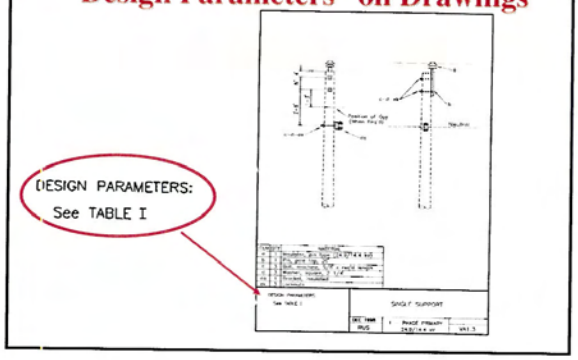
Re-calculate for Grade B

RUS *designation* based crushing of wood fibers

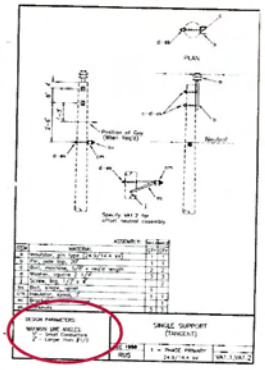
Decrease because of values in NESC Table 261-1A

Tables and formula in Exhibit 1 at end of bulletin

Maximum Line Angles Referenced in "Design Parameters" on Drawings

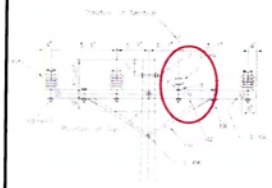


Line Angles - Tangent Assemblies



Based on neutral conductor slipping off from insulator

Use Washers Under Crossarm Pins



Increases designated load
500 lbs. to 750 lbs.

and line angles
Table 1 to Table 2

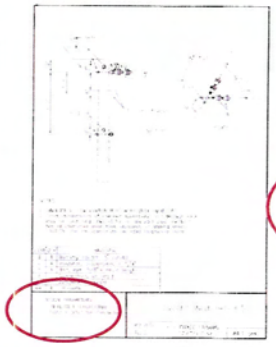
Not needed if pins have wide necks

RUS designates the crushing of wood fibers as a failure, and only allows 900 lbs. / square inch of load on wood.

Maximum Line Angles: Summary

- ✓ Tables added to save engineering time and improve accuracy
- ✓ Tables used for both primary pole top and neutral assemblies
- ✓ Maximum line angle formula and tables in Exhibit 1
- ✓ Maximum line angle tables are referenced in design parameters on drawings

Assembly Loading Limitations are given on the "Design Parameters" on Assembly Drawings

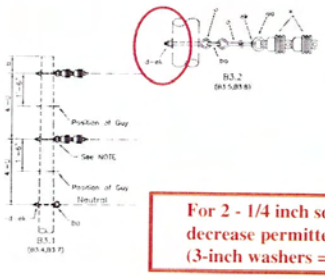


DESIGN PARAMETERS
Permitted Longitudinal
Load = 5,000 lbs./conductor

Permitted Longitudinal Loads

- Based on 50% of the M&E rating of insulators per the NESC *(the weakest link)*
- "5,000 lbs/conductor" assumes the installation of 4 - 1/4 inch suspension insulators (M & E rating = 10,000 lbs.)
- ***All applied loads must be multiplied by the appropriate overload factors of NESC Table 253-1***

Permitted Longitudinal Loads Assume Installation of 3-inch, Curved Washers



Required to

- **Minimize crushing of wood fibers**
- **Increase permitted loads to meet design parameters**

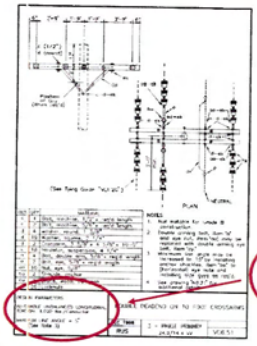
For 2 - 1/4 inch square washers, decrease permitted loading to 3,600 lbs. (3-inch washers = 6,600 lbs.)

Vertical Loading on Standard RUS Crossarm Assemblies

$$\sum\left(S_i \times W_i \times D_j \times F_{OL}\right) + 1{,}000 \le N \times M_v \times F_s \quad \text{(ft-lbs)}$$

S_i = ½ of the span length of the conductor "into" or "out from" the crossarm assembly (ft)
W_i = unit weight of the conductor (plus wind and ice loading, if applicable) "into" or "out from" the crossarms (lb/ft)
D_j = distance of load "L_i" from center of the crossarm(s) (ft)
F_{OL} = NESC vertical overload factor (Table 253-1 of the NESC)
= 1.90 for Grade C construction or 1.50 for Grade B construction
1,000 = vertical load moment times overload factor attributed to the weight of a lineworker and equipment (ft-lbs)
N = number of crossarms (N equals 1, 2 or 3)
M_v = vertical moment capacity (= 7,650 ft-lbs)
F_s = NESC strength factor (Table 261-1A of the NESC)
= 0.85 for Grade C construction or 0.65 for Grade B construction

From RUS Crossarm Bulletin 1724E-152



"... vertical loading on RUS standard distribution crossarm assemblies only needs to be considered for exceptionally long span lengths (> 600 ft) with large or extra large conductors."

Note: Permitted vertical conductor loading not considered

Longitudinal Loading on Standard RUS Crossarm Assemblies

$$\frac{\sum \text{Applied Vertical Moments}}{\text{Permitted Vertical Moment (Capacity)}} + \frac{\sum \text{Applied Longitudinal Moments}}{\text{Permitted Longitudinal Moment (Capacity)}} \le 1$$

The following applies to RUS standard distribution, deadend, crossarm assemblies:

- *Permitted Vertical Moment (Capacity) of Assembly* $= N \times M_v \times F_s$
- *Permitted Longitudinal Moment (Capacity) of Assembly* $= N \times M_L \times F_s$
- Σ *Applied Vertical Moments* =
$$D_1 \times \left[\left(S_{in} \times W_1\right) + \left(S_{out} \times W_2\right)\right] \times F_{OLV} + D_2 \times \left[\left(S_{in} \times W_3\right) + \left(S_{out} \times W_4\right)\right] \times F_{OLV} + M_{LW}$$
(See Diagram 1 below.)
- Σ *Applied Longitudinal Moments* =
$$\left[D_1 \times \left(L_{1\text{-}in} - L_{1\text{-}out}\right) + D_2 \times \left(L_{2\text{-}in} - L_{2\text{-}out}\right)\right] \times F_{OLL}$$

Longitudinal Loading on Standard RUS Crossarm Assemblies *(cont.)*

M_v	= 7,650	Vertical crossarm moment (capacity) (ft-lbs)
M_h	= 5,060	Longitudinal crossarm moment (capacity) (ft-lbs)
M_{LW}	= 1,000	Load moment attributed to weight of lineworker (ft-lbs)
F_s	= 0.85	Strength Factor (2002 NESC Table 261-1A) - Grade C
	= 0.65	" " " " " " - Grade B
F_{OLV}	= 1.90	Overload factor - Vertical (2002 NESC Table 253-1) - Grade C
	= 1.50	" " " " " " - Grade B
F_{OLL}	= 1.30	Overload factor - Longitudinal (2002 NESC Table 253-1) - Grade C
	= 1.65	" " " " " " - Grade B
D_1	= 1.75	Distance to nearest conductors on 10-foot crossarm assemblies (ft)
D_2	= 4.50	Distance to farthest conductors on 10-foot crossarm assemblies (ft)
D_3	= 3.50	Distance to conductor(s) on 8-foot crossarm assemblies (ft)
W_1	=	Vertical unit weight of conductor plus NESC ice and wind loads (lbs/ft)
S_{in}	=	One-half of the total span length "into" the assembly (ft)
S_{out}	=	One-half of the total span length "out from" the assembly (ft)
N	=	Number of crossarms
L_{in}	=	Tension of each conductor "into" the assembly (lbs)
L_{out}	=	Tension of each conductor "out from" the assembly (lbs)

Longitudinal Loading on Crossarm Assemblies

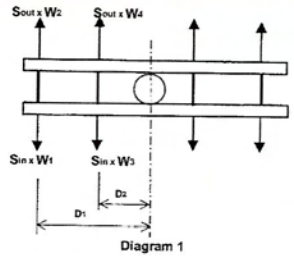


Diagram 1

$$\frac{(D_1+D_2)\times(W\times S)\times F_{OLF}\div 1{,}000}{N\times M_v\times F_s}+\frac{(D_1-D_3)\times L\times F_{OLL}}{N\times M_h\times F_s}\le 1 \quad \text{(ft-lbs)}$$

Permitted Unbalanced Conductor Tension (Longitudinal Loading on Crossarm Assemblies)

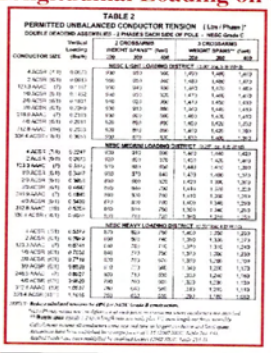


TABLE 2
PERMITTED UNBALANCED CONDUCTOR TENSION (Lbs / Phase)*
DOUBLE DEADEND ASSEMBLIES – 2 PHASES EACH SIDE OF POLE – NESC Grade C

RUS has performed calculations for standard crossarm assemblies and tabulated results.

Formula and tables in Exhibit 2 at end of Bulletin

Permitted Unbalanced Conductor Tension - Assumptions Used

- ***Reduce tabulated tensions by 40% for NESC Grade B construction.***

**(Lbs/Phase) means tension difference at each point on crossarms where conductors are attached.*
***Weight span equals 1/2 span length into assembly plus 1/2 span length out from assembly.*
Calculations assume all conductors same size and type as largest conductor and level spans.
Assemblies have been multiplied by strength factor of 0.85 (2002 NESC Table 261-1A).
Applied loads have been multiplied by overload factors (2002 NESC Table 253-1).

Conductor Loading on Crossarm Assemblies - Summary

- Permitted unbalanced loads given in tables in Exhibit 2 which are referenced in the design parameters on assembly drawings.
- Applied loads need to be multiplied by appropriate OL factor of NESC Table 253-1.
- Calculate vertical loads on crossarms for spans over 600 feet with large conductors.

Bulletin 1724E-153 "Electric Distribution Line Guys and Anchors"

- **Tables for:**
  - **Holding power of anchor assemblies**
  - **Guy wire strengths**
  - **Permitted loads of guy assemblies**
  - **Loads permitted on washers and hardware**
  - **NESC conductor loading (ice and wind) for each loading district (in Appendix)**
- **NESC factors and requirements**
- **Guy & anchor installation - RUS requirements**
- **Equation for pole loading moment**

Bulletin 1724E-153 *(cont.)*

- Calculations for
  - horizontal guy loads
  - permitted guy assembly loads
  - minimum guy leads
- Methodology for multiple guys
- Solved example problems for selection of guys and anchors
- Equations and solved problem to determine pole class to support vertical loads

Designated Capacities (Strengths) of Guy Assembly Components

Guy Assembly Component	RUS Designated Capacity (lbs)	
2 ¼ -inch square (flat) washer	4,089	(1)
3-inch square, curved, washer	7,766	(1)
4-inch square, curved, washer	13,779	(1)
5/8 inch machine bolt	8,300	(2)
3/4 inch machine bolt	12,400	(2)
Guy Attachments		
Guy Hook type	10,000	(3)
Plate type	10,000	(3)
Wrapped type guy	90% of RBS	(4)
Guy Strain Insulator	10,000	(3)
Guy Wire	90% of RBS	(4)

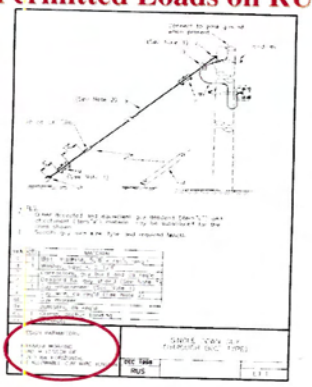
(1) RUS designated capacity equals washer area times 900 lbs/sq. in.

(2) Based on ANSI and manufacturers' ratings

(3) Based on RUS specifications and manufacturers' test results

(4) Rated Breaking Strength times 0.90 (NESC Table 261-1A)

Permitted Loads on RUS Guy Assemblies



Note: Permitted Loads are In any direction

Line Angle Tables & Assembly Loading

Remember

- Multiply loads by NESC strength factor

Next: Miscellaneous Topics

New Staking Sheets & Contract Forms

Has RUS developed new Staking Sheets?

However, the new contract forms (830 etc.) include all 19 (10 new) assembly categories *(albeit some are somewhat modified)*

Retirement of (discontinued) Assemblies

- New (CPR) tables will be published in Bulletin 1767B-2, "Work Order Procedures"
- Both new and re-used (dual) assemblies (dual numbers) will be listed
- *There will be instructions on how to account for discontinued assemblies (hopefully!)*
- Meanwhile, RUS advises that borrowers keep copies of old retirement tables and old Bulletin 50-3

www.usda.gov/rus/electric/bulletins.htm

USDA Rural Development

Rural Utilities Service
Electric Program

1724E-150	249K	N/A	N/A	Unguyed Distribution Poles – Strength Requirements (7/30/03)
1724E-151	511K	N/A	N/A	Mechanical Loading on Distribution Crossarms (11/21/02)
1724E-152	225K	N/A	N/A	The Mechanics of Overhead Distribution Line Conductors (7/30/03)
1724E-153	345K	N/A	N/A	Electric Distribution Line Guys and Anchors (4/25/01)
1724E-154	317K	N/A	N/A	Distribution Conductor Clearances and Span Limitations (7/30/03)