SECTION 2

LINE DESIGN

DESIGN CRITERIA – WIND LOADING

The structure loading in Grand Cayman is from wind only and since we are located in a hurricane zone we must consider hurricane wind force.

The Normal loading criteria for wood pole lines is to design for a storm that has a 20 or 25 year return – this means that you can expect a storm of this severity once in a 20 or 25 year period; a 40 year return is also used in some areas.

The National Electrical Safety Code (NESC) specifies weather loadings to be applied to Utilities' power and communication facilities. The NESC requires structures or its supported facilities that exceed 60 feet above ground or water to meet extreme wind loading criteria. For structures less than this, only the structure must meet the extreme wind loading and not its supported facilities. The NESC lists basic wind speeds (3-second gust wind) for Puerto Rico and Virgin Islands at 145 mph and the coast of Florida at 150 mph.

In Grand Cayman the most severe hurricanes since 1932 were Gilbert in 1988 (with maximum sustained winds at 93 mph[1]) and Ivan in September of 2004 (with maximum sustained winds of 155 mph[2]).

Based upon the NESC, the history of these storms, the velocity of the winds, the probability of being hit by another category 5 hurricane, and the cost to build our electrical system to sustain 155 mph winds - it is practical to design distribution structures for a wind load of 108 mph (i.e. a 155 mph 3-second wind gust or a 120 mph sustained wind at 90%).

WIND PRESSURE CALCULATIONS

The formulae for calculating wind pressure is $P = 0.00256V^2$ for a cylindrical surface (such as a pole, conductor etc.) and $P = 0.004V^2$ for a flat surface, where V is the wind velocity in miles per hour (mph) and the resulting pressure is in pounds per square foot (psf).
For our selected wind velocity of 108 mph the resulting pressure is $0.00256\ (108)^2 = 29.9$ psf rounded off to 30 psf.

---

[1] Hurricane City.com lists wind gusts to 120 mph.

[2] Hurricane City.com lists winds at 155 mph and high gust at 169 mph.

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DRAWN: C. Rose
REV.:
DATE:

DISTRIBUTION STANDARDS

LINE DESIGN CRITERIA

APPROVED BY: C. Rose
DATE: August 4, 2017

STANDARD NO.
2-1

MAXIMUM WIND VELOCITY – NEW POLE

In designing a line using wood poles, it is normal practice to use a safety factor (SF) of 1⅓ or more. This means the load that the structure will be subjected to, due to the wind on the pole, the conductor and equipment, will be 75% (1 ÷ 1⅓ = 0.75) of the load that the pole is rated to carry. This safety factor is a means to account for the loss of strength in the pole due to age and deterioration and to account for the variability of wood for the same class pole – therefore the structure should be able to carry the design load for the majority of its life.

The load a new pole can carry, with no safety factor, based on the design resultant wind velocity of 108 mph would therefore, in the initial life of this pole, withstand loads due to winds of up to 124 mph.

POLE STRENGTH CALCULATIONS

The working strength as indicated on page 3-2 has been calculated for the minimum pole circumference; for poles with a ground line circumference greater than that indicated, the new working load can be calculated using the actual circumference. The actual pole strength is calculated using the following formula:

$$M_r = S_f K_r F_b C_g^3$$

Where:
M_r = Resisting moment of the wood pole (ft-lbs)
S_f = NESC strength factor (0.75 for extreme wind loading)
K_r = Calculation constant, 2.64×10^{-4} (ft/in)
F_b = Ultimate fiber stress in bending for wood poles (psi), {8000 psi for SYP}.
C_g = Pole circumference at ground line (inches)

The value obtained from this formula is the ultimate strength of the pole in bending. When calculating the pole strength at a guy attachment, the pole circumference (C) at the guy attachment is used.

The load on a pole is made up from several sources: (1) the load due to the wind on the pole itself, (2) the load due to the wind on the conductors and, (3) the load due to the wind on equipment such as transformers, reclosers, etc.

The load due to the wind on the pole itself can be calculated by using the formula:

$$M_p = F_{ow}\, W_p \left[\frac{(2C_t + C_g)}{K_c}\right] \mathrm{H}_p^2$$

Where:
M_p = Bending moment due to the wind on the pole (ft-lbs)
F_{ow} = NESC (Table 253-1) load factor for wind loads
W_p = Wind load on surface of pole (psf)
H_p = Height of pole above ground (feet)
C_t = Circumference of pole at top (inches)
C_g = Circumference of pole at ground line (inches)
K_c = Calculation constant, 72π

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POLE STRENGTH CALCULATIONS

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DATE: August 4, 2017

STANDARD NO.
2-3

The value of the bending moment due to the wind on the pole is normally subtracted from the ultimate bending moment of the pole to determine the design load for the conductors and equipment.

Example: 40’, Class 3 SYP wood pole

Resisting moment:

$$M_r = S_f K_r F_b C_g^3$$

$$= (0.75)\,(2.64\text{x}10^{-4})\,(8000)\,(36)^3 = 73{,}903 \text{ ft-lbs}$$

Wind on pole:

$$M_p = F_{ow}\, W_p \left[\frac{(2C_t + C_g)}{K_c}\right] H_p^2$$

$$M_p = (1)\,(30)\left[\frac{(2)(23)+(36)}{72\pi}\right](34)^2 = 12,\ 572 \text{ ft-lbs}$$

$$M_r - M_p = 73{,}903 - 12{,}572 = 61{,}331 \text{ ft-lbs}$$

The conductor and equipment load that the pole can be subjected to is now 61,331 ft-lbs. Since we have already chosen to reduce the wind load from the NESC extreme wind load values, we have used a F_{ow} value of 1.

This is our working or design load.

The value for a 40ft Class 3, wood pole on page 3-2 has been rounded off to **61,300** ft-lbs.

The conductor and equipment load (horizontal) that this pole can be subjected to is now limited to 61,300 ft-lbs to meet our design criteria.

STRUCTURE LOADING CALCULATIONS

The moment load on the pole due to wind on the conductors depends on the length of conductor (horizontal wind span) and the diameter of the conductor; the longer the wind span or the larger the conductor size the greater the loading.

The horizontal wind span (S_h) for any pole or structure is one half the sum of the two adjacent spans. This assumes that the wind force on the conductors is shared equally or evenly between the two supporting structures.

The horizontal wind span for a structure having adjacent span lengths of 130 ft and 270 ft is: $S_h = (130 + 270)/2 = 400/2 = 200$ feet.

The moment per unit length of conductor (M_{wc}) is determined as follows:

$$M_{wc} = F_{ow} \left\{ \sum (W_c H_c) \right\} \cos\theta/2$$

Where: F_{ow} = NESC (Table 253-1) load factor for wind loads
W_c = Wind load per unit length of each conductor (lb/ft)
H_c = Height of each conductor attachment above ground line (ft)
θ = Line angle at pole (degrees)

The wind load on each conductor is found by multiplying the design wind loading (30 lb/ft^2) by the area of the conductor. The following table shows the wind load on our standard conductors and a 1 inch communications cable.

Conductor	**Area** (in)	**W_c** (lb/ft)
477 AAC	0.792	1.98
4/0 AAC	0.522	1.305
2/0 AAC	0.414	1.035
Communications	1.0	2.5

Primary Conductors

For a typical tangent structure the primary conductors will all be at the same height, so the moment arm for a 40 foot pole will be 34.6 feet. If we assume it is a non-joint use pole, then the moment arm for the neutral is 26.5 feet. Now, for a 3-phase primary with 477

AAC and 4/0 AAC neutral, the summation of the moments per unit length of conductor due to wind is:

Phase	$W_c H_c$		
A	(1.98)(34.6)	=	68.5
B	(1.98)(34.6)	=	68.5
C	(1.98)(34.6)	=	68.5
N	(1.305)(26.5)	=	34.6
Total			240.1 ft-lb/ft

The moment on the pole due to wind on the conductors is:

M_{wc} = (1) (240.1) (cos 0°) = 240.1 ft-lb/ft

The design or working load for a 40ft. class 3 pole was 61,300 ft-lbs as calculated on page 2-4. The structure load due to wind on the conductor for a 477 AAC circuit with 4/0 AAC neutral is 240.1 x wind span. We can now calculate the maximum horizontal wind span this pole can be subjected to and stay within the design load of 61,300 ft-lbs.

Therefore, with only primary conductor, the maximum wind span = 61,300/240.1 = **255 ft.**

Secondary Conductor

Since many of our structures also include secondary we must also include the wind loading for the secondary conductors with a 23.5 foot moment arm for one conductor and a 25 foot moment arm for the second conductor. The bending moment due to the wind on the secondary conductors is:

M_{wc} = (1) [(1.305) (23.5) + (1.305) (25)] (cos 0°) = 63.3 ft-lb/ft

Adding this to the total for the primary and neutral loading, we get (240.1 x wind span) + (63.3 x wind span) = **303.4 x wind span**.

Now, with primary and secondary the maximum wind span = 61,300/303.4 = 202 ft

The maximum wind span a 40 ft, class 3 pole can be subjected to (477 primary with 4/0 neutral and secondary) and stay within the design limitation of 61,300 ft-lbs is now **202 ft**.

Equipment

The final source of structure loading is equipment. A 40 ft pole has sufficient space to accommodate transformers.

The bending moment due to the wind on a transformer is not dependent on the span length but on the area (ft^2) of the transformer (e.g. A 50 kVA transformer 24” in diameter and 48” high has an area of (24 x 48)/12 = 8 ft^2).

With a wind load of 30 psf and a moment arm of 29 ft (i.e. height to the center of the transformer above ground) the bending moment due to the wind on the transformer tank is:

M_{we} = (30) (8) (29) = 6960 ft-lbs

If we reduce the working moment on the pole due to the equipment moment, then the maximum wind span becomes:

Maximum wind span = (61,300 – 6,960)/303.4 = 179 ft

Thus, the maximum wind span for a 40’ C3, SYP pole with 477 primary, 4/0 Neutral and Secondary and a 50 KVA transformer is now **179 ft**.

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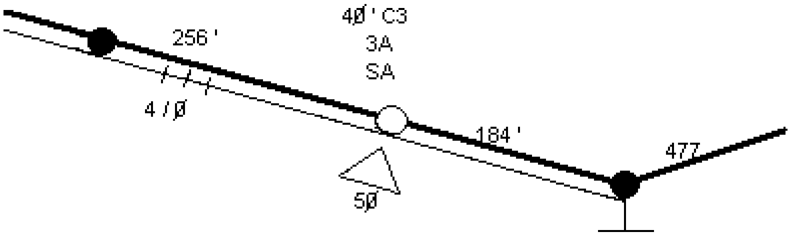
		DATE: August 4, 2017	

CALCULATING STRUCTURE LOADING

We will now go through the calculations required to determine the wind load on a structure. The span lengths, conductor sizes, pole length and structure type are shown below.



1. The first calculation we require is the wind span (S_h) for this structure; refer to page 2-5 for details.

$$\mathbf{S_h = (184 + 256)/2 = 220\ ft.}$$

2. We can now calculate the load and bending moment due to the wind on the conductors; bending moment = wind span x the summation of moments per unit length of conductor (No. of conductors) x (area of conductors) x (wind load) x (moment arm); the moment arm length can be obtained from page 8-11.

Conductor	W_cH_c		
Primary (477 AAC)	(3)(1.98)(34.6)	=	205.5
Neutral (4/0 AAC)	(1.305)(26.5)	=	34.6
Secondary (4/0 AAC)	(1.305)(25)	=	32.6
Secondary (4/0 AAC)	(1.305)(23.5)	=	30.7
Total			303.4 ft-lb/ft

The total moment due to the wind on the conductors is:

$$\mathbf{S_h\, M_{wc} = (220)\ (303.4) = 66{,}748\ ft\text{-}lbs}$$

3. The wind on the transformer also adds to the total load (transformer area is 2' x 3' = 6 ft^2).

$$\mathbf{M_{we} = (30)\ (6)\ (29) = 5{,}220\ ft\text{-}lbs.}$$

The total moment now becomes:

$$M_g = S_h M_{wc} + M_{we} = (66{,}748 + 5{,}220) = 71{,}968 \text{ ft-lbs.}$$

The resisting moment or design load that a 40ft Class 3 SYP pole can be subjected to is 61,300 ft-lbs, in accordance with the chart on page 3-2. The loading due to the wind on this structure of 71,968 ft-lbs is more than the maximum allowable load of 61,300 ft-lbs; therefore this structure cannot handle the wind load for this wind span length of 220 ft. Either the structure must be replaced with a higher class pole or a mid-span structure may be installed to reduce the wind span.

CONDUCTOR TENSIONS

The following table indicates the tension for our standard conductor sizes, under various loading conditions; # 2 ACC is also included as we have many miles of this in service. These tensions were calculated for a ruling span length of 200 feet and should be adequate for most of our distribution lines.

INITIAL TENSIONS (lbs)					RATED TENSILE STRENGTH (lbs)
CONDUCTOR SIZE	NO LOAD		WIND LOAD		
			60 MPH	HURRICANE	
	90 °F	70 °F	60 °F	80 °F	
2/0	471	627	851	1240	2510
4/0	713	958	1253	1742	3830
477	1250	1672	2183	2971	8360
2	257	338	484	742	1350

The conductor tensions listed under hurricane wind loading are the tensions that we must design for in our structure guying.

The tensions listed under no load at 90 °F are actual tensions that can be expected under normal everyday conditions; the tensions that could be expected under hurricane wind conditions are approximately 2 to 2.5 times the tensions under normal everyday conditions.

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CONDUCTOR DESIGN TENSION

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DATE: August 4, 2017

STANDARD NO.
2-10

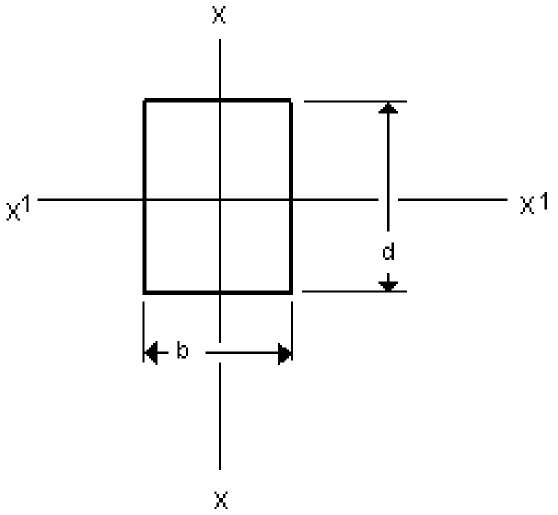
CROSSARM STRENGTH IN BENDING

The strength of a crossarm, in bending, can be calculated from the formula:

$$M_A = f_b Z$$

Where M_A = bending moment for a crossarm (inch-pounds)
f_b = fiber stress (psi)
Z = section modulus

The working stress for Douglas-fir in bending is 2050 psi; however when designed for occasional loads such as hurricane wind, the working stress may be increased by 33% for a working stress of **2733 psi.**



The section modulus is determined from the size of the crossarm: $Z = \frac{bd^2}{6}$ where "b" & "d" are measured in inches.

The section modulus for the x-x axis is $Z_{x\text{-}x} = \frac{bd^2}{6}$; which is the section modulus for a vertical load.

The section modulus for the x'-x' axis is $Z_{x'\text{-}x'} = \frac{db^2}{6}$; this is the modulus for a horizontal load (conductor deadended on arms such as a 2DE or 3DE).

The effect of the braces are neglected when calculating the strength of a crossarm, and the arm is assumed to be fixed at the center bolt position.

The strength of our standard crossarm (3⅝" x 4⅝" x 8') for a vertical load is:

$M_A = f_b Z = f\,\frac{bd^2}{6} = 2733\,\frac{[3⅝ \text{ x } (4⅝)^2]}{6}$ **= 35,320 inch-pounds**

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		APPROVED BY: C. Rose DATE: August 4, 2017	**STANDARD NO.** **2-11**

Since the pin location is 44" from the center of the arm, the moment arm for a vertical load at the pin is 44 inches.
The vertical load that the crossarm can safely support at the pin location is:

Load (vertical) = $M_A/44 = 35{,}320/44 =$ **803 lbs**

The strength of our standard crossarm for horizontal load is:

$M_A = f_b Z = f\,\frac{bd^2}{6} = 2733\,\frac{[4\tfrac{5}{8} \text{ x } (3\tfrac{5}{8})^2]}{6} =$ **27,683 inch-pounds**

The horizontal load on a crossarm is located at the DA bolt location which is 42 inches from the center; the moment arm for a horizontal load is therefore 42 inches.

The horizontal load that the crossarm can safety support at the DA bolt location is:

Load (horizontal) = $M_A /42 = 27{,}683/42 =$ **659 lbs**

Since the crossarms are doubled for a DE type structure the load that two crossarms can safely support is (2 x 659) = 1318 lbs.

The design tension for 2/0 AAC under hurricane load conditions is 1240 lbs; two crossarms will support the 2/0 AAC conductor.

However since the design tension for 4/0 AAC is 1742 lbs we will normally require three (3 x 659 = 1977 lbs) to support 4/0 AAC.

Therefore, two crossarms will be sufficient for 2/0 AAC dead-ends and three crossarms will be required to dead end 4/0 AAC.

In order to dead end 477 AAC on crossarms, we will require larger crossarms such as two of our 5 5/8 x 7 3/8 x 9'0" crossarms or fiberglass crossarms.

Load (horizontal) = $\frac{2MA}{48} = \frac{2\ x\ 2733\ x\ \frac{7\tfrac{3}{8}\ x\ (5\tfrac{5}{8})^2}{6}}{48}$ = **4430 lbs.**

The design tension for 477 AAC is 2971 lbs.

CONDUCTOR SPACING OR SEPARATION

Conductor separation is intended to provide sufficient work space for linemen and to prevent swinging contact and flashover between conductors.

The actual amount of separation required is dependent on (a) the line voltage (b) the conductor sag and (c) the framing or structure configuration.

The horizontal separation (HS) required for any span can be determined from this formula:

$$HS = 0.025KV + F\sqrt{S} + 0.6L$$

Where: KV = line to line voltage
S = the final sag in the conductor at 60° F (ft)
L = the length of the insulator string (ft) ($L= 0$ for a pin insulator)
F = an experience factor, normally greater than 1.0, 1.25, or 1.40 are frequently used, however 1.25 should be sufficient for Grand Cayman as unequal conductor loading does not occur

The vertical separation is given by: $VS = 0.025KV + F\sqrt{S}$.

For our 13 kV feeders using 477 kcmil conductor (for RS = 200 ft, RS sag = 2.06 ft, Sag for 235’ span = 2.84 ft) the required spacing for a 250 ft span is:

$$\begin{aligned} HS &= 0.025 \times (13) + 1.25\sqrt{2.84} + 0.6\,(0) \\ &= 0.33 + 2.11 + 0 \\ &= 2.44 \text{ ft (29 inches)} \end{aligned}$$

Our standard crossarm has a conductor separation of 44 inches from the pole and 29 inches to the second pin hole – therefore the separation is adequate, however for spans in excess of 235 ft, additional spacing is required.

In all cases, the required separation is most crucial at mid span. For long spans, it may be necessary to alternate the placement of the center pin at each structure, which will increase the mid span separation to 44 inches.

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For the 69 kV using the same span length and conductor the required horizontal separation is:

$$\begin{aligned} HS &= 0.025\ (69) + 1.25\ \sqrt{2.84} + 0.6\ (38/12) \\ &= 1.73 + 2.11 + 1.90 \\ &= 5.74 \text{ ft (for a structure with a suspension string of 6 insulators)} \end{aligned}$$

Using post insulators the L factor becomes zero; the required horizontal spacing then becomes (1.73 + 2.11) 3.84 ft.

CONDUCTOR CLEARANCES – VERTICAL

The CI Traffic Law states that the height of a normal vehicle shall not be more than 14 feet; anything over 14 feet requires a special police permit.

The CI Traffic Law also states that the minimum height for a traffic light is 17ft. 4 in. to the center of the green lens – approximately 17 feet above ground.

NESC requires a minimum clearance of 15 feet 6 inches for service cables (triplex) and grounded neutrals and guys, and 18 feet 6 inches for open supply conductors over 750 volts, crossing streets and roads. CSA requires 18 feet for service cables, grounded neutrals and guys, crossing roads and streets.

These clearances are required minimums and can be increased by the utility if so desired. Also, these clearances are the clearances with the conductor in its lowest position – which in Grand Cayman is normally the final sag at 120 degrees F or the final sag at the conductor operating temperature, if over 120 degrees F.

For Joint Use lines, the lowest point of attachment will be communication cable attached at 18 feet 6 inches. Since the communication cable must meet a minimum of 15 feet 6 inches above ground, the maximum span length must be 190 feet or less. CUC's lowest point of attachment (neutral or secondary) will be 25 feet above ground. Therefore we have adequate clearance for our conductors up to this maximum span length.

For non-Joint Use lines, we could increase the span lengths and reduce the clearances somewhat. However, we do not recommend building new lines with longer span lengths and vertical clearances across roadways and streets of less than 18 feet.

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DISTRIBUTION STANDARDS

VERTICAL CLEARANCES

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DATE: August 4, 2017

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2-15

CLEARANCE OF OVERHEAD LINES

TABLE 1

Vertical Clearance of Conductors above Ground or Roadway

(Based on NESC Table 232-1)
(Feet)

SURFACES CROSSED	MULTI GROUNDED NEUTRALS, GROUNDED GUYS	SERVICE CABLES 0-750 VOLT	OPEN WIRE SECONDARIES 0-750 VOLT	OPEN SUPPLY CONDUCTORS OVER 750 VOLT
streets, roads, commercial driveways etc. subjected to truck traffic, including residential driveways	**15.5**	**16**	**16.5**	**18.5**
spaces & ways subjected to pedestrian or restricted traffic only	**9.5**	**12**[3]	**12.5**	**14.5**
alongside roads & streets with no overhang	**15.5**	**15.5**	**16.5**	**18.5**

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[3] Where the height of a residential building does not permit its service drop to meet this value, the clearance may be reduced to 10.5 ft for insulated supply service drops limited to 150 volts to ground.

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		DATE: August 4, 2017	

CLEARANCE OF OVERHEAD LINES

TABLE 2

Vertical Clearance of Equipment Cases, Supports and Unguarded Live Parts above Ground or Roadway

(Based on NESC Table 232-2)
(Feet)

Surface Below	Nonmetallic or grounded supports and equipment cases	Ungrounded rigid live parts and ungrounded cases of equipment connected to circuits		
		Up to 750 V	13 kV	69 kV
Roads and other areas subject to vehicles exceeding 8 feet in height	**15.0**	**16.0**	**18.0**	**18.6**
Along roads & streets with no overhang where vehicles are unlikely to cross under the line	**13.0**	**14.0**	**16.0**	**16.6**
Spaces & ways subjected to pedestrians only	**11.0**	**12.0**	**14.0**	**14.6**

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CLEARANCE OF OVERHEAD LINES

TABLE 3

Horizontal Clearance of Conductors Carried on Different Supporting Structures

(Based on NESC Rule 233B)
(Feet)

Type of Conductor	Anchor Guy Wires	Span Guys and Neutrals	Secondary Conductors	13 kV Conductors	69 kV Conductors
Anchor Guy Wires	**0.5**	**2.0**	**5.0**	**5.0**	**5.6**
Span Guys and Neutrals	**2.0**	**5.0**	**5.0**	**5.0**	**16.6**
Secondary Conductors	**5.0**	**5.0**	**5.0**	**5.0**	**5.7**
13 kV Conductors	**5.0**	**5.0**	**5.0**	**5.0**	**5.9**
69 kV Conductors	**5.6**	**5.6**	**5.7**	**5.9**	**7.0**

Horizontal clearance between conductors must be determined with conductor blowout.

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HORIZONTAL CLEARANCE OF CONDUCTORS ON DIFFERENT SUPPORTING STRUCTURES

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2-18

CLEARANCE OF OVERHEAD LINES

TABLE 4

Vertical Clearance of Conductors Carried on Different Supporting Structures

(Based on NESC Table 233-1)
(Feet)

Lower Level	Upper Level				
	Neutrals and Grounded Span Guy Wires	**Secondary Cables**	**Open Wire Secondary Conductors**	**13 kV Conductors**	**69 kV Conductors**
Communications Conductors	2.0	2.0	4.0	5.0	5.6
Grounded Span Guy Wires, Neutrals and Secondary Cables	2.0	2.0	2.0	2.0	2.6
Open Wire Secondary Conductors	2.0	N/A	2.0	2.0	2.7
13 kV Conductors	2.0	N/A	N/A	2.0	2.9
69 kV Conductors	N/A	N/A	N/A	N/A	7.0

N/A – Not Allowed

The above clearances are the minimum distances between the upper and lower conductors for the entire range of operating temperatures. This is normally when the lower conductor is at the lowest temperature and the upper conductor is at the highest operating temperature.

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DRAWN: C. Rose		
REV.:	**VERTICAL CLEARANCE OF CONDUCTORS ON DIFFERENT SUPPORTING STRUCTURES**	
DATE:		
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	DATE: August 4, 2017	

CLEARANCE OF OVERHEAD LINES

TABLE 5

Clearance of Conductors from Other Supporting Structures

Support structures for lighting, traffic signals, or other lines
(Based on NESC Rules 234B1 & 234B2)
(Feet)

Conductor Type	Vertical Clearance	Horizontal Clearance	
		Without Wind	Displaced by Wind
Grounded Span Guy Wires, Neutrals and Secondary Cables	**2.0**	**3.0**	**3.0**
Open Wire Secondary Conductors	**4.5**	**5.0**	**3.5**
13 kV Conductors	**4.5**	**5.0**	**4.5**
69 kV Conductors	**5.5**	**5.0**	**5.0**

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CLEARANCE OF OVERHEAD LINES

TABLE 6

Clearance of Conductors from Buildings (Not Attached)

(Based on NESC Table 234-1)
(Feet)

	Neutrals and Grounded Span Guy Wires	Secondary Cables	0-750 V Unguarded Rigid Live Parts	Open Wire Secondary Conductors	13 kV Unguarded Rigid Live Parts	13 kV Conductors	69 kV Conductors
Horizontal							
No Wind	**4.5**	**5.0**	**5.0**	**5.5**	**7.0**	**7.5**	**8.1**
Displaced by Wind	**3.5**	**3.5**	**5.0**	**3.5**	**7.0**	**4.5**	**5.1**
Vertical							
Over or under roofs or projections not readily accessible to pedestrians	**3.0**	**3.5**	**10.0**	**10.5**	**12.0**	**12.5**	**13.1**
Over areas readily accessible to pedestrians and vehicles but not truck traffic	**10.5**	**11.0**	**11.0**	**11.5**	**13.0**	**13.5**	**14.1**
Over roofs or decks accessible to truck traffic	**15.5**	**16.0**	**16.0**	**16.5**	**18.0**	**18.5**	**19.1**

CLEARANCE OF OVERHEAD LINES

TABLE 7

Clearance of Conductors from Signs, Chimneys, Billboards, Antennas, etc.

(Based on NESC Table 234-1)
(Feet)

	Neutrals and Grounded Span Guy Wires	Secondary Cables	0-750 V Unguarded Rigid Live Parts	Open Wire Secondary Conductors	13 kV Unguarded Rigid Live Parts	13 kV Conductors	69 kV Conductors
Horizontal							
No Wind	**4.5**[4]	**5.0**[5]	**5.0**	**5.5**	**7.0**	**7.5**	**8.1**
Displaced by Wind	**3.5**	**3.5**	**5.0**	**3.5**	**7.0**	**4.5**	**5.1**
Vertical							
Over or under catwalks and other surfaces upon which personnel walk	**10.5**	**11.0**	**11.0**	**11.5**	**13.0**	**13.5**	**14.1**
Over or under other portions of such installations	**3.0**	**3.5**	**5.5**	**6.0**	**7.5**	**8.0**	**8.6**

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[4] 3.0 feet for portions not readily accessible to pedestrians

[5] 3.5 feet for portions not readily accessible to pedestrians

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DISTRIBUTION STANDARDS

CLEARANCE OF CONDUCTORS FROM SIGNS, ETC.

APPROVED BY: C. Rose
DATE: August 4, 2017

STANDARD NO. 2-22

CLEARANCE OF OVERHEAD LINES

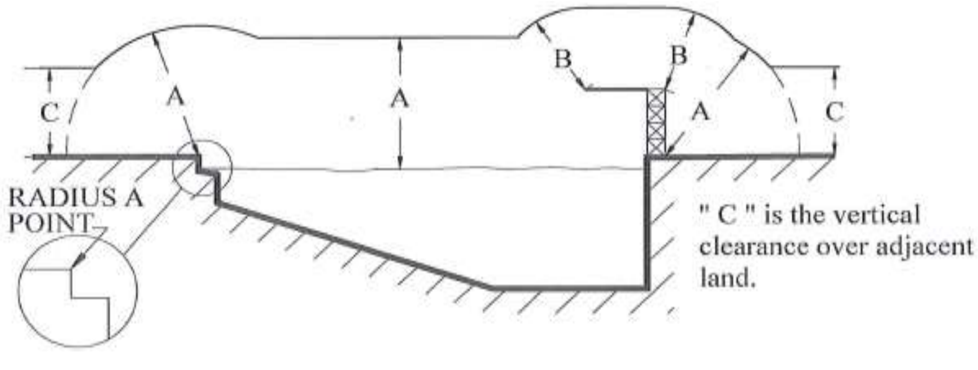
TABLE 8

Clearance of Conductors and Unguarded Live Parts Over or Near Swimming Pools

(Based on NESC Table 234-3)
(Feet)

Clearance In Any Direction	Neutrals and Grounded Span Guy Wires	0-750 V Secondary Cables and Unguarded Rigid Live Parts	Open Wire Secondary Conductors	13 kV Unguarded Rigid Live Parts	13 kV Conductors	69 kV Conductors
A. From the water level, edge of pool, base of diving platform, or anchored raft	22.0	22.5	23.0	24.5	25.0	25.6
B. To the diving platform, tower, slide or other fixed pool-related structures	14.0	14.5	15.0	16.5	17.0	17.6

Note: Supply conductors shall not be installed over swimming pools or within clearance "A" of the edge of a swimming pool. Clearances are for reference purposes only.



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DISTRIBUTION STANDARDS

CLEARANCE OF CONDUCTORS NEAR SWIMMING POOLS

APPROVED BY: C. Rose
DATE: August 4, 2017

STANDARD NO. 2-23

CLEARANCE OF OVERHEAD LINES

TABLE 9

Clearance of Conductors and Communication Cables on Joint Use Structures

(Based on NESC Rule 235C and Table 235-5)
(Inches)

Upper Conductor	At the Structure	Mid-Span
Neutral conductors[6]	**40**	**30**
Secondary cables and open-wire conductors	**40**	**30**
13 kV Conductors	**40**	**30**
69 kV Conductors	**53**	**40**

Note: For longer spans, the mid-span clearance will usually be the limiting factor, which will require a greater clearance at the structure than specified above. However, where the communication attachment points are fixed, longer spans will require individual designs to increase cable design tension to maintain ground clearance.

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[6] Where the supply neutral is bonded to the communication messenger and no secondary exists, the spacing may be reduced to 30 inches at the structure and 12 inches at mid-span.

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DISTRIBUTION STANDARDS

CLEARANCE OF CONDUCTORS
ON JOINT USE STRUCTURES

APPROVED BY: C. Rose
DATE: August 4, 2017

STANDARD NO.
2-24

CLEARANCE KILOWATT HOUR METERS AND INSTRUMENT TRANSFORMERS WITH COMBUSTIBLE MATERIAL

The 2014 NEC Code Rule 501.105 states that kilowatt-hour meters and instrument transformers shall be provided with enclosures identified for Class I, Division 1 locations. Enclosures for Class 1, Division 1 locations include explosion proof enclosures and purged and pressurized enclosures. CUC meters and instrument transformers meet these regulations.

Any propane or flammable material must be a minimum of three (3) feet from a CUC meter or instrument transformer for access purposes.

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DISTRIBUTION STANDARDS

CLEARANCE OF METERS
FROM COMBUSTIBLE MATERIALS

APPROVED BY: C. Rose
DATE: August 4, 2017

STANDARD NO.
2-25

CLEARANCE OF DIELECTRIC LIQUID-FILLED EQUIPMENT

SCOPE OF THE STANDARD:
This standard establishes the minimum clearance and proximity distances required by Caribbean Utilities Company Ltd. (CUC) to comply with the guidelines provided by regulatory authorities such as the National Electrical Safety Code (NESC) and the American National Standards Institute (ANSI).

GENERAL:
This document establishes the minimum clearance and proximity distances required by CUC to ensure the safe operation of dielectric liquid-filled equipment near combustible materials and/or containers of combustible materials and/or windows, doors, ventilation inlet or outlet, and stairwells of buildings.

DESCRIPTION OF COMBUSTIBLE MATERIALS AND CONTAINERS OF COMBUSTIBLE MATERIALS:
For this Standard, any material that has a flash point of 70 °C or less is a Combustible Material and is considered capable of causing a fire or explosion if ignited or heated to the flash point temperature. Any container of Combustible Materials is considered to have the same or greater potential for causing a fire or explosion whether, or not, it is full, partially full, or empty.

DESCRIPTION OF PROXIMITY TO WINDOWS, DOORS AND STAIRWELLS:
Any public access route to a building or any window that is within the blast radius of CUC energized high voltage equipment.

MINIMUM CLEARANCE AND PROXIMITY DISTANCES:
The minimum clearance and proximity distance for CUC high voltage equipment shall be:

1) Twenty feet from the nearest point of CUC's energized high voltage equipment to the Combustible Materials or a container of Combustible Materials. Examples of Combustible Materials include but are not limited to the following:
   - Building materials with a flash point of 60 °C or greater
   - Liquefied Petroleum tanks
   - Service Station Fuel Pumps
   - Fuel Storage Tanks
   - Carbon based fueled equipment storage

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2) Twenty feet from a window, door, ventilation inlet or outlet, or stairwell of a building

3) Notwithstanding the requirements of item 2, the equipment shall be permitted to be installed within 20 feet of these items provided that a wall or barrier with non-combustible surfaces or material is constructed between the equipment and that item.

4) Three feet from a fire/blast wall, as noted in item 3, that separates CUC's high voltage equipment from any item listed in item 2.

5) Dielectric liquid-filled pad-mounted distribution transformers shall be installed at least 10 feet from any combustible surface or material on a building and at least 20 feet from any window, door, or ventilation inlet or outlet on a building, except where

   a. A wall or barrier with non-combustible surfaces or material is constructed between the transformer and any door, window, ventilation opening, or combustible surface; or

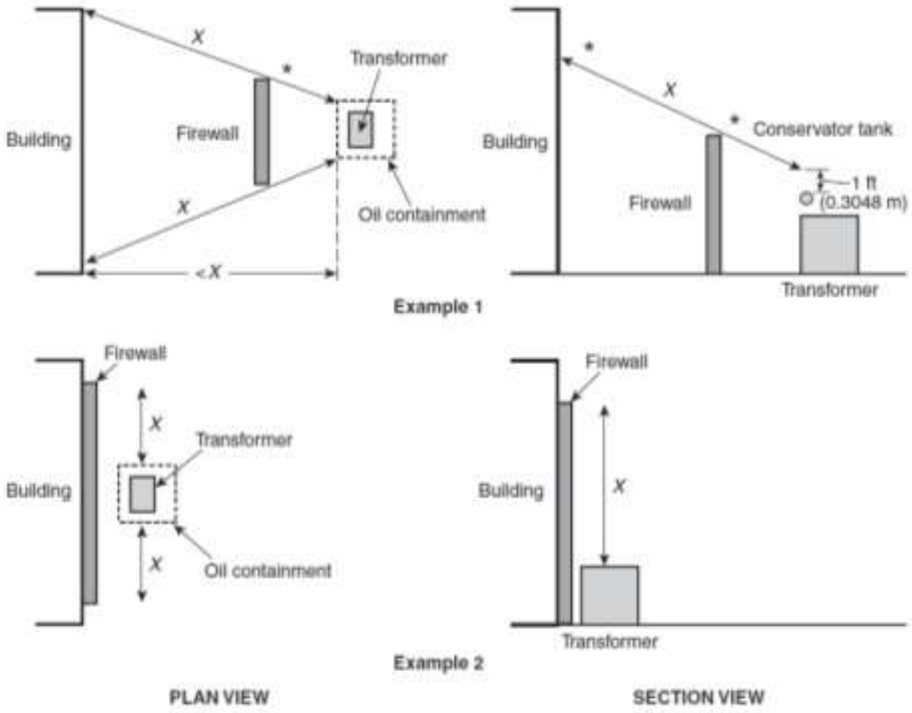
   b. The transformer is protected by an internal current-limiting fuse and equipped with a pressure relief device, with working spaces around the transformer of at least 10 feet on the access side and on all other sides:
      i. 3 feet for three-phase transformers; and
      ii. 2 feet for single-phase transformers

A fire/blast wall, as noted in items 4 and 5 above, shall have minimum construction requirements as follows:

- The height shall be such that the minimum line-of-sight separation without the firewall is maintained.
- The width shall be such that the minimum line-of-sight separation without the firewall is maintained.
- The thickness shall be at least six inches thick solid concrete with steel reinforcement (including the foundation) and able to withstand fire and explosion of the Combustible Materials or Combustible Materials Container.

- The fire/blast wall design and installation shall be approved by CUC before service is allowed to customers affected by this Standard.

Example diagrams for a firewall:



* the firewall should extend at least 1 foot above the top of the transformer casing and oil conservator tank and at least the width of the transformer oil containment.

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