Part 2:

Live-Line Rigging Calculations

Contents

1. Calculate Conductor Weight

Conductor Weight is the weight of the conductor at the support point either on the insulator or in the shoe on suspension insulators. For Live-Line work on tangent structures, you will need to know the weight of a conductor to be lifted or supported. (See **6. PG&E Wire Data**.)

Theoretically the conductor weight consists of half the weight of the two spans adjacent to the structure being worked. To allow for other variables such as wind loading and peakers a safety factor is used. The safety factor is 2 for short spans (250 feet or less) and 1.5 for long spans (250 feet or more). One must not forget that as the conductor is raised from its existing position the weight at the support point increases.

The Calculation

To calculate the conductor weight you take half the length of **Span A** and half of **Span B** or **Span A + Span B** divided by 2, multiply it by the weight of the conductor per foot (see PG&E Wire Data) and multiply it by the **safety factor** (1.5 or 2 depending on span length). This can be stated in the formula:

$$\text{Conductor Weight} = \frac{\text{Span A} + \text{Span B}}{2} \times \text{Weight per foot} \times \text{Safety Factor}$$

SAFETY FACTOR = 1.5 for spans greater than 250 feet
= 2 for spans less than 250 feet

For example: What is the conductor weight on an H-frame tangent structure, using 477 Hawk conductor, a span of 640 feet one way and 550 feet the other?

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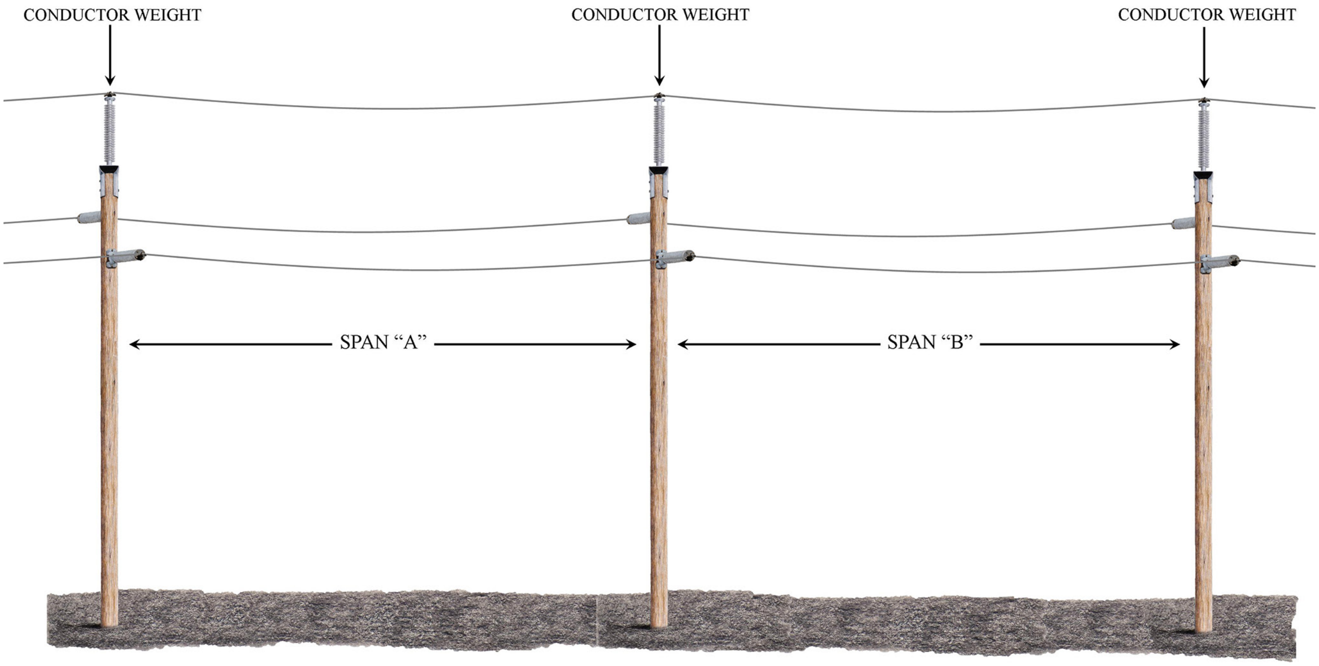

Figure ~~1~~1. Conductor Weight.

Using the formula:

$$\textbf{Conductor Weight} = \frac{\textbf{Span A + Span B}}{2} \times \textbf{Weight per foot} \times \textbf{Safety Factor}$$

From the information given, we can calculate the conductor weight by applying the formula. Span A = 640, span B = 55, Weight per foot = 0.655 (from conductor table in the Live Line Manual), and the Safety Factor = 1.5 because the spans are more than 250 feet.

$$\textbf{Conductor Weight} = \frac{640 + 550}{2} \times 0.655 \times 1.5$$

$$= 595 \times 0.655 \times 1.5 \quad = 584.6 \text{ or } 585 \text{ lbs.}$$

Example: What is the conductor weight on a three-phase lift used to support three 2/0 Quail conductors, with span lengths of 180 feet and 220 feet?

$$\textbf{Conductor Weight} = \frac{180 + 220}{2} \times 0.1831 \times 2$$

$$= 200 \times 0.1831 \times 2 = 73.24 \text{ lbs. per phase}$$
$$= 73.24 \times 3 \text{ (phases)} = 219.72 \text{ or } 220 \text{ lbs.}$$

2. Calculate Conductor Tension

Conductor Tension or **Line Tension** is the pull of the conductor or the force acting on the conductor, which tends to stretch it. When performing Live Line Maintenance on deadend structures, vertical corners, running angles, etc., the conductor tension must be known. In many cases this tension or weight must be supported, and the mechanical load to be imposed on tools must be known.

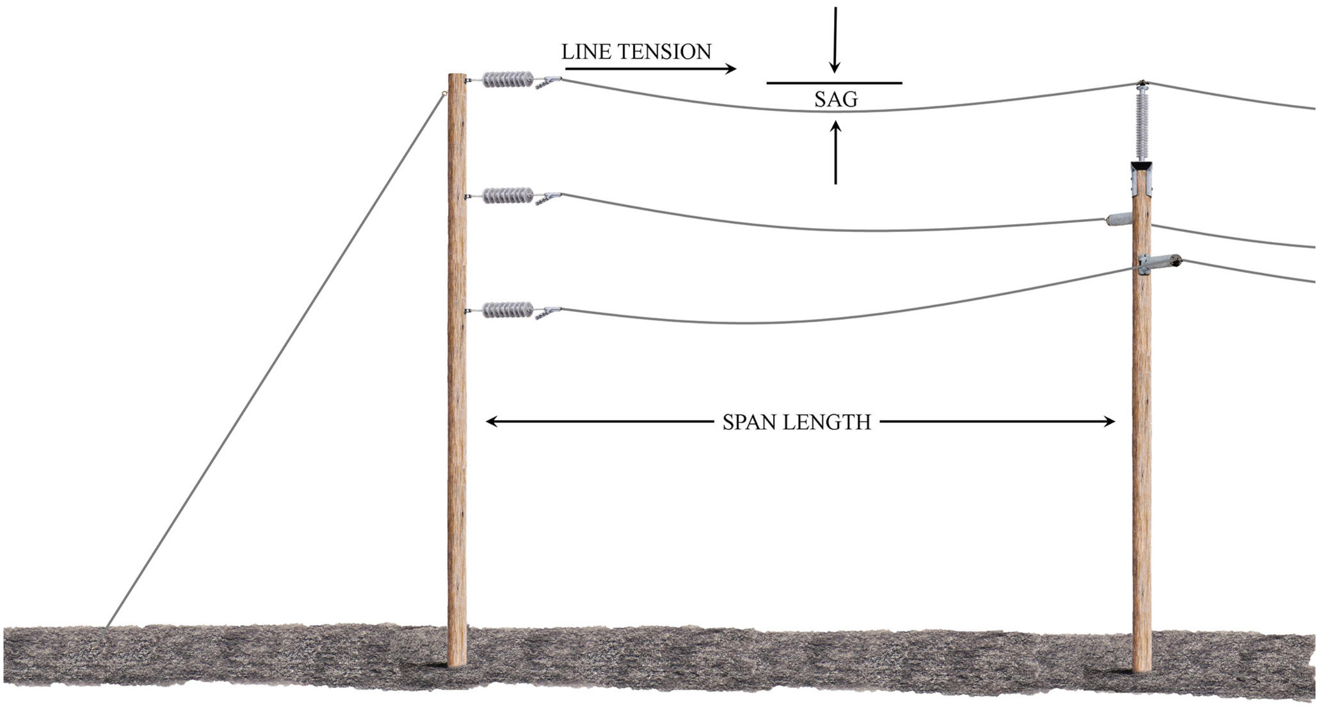

Figure 2.1. Calculate Conductor Tension.

The Calculation

To calculate the conductor tension, you take the **weight of the conductor per foot (W)** (see PG&E Wire Data), multiply it by the **Span Length**^{2}
(Span Length x Span Length), and divided this by **8** (constant) times the **Sag in feet**. This can be stated by the formula:

$$\textbf{Conductor Tension} = \frac{W \times (\text{Span Length})^2}{8 \times \text{Sag in Feet}}$$

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For Example: What is the Conductor Tension that must be supported to change out a set of broken deadend insulators on a structure where the conductor is 2/0 Quail (weight of conductor per foot is 0.1831 lbs.), the Span Length is 320 feet, and the sag in that span is 6.5 feet?

By applying this information to the formula, we can calculate the Conductor Tension.

$$\text{Conductor Tension} = \frac{W \times (\text{Span Length})^2}{8 \times \text{Sag in Feet}}$$

$$= \frac{0.1831 \times (320)^2}{8 \times 6.5}$$

$$= \frac{18749}{52}$$

$$\text{Conductor Tension} = 360.5 \text{ lbs.}$$

Example: What is the Conductor Tension that has to be supported to change the insulators on a transmission deadend where the conductor is 0.477 MCM Hawk (conductor weight per foot is 0.655 lbs.), the Span Length is 1275 feet, and the sag in the span is 35 feet ?

$$\text{Conductor Tension} = \frac{0.655 \times (1275)^2}{8 \times 35}$$

$$= \frac{1064784}{280}$$

$$\text{Conductor Tension} = 3802.8 \text{ lbs.}$$

For the second example, it can be seen that the Conductor Tension is more than 3800 lbs., which would require that the rigging and tools be selected carefully in order to support the greater tension. This emphasizes the importance for calculating the forces that will have to be supported. One must also take into consideration the effects of conductor loading. Ice loaded or rain soaked conductors may be considerably heavier than calculated. Also heavily loaded (amperage) conductors could be somewhat lighter than calculated because the increased load heats the conductor and increases the sag. In these cases, rig for heavier anticipated tension to allow for decrease in load as the job progresses.

3. Calculate the Compressive Force on a Deadend Pole

To choose the correct rigging method and apparatus, it is important to understand the forces acting on a deadend pole.

Compressive Force is the downward force on a pole resulting from the addition of a down guy to support the line tension. The tension in the guy and the line tension wants to straighten the conductor out, so the pull is in a straight line as shown below. If the pole was guyed horizontally, the tension in the guy would equal the tension in the conductor. There would be no compressive force acting down on the pole, other than conductor weight. However, guys increase the compressive force by pulling down on the pole.

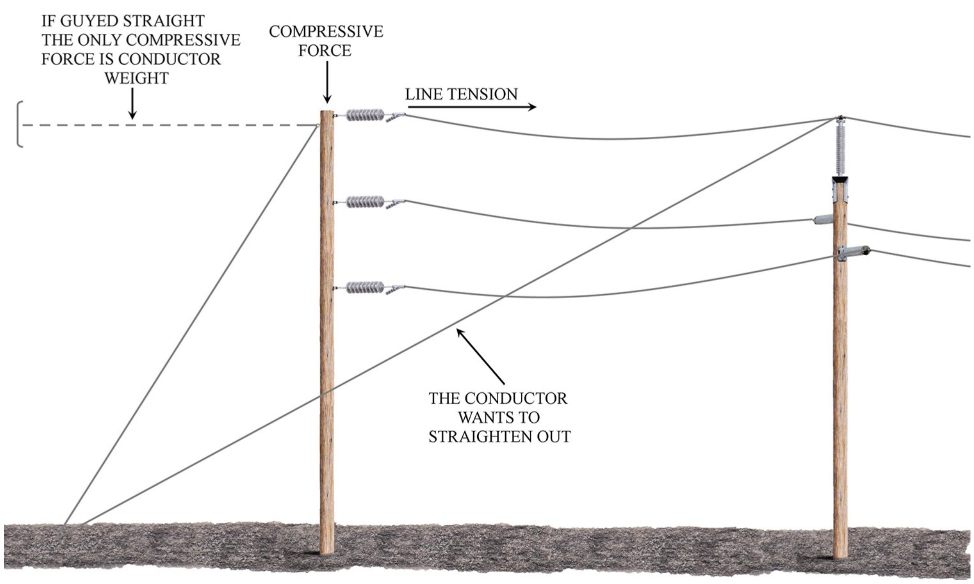

Figure ~~3.1.~~ Compressive Forces.

The Calculation

To calculate the compressive force of a pole, you take the line tension, divide it by the distance from the anchor head to the butt of the pole (anchor distance), and multiply it by the height of the pole. This can be stated by the formula:

$$\text{Compressive Force} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Pole Height}$$

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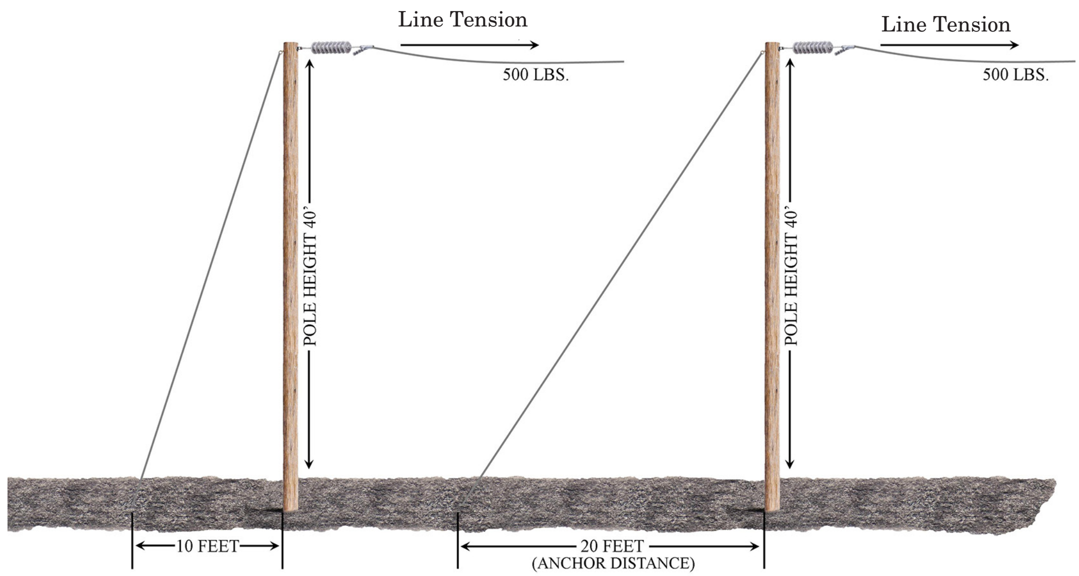

Figure 3.2. Anchor Distance.

Figure 3.3.

For example: What is the compressive force of the pole in Figure 3.2 above?

By applying the formula:

$$\textbf{Compressive Force} = \frac{\textbf{Line Tension}}{\textbf{Anchor Distance}} \times \textbf{Pole Height}$$

$$\textbf{Compressive Force} = \frac{500}{10} \times 40 = 50 \times 40 = 2000 \text{ lbs.}$$

Example: What is the compressive force on the pole in Figure 3.3 above?

$$\textbf{Compressive Force} = \frac{500}{20} \times 40 = 25 \times 40 = 1000 \text{ lbs.}$$

It can be seen from the two examples, that by increasing the anchor distance the compressive force is reduced. In this case by doubling the anchor distance, the compressive force is cut in half.

Example: What is the compressive force on a three-phase deadend pole, given three conductors with a line tension of 475 lbs. each, an anchor distance of 12 feet and a pole height of 38 feet?

$$\textbf{Total Line Tension} = 3 \times 475 = 1425 \text{ lbs.}$$

$$\textbf{Compressive Force} = \frac{1425}{12} \times 38 = 118.75 \times 38 = 4512.5 \text{ lbs.}$$

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4. Working Loads for Principal Hot Line Tools

The maximum load any hot line tool will support without danger of breaking, depends upon the position of the tool on the structure and its relation to other tools used in conjunction with it.

The following tables and accompanying figures show the maximum loads that can be applied to wire tongs when used as pictured. In the case of link sticks and miscellaneous tools, the load values given in the tables refer to the normal direct loads that can be applied. Loading for certain variations can be readily calculated; however, caution should be exercised when loading a tool near the limit given in the tables.

The maximum working load given in the wire tong table represents the actual breaking load as determined by tests, less 15 percent for possible variations in the structure, and the result divided by a safety factor of 2. When it becomes necessary to use wire tongs to handle larger wire sizes or larger spans than the ones mentioned in the table, double tongs should be employed. Where small diameter tongs are listed, a larger diameter tong should be selected.

It should be remembered that loading increases considerably at hilltop structures, the extra weight depending upon the steepness of the line grade. It is possible that this force may exceed the weight of the conductor; therefore, hilltop and other unusual problems require special analysis in the selection of wire tongs.

LINK STICKS — WORKING LOADS		
Type	**Pole Diameter (In inches)**	**Max. Work. Load (in Pounds)**
Strain	1-1/4	3500
Strain	1-1/2	6500
Roller	1-1/4	1000
Suspension	1-1/2	6500

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MISCELLANEOUS TOOLS —WORKING LOADS	
Tool	**Max. Working Load (in Pounds)**
Wire Tong Saddle	1000
Wire Tong Saddle Ext.	800
Extension Chain	2500
Rope Snubbing Bracket	1000
Single Lever Lift	1500
Double Lever Lift	750 (each trunnion)
Two-Pole Strain Carrier	15,000 (Epoxiglas)
Double-String Dead-End Tool*	12,000 (Epoxiglas)
Aerial Platform	500

*Special designs available for High Tension.

WIRE TONGS — WORKING LOADS									
Fig. No.	**Diameter (in inches)**			**TYPE SUPPORT**	**Max. Working Load (lbs. Per Conductor)**	**Max. Wire Size and Span (in Feet / Level Ground)**			
						ACSR		**CPR**	
	"A"	**"B"**	**"C"**			**Size**	**Span**	**Size**	**Span**
4.1	1-1/2 x 10	2 x 12		Saddle	275	4/0	700	4/0	300
	1-1/2 x 10	2-1/2 x 12		Lever Lift	475	4/0	1200	4/0	500
	1-1/2 x 10	3 x 12		Saddle	600	2 in.	—	2 in.	—
	1-1/2 x 10	3 x 12		Lever Lift	850	2 in.	—	2 in.	—
	1-1/2 x 10	3 x 14		Saddle	600	2 in.	—	2 in.	—
	1-1/2 x 10	3 x 14		Lever Lift	700	2 in.	—	2 in.	—
	1-1/2 x 12	3 x 16		Saddle	600	2 in.	—	2 in.	—
	1-1/2 x 12	3 x 16		Lever lift	550	2 in.	—	2 in.	—
				Saddle	275	4/0	700	4/0	300
				Lever Lift	475	4/0	1200	4/0	500
4.2	1-1/2	2 x 12		Lever Lift	350	4/0	850	4/0	375
	1-1/2	2-1/2 x 12		Lever Lift	1000	397.5	1150	250	850
	1-1/2	3 x 12		Lever Lift	1000	2 in.	—	2 in.	—
	1-1/2	3 x 14		Lever Lift	1000	2 in.	—	2 in.	—
	1-1/2	3 x 16		Lever Lift	1000	2 in.	—	2 in.	—
4.3	2 x 8	2-1/2 x 12		Saddle	225*	4/0	550	4/0	230
4.4	2-1/2	—	—	Saddle	500	4/0	1250	4/0	525

* With maximum lift of 5 feet above saddle, Max. unbalance of 225 lbs. on one side.

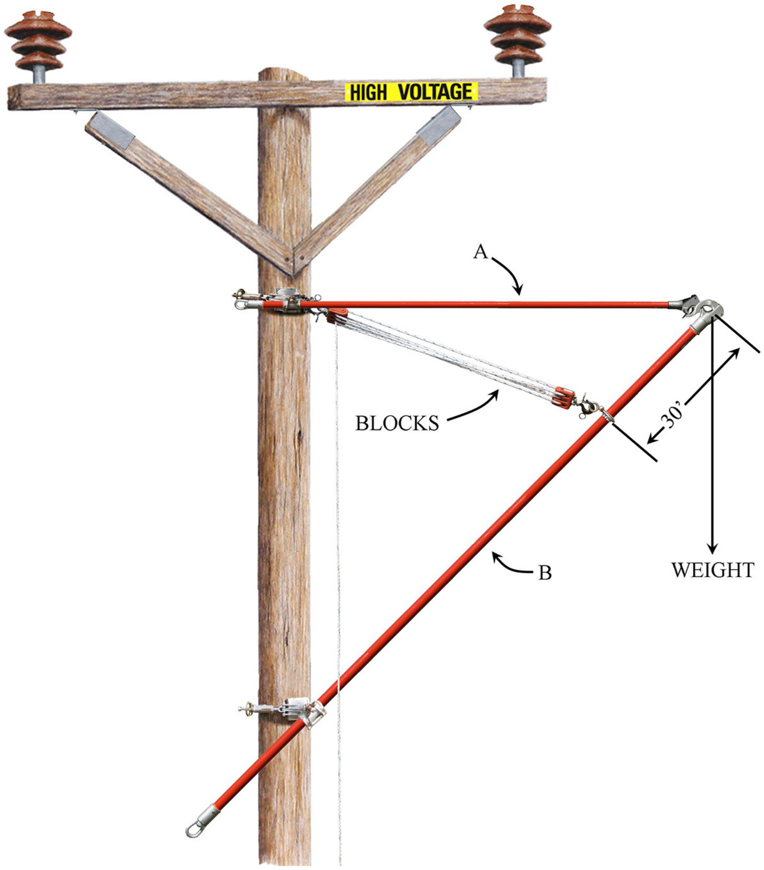

Figure 4.1. Wire tong working loads.

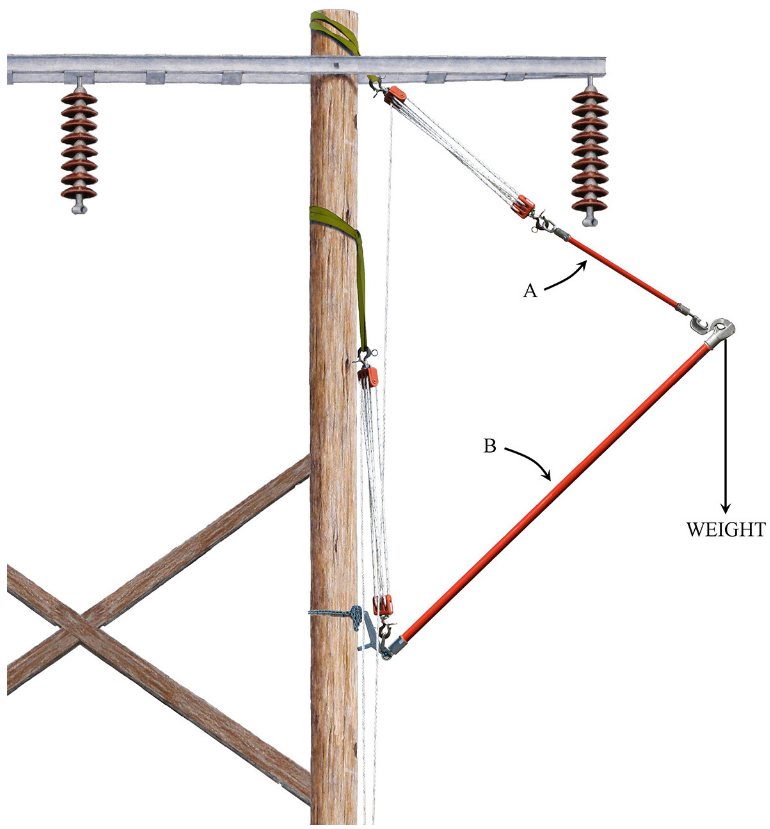

Figure 4.2. Wire tong working loads.

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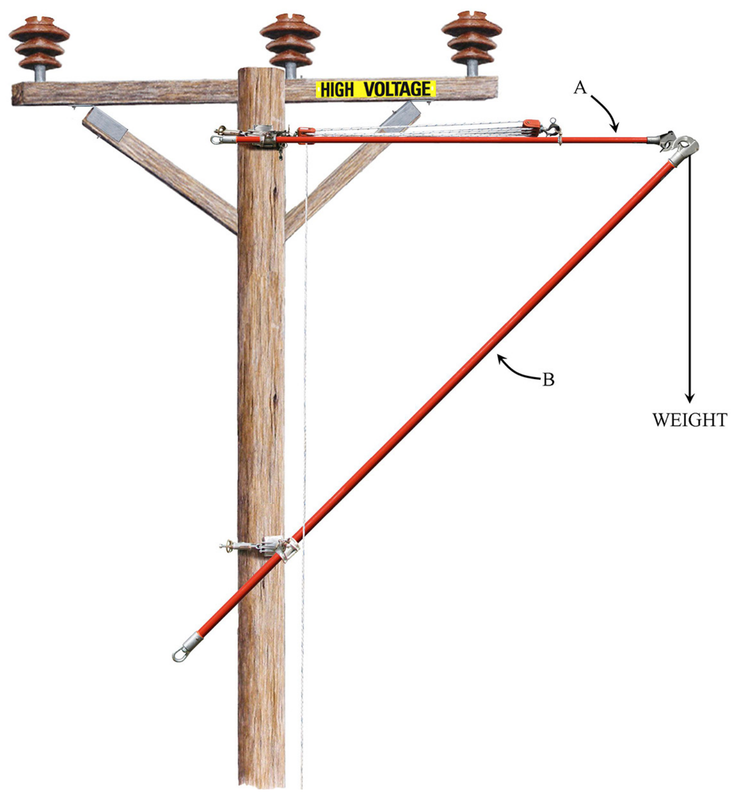

Figure 4.3. Wire tong working loads.

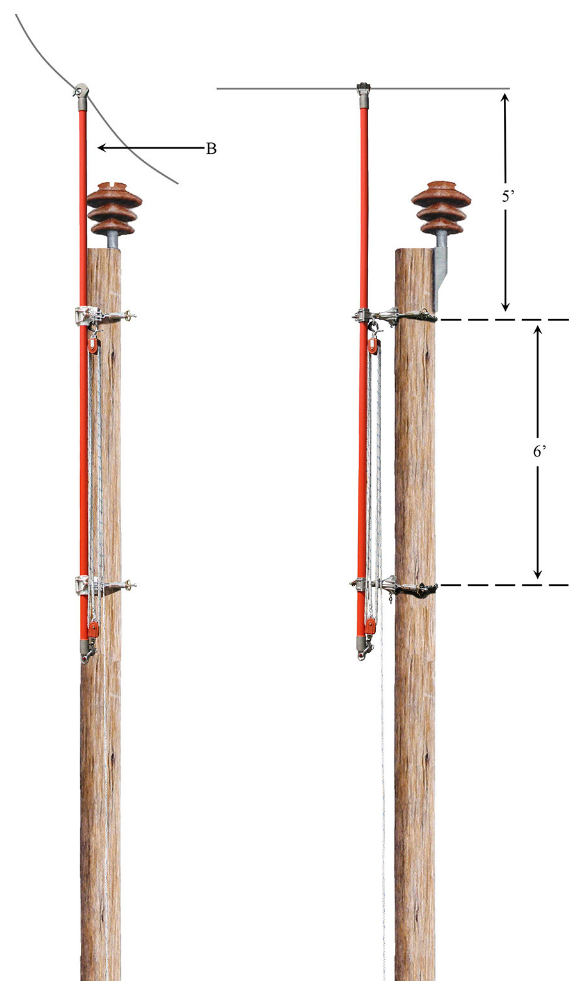

Figure 4.4. Wire tong working loads.

5. Calculate Weights & Forces on Live Line Tools

Calculating the demands placed upon live line tools, the lineman must know and be able to apply all the calculations for weights and forces previously discussed. Each job will require careful consideration of all weights and forces present that will have to be moved or supported. In some cases the calculations (compressive force for example) can be used to find the force applied to a tool instead of a pole and will be shown here. The following are examples of typical live line jobs and will illustrate different rigging methods and the weights and forces present for each situation.

Single Ø Tangent Insulator Change

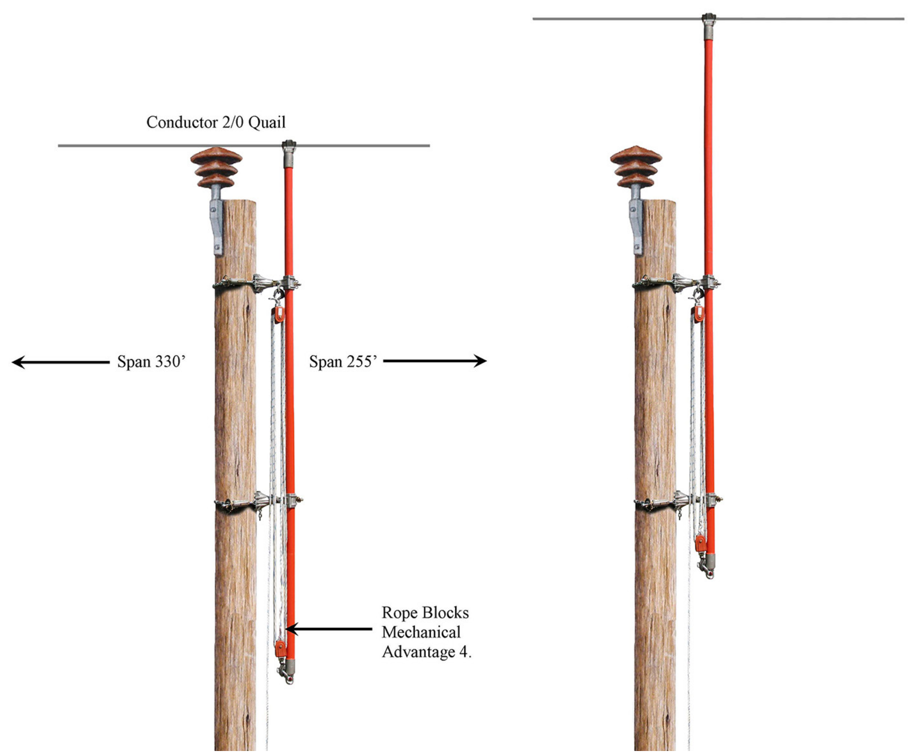

Figure 5.1.

Figure 5.1 illustrates the moving of a single phase conductor using a 2-1/2" wire tong and a set of rope blocks with a mechanical advantage of 4. The weights and forces involved in this job are: conductor weight,; compressive force on the wire tong; the pull on the fall line of the rope blocks; and the weight on the saddles.

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- What is the conductor weight to be lifted with the wire tong?

$$\textbf{Conductor Weight} = \frac{\textbf{Span A + Span B}}{2} \times \textbf{Weight Cond. per ft.} \times \textbf{S.F.}$$

$$\textbf{Conductor Weight} = \frac{330 + 255}{2} \times 0.1831 \times 1.5 = \frac{525}{2} \times 0.1831 \times 1.5$$

$$= 292.5 \times 0.1831 \times 1.5 = 53.56 \times 1.5 = 80.34 \text{ lbs.}$$

- What is the compressive force (weight) on the wire tong?

Compressive Force = Conductor Weight = 80.34 lbs.

- What is the pull on the fall line required to lift the wire tong?

  The weight to be lifted with the rope blocks is 80.34 or 80 lbs., and the mechanical advantage of the blocks is 4.

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of weight}$$

$$\textbf{Pull on Fall Line} = \frac{80}{4} + 8 = 20 + 8 = 28 \text{ lbs.}$$

- What is the weight on the saddle if the rope blocks were attached to the shackle?

Weight on Saddle = Conductor Weight + Pull on Fall Line

Weight on Saddle = 80 + 28 = 108 lbs.

It can be seen that the weights involved in this job are within the ratings of all tools. The weight of 108 lbs. on the saddle is well within the rating of the saddle (1000 lbs., or 800 lbs. with extension). To reduce the weight on the saddle a recommended practice is to attach the blocks to a sling installed around the pole.

Tangent X-arm Insulator Change

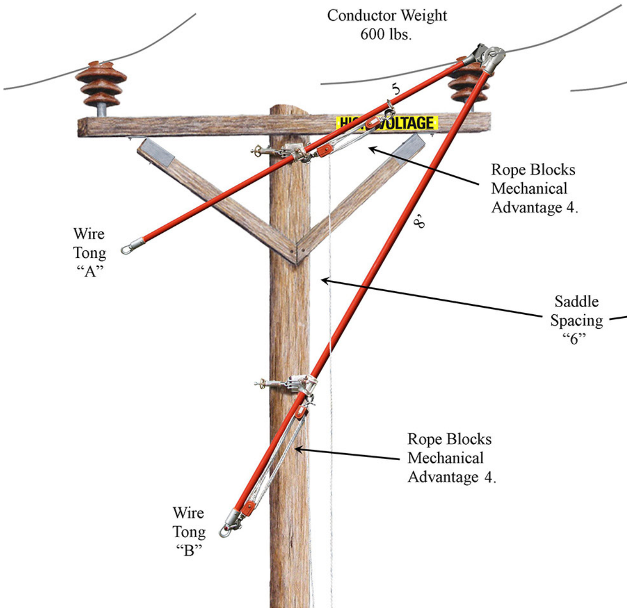

Figure 5.2.

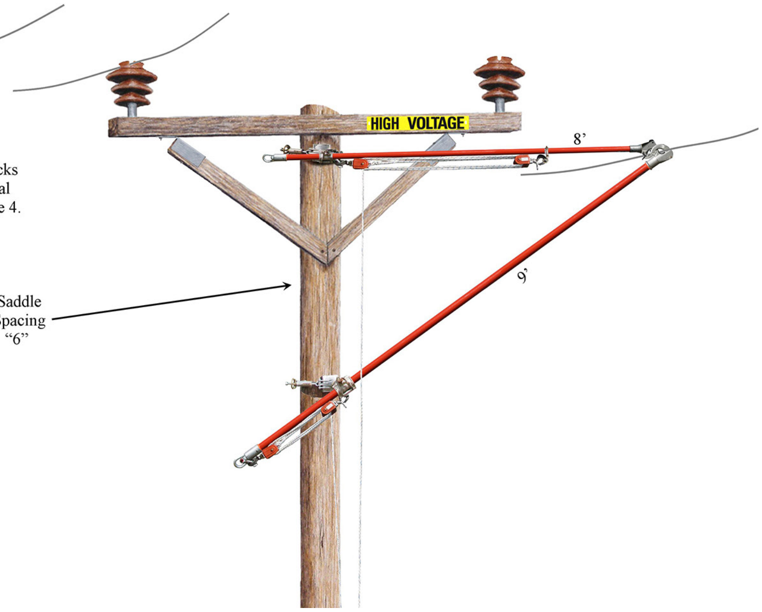

Figure 5.3.

Figures 5.2 and 5.3 show the rigging used to change the insulator on an X-arm using a 1-1/2" wire tong "A", and a 2-1/2" wire tong "B". The rope blocks used to support wire tong "A" have mechanical advantage of 4; and the blocks on wire tong "B" have a mechanical advantage of 4. The conductor weight is 600 lbs., which applies tension to wire tong "A" and compressive force to wire tong "B".

To calculate the tension on wire tong "A" in Figure 5.2, remember how you calculated guy tension previously and apply the same formula here. Consider wire tong "A" to be the guy wire; wire tong "B" to be the pole; the saddle spacing to be the anchor distance; and the conductor weight to be the line tension. By substituting these into the guy tension formula, the tension on wire tong "A" can be calculated.

$$\text{Guy Tension} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Guy Length}$$

$$\text{Tension Wire Tong "A"} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Length Wire Tong "A"}$$

$$\text{Tension Wire Tong "A"} = \frac{600 \times 5}{6} = 100 \times 5 = 500 \text{ lbs. Tension}$$

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To calculate the compressive force on wire tong "B" in Figure 5.2, remember how you calculated compressive force on a pole previously and apply the same formula here. Consider wire tong "A" to be the guy wire; wire tong "B" to be the pole; the saddle spacing to be the anchor distance; and the conductor weight to be the line tension.
By substituting these into the compressive force formula, the compressive force on wire tong "B" can be calculated.

$$\text{Compressive Force} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Pole Height}$$

$$\text{Compression Wire Tong "B"} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Length Wire Tong "B"}$$

$$\text{Compression Wire Tong "A"} = \frac{600}{6} \times 8 = 100 \times 8 = 800 \text{ lbs. Compression}$$

- What is the tension on wire tong "A" in Figure 5.3?

$$\text{Tension Wire Tong "A"} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Length Wire Tong "A"}$$

$$\text{Tension Wire Tong "A"} = \frac{600}{6} \times 8 = 100 \times 8 = 800 \text{ lbs. Tension}$$

- What is the compressive force on wire tong "B" in Figure 5.3?

$$\text{Compression Wire Tong "B"} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Length Wire Tong "B"}$$

$$\text{Compression Wire Tong "A"} = \frac{600}{6} \times 9 = 100 \times 9 = 900 \text{ lbs. Compression}$$

- What is the pull on the fall line of the rope blocks required to move wire tong "A" in Figure 5.2?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of weight}$$

$$\text{Pull on Fall Line} = \frac{500}{4} + 50 = 125 + 50 = 175 \text{ lbs.}$$

- What is the pull on the fall line of the rope block required to move wire tong "B" in Figure 5.2?

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of weight}$$

$$\textbf{Pull on Fall Line} = \frac{800}{5} + 80 = 160 + 80 = \textbf{240 lbs.}$$

- What is the pull on the fall line of the rope blocks required to move wire tong "A" in Figure 5.3?

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of weight}$$

$$\textbf{Pull on Fall Line} = \frac{800}{4} + 80 = 200 + 80 = \textbf{280 lbs.}$$

- What is the pull on the fall line of the rope block required to move wire tong "B" in Figure 5.3?

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of weight}$$

$$\textbf{Pull on Fall Line} = \frac{900}{5} + 90 = 180 + 90 = \textbf{270 lbs.}$$

It can be seen from the above examples that as the conductor is moved out away from the pole the tension and compressive force on the wire tongs increases. If the saddle spacing was reduced to 3 feet, the weight per foot on the triangle would double to 200 lbs., and therefore the tension and compressive force on the wire tongs would double. This demonstrates the importance of spacing the saddles as far apart as possible to reduce the loads placed upon tools.

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H-Frame Insulator Change

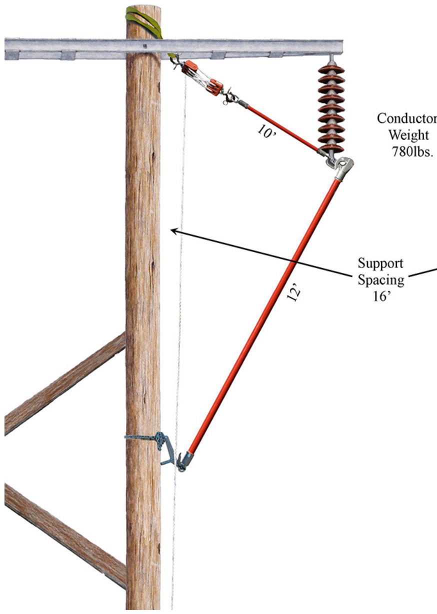

Figure 5.4.

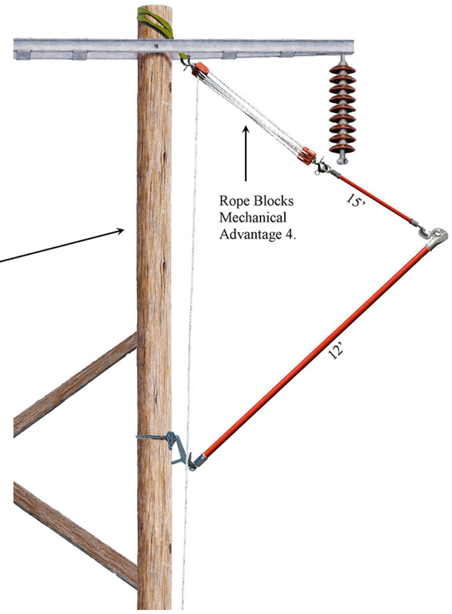

Figure 5.5.

Figures 5.4 and 5.5 show the rigging used to change a set of insulators on an H-frame structure using a 2-1/2" x 12-inch wire tong and a 1-1/2" link stick attached to a set of rope blocks with a mechanical advantage of 4. The conductor weight to be supported is 780 lbs., which applies a tension to the rope blocks and link stick, and compressive force to the wire tong.

To calculate the tension on the rope blocks and link stick in Figure 5.4, remember how you calculated guy tension previously and apply the same formula here. Consider the rope blocks and link stick to be the guy wire; the wire tong to be the pole; the support spacing to be the anchor distance; and the conductor weight to be the line tension.
By substituting these into the guy tension formula, the tension on the rope blocks and link stick can be calculated.

$$\text{Guy Tension} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Guy Length}$$

$$\text{Tension Link Stick} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length Blocks \& Link Stick}$$

$$\text{Tension Link Stick} = \frac{780}{16} \times 10 = 48.75 \times 10 = 487.5 \text{ lbs. Tension}$$

To calculate the compressive force on the wire tong in Figure 5.4, remember how you calculated compressive force on a pole previously and apply the same formula here. Consider the rope blocks and link stick to be the guy wire, the wire tong to be the pole, the support spacing to be the anchor distance, and the conductor weight to be the line tension. By substituting these into the compressive force formula, the compressive force on the wire tong can be calculated.

$$\text{Compressive Force} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Pole Height}$$

$$\text{Compression Wire Tong} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length Wire Tong}$$

$$\text{Compression Wire Tong} = \frac{780}{16} \times 12 = 48.75 \times 12 = 585 \text{ lbs. Compression}$$

- What is the tension on the rope blocks and link stick in Figure 5.5?

$$\text{Tension Link Stick} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length Blocks \& Link Stick}$$

$$\text{Tension Link Stick} = \frac{780}{16} \times 15 = 48.75 \times 15 = 731.25 \text{ lbs. Tension}$$

- What is the compressive force on the wire tong in Figure 5.5?

  The compressive force on the wire tong remains the same as the length on the wire tong, support spacing and conductor weight remains the same.

- What is the pull on the fall line of the rope blocks required to move the conductor in Figure 5.4?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of weight}$$

$$\text{Pull on Fall Line} = \frac{487.5}{4} + 48.75 = 121.88 + 48.75 = 170.63 \text{ lbs.}$$

- What is the pull on the fall line of the rope block required to move the conductor in Figure 5.5?

$$\text{Pull on Fall Line} = \frac{731.25}{4} + 73.12 = 182.81 + 73.12 = 255.93 \text{ lbs.}$$

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Single Ø Angle Insulator Change

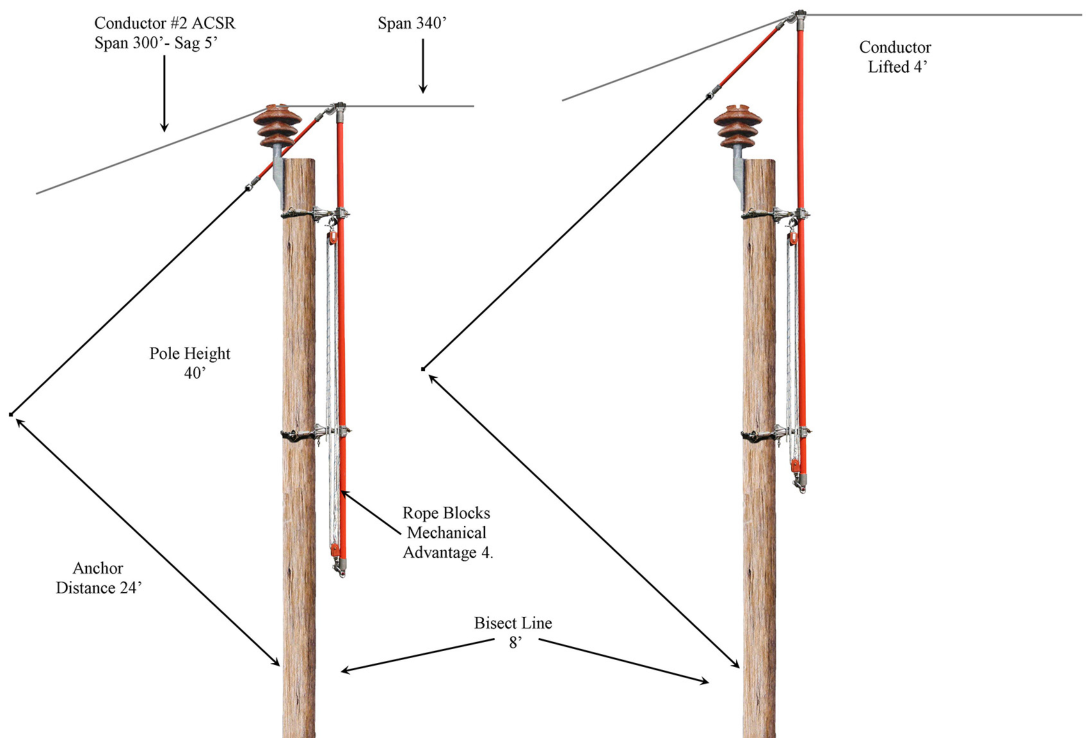

Figure 5.6. Figure 5.7.

Figures 5.6 and 5.7 illustrate a single phase angle insulator change using a 2-1/2" x 12-foot wire tong, a roller link stick with a guy rope, and a set of rope blocks with a mechanical advantage of 4. In this job the weights and forces involved are: conductor weight, line tension, bisect tension, tension on the roller link stick and guy rope, the compressive force on the wire tong, pull on the fall line of the rope blocks; and the weight on the saddles. As the conductor is moved up 4 inches to allow for working clearance, the forces change on the equipment.

- What is the weight of the conductor at the point of lifting?

$$\textbf{Conductor Weight} = \frac{\text{Span "A"} + \text{Span "B"}}{2} \times \text{Weight of Cond. per ft.} \times \text{S.F.}$$

$$\textbf{Conductor Weight} = \frac{300 + 340}{2} \times 0.0913 \times 1.5 = \frac{640}{2} \times 0.0913 \times 1.5$$

$$= 320 \times 0.0913 \times 1.5 = 29.2 \times 1.5 = 43.9 \text{ lbs.}$$

- What is the line tension that has to be calculated to find the bisect tension?

$$\text{Line Tension} = \frac{\text{Weight of Cond. per ft.} \times (\text{Span})^2}{8 \times \text{Sag in ft.}}$$

$$\text{Line Tension} = \frac{0.0913 \times (300)^2}{8 \times 5} = \frac{0.0913 \times 90000}{40} = \frac{8217}{40} = 205.4 \text{ lbs.}$$

- What is the bisect tension of the angle shown in Figures 5.6 and 5.7?

$$\text{Bisect Tension} = \frac{\text{Line Tension}}{50} \times 2 \times \text{Bisect Line}$$

$$\text{Bisect Tension} = \frac{205.4}{50} \times 2 \times 8 = 4.1 \times 2 \times 8 = 8.2 \times 8 = 65.6 \text{ lbs.}$$

- What is the tension on the roller link stick and guy rope used to support the bisect tension in Figure 5.6?

  In order to find the tension on the roller link and guy rope the length must first be calculated.

$$\text{Guy Length} = \sqrt{\text{Anchor Distance}^2 + \text{Pole Height}^2}$$

$$\text{Guy Length} = \sqrt{24^2 + 40^2} = \sqrt{576 + 1600} = \sqrt{2176} = 46.65 \text{ feet}$$

$$\text{Guy Tension} = \frac{\text{Line Tension}}{\text{Anchor Distance}} \times \text{Guy Length}$$

  In this case the roller link stick and guy rope are supporting only the bisect tension and therefore, we substitute bisect tension for line tension in the guy tension formula.

$$\text{Guy Tension} = \frac{\text{Bisect Tension}}{\text{Anchor Distance}} \times \text{Guy Length}$$

$$\text{Guy Tension} = \frac{65.6}{24} \times 46.65 = 2.73 \times 46.65 = 127.35 \text{ lbs.}$$

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- What is the tension on the roller link stick and guy rope used to support the bisect tension in Figure 5.7?

  Because the conductor was lifted 4 feet, the guy length increased and has to be recalculated.

$$\text{Guy Length} = \sqrt{\text{Anchor Distance}^2 + \text{Pole Height}^2}$$

$$\text{Guy Length} = \sqrt{24^2 + 44^2} = \sqrt{576 + 1936} = \sqrt{2512} = 50.12 \text{ feet}$$

$$\text{Guy Tension} = \frac{\text{Bisect Tension}}{\text{Anchor Distance}} \times \text{Guy Length}$$

$$\text{Guy Tension} = \frac{65.6}{24} \times 50.12 = 2.73 \times 50.12 = 136.8 \text{ lbs.}$$

- What is the total compressive force on the wire tong in Figure 5.6?

$$\text{Compressive Force} = \frac{\text{Bisect Tension}}{\text{Anchor Distance}} \times \text{Pole Height}$$

$$\text{Compressive Force} = \frac{65.6}{24} \times 40 = 2.73 \times 40 = 109.2 \text{ lbs.}$$

  The 109.2 lbs. is the compressive force applied to the wire tong supporting the bisect tension. To find the total compressive force on the wire tong, we add the compressive force and the conductor weight.

$$\text{Total Compressive Force} = \text{Compressive Force} + \text{Conductor Weight}$$

$$\text{Total Compressive Force} = 103.2 + 43.9 = 153.1 \text{ lbs.}$$

- What is the total compressive-force on the wire tong after the conductor has been moved up 4" as shown in Figure 5.7?

$$\text{Compressive Force} = \frac{\text{Bisect Tension}}{\text{Anchor Distance}} \times (\text{Pole Height} + 4)$$

$$\text{Compressive Force} = \frac{65.6}{24} \times (40 + 4) = 2.73 \times 44 = 120.12 \text{ lbs.}$$

$$\text{Total Compressive Force} = \text{Compressive Force} + \text{Conductor Weight}$$

$$\text{Total Compressive Force} = 120.1 + 43.9 = 164 \text{ lbs.}$$

- What is the pull required on the fall line of the rope blocks to lift the wire with the wire tong in Figure 5.6?

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of Weight}$$

$$\textbf{Pull on Fall Line} = \frac{153}{4} + 15.3 = 38.25 + 15.3 = 53.55 \text{ lbs.}$$

- What is the pull on the fall line of the rope blocks in Figure 5.7?

$$\textbf{Pull on Fall Line} = \frac{\textbf{Weight to be Lifted}}{\textbf{Mechanical Advantage}} + \textbf{10\% of Weight}$$

$$\textbf{Pull on Fall Line} = \frac{164}{4} + 16.4 = 41 + 16.4 = 57.4 \text{ lbs.}$$

- What is the weight on the saddles in Figure 5.6 if the rope blocks were attached to the saddle clevis?

Weight on Saddle = Compression on Wire Tong + Pull on Fall Line

Weight on Saddle = 120.1 + 57.4 = 177.5 lbs.

- What is the weight on the saddles in Figure 5.7 if the rope blocks were attached to the saddle clevis?

Weight on Saddle = Compression on Wire Tong + Pull on Fall Line

Weight on Saddle = 164 + 57.4 = 221.4 lbs.

From the above examples, it can be seen that as the conductor is moved up for working clearance the weights and forces on all the equipment increases. It is important, when calculating the weights and forces to be handled, that they are calculated for both the conductor in the original position and for the conductor at the moved position. If in this job the weights and forces were heavier, they may exceed equipment ratings in the moved position.

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Cross Arm Angle Insulator Change

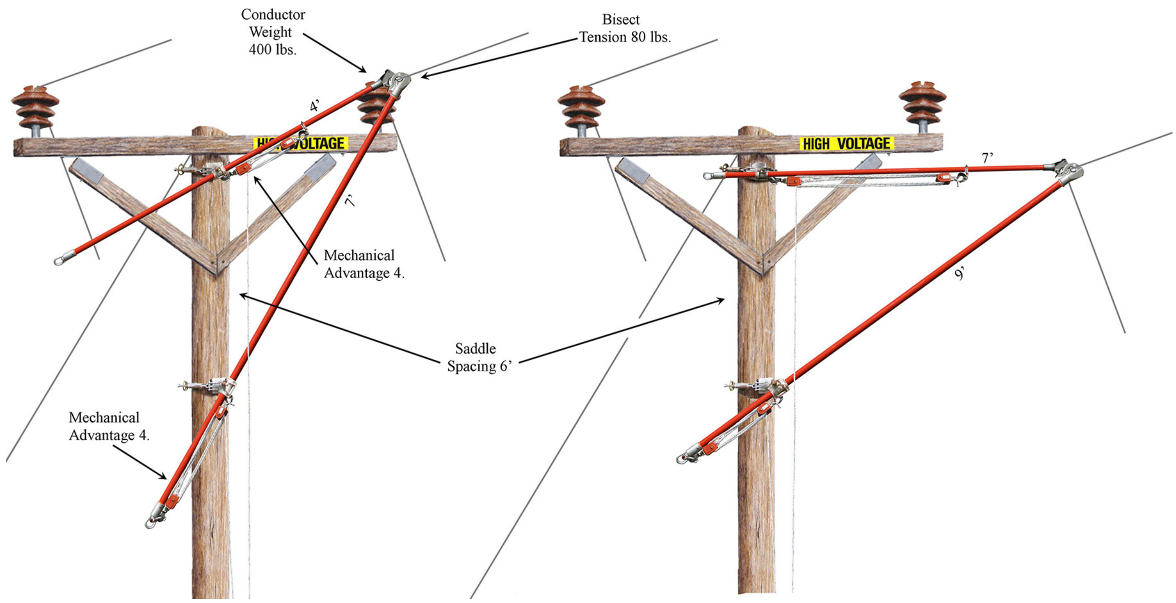

Figure 5.8. Figure 5.9.

Figures 5.8 and 5.9 show the rigging used to change the insulator on the cross arm of an angle structure, using a 1-1/2" x 10-foot wire tong ("A") with a set of rope blocks supporting the tension having a mechanical advantage of 4; and a 2-1/2" x 12-foot wire tong ("B") under compression of the conductor weight. A set of rope blocks with a mechanical advantage of 4 is used to support this weight.

The saddle spacing is 6 feet, the conductor weight is 400 lbs., and the bisect tension of the corner is 80 lbs. For this job we need to know the tension on wire tong "A" in Figure 5.8; the pull on the fall line of the rope blocks supporting this tension; the compression on wire tong "B" to Figure 5.8; the pull on the fall line of the rope blocks on wire tong "B" in Figure 5.8; and the weights on the saddles of both wire tongs in Figure 5.8 if the rope blocks are attached to the saddle clevis. Finally, we need to know how all these weights and forces will change when the conductor is moved out to provide working clearance as shown in Figure 5.9.

- What is the tension on the wire tong "A" in Figure 5.8?

$$\textbf{Tension} = \frac{\textbf{Conductor Weight}}{\textbf{Saddle Spacing}} \times \textbf{Wire Tong Length}$$

$$\textbf{Tension} = \frac{400}{6} \times 4 = 66.7 \times 4 = 266.7 \textbf{ lbs.}$$

- Wire tong “A” is also supporting the bisect tension, so this must be added to the tension on the wire tong from the conductor weight to find the total tension on the wire tong.

Tension Wire Tong “A” = 266.7 + 80 = 346.7 lbs.

- What is the pull on the fall line of the rope blocks on wire tong “A” in Figure 5.8?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{347}{4} + 34.7 = 86.75 + 34.7 = 121.45 \text{ lbs.}$$

- What is the compressive force on wire tong “B” in Figure 5.8?

$$\text{Compression} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Wire Tong Length}$$

$$\text{Compression} = \frac{400}{6} \times 7 = 66.7 \times 7 = 466.9 \text{ lbs.}$$

- What is the pull on the fall line of the rope blocks on wire tong “B” in Figure 5.8?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{467}{4} + 46.7 = 116.75 + 46.7 = 163.45 \text{ lbs.}$$

- What is the weight on the saddle of wire tong “A” in Figure 5.8, if the rope blocks were attached to the clevis on the saddle?

Weight on Saddle = Tension + Pull on Fall Line

Weight on Saddle = 346.7 + 121.45 = 468.15 lbs.

- What is the weight on the saddle of wire tong "B" in Figure 5.8, if the rope blocks were attached to the clevis on the saddle?

Weight on Saddle = Tension + Pull on Fall Line

Weight on Saddle = 466.9 + 163.45 = 630.35 lbs.

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- What is the tension on wire tong "A" in Figure 5.9?

$$\text{Tension} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Wire Tong Length}$$

$$\text{Tension} = \frac{400}{6} \times 7 = 66.7 \times 7 = 466.9 \text{ lbs.}$$

Total Tension = Tension + Bisect Tension

Total Tension = 46&9 + 80 = 546.9 lbs.

- What is the pull required on the fall line of the rope blocks on wire tong "A" to move the conductor back into position as shown in Figure 5.9?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{546.9}{4} + 54.7 = 136.7 + 54.7 = 191.4 \text{ lbs.}$$

- What is the compressive force on wire tong "B" in Figure 5.9?

$$\text{Compression} = \frac{\text{Conductor Weight}}{\text{Saddle Spacing}} \times \text{Wire Tong Length}$$

$$\text{Compression} = \frac{400}{6} \times 9 = 66.7 \times 9 = 600.3 \text{ lbs.}$$

- What is the pull on the fall line of the rope blocks on wire tong "B" in Figure 5.9?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{600}{4} + 60 = 150 + 60 = 210 \text{ lbs.}$$

- What is the weight on the saddle of wire tong "A" in Figure 5.9, if the rope blocks were attached to the clevis on the saddle?

Weight on Saddle = Tension + Pull on Fall Line

Weight on Saddle = 546.9 + 191.4 = 738.3 lbs.

- What is the weight on the saddle of wire tong "B" in Figure 5.9, if the rope blocks were attached to the clevis on the saddle?

Weight on Saddle = Tension + Pull on Fall Line

Weight on Saddle = 600 + 210 = 810 lbs.

It can be seen that when the conductor is moved, the weight on the wire tongs, pull on the fall lines, and the weight on the saddles increase as the conductor is laid out. The weight on the saddle is getting near the rating of a saddle with an extension (800 lbs.), and it is advised to put the blocks on a sling around the pole in this example to remove the pull of the fall lines from the saddles.

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Running Angle Insulator Change

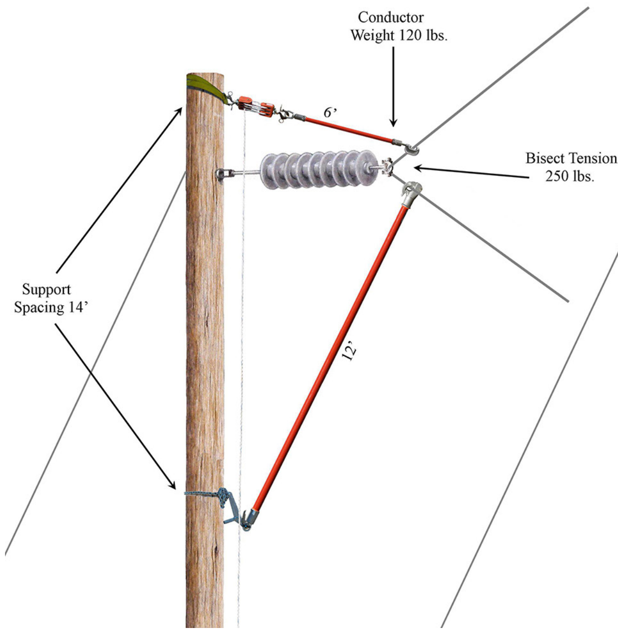

Figure 5.10.

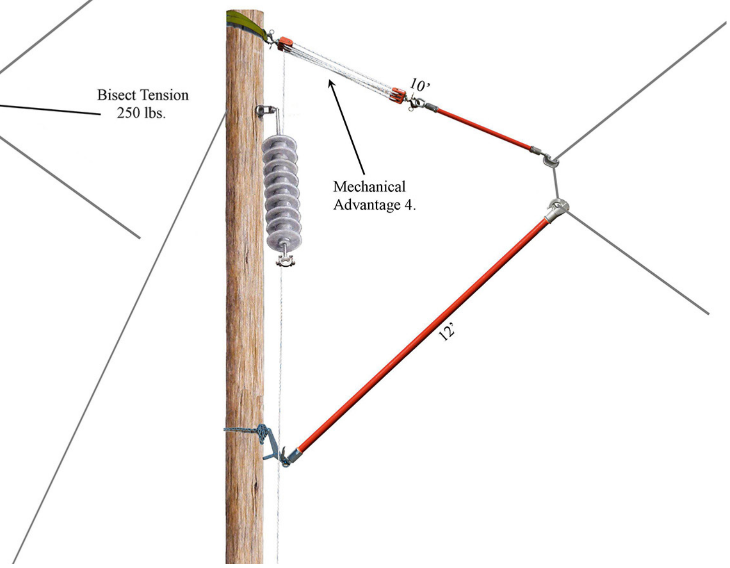

Figure 5.11.

Figures 5.10 and 5.11 show the rigging used to change the insulators on a running angle structure, using a 1-1/2" x 4-foot strain link stick with a set of rope blocks with a mechanical advantage of 5. A lever lift with a 2-1/2" x 12-foot wire tong is used to support the weight of the conductor. The conductor weight is 120 lbs., the bisect tension is 250 lbs., and the spacing between the support points is 14 feet. In this job we need to calculate the tension on the rope blocks and link stick, the pull on the fall line of the rope blocks, and the compression on the wire tong in Figure 5.10. We must also calculate these weights and forces for Figure 5.11 where the wire has been moved out for working clearance.

- What is the tension on the rope blocks and link stick in Figure 5.10?

$$\text{Tension} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length Link Stick and Blocks}$$

$$\text{Tension} = \frac{120}{14} \times 6 = 8.6 \times 6 = 51.6 \text{ lbs.}$$

$$\text{Total Tension} = \text{Tension} + \text{Bisect Tension}$$

$$\text{Total Tension} = 51.6 + 250 = 301.6 \text{ lbs.}$$

- What is the pull on the fall line of the rope blocks on the link stick in Figure 5.10?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\%\text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{301.6}{4} + 30.2 = 75.4 + 30.2 = 105.6\text{ lbs.}$$

- What is the compression on the wire tong and lever lift in Figure 5.10?

$$\text{Compression} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length of Wire Tong}$$

$$\text{Compression} = \frac{120}{14} \times 12 = 8.6 \times 12 = 103.2\text{ lbs.}$$

- What is the tension on the rope blocks and link stick after the conductor is moved out for working clearance as shown in Figure 5.11?

$$\text{Tension} = \frac{\text{Conductor Weight}}{\text{Support Spacing}} \times \text{Length Link Stick and Blocks}$$

$$\text{Tension} = \frac{120}{14} \times 10 = 8.6 \times 10 = 86\text{ lbs.}$$

$$\text{Total Tension} = \text{Tension} + \text{Bisect Tension}$$

$$\text{Total Tension} = 86 + 250 = 336\text{ lbs.}$$

- What is the pull required on the fall line of the rope blocks in Figure 5.11 to move the conductor back into its original position?

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\%\text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{336}{4} + 33.6 = 84 + 33.6 = 117.6\text{ lbs.}$$

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Vertical Corner Insulator Change

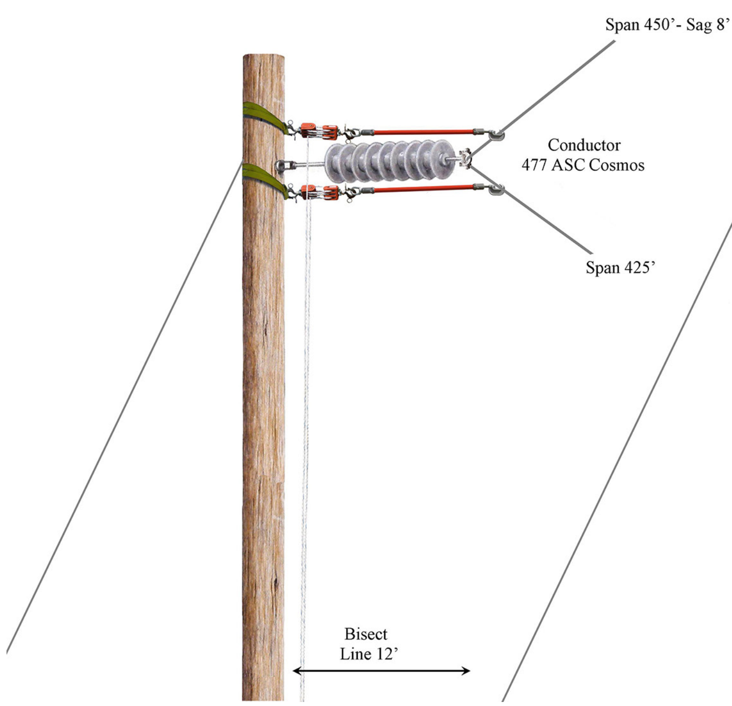

Figure 5.12.

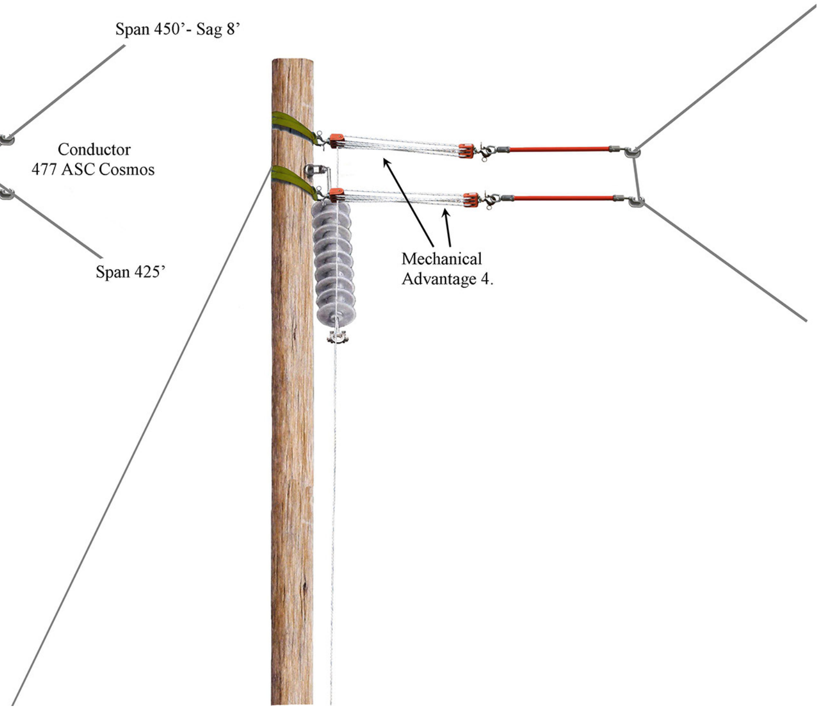

Figure 5.13.

Figures 5.12 and 5.13 illustrate the rigging used to change the insulators on a vertical corner. The conductor is supported by two 1-1/2" x 42-inch spiral link sticks, each attached to a set of rope blocks with a mechanical advantage of 5. The span lengths are 450 feet and 425 feet, the sag in the 450-foot span is 8 feet, the conductor is 477 ASC Cosmos, and the bisect line has been measured at 12 feet. For this job we need to calculate the line tension, the bisect tension that has to be supported, the conductor weight, and the pull on the fall lines of the rope blocks in Figure 5.12.

- What is the line tension that has to be calculated in order to find the bisect tension?

$$\textbf{Line Tension} = \frac{\textbf{Conductor Weight/ft} \times (\textbf{Span Length})^2}{8 \times \textbf{Sag in feet}}$$

$$\textbf{Line Tension} = \frac{.446 \times 450^2}{8 \times 8} = \frac{.446 \times 202500}{64} = \frac{90315}{64} = 1411 \text{ lbs.}$$

- What is the bisect tension that has to be supported?

$$\text{Bisect Tension} = \frac{\text{Line Tension}}{50} \times 2 \times \text{Bisect Line}$$

$$\text{Bisect Tension} = \frac{1411}{50} \times 2 \times 12 = 28.22 \times 2 \times 12 = 56.44 \times 12 = 677.28 \text{ lbs.}$$

- What is the conductor weight at the point of attachment to the insulators?

$$\text{Conductor Weight} = \frac{\text{Span "A"} + \text{Span "B"}}{2} \times \text{Cond. Weight/ft.} \times \text{SF.}$$

$$\text{Conductor Weight} = \frac{450 + 425}{2} \times .446 \times 1.5 = \frac{875}{2} \times .446 \times 1.5$$

$$= 437.5 \times 446 \times 1.5 = 195.1 \times 1.5 - 292.7 \text{ lbs.}$$

- What is the total tension that must be supported by the rope blocks and link sticks?

$$\text{Total Tension} = \text{Conductor Weight} + \text{Bisect Tension}$$

$$\text{Total Tension} = 292.7 + 677.3 = 970 \text{ lbs.}$$

- What is the pull on the fall lines of the rope blocks?

  The way this job is rigged splits the tension that must be supported in half between each set of rope blocks and link sticks.

$$\text{Weight} = 970 / 2 = 485 \text{ lbs.}$$

$$\text{Pull on Fall Line} = \frac{\text{Weight to be Lifted}}{\text{Mechanical Advantage}} + 10\% \text{ of Weight}$$

$$\text{Pull on Fall Line} = \frac{485}{4} + 48.5 = 121.25 + 48.5 = 169.75 \text{ lbs.}$$

In Figure 5.13 the weights and forces that have to be supported when the Conductor is let out for working clearance will be less than those calculated in Figure 5.12. As the conductor is let into the comer, the bisect and line tensions will decrease as slack is added to the line. If the conductor had to be moved away from the corner the weights and forces would increase,

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Deadend Insulator Change

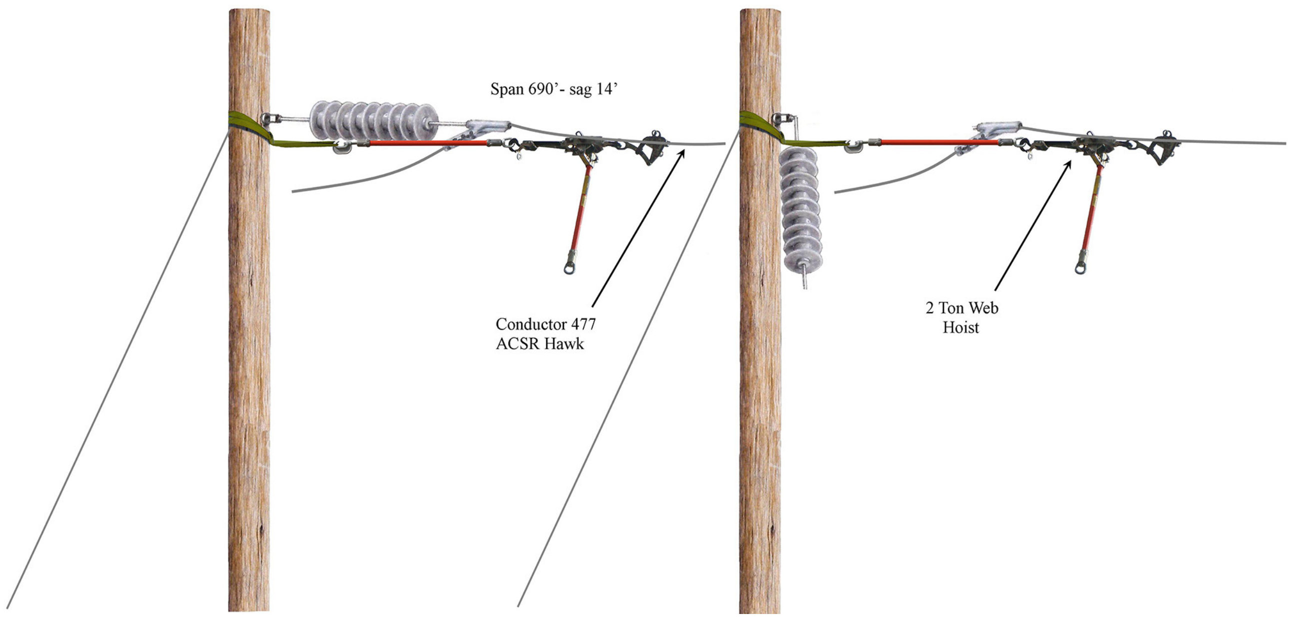

Figure 5.14.

Figure 5.14 shows the rigging used to change the insulators on a deadend structure, the span length is 690 feet, the sag in the span is 14 feet, and the conductor is 477 ACSR Hawk. The rigging used on this job is a 1-1/2" x 42-inch spiral link stick and a 2-ton web hoist, the only force to deal with on this job is line tension. We must calculate it to make sure all the rigging (slings, link stick, and web hoist) is capable of handling the line tension.

- What is the line tension that has to be supported to change the deadend insulators in Figure 5.14?

$$\textbf{Line Tension} = \frac{\textbf{Conductor Weight/ft} \times \textbf{(Span Length)}^2}{8 \times \textbf{Sag in feet}}$$

$$\textbf{Line Tension} = \frac{.655 \times 690^2}{8 \times 14} = \frac{.655 \times 476100}{112} = \frac{311845.5}{112} = 2784.3 \text{ lbs.}$$

It can be seen that the line tension of 2785 lbs. can be safely handled by the 2-ton web jack (4000 lbs.) and the link stick (3500 lbs.). A sling must be chosen to ensure that it is capable of supporting this weight.

6. PG&E Wire Data

Table 1. Bare Aluminum Conductor (AAC)

Size-Stranding	Code Word	Class	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil			(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
1/0 - 7	Poppy*	A,AA	0.368	0.099	0.1670	0.2000	42.9
2/0 - 7	Aster*	A,AA	0.414	0.125	0.1330	0.1590	54.1
3/0 - 7	Phlox*	A,AA	0.464	0.157	0.1050	0.1260	68.0
4/0 - 7	Oxlip*	A,AA	0.522	0.198	0.0835	0.1000	85.7
250 - 19	Valerian**	A	0.574	0.235	0.0709	0.0849	101.8
266.8 - 7	Daisy*	AA	0.586	0.250	0.0663	0.0793	108.3
266.8 - 19	Laurel*	A	0.593	0.250	0.0663	0.0793	108.3
300 - 19	Peony**	A	0.629	0.282	0.0591	0.0707	122.1
336.4 - 19	Tulip*	A	0.666	0.316	0.0526	0.0630	136.8
350 - 19	Daffodil*	A	0.679	0.328	0.0506	0.0605	142.0
397.5 - 19	Canna*	A,AA	0.723	0.372	0.0446	0.0534	161.1
477 - 37	Syringa*	A	0.795	0.447	0.0373	0.0445	193.6
500 - 37	Hyacinth*	A	0.813	0.468	0.0356	0.0425	202.6
715.5 - 37	Violet*	AA	0.974	0.671	0.0251	0.0299	290.5
954 - 37	Magnolia*	AA	1.124	0.895	0.0191	0.0226	387.5
954 - 61	Goldenrod*	A	1.126	0.895	0.0191	0.0226	387.5
1113 - 61	Marigold*	A,AA	1.216	1.044	0.0165	0.0195	452.1
1431 - 61	Carnation*	A,AA	1.379	1.342	0.0132	0.0155	581.1
2300 - 61	Pigweed*	A	1.749	2.177	0.0090	0.0103	942.6

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* REYNOLDS METALS COMPANY — PROJECT DATA SHEET, NOVEMBER 1991.

** ALCOA CONDUCTOR PRODUCTS COMPANY — T&D CONDUCTORS, SUMMER 1994.

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Table 2. Bare Aluminum Conductor Steel Reinforced (ACSR)

Size-Stranding	Code Word	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil		(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
4 - 6/1	Swan*	0.250	0.057	0.4120	0.5220	20.8
2 - 6/1	Sparrow*	0.315	0.091	0.2590	0.3360	33.1
2 - 7/1	Sparate*	0.325	0.107	0.2560	0.3300	36.6
80 - 8/1	Grouse*	0.367	0.149	0.2110	0.2610	48.5
1/0 - 6/1	Raven*	0.398	0.145	0.1630	0.2160	52.6
2/0 - 6/1	Quail*	0.447	0.183	0.1300	0.1760	66.4
3/0 - 6/1	Pigeon*	0.502	0.231	0.1030	0.1450	84.0
4/0 - 6/1	Penguin*	0.563	0.291	0.0822	0.1160	105.4
266.8 - 26/7	Partridge*	0.642	0.367	0.0651	0.0780	133.7
336.4 - 30/7	Oriole*	0.741	0.526	0.0513	0.0615	182.8
397.5 - 26/7	Ibis*	0.783	0.547	0.0438	0.0524	199.1
452.3 - 30/7	**	0.861	0.710			
518 - 42/19	***	1.000	1.117	0.0320	0.0383	354.0
518 - 42/19	****	1.000	1.117	0.0320	0.0383	346.8
605 - 30/19	Teal*	0.994	0.939	0.0287	0.0343	326.7
795 - 54/7	Condor*	1.092	1.023	0.0222	0.0273	383.5
954 - 54/7	Cardinal*	1.196	1.227	0.0186	0.0228	460.3
804.5 - 38/19	*****	1.213	1.570			
1113 - 54/19	Finch*	1.292	1.429	0.0161	0.0197	537.2
1272 - 45/7	Bittern*	1.345	1.432	0.0144	0.0171	569.3
1852 - 51+12/7	******	1.600	1.940			800.7
1855-69/37	*******	1.753	2.951			

Lt. Gray	Not Approved For Purchase

* DATA FROM REYNOLDS METALS COMPANY — PROJECT DATA SHEET, NOVEMBER 1991.

** PG&E CONDUCTOR DATA SHEET, GREAT WEST. PWR CO, 4/12/20, CARIBOU-GOLDEN GATE T/L.

*** PG&E CONDUCTOR DATA SHEET, ALCOA COMPANY OF AMERICA, 6/6/30, PIT #3 T/L.

**** PG&E CONDUCTOR DATA SHEET, ALCOA COMPANY OF AMERICA, TIGER CREEK-NEWARK T/L.

***** PG&E SAG TEN PROGRAM, ALCOA COMPANY OF AMERICA.

****** PG&E CONDUCTOR DATA SHEET, ROME CABLE CORPORATION, 11/8/62.

******* PG&E SAG AND TENSION PROGRAM.

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Table 3. Bare Aluminum Conductor Steel Supported (ACSS)

Size-Stranding	Code Word	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil		(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
477 - 24/7	Flicker/SSAC*	0.846	0.614	0.0357	0.0429	229.8
954 - 54/7	Cardinal/SSAC*	1.196	1.227	0.0181	0.0223	460.3
1113 - 54/19	Finch/SSAC*	1.292	1.429	0.0157	0.0193	537.2
2156 - 90/37	**	2.012	4.406	0.0085	0.0104	1395.2

* DATA FROM REYNOLDS METALS COMPANY — PROJECT DATA SHEET, NOVEMBER 1991.

** PG&E CONDUCTOR DATA SHEET, REYNOLDS METALS COMPANY, 7/29/81, LAKEVILLE-SOBRANTE 230KV T/L.

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Table 4. Bare MHD Concentric Stranded Copper Conductor

Size-Stranding	ASTM Class	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil		(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
4 - 7	A	0.232	0.129	0.2670	0.3184	24.8
3 - 3	AA	0.285	0.161	0.2099	0.2495	30.9
2 - 7	A	0.292	0.205	0.1670	0.1992	39.4
2 - 3	AA	0.320	0.203	0.1660	0.1979	39.0
1 - 7	A	0.328	0.258	0.1330	0.1586	49.5
1/0 - 7	AA	0.368	0.326	0.1052	0.1254	62.6
2/0 - 7	AA	0.414	0.411	0.0836	0.0997	78.9
3/0 - 7	AA	0.464	0.518	0.0662	0.0789	99.5
4/0 - 7	AA	0.522	0.653	0.0525	0.0626	125.4
250 - 19	A	0.574	0.772	0.0447	0.0533	148.2
500 - 37	A	0.813	1.544	0.0227	0.0270	296.4
500 - 37/7	G	0.922	1.585	0.0232	0.0277	304.3
1000 - 37	AA	1.151	3.088	0.0119	0.0142	592.9

Lt. Gray	Not Approved For Purchase

ANACONDA WIRE AND CABLE COMPANY, SECTION 16, CONDUCTORS FOR WIRE AND CABLE, PUBLICATION C-79, 1951.

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Table 6. Bare Solid MHD Copper Conductor

Size-Stranding	Class	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil		(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
6 - 1	MHD	0.162	0.079	0.4155	0.4954	15.2
4 - 1	MHD	0.204	0.126	0.2608	0.3110	24.2

Lt. Gray	Not Approved For Purchase

COPPER WIRES AND CABLES, CATALOG 490-CUWC, 1949 EDITION, GENERAL CABLE CORPORATION.

9/3/96 — FINAL REVISION — ALL VALUES VERIFIED AND CHECKED.

Table 7. Bare Stranded Copperweld-Copper Conductor

Size-Stranding	Type	Diameter	Weight	AC Resistance At 25° C.	AC Resistance At 75° C	Heat Capacity
AWG or kcmil		(in.)	(lbs./ft.)	(Ohms\1000 ft.)	(Ohms\1000 ft.)	(Watts-S/ft.-C)
4A - 2/1	A	0.290	0.162	0.2686	0.3184	32.4

Lt. Gray	Not Approved For Purchase

ALCOA CONDUCTOR PRODUCTS COMPANY DATA SHEET, BIMETALLIC PRODUCTS, TABLE 1, PAGE 12.

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