TALL TOWER INSTALLATION MANUAL

ARE Tilt-up, Guyed, Pipe Towers for ARE110 & AWP-3.6 Wind Generators

Tall Towers - 106 and 127 feet tall

Contents

1) Introduction

This installation manual pertains to a set of towers designed and manufactured by ***ABUNDANT RENEWABLE ENERGY (ARE)*** for the AWP-3.6 wind generator. These towers are tilt up, guyed, pipe towers from 43 to 127 feet tall. This manual covers only towers of heights 106 and 127 feet. The 43, 64, and 85 foot towers are covered in the "Short Tower Installation Manual". All of these towers are based on galvanized 4-inch, schedule-10 pipe. The tower consists of a series of 21-foot sections, joined together by couplers. These couplers are the upper attachment points for the guy cables, except the topmost guy attachments, which are made at four (4) points below the wind generator to allow for blade clearance. Tall towers utilize a 42-foot long gin pole – comprised of two 21-foot sections – which acts as a lever arm to raise and lower the tower. The tower is secured by guy cables connected to anchors at three points and to the gin pole for the fourth point. For these towers, there are five concrete foundations: one for the tower base and four for guy cable anchors.

Tilt-up towers are NOT designed to be climbed at any time.

2) Site Selection and Preparation

The ideal site for a tower is a flat, level field. However, any reasonably level space, in which there is sufficient space for the foundations, can be utilized. A hillside can also be usable if a line in the terrain can be located, permitting the side guy anchors and the base to be level with each other.

Tall tower anchors are approximately 43 feet, 6 inches from the base. The site should be free from obstructions (e.g. trees, buildings) and the tower height should extend at least 35 feet above any obstacles within a 500-feet radius from the tower. Plan for the future, bearing in mind that trees will grow taller over time. See the AWP-3.6 wind generator installation manual for more detailed information on siting a wind generator/tower.

The tower site must be cleared of all trees and brush to allow for the assembly and raising of the tower. The foundation radius from the center foundation is approximately 46 feet. An additional strip of land 114 or 135 feet (for 106 or 127 foot towers, respectively) must be cleared on the "down-side" (opposite the hoist-side) for the tower when it is in the "down" position. See drawings D2, D3, D6, D7, D8, D9, and D12 in the manual appendix to assist with selecting and laying out your site.

3) Tools & Materials List

Foundation:

- Gloves
- Shovel
- Tape measure (50-100 ft.)
- Leveling tool & laser level or string
- Site level or transit
- Masonry mortar type “S”
- Clamps
- Rebar bender
- Rebar or wire mesh (see Section 5 “Tower Foundations”)
- Wire ties

Tower Installation:

- Concrete (minimum 5 yards)
- Pliers/channel locks
- Combination wrenches or nut drivers for saddle clamps (7/16” & 1/2"), pivot and pin bolts (3/4”, 15/16”, 1-1/16”), and turnbuckles (7/8” & 9/16”)
- Round file (Ø1/8” – 3/8” range)
- Cable cutters (for steel wire rope)
- Galvanizing spray (zinc-rich spray paint, such as “Hard Hat” …)
- Heavy hammer & block of wood
- Rope
- Winch or Grip-Puller/GripHoist

4) Tower Parts List

The complete tower kit contents are listed in Table 1 below.

Part Description	Qty. Per Tower	
	106’	127’
Foundation Kit		
Anchor	4	4
J-Bolt – 5/8” x 8”	4	4
Nut – 5/8”	8	8
Washer – 5/8”	8	8
Eye Bolt – 1/2” x 6”	2	2
Nut – 1/2”	4	4
Washer – 1/2”	4	4
Template (paper), base plate	1	1
Tower & Gin Pole Pipe Sections		
Pipe, tower base	1	1
Pipe, tower middle	3	4
Pipe, tower top	1	1
Pipe, gin pole base	1	1
Pipe, gin pole end	1	1

Part Description	Qty. Per Tower	
	106'	127'
Attachments to Tower, Gin Pole, Guy & Anchor Cables		
Plate, tower base	1	1
Plate, equalizer (6-hole)	3	3
Plate, equalizer (4-hole for gin pole)	1	1
Fitting, gin pole end (6-hole)	1	1
Fitting, top flange	1	1
Coupler, gin pole	1	1
Gusset, gin pole	2	2
Tang, top guy	4	4
Saddle clamp – 3/16”	63	78
Saddle clamp – 5/16”	15	15
Shackle – 1/2”	4	4
Shackle – 5/8”	4	4
Thimble – 3/8” (for Ø3/16” cable)	21	26
Thimble – 1/2” (for Ø5/16” cable)	5	5
Turnbuckle, jaw-eye – 1/2” x 12”	20	24
Turnbuckle, jaw-jaw – 5/8” x 6”	1	1
Bolt – 1/2” x 6” (pin)	7	7
Bolt – 5/8” x 7” (tangs)	2	2
Bolt – 3/4” x 8” (pivot)	1	1
Nut, Nylok – 1/2” (pin)	7	7
Nut, Nylok – 5/8” (tangs)	2	2
Nut – 3/4” (pivot)	2	2
Washer – 1/2” (pin)	14	14
Washer – 3/4” (pivot)	2	2
Hoist Rigging		
Cable – Ø3/16” (backhaul leash)	1 (x 190’)	1 (x 250’)
Cable – Ø5/16” x 4’ with crimped eye (top cable leash)	1	1
Eye Bolt – 1/2” x 6” (to mount backhaul leash pulley – 127’ only)	0	1
Pulley (backhaul) – 3”	0	1
Saddle clamp – 3/16”	9	9
Shackle – 1/2”	7	8
Thimble – 1/2” (for Ø5/16” cable)	1	1
Winch - Cable – Ø5/16” x 4’ with crimped eye (backhaul leash)	0	1
Guy Couplers & Cables		
Coupler – attached with (4) Ø3/16” x 52’ cables (tower)	1	1
Coupler – attached with (3) Ø3/16” x 65’ cables (tower)	1	1
Coupler – attached with (3) Ø3/16” x 81’ cables (tower)	1	1
Coupler – attached with (3) Ø3/16” x 100’ cables (tower)	1	1
Coupler – attached with (3) Ø3/16” x 120’ cables (tower)	0	1
Cable – Ø3/16” x 65’ without crimped eye (tower)	1	1
Cable – Ø3/16” x 81’ without crimped eye (tower)	1	1
Cable – Ø3/16” x 100’ without crimped eye (tower)	1	1
Cable – Ø3/16” x 120’ without crimped eye (tower)	0	1
Cable – Ø5/16” x *(see chart)* with crimped eye (tower top)	3 (x 115’)	3 (x 135’)
Cable – Ø5/16” x *(see chart)* without crimped eye (tower top)	1 (x 115’)	1 (x 135’)
Cable – Ø3/16” x 65’ with crimped eye (gin pole)	2	2

Table 1

5) Tower Foundations

The typical foundations are concrete blocks 3' x 3' x 4' deep, using steel anchors and reinforcing bar or wire mesh. The foundations are cast in holes dug in the ground. The minimum concrete strength is 2,500 psi. Foundations laid in areas where the ground freezes deeper than 4 feet must be modified to extend below the frost line. If excavating becomes difficult within the 3' x 3' footprint, the foundation may be drilled. Concrete forms are required for foundations only if the foundation must extend above the soil surface (in order to have guy foundations level with the base). Even when using forms, the hole depth should be a minimum of 4 feet below the soil surface and extend below the frost line. *Note: Concrete poured directly into holes in the earth has better retention properties than when poured into wooden forms and then backfilled with soil.*

Center Foundation

The center foundation is reinforced using wire mesh or a rebar lattice. Use #2 or #3 rebar (1/4" or 3/8" diameter) for the lattice. Wire mesh may be 4 x 4 (W1.4 x W1.4) to 6 x 6 (W4.0 x W4.0).

The center foundation must be reinforced on all side and top faces of the concrete block. Locate the reinforcement 3 to 5 inches to the interior of each concrete face. See drawing D10 in the manual appendix for a typical rebar lattice layout.

The center foundation supports the tower base. It is anchored to the foundation using J-bolts (5/8" x 8"). See drawings D5 and D9 in the manual appendix for J-bolt locations. The tower base or a pattern of the bolt holes should be used to properly set J-bolt locations.

Outer Guy Cable Anchor Foundations

The remaining four (4) foundations are also reinforced using rebar or wire mesh. Follow guidelines given in the "Center Foundation" section above, except reinforcement is only required on the top and on the side which faces the center tower base. Drawing D11 of the manual appendix illustrates a typical rebar lattice for the outer foundations.

The outer foundation supports anchors for the tower and gin pole guy cables. The steel anchors for the tower guy cables are cast in the concrete at the angle 'A' indicated in Table 2 below. See drawings D2, D3, D4, D7, D8, D9 and D12 in the manual appendix for anchor locations.

Tower Height	A
106 feet	58°
127 feet	62°

Table 2

The anchor should be buried as deeply in the concrete as possible while maintaining proper height and placement. It is acceptable to increase the excavation size or depth to seat the anchor more fully in the concrete. If necessary, use a form to raise the foundation height above the soil level to fully bury the anchor in the foundation. Maintain the same minimum foundation size – 3' x 3' x 4' deep – outlined in the "Center Foundation" section above. The anchor's eye should be no more than 4 inches above the foundation's surface.

Hoist Anchor

See drawing D12 in the manual appendix for possible hoist anchor locations. A set of holes are provided in the gusset plates to adjust for higher or lower placement of the anchor. Each hole is a 5 degree adjustment and moves the gin pole's end 44 inches at the hoist anchor.

If the anchor locations shown in drawing D12 for the anchor are difficult to achieve, an extension kit consisting of 1/2" chain and a 7/16" shackle may be provided to attach the retaining turnbuckle to the gin pole end fitting.

More extreme variations may be accommodated, especially a lower hoist anchor placement: A longer hoist turnbuckle leash and hoist cable will be required in order to move the hoist anchor further from the base, keeping the angle correct. Consult with ***ARE*** for this or other difficult installation adjustments.

Down-side Anchor

The down-side anchor eye's height is less critical than on the hoist side. The anchor may vary (higher or lower) from the tower base by as much as 12 inches. Please consult ***ARE*** if larger variations are required. ***On 127' towers****: Place one eyebolt in the down-side foundation (exact location unimportant); this will be used to mount the pulley used for the backhaul leash.*

Left- and Right-side Anchors

The left- and right-side anchor eyes should be at the same height as the tower base pivot pin. The side anchors are offset by four (4) inches toward the down-side anchor from the centerline of the center foundation. See drawing D3 of the manual appendix. This offset permits the side guy cables to become slack during the lowering of the tower, minimizing the likelihood of over-tensioning the cables.

The eyebolts for the gin pole guy cables are located on the left- and right-side foundations. They are offset by four (4) inches toward the hoist side anchor from the centerline of the center foundation for the same reason as discussed above. See drawings D3 and D4 in the manual appendix. These locations are important and should be held to within ±1 inch.

Pouring the Concrete

As realignment of anchors, bolts, and rebar may be difficult or impossible after the concrete is poured, it is imperative that all are securely located prior to the pour. If pouring from a mixing truck, concrete should be poured directly over the anchor to avoid displacement.

The foundation should cure for 4 weeks (28 days) before any significant loads are placed on them (including tightening the nuts on the base plate anchor bolts). Consult ***ARE*** if shorter curing times are necessary.

6) Tower Section Preparation

If the ***ARE*** tower kit is purchased without pipe, 21 feet long sections of four inch schedule-10 galvanized steel pipe must be provided by the customer. Use of other pipe sizes or material is not permitted, as doing so will compromise the tower design. Inspect the pipe sections carefully for dents, belled ends, and/or general bowing curvature. Do not use pipe which is bowed or significantly damaged; consult ***ARE*** with any questions regarding the use of slightly damaged pipe. If pipe is purchased separately by the customer, some holes will need to be drilled in the pipe prior to tower assembly and installation. See Table 3 below for pipe-drilling.

Pipe Section	Drilling Reference
Tower base	Drawing 101011
Tower middle	N/A (no drilling required)
Tower top	Drawing 101013
Gin pole base	Drawing 101014
Gin pole end	Drawing 101015

Table 3

As hole alignment between pipe ends and gusset plates is important, the following drilling procedure is advised:

- Lay an angle iron (at least two feet long) on the pipe lengthwise. Mark a line on the pipe along one side of the angle iron. This line should extend from the end of the pipe to a point past your last hole. Measure, mark, and center-punch holes.
- On both ends of the line, measure half way around the pipe and mark it.
- Use the angle iron to draw a line between your marks. Measure, mark, and center-punch the holes.
- Drill pilot holes then finish holes at each location.
- Remove burrs from the edges of the holes, and paint with spray galvanizing (zinc rich spray paint).

7) Lightning and Grounding Protection

Grounding

The tower should be grounded at each foundation point. Legal requirements in most areas only require grounding of the tower, but guy-cable grounding is advised as well. Five (5) 8'-long grounding rods and 4-8 AWG, single strand, bare copper wire will be required. Embed a grounding rod in the ground near each of the foundations, so the top of the rod is a minimum of 6 inches below the surface. Connect a ground wire between each of the outer grounding rods, making a circle around the center foundation. Next, make a connection between one of the outer grounding rods and the center grounding rod. These connecting wires must be buried a minimum of 18 inches below the ground surface (check your local regulations). At each guy cable foundation, attach a ground wire from the grounding rod to the guy cables just above the saddle clamps near the turnbuckle. Never attach the copper grounding wire directly to the working part of a guy cable – instead, chain one of the guy cable ends between each of the guy cables with saddle clamps (See Figure 1 below). Attach the end of this guy cable to the copper ground wire. Attach a ground wire between the tower base section or gusset and the center grounding rod.

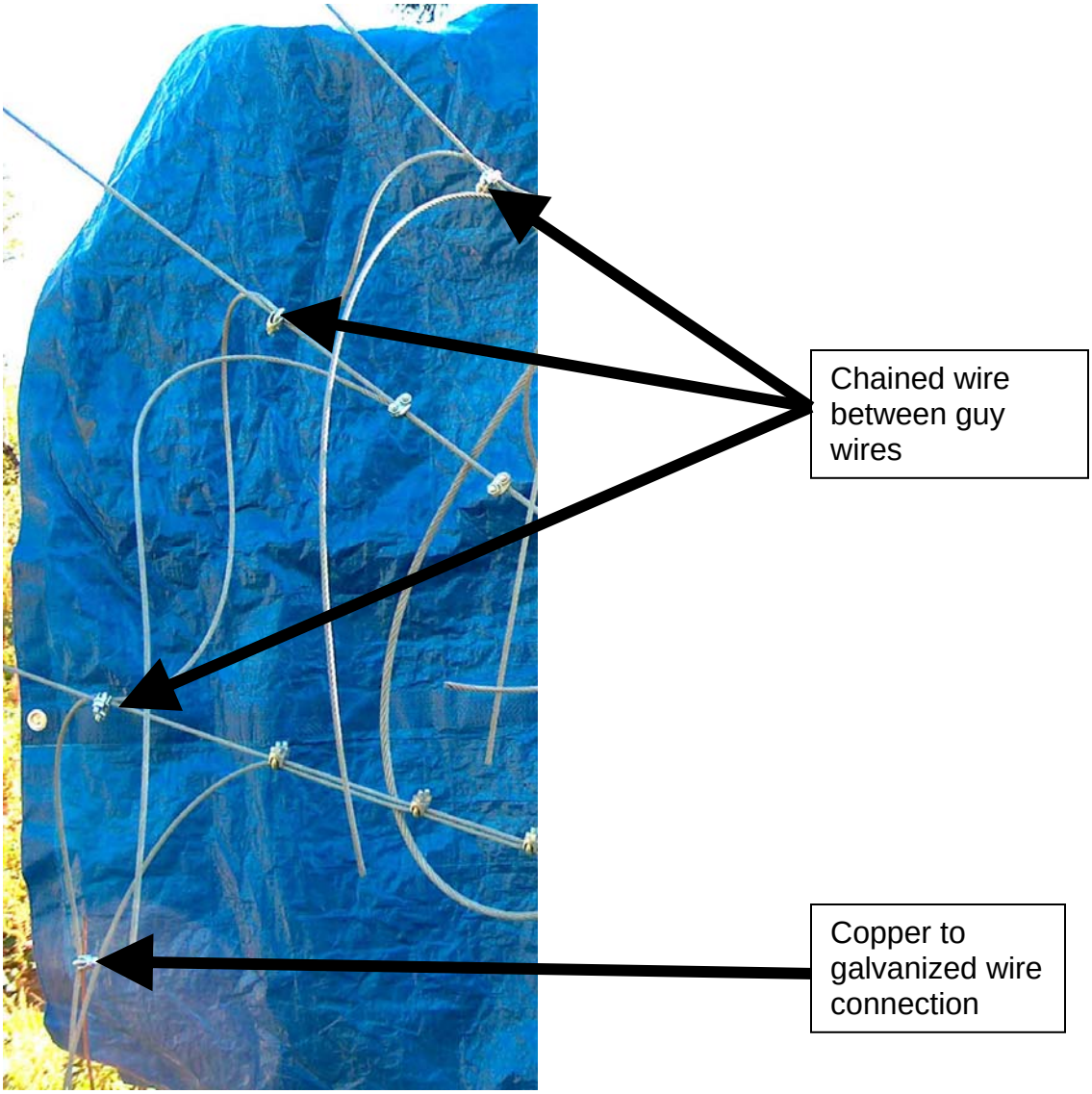


Figure 1

Junction Box

Use of a junction box at the base of the tower is recommended for access to the wires running between the power controls and the generator wires in the tower. This allows a convenient location for maintenance between the generator and power controls. If the generator does not have slip-ring yaw head, this also provides a location where tower wire twists (which may occur over time due to wind generator rotation) can be easily unwound. Additionally, an onsite brake switch may be located in this junction box. For safety reasons, a lockable enclosure is advised.

Lightning Arresters

It is advised that lightning arrestors be installed in the wiring of the system – one in a junction box at the tower base and one in the power room. Consult ***ARE*** for available lightning protection packages.

8) Tower Raising Options

ARE's tall (106' & 127') tilt-up towers should be raised and lowered with a winch (manual or electrical) or a grip-pulling device (not with a vehicle), as extra care is required to maintain a slow, steady lift/descent. See Figure 10 for a visual overview of important points while raising and lowering ***ARE***'s tall towers. A small backhaul winch—driven with an electric drill—is provided with 127' towers; electric winches and grip-pulling devices are available for purchase through ***ARE***.

Whichever hoisting method is chosen, make certain that the pulling means is sufficiently rated for the applicable load. The approximate straight-pull loads are listed below in Table 4. Use of pulleys will reduce the force but increase the required cable length.

Tower Height	Straight-Pull Load
106 feet	2,000 lbs (1 ton)
127 feet	4,000 lbs (2 ton)

Table 4

9) Tower Assembly

Step 1 (Base Installation and Anchor Setup)

Base Installation

Tower assembly begins with the base plate. Mount the base plate on the center tower foundation bolts and level it. Use 5/8" nuts on bolts beneath the base plate, adjusting them to level the base. Next, install the base plate with 5/8" washers—one on each side of the plate—and a 5/8" nut on top. Tighten the nuts, check for level, and readjust until level. Use a non-shrinking grout under the base plate to make a solid support. See drawing D9 in the manual appendix and Figure 2 below.

Anchor Set Up

Attach the 6-hole equalizer plates to the left-, right-, and down-side anchors, using 5/8" shackles (provided) and making certain that each equalizer plate's longest side is facing away from the ground (see Figure 3 below). Attach the jaw side of the jaw-eye turnbuckles (1/2" x 12") to the equalizer plate. Start with the lowest hole and work upward, always placing the final turnbuckle in the topmost hole. There is one turnbuckle per tower section (e.g. the 106 foot tower has five (5) turnbuckles). Adjust turnbuckles to slightly more than halfway open for the left-, right-, and down-side foundations.

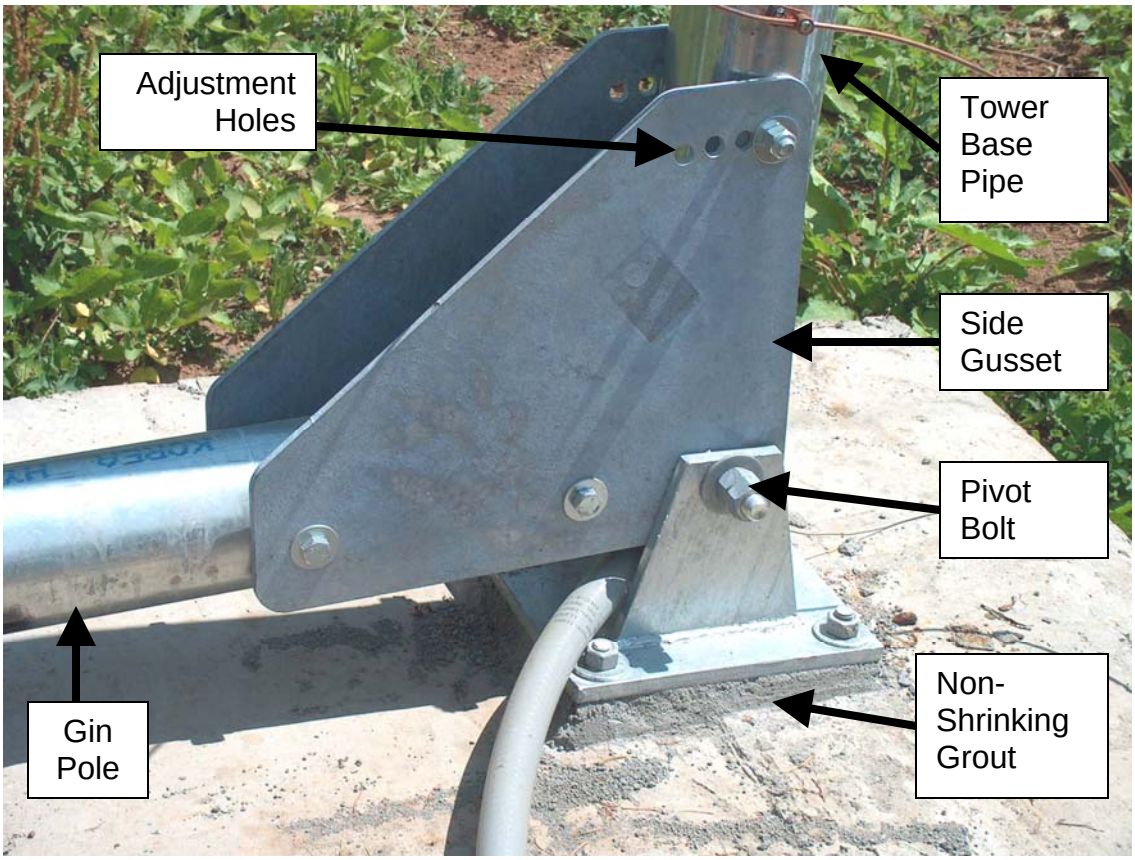


Figure 2

Figure 3

Step 2 (First Tower Section Installation & Raising)

Begin with the tower base pipe section laid out horizontally between the down-side anchor and the tower base foundation. Insert the first tower coupler (attached with 52' guy cables) into the top of the base tower section. *Note: This is the only coupler with all four cables already attached.* Attach a separate rope to the coupler, which will be used to hoist the gin pole into position later (Step 4).

Attach the tower base pipe and the two (2) side gussets to the base plate with the 3/4" pivot bolt and washers on both sides of the bolt. Hand tighten a 3/4" nut then tighten a second 3/4" nut against the first; this will secure the bolt's position but allowing the tower to pivot about the bolt. Install a bolt (1/2" x 6") through one of the four (4) gusset adjustment holes, including a washer on the outside of each gusset plate; secure with a 1/2" Nylok nut and tighten until snug (see Figure 2 above).

Use drawing D12 in the manual appendix and Figure 2 above to determine appropriate gin pole and hoist anchor positioning and gusset plate adjustment hole selection.

With the gin pole base pipe handy, tilt the tower base pipe up by hand and attach the gin pole base to the tower gussets. Use bolts (1/2" x 6"), washers, and nuts, as detailed above. *Caution: Tighten nuts until snug, but do not over-tighten, as this may cause deformation in the pipe.* Insert the gin pole coupler into the gin pole base pipe, followed by the gin pole end pipe. Use two (2) bolts (1/2" x 6"), washers, and nuts to fix the gin pole coupler in place between the two pipes.

Step 3 (Prepare the Gin Pole)

Insert the gin pole end fitting (6-hole) in the gin pole end section and secure with a 1/2" x 6" bolt, washers, and nut. Attach pulleys using 1/2" shackles to the bottom side of the gin pole end fitting (see Figure 4 below). Attach the jaw side of the jaw-eye turnbuckles (1/2" x 12") to the top side of the gin pole end fitting. Start with the hole closest to the center foundation and work outward. There is one turnbuckle per tower section (e.g. the 106 foot tower will have five (5) turnbuckles). Attach both gin pole guy cables to the gin pole end fitting with a 1/2" shackle, using the crimped-eye end.

Attach the 4-hole equalizer plate to the hoist anchor with a 5/8" shackle. Arrange pulleys (if used) in the equalizer plate holes and gin pole end fitting, as required, to permit a clear cable path. Attach pulleys with 1/2" shackles, and attach the crimped-eye end of the hoist cable with a 1/2" shackle. See Table 4 below for hoist cable end attachment and pulley locations. *Note: If hoisting system is purchased from **ARE**, pulleys (as outlined below) are used with the electric winch option but not with grip-pulling devices.*

Tower Height	Total Pulley Qty.	Hoist Cable End Attachment Loc'n	Pulley Qty. (Eq. Plate)	Pulley Qty. (GP End Fitting)
106 foot	3	Gin Pole End Fitting	2	1
127 foot	4	Equalizer Plate	2	2

Table 4

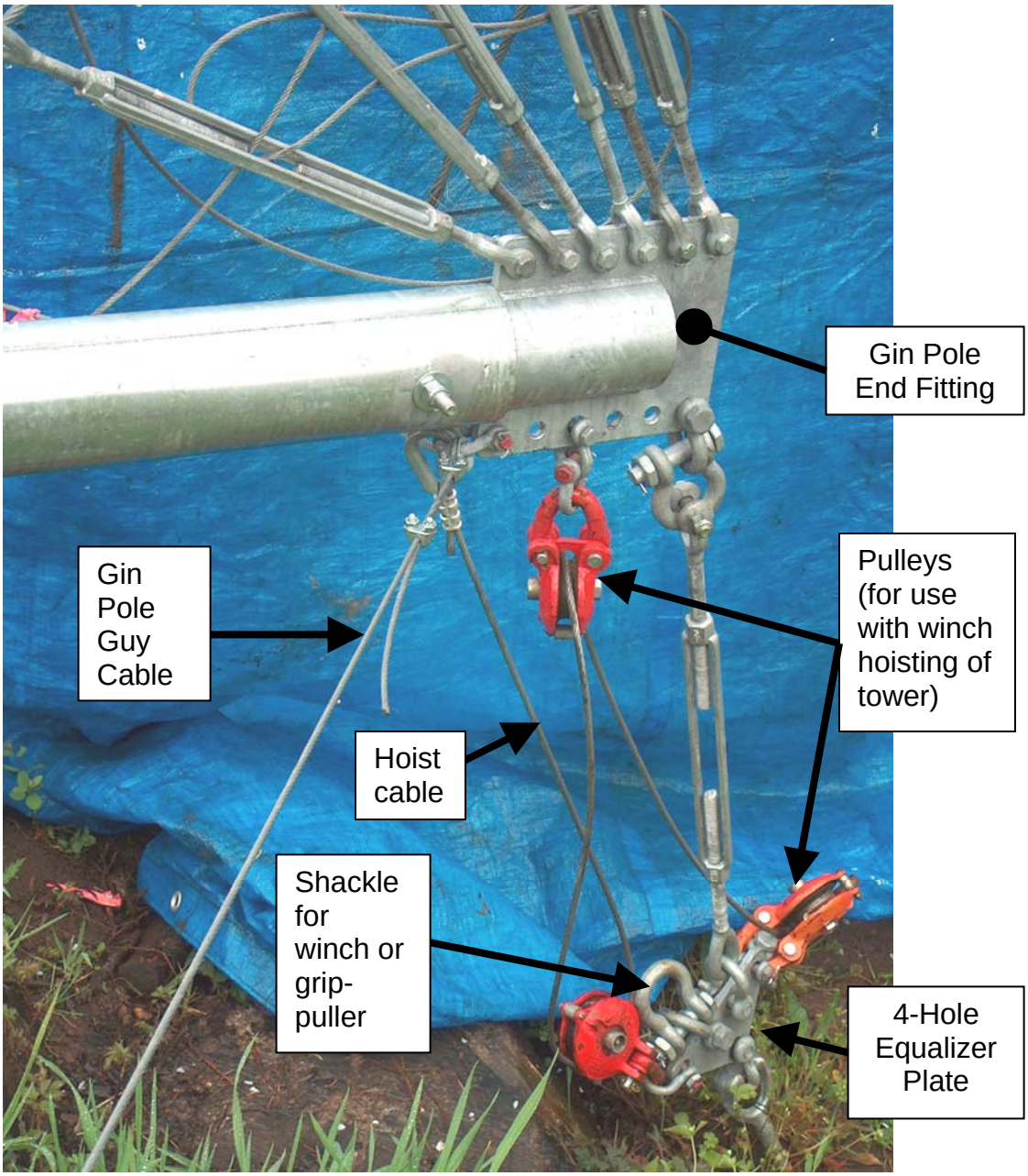


Figure 4

Attach Guy Cables to Gin Pole

Attach the Ø5/16" tower guy cable (without crimped eye) to the eye of the turnbuckle furthest from the center foundation using an open 1/2" thimble. Squeeze the thimble closed before proceeding. Secure cables into position with three (3) 5/16" saddle clamps. Refer to saddle clamp installation procedure in Figure 5, and make the dead end approximately 30 inches long.

Attach the guy cable that is already attached to the first tower coupler to the turnbuckle closest to the tower base. Pull this cable snug before securing with three (3) 3/16" saddle clamps and a 5/16" open thimble, per the procedure below.

Attach the remaining Ø3/16” guy cables (not attached to couplers) to the remaining turnbuckle eyes, using open 3/8” thimbles; squeeze thimbles closed before proceeding. Secure with three (3) 3/16” saddle clamps per guy cable, installing the shortest closest to the tower base first and working outward with successively longer cables. See drawings D1 and D6 in the manual appendix. Refer to the “Saddle Clamp Installation Procedure” and the illustration in Figure 5 below. The cable “dead end” should be approximately 30 inches at each turnbuckle.

Saddle Clamp Installation Procedure

1. Locate the first saddle clamp as near as possible to the thimble with the U-bolt over the dead end and the live end in the clip saddle. See Figure 5 below.
2. Install two additional saddle clamps at 6-inch intervals (3 clamps total).
3. Do not over-tighten, deform, or damage cables. *(Recommended torque for both 3/16 & 5/16 saddle clamps: 30 in-lb)*. A nut driver may be used during set-up and while adjusting the tower to vertical. All saddle clamps should then be tightened with a thread-locking compound.

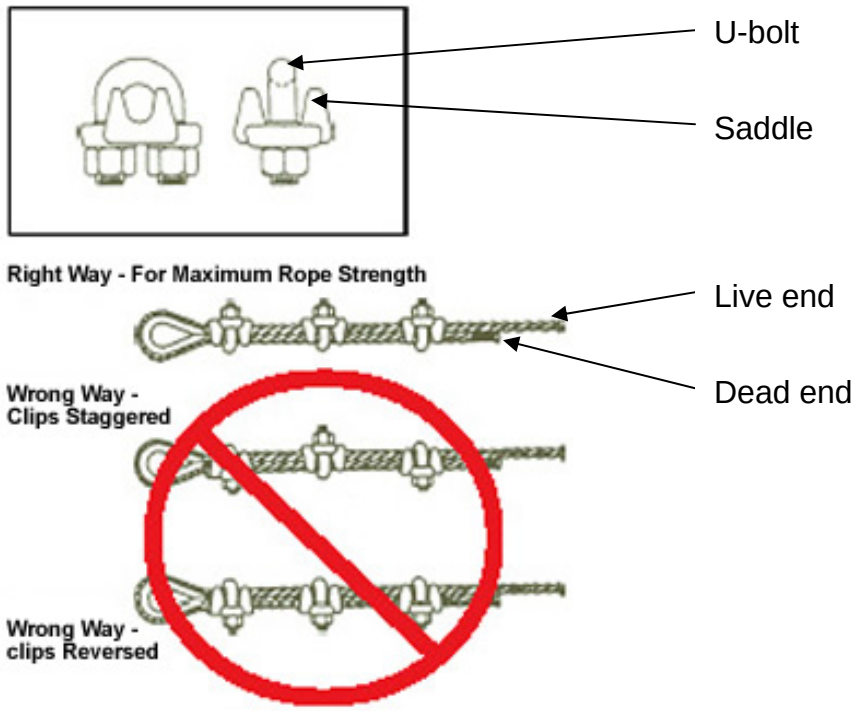


Figure 5

Step 4 (Raising the Gin Pole)

Attach the four (4) guy cables from the tower base pipe coupler to the left-, right-, and down-side foundations and the gin pole end fitting. Use an open 3/8” thimble through the eye of each applicable turnbuckle; squeeze the thimbles closed before proceeding. Pull guy cables taut then slack off approximately six inches before securing with three (3) 3/16” saddle clamps. Refer to the “Saddle Clamp Installation Procedure” and the illustration in Figure 5. As guy cables will be readjusted later during the tuning process, do not risk deforming cables by fully tightening cable clamps. Adjust all the guy cables so that the tower section is plumb.

Adjust the hoist-side guy cable to hold the gin pole's weight. Ensure the tower is plumb, using turnbuckles to make small adjustments, as required. For larger adjustments, loosen saddle clamps and adjust the cable length accordingly. The hoist- and down-side guy cables will be tight (without slack) due to the gin pole weight being supported. The left- and right-side guy cables should each have approximately four inches of sag.

Lift the gin pole to a vertical position using the rope attached to the coupler (in Step 2), and let out the hoist cable simultaneously. A small winch or grip-pulling device may be used to assist in this step. Once at around 60°, the gin pole will reach its balance point. Maintain control by feeding the hoist cable slowly and gently lowering the tower base pipe to the ground. When the tower base pipe is horizontal, secure the hoist cable to maintain the gin pole's position as the remainder of the tower is assembled.

A vehicle may be used during this step in the following manner:

- Park a vehicle about halfway between the down-side foundation and the tower base. This will provide the hard point for raising the gin pole. Ensure the vehicle will not be in the way of the guy wires as the gin pole is raised.
- Standing at the base of the tower, attach the rope tied to the top of the tower base section. Attach a winch cable as far up the rope as is reachable. Alternatively, two hand ratchet cable pullers ("come-a-longs") can be used in series. Attach the opposite end to the vehicle.
- Use the winch to pull on the top of the tower base section and lift the gin pole. Play out the hoist cable as you do so

Step 5 (Gin Pole Guy Cable Attachment)

Attach the gin pole guy cables to their anchors at the left- and right-side foundations. Use open 5/16" thimbles and three 3/16" saddle clamps at each location. Refer to the "Saddle Clamp Installation Procedure" and the illustration in Figure 5. Use a leveling tool to plumb the gin pole with tension adjusted so there are about four inches of sag in each cable.

Step 6 (Tower Assembly)

Lay Out

Place all of the remaining tower pipes, tower couplers, and guy cables on the ground in assembly order. The assembly consists of the tower base pipe, as many middle pipes as are required for your tower height—each connected by a tower coupler—and finally a tower top pipe. Lay out the tower horizontally level and perpendicular to the line of side guys, if possible, as this will result in a nearly vertical tower on the first raising. See drawings D1 and D6 in the manual appendix for a general diagram of the assembled tower.

Assembly

Install the second tower pipe onto the first coupler and the second coupler into the second pipe. Align the open hole in the coupler guy cable eye with the gin pole. This is the location the hoist-side guy cables will attach to in a later step.

Install the next pipe section onto the coupler and repeat the procedure until the tower is assembled on the ground. The tower sections may need to be supported above the ground in order to facilitate assembly.

Guy Cable Attachment

Attach the bottommost tower coupler's attached guy cables to the lowest available turnbuckles at the left- and right-side foundations. Place an open 5/16" thimble through the eye of the turnbuckle. After placing all thimbles in this manner, squeeze them closed before installing cables and saddle clamps. Pull guy cables taut then slack off approximately six inches before securing with three 3/16" saddle clamps. Refer to the "Saddle Clamp Installation Procedure" and the illustration in Figure 5. As guy cables will be readjusted later during the tuning process, do not risk deforming cables by fully tightening cable clamps.

Ensure that the tower pipes remain square with the base plate, so the tower will be approximately vertical when erected.

Pull the down-side guy cable to either the left- or right-side guy anchor and mark the distance on the cable with tape. This will be the reference for attaching the guy cable to the down-side anchor. Take care to not cross or tangle the guy cables while measuring and marking, as this could damage the guy cables and/or prevent the tower from being raised properly.

Attach the down-side guy cable in the same manner as the left- and right-side guys, *but do not add six inches to the tape mark*. The length of the guy cable may need to be adjusted to account for differences in elevation between the down-side guy anchor and the left- and right-side guy anchors. If the down anchor is lower than side anchors, guys will be too short, but they can be adjusted after the tower is raised. If, however, the down anchor is higher than the side anchors, the guys will be too long; thus, adjustments to shorten the cable should be made before raising the tower. Secure the guy cable with saddle clamps.

Repeat the above procedure with each coupler, working gradually upward on the equalizer plates and toward what will eventually be the tower top.

Note: To assist (later) in Steps 9 & 11, attach the shorter "leash" (4' long, provided—see Figure 8) approximately halfway up the top down-side guy cable. A rope—tied to the leash—will be used (from a safe location) to control the guy cable tension (see Figure 8). On 127' towers, similarly attach the longer leash (250' long) to the third-from-top down-side guy cable approximately halfway up. This cable should run through a pulley then to the tower's hoist-side, where it should be reeled onto the small, worm gear backhaul winch (provided). See Figure 10 for a visual overview of important points while raising and lowering ***ARE****'s tall towers*.

Step 7 (Top Guy Cable Attachment)

The top guy cables are attached four feet from the end of the tower top pipe with four "tangs". Install the short leg of the tangs to the tower in two locations with bolts (5/8" x 7"). See Figure 6 below. *Note: The bolts fit tightly through the holes in the tower and tangs.* Tighten nuts snugly, but do not over-tighten, as this may deform the pipe. Attach the left-, right-, and down-side 5/16" guy cables (with crimped eyes) to the tangs using 1/2" shackles. Attach the opposite guy cable ends to turnbuckles at the left-, right-, and down-side foundations, per the above procedure, using three 5/16" saddle clamps and an open 1/2" thimble at each location.

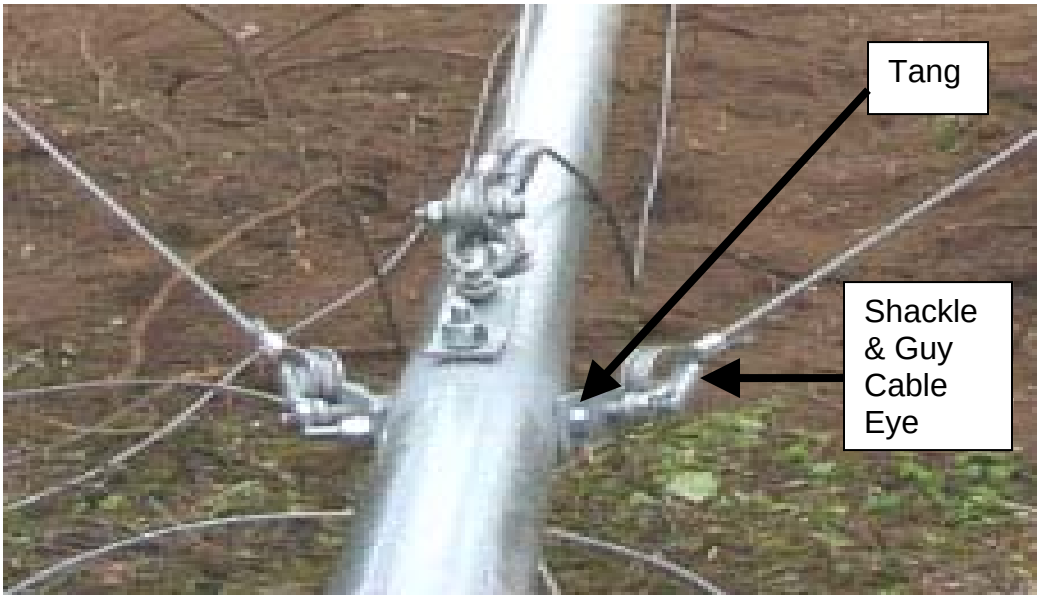


Figure 6

Step 8 (Hoist Guy Cable Attachment)

With the first two (2) tower sections level, attach the second Ø3/16" guy cable between the gin pole end fitting and the open hole in the second coupler guy cable eye, using a 5/16" thimble and three (3) 3/16" saddle clamps. Pull the guy cable tight. *Note: There will be excess cable at this time, which will be trimmed after the tower has been adjusted.* Refer to the "Saddle Clamp Installation Procedure" and the illustration in Figure 5. It will be easier to tighten saddle clamps if the guy cable is led through the coupler from above and fed back on the lower side nearest the tower base (see Figure 7 below).

Repeat the above procedure for the remaining guy cables attached to the gin pole. Lift or block each tower pipe section to ensure levelness then pull the guy cable tight. This will allow the tower to lift evenly.

Use one (1) 1/2" thimble, three 5/16" saddle clamps, and one 1/2" shackle for the Ø5/16" top guy cable.

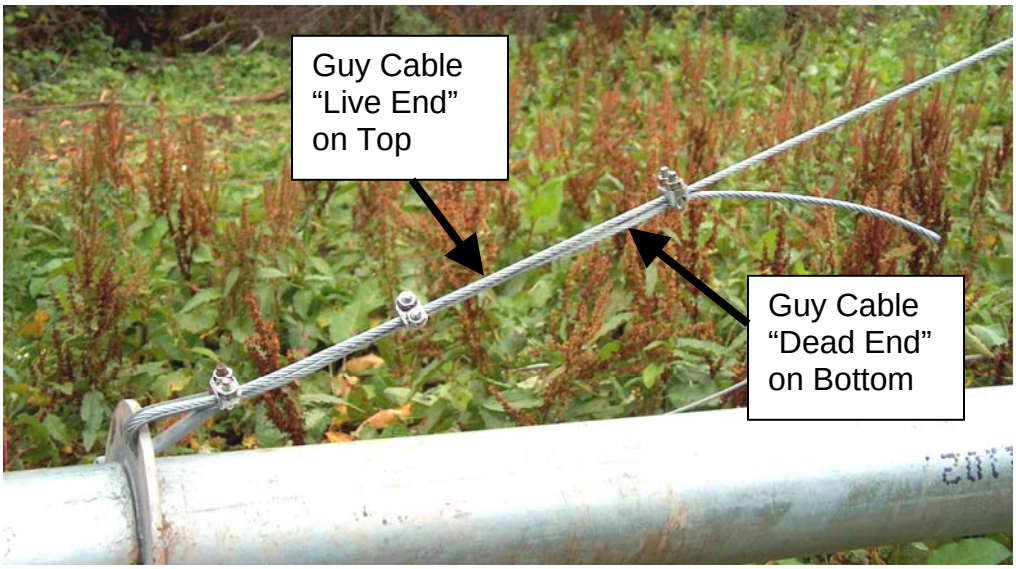


Figure 7

Figure 8

Step 9 (First Tower Raising)

The tower should now have four (4) guy cables at each coupler and four (4) guy cables attached to tangs on the tower top pipe. All guy cables should also be attached to their foundations or to the gin pole.

The purpose of the first lift is to check and adjust the rigging prior to attachment of the wind generator. *DO NOT INSTALL THE WIND GENERATOR AT THIS TIME.* The hoist winch or grip-puller is used to raise the tower. Ensure that all guy cables are securely attached and run clear with no tangles or kinks.

IMPORTANT SAFETY REQUIREMENTS:

- **All people must remain clear of the tower during hoisting. No one should walk under the tower or rigging during hoisting.**
- **It is critical to raise and lower the tower very slowly and steadily, as this allows careful monitoring of equipment and personnel.**
- **Side guy cable tension must be continuously monitored. Guy cables should consistently show visible sag/slack throughout the tower raising. If slack is not visible, it is difficult to determine the amount of tension in the cables; as a result, the cables may become too tight. Over-tensioned cables can break and cause the tower to fall.**
- **Gin pole guy cable tension should also be monitored, but the gin pole guys should have increased sag as the tower is raised.**
- **Remain in contact with all members of the lifting team during the entire process to ensure that problems can be immediately responded to. Each member of the lifting team should be authorized to call a "stop" at any time.**

As the tower is being hoisted, watch for any tangled, snagged, or misled guy cables. This most commonly occurs in the down-side guy cables. Ensure that guy cables and thimbles lead properly from each attachment on the tower and at the anchors. During the last 20˚ of the tilt-up, constant tension should be maintained on the backhaul cable (leash).

As the tower nears vertical, the weight of the gin pole will start to balance with the tower weight. At this point, one team member should take hold of the top down-side guy cable and pull it to the side (alternatively: hold the gin pole and ease it down). This step is most effectively achieved by pulling (from a safe location) on the rope tied to the "leash" (attached to the top down-side guy wire at the end of Step 6) to control the guy cable tension and prevent slapping as the tower arrives at the vertical position.

When the tower is vertical, secure the gin pole by installing a jaw-jaw turnbuckle between the equalizer plate and the gin pole end fitting. If the turnbuckle cannot be adjusted to secure the gin pole, an "extension kit" (consisting of 1/2" chain and a 5/8" shackle) is offered by ***ARE*** to attach the retaining turnbuckle to the gin pole end fitting. Also, a set of holes are provided in the gusset plates to adjust for higher or lower placement of the anchor. Each hole is a 5° adjustment and moves the end of the gin pole 21 inches at the hoist anchor.
When in its upright, vertical position, the tower may appear crooked, due to imperfect adjustment in the guy cables. This is normal at this step and should not be a concern.

Step 10 (Tower Adjustment)

This step will finish with a vertically straight, secure tower. Start by checking the lower tower pipe with a leveling tool to ensure vertical positioning in both directions (side to side and front to back). Adjust the guy cable tension so that there are about four inches of sag in the side guys of the first guy cable set, while maintaining the lower section's vertical position. Small adjustments can be made with the turnbuckles, but larger adjustments will require loosening the saddle clamps and taking up slack or letting out cable. Whenever saddle clamps are moved be certain to maintain tension on the guy cable.

The lowest hoist and down-side guy cables are unique in that they hold the gin pole from falling into the hoist foundation. As a result, these cables are tight with little or no sag compared to the other guy cables. Adjust the lowest hoist side guy cable so it is just tight enough to support the weight of the gin pole but not the two bolts in the gussets. Adjust the down-side guy until the tower base pipe is vertical. If the turnbuckle between the gin pole and the hoist anchor is in place, it may need to be adjusted to provide slack during this procedure.

Continue by adjusting the other sections so that the rest of the tower is visibly in line with the lower section. Allow the amount of sag to increase in each higher guy cable. The longer the guy cable, the more sag there will be for the same tension. Tower adjustments may need to be made several times until all the sections are aligned vertically. View tower upward along the pipe for best results.

Each turnbuckle must have room for adjustment. Adjust the saddle clamps to accomplish this, if required. As the tower is stressed in service, things will settle in and stretch. The guy cables will need to be adjusted after a couple of months or after the first significant windstorm. It should be possible to make these adjustments with turnbuckles only.

Step 11 (Tower Lowering)

Once the tower is vertically aligned, it can be lowered. See Figure 10 for a visual overview of important points while lowering ***ARE***'s tall towers.

Before beginning the tower lowering process, make certain that the hoist cable and pulleys are attached and not tangled, snagged, or blocked. The end of the hoist cable must be securely attached to the winch or grip-puller with minimal slack to prevent an uncontrolled situation.

To begin, release the gin pole turnbuckle and gently pull on the top down-side guy cable (with the rope attached to the top "leash") while pulling with the backhaul winch. Provide slack on the hoist winch or grip-puller only as needed. From a safe location a person should maintain tension on the top down-side guy cable during the first 5-10° of the tilt-down. Tension must be maintained on the third-from-top guy cable during the first 20° of tilt-down, per Figure 10. Once the tower has tilted to 20° from vertical, the gin-pole guy cables will provide adequate tension and stability to safely tilt the tower to the horizontal position, using the hoist winch or grip-puller.

When lowering the tower, use the same caution as when raising it. Monitor the tension of the side guy cables to prevent over-tension. If foundation attachments are properly placed, the side guys should have increasing slack as they are lowered. This allows the tower to raise and lower without adjusting the guy cables.

The gin pole guy cables should tighten as the gin pole goes up. Monitor cables carefully and give them additional slack if necessary. If adjusted, check the gin pole for vertical, and do not remove this additional slack when next raising the tower.

Step 12 (Re-Raising the Tower)

At this point, it is recommended that a test lift be performed without the generator, following the instructions of Step 9. If the tower is vertically straight upon re-raising—without the need to adjust guy cables—the tower may be re-lowered and the wind generator installed.

Step 13 (Final Raising of the Tower)

Approximately four feet from the end (top), block the tower three to four feet above the ground. This will provide adequate clearance for attaching the AWP-3.6 generator. Follow the instructions in the "AWP-3.6 Owner's Manual" to assemble and attach the generator to the tower.

When the generator is attached and ready, slowly and cautiously raise the tower again, per Step 9. *Note: The tower's balance point will occur at a different angle, now that the wind generator is attached, and wind will have a larger impact on the balance point.*

Step 14 (Final Check)

Before leaving the site, make a final check of all cables and hardware. Ensure that each shackle is secured with either a nut and cotter pin or a cable. All turnbuckle jaw bolts should have Nylok nuts securing the jaw ends. It is good safety practice to weave the end of one guy cable through the turnbuckle eyes and bodies to prevent loosening (see Figure 9). While it is advised that the gin pole guy cables be left in place, they are a tripping hazard and should be marked with surveyors tape. If the gin pole guy cables must be removed, cable lengths should be marked for accurate reassembly. Never lower or raise the tower without the gin pole guy cables attached.

10) Tower Maintenance

The tower should be inspected every six (6) months at minimum:

- Ensure that all hardware is tight.
- Ensure proper tension in the guy cables.
- Inspect for corrosion. If corrosion is found, remove any scale, clean, and add paint.

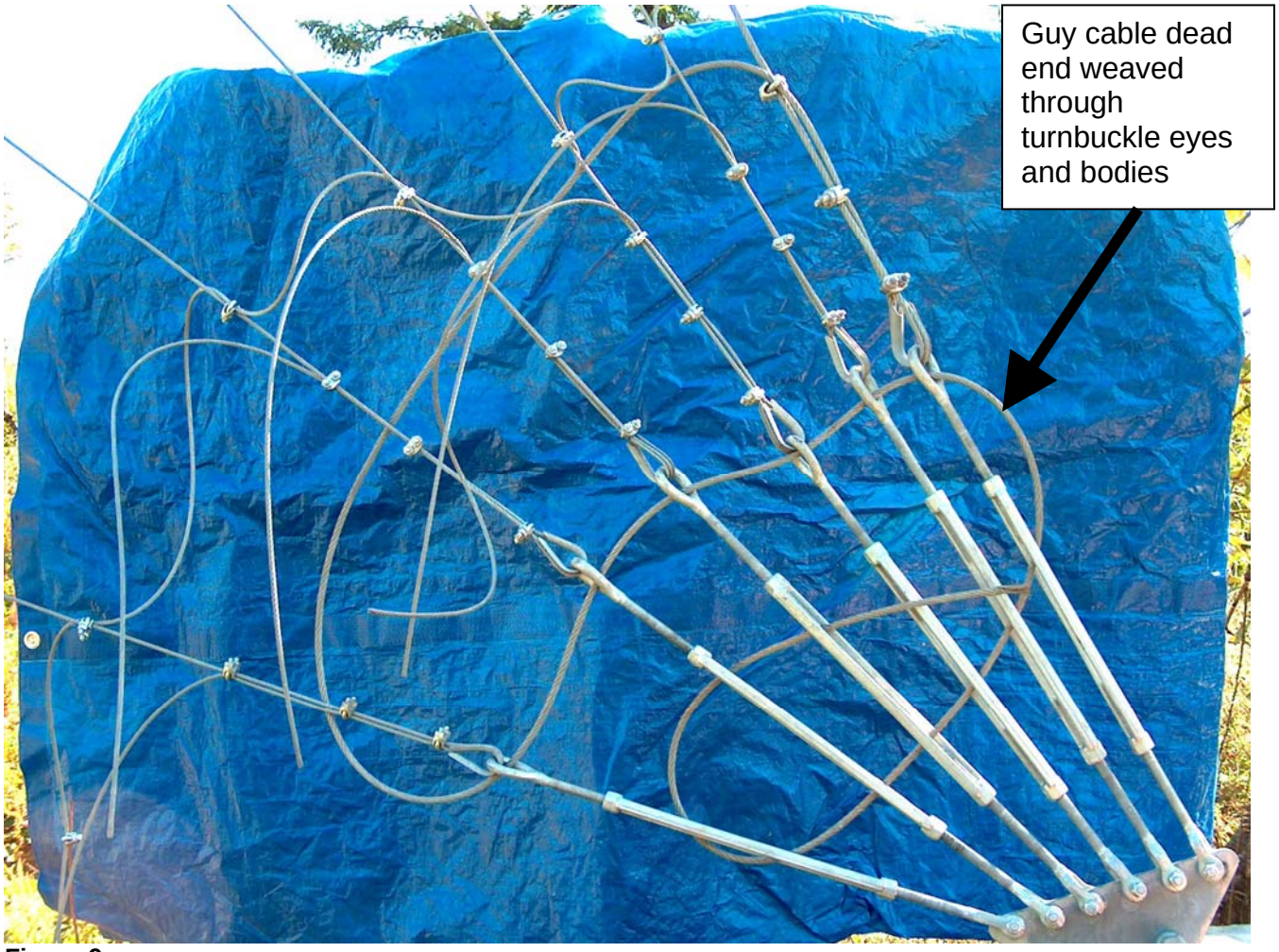


Figure 9

Important Tilt-Down & Raising Guidelines for 127' Towers

The top down-side guy wire should be held in tension while the tower is within 10° of its upright, vertical "run" position. A person may pull on a rope fastened to the approximate midpoint of the top guy cable, or a winch and cable may be used similarly. Force should be exerted in a smooth, steady manner (no quick jerking motions).

PLEASE NOTE:
The person pulling on the top guy wire should be positioned to the side, not in the fall path of the descending tower -- the diagram shows a person in this location for clarity only.

ALL PEOPLE INVOLVED IN TOWER TILT-DOWN OR RAISING SHOULD BE OUT OF THE TOWER'S FALL PATH.

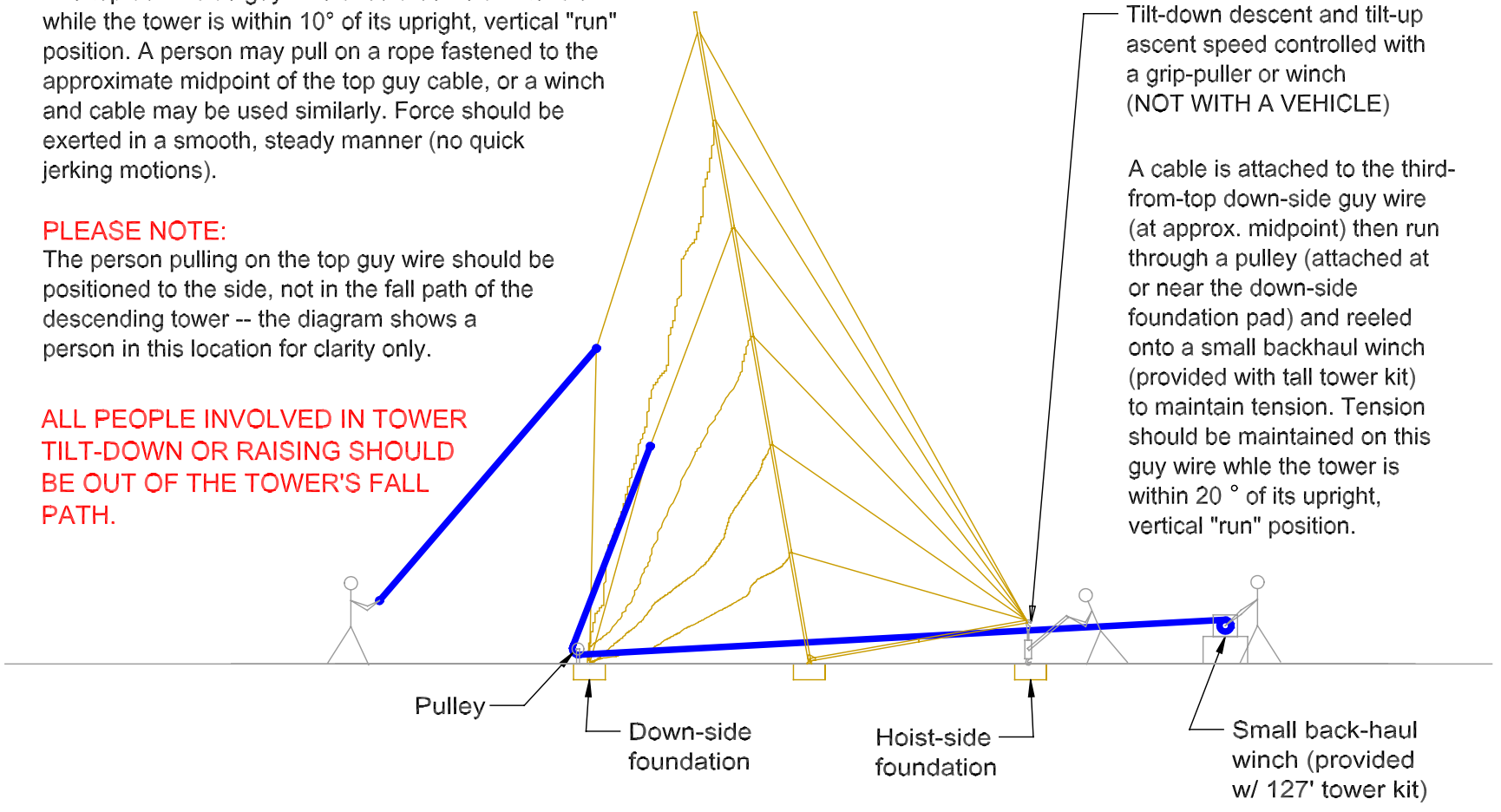
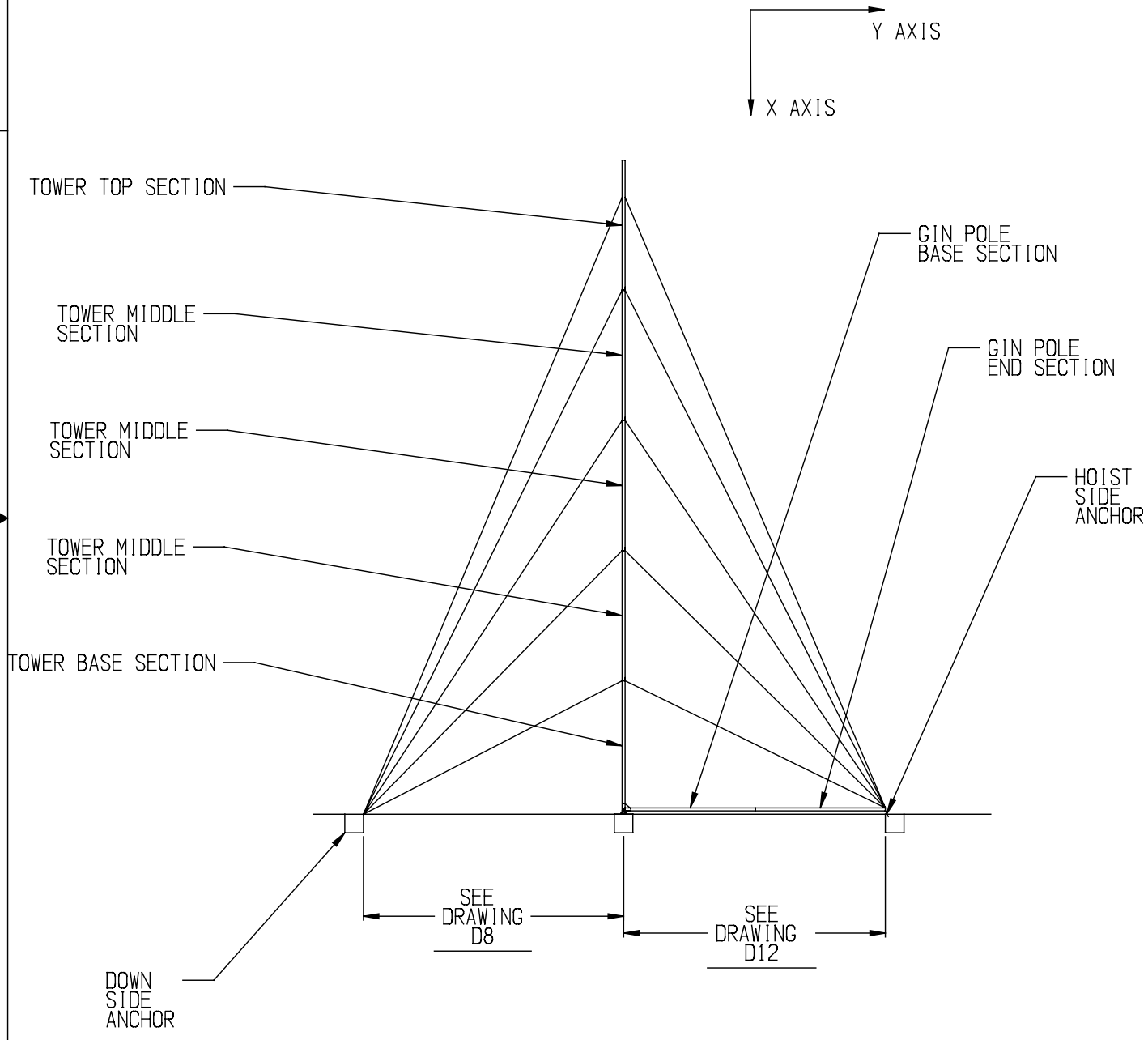


Figure 10

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

REV
SH
DWG NO



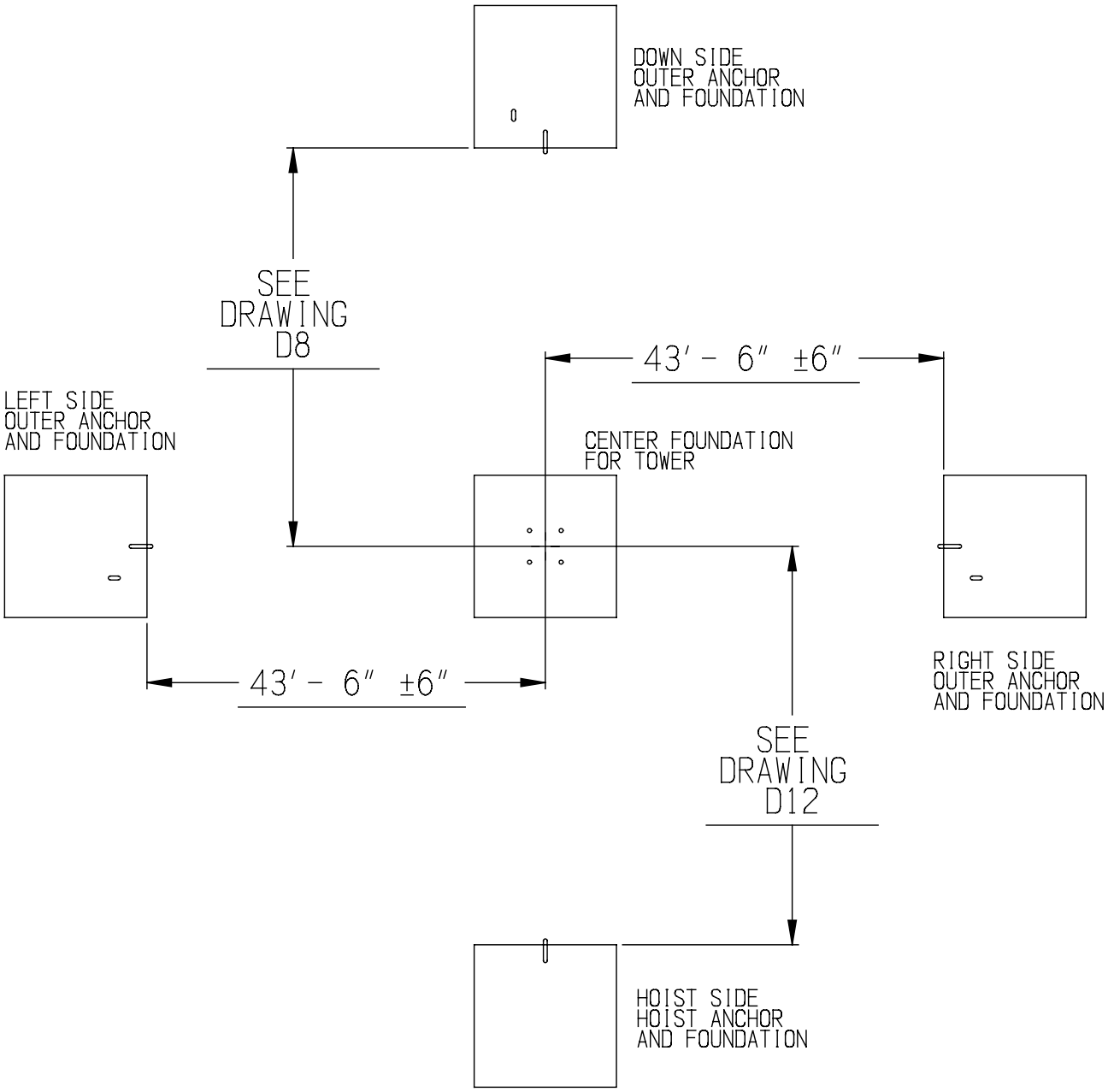
106 FOOT TOWER SHOWN
127 FOOT TOWER SIMILAR

Abundant Renewable Energy		TALL TOWER IN OPERATING POSITION			
DESIGNER		SIZE: A	CAGE CODE	DWG NO: D1	REV
APPROVED		SCALE	RELEASE DATE	WEIGHT	SHEET

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

REV
SH
DWG NO

NOTE:
NOT TO SCALE



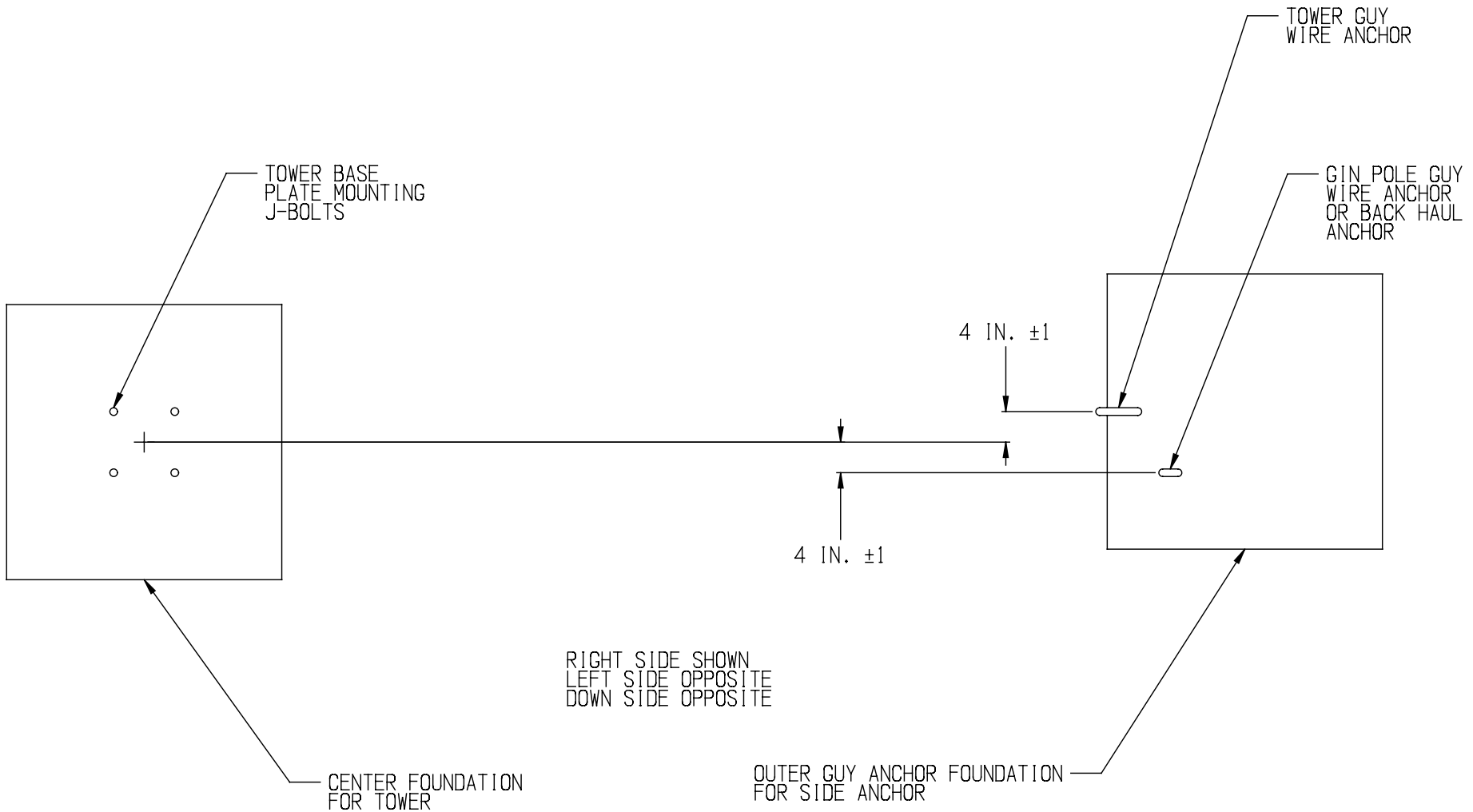
Abundant Renewable Energy	FOUNDATION LAYOUT (TALL)				
DESIGNER	SIZE A	CAGE CODE	DWG NO D2		REV
APPROVED	SCALE	RELEASE DATE	WEIGHT	SHEET	

DWG NO	SH	REV

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES:
1. NOT TO SCALE
2. CENTER HOIST SIDE ANCHOR



Abundant Renewable Energy

SIDE ANCHOR OFFSET (TALL)

DESIGNER		SIZE	CAGE CODE	DWG NO	REV
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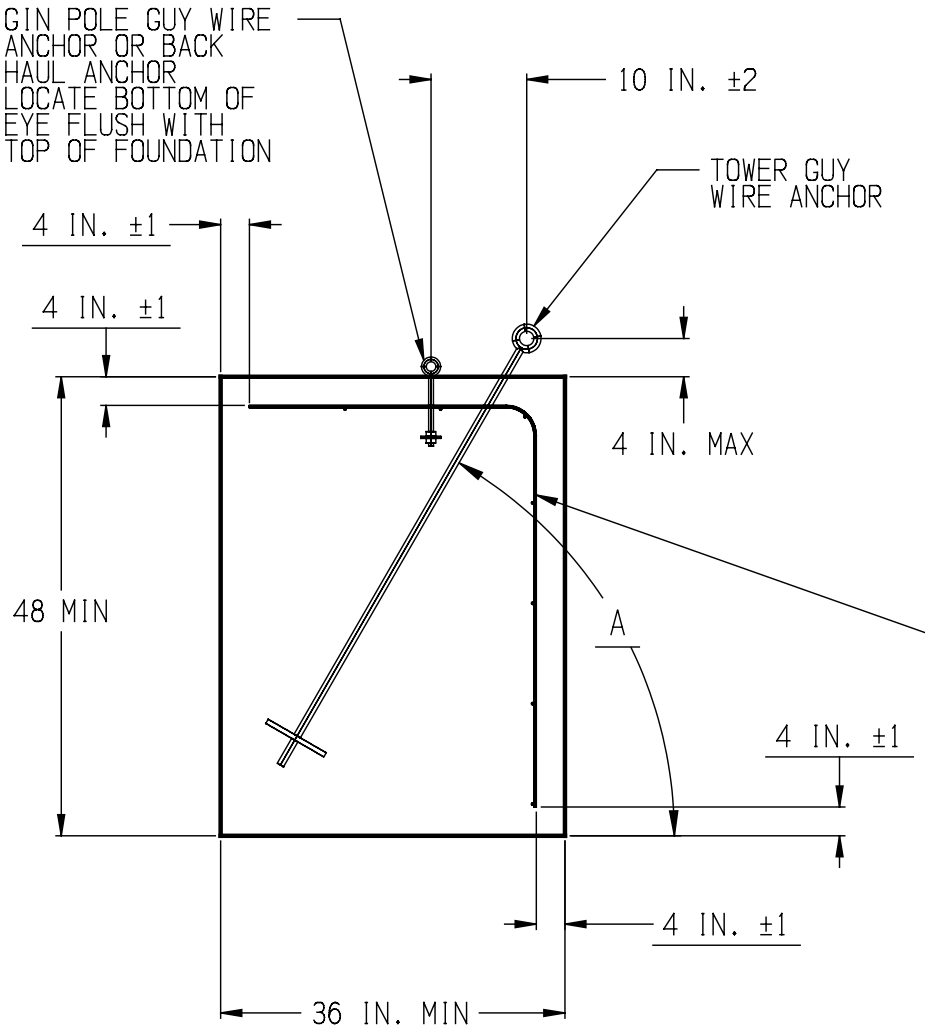
APPROVED		SCALE	RELEASE DATE	WEIGHT	SHEET

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

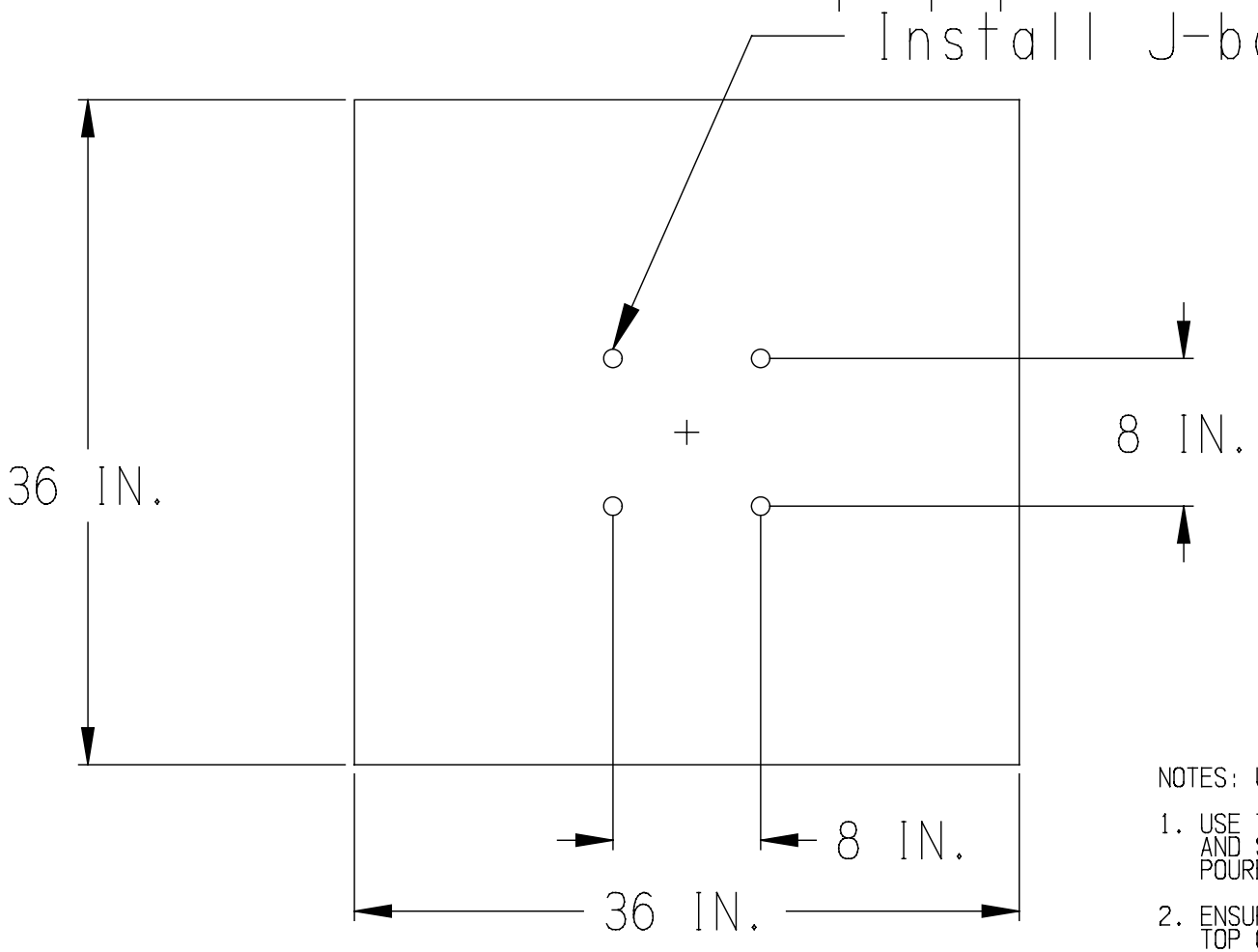


Notes:
1. Foundation is a miniimum of 4 foot deep and 3 foot square.
2. Min. concrete strength 2500 psi.
3. Allow concrete to set 28 days.
4. Cast concrete into hole with undisturbed soil.
5. "A" is the angle for the anchor rod. See table in Tower Installation Manual for values.
6. Hoist Side Foundation only, uses the tower guy wire anchor.

CROSS-SECTION OF TOWER GUY WIRE ANCHOR FOUNDATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS: ± DECIMALS: .X ± .XX ± .XXX± DO NOT SCALE DRAWING	CONTRACT NO		Abundant Renewable Energy
	APPROVALS	DATE	TITLE: Tower Anchor Foundation (TALL)
MATERIAL	DRAWN		
	CHECKED		
FINISH	DESIGNER		SIZE: A; CAGE CODE; DWG NO: D4; REV
	APPROVED		SCALE; RELEASE DATE; WEIGHT; SHEET

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

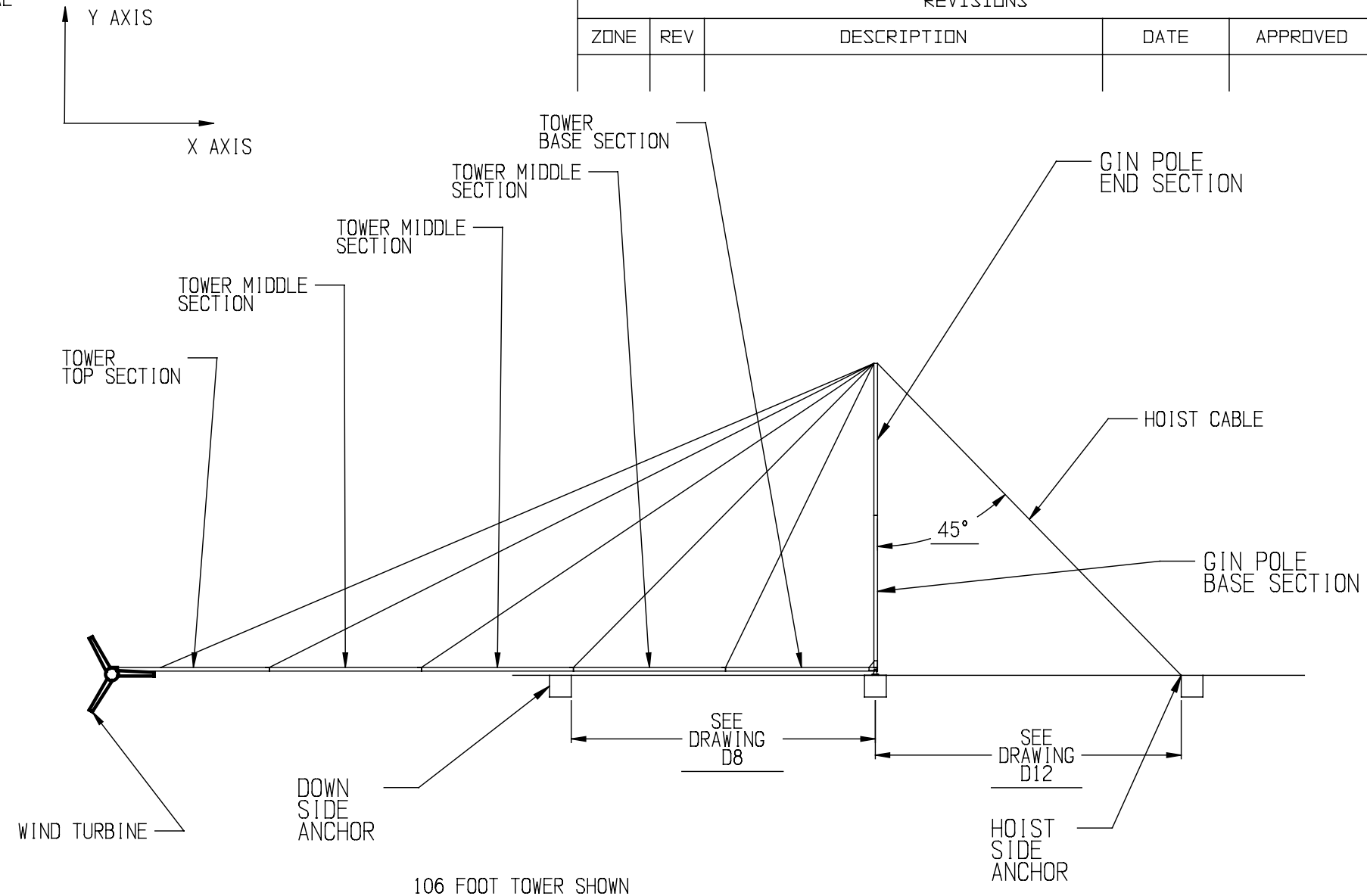
1. USE THE TOWER BASE OR A TEMPLATE TO LOCATE AND SECURE THE J-BOLTS BEFORE THE CONCRETE IS POURED
2. ENSURE 2-3 INCHES OF BOLT EXTENDS FROM THE TOP OF THE FOUNDATION. SEE DRAWING D9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS: ± DECIMALS: .X ± .XX ± .XXX± DO NOT SCALE DRAWING	CONTRACT NO		**Abundant Renewable Energy**
	APPROVALS	DATE	TITLE: **Tower Base Foundation**
MATERIAL	DRAWN		
	CHECKED		SIZE: A; CAGE CODE; DWG NO: D5; REV
FINISH	DESIGNER		
	APPROVED		SCALE; RELEASE DATE; WEIGHT; SHEET

DWG NO	SH	REV

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



106 FOOT TOWER SHOWN
127 FOOT TOWER SIMILAR

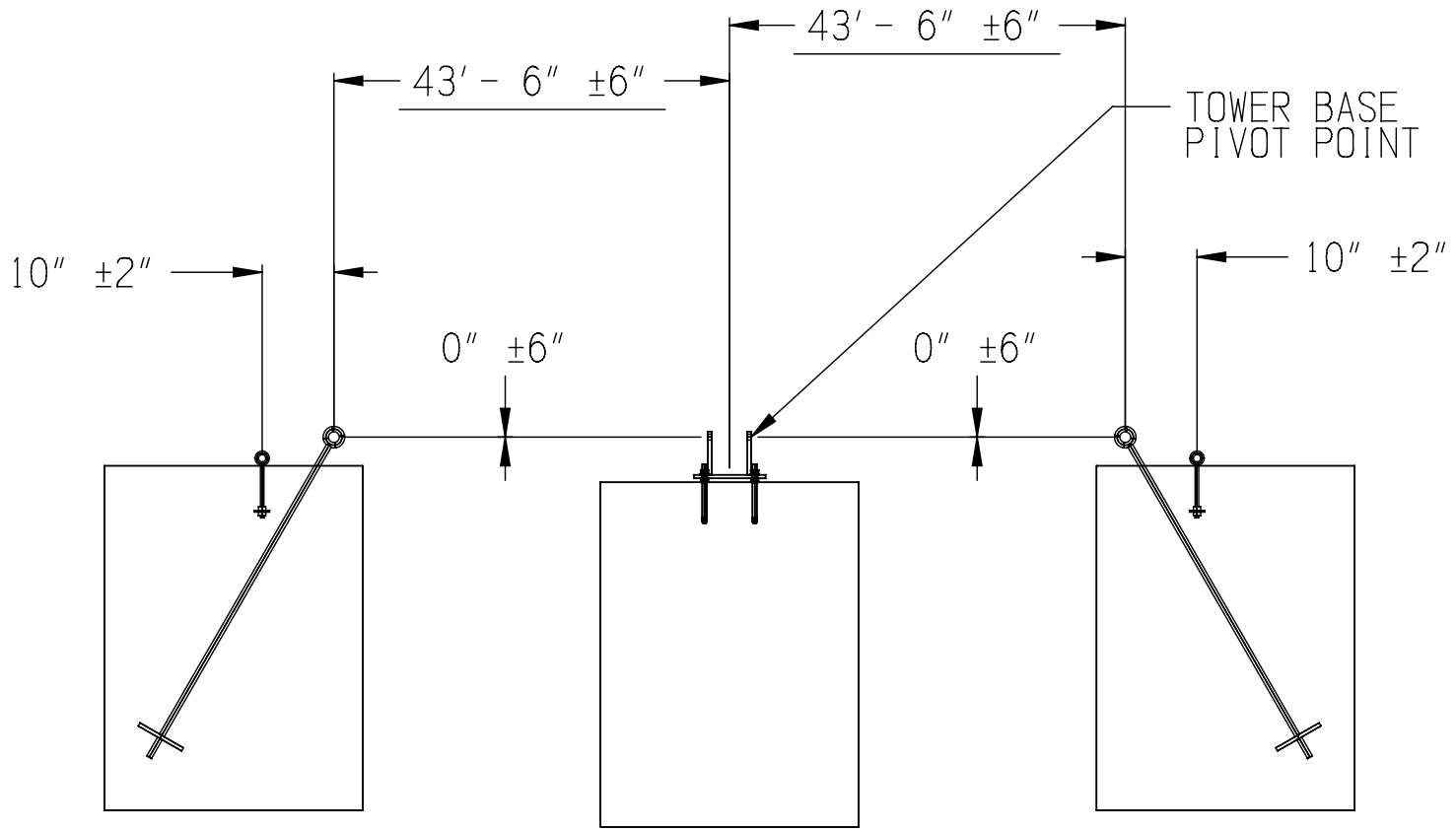
Abundant Renewable Energy

TALL TOWER IN DOWN POSITION

DESIGNER		SIZE	CAGE CODE	DWG NO	REV
		A		D6	
APPROVED		SCALE	RELEASE DATE	WEIGHT	SHEET

DRAWING NO.	D7		REV A
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/12/04	E.DRAPER

NOTES: UNLESS OTHERWISE SPECIFIED



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
LINEAR
FRACTION ± 1/16″
.XX ± .03
.XXX ± .015
ANGULAR
± 1.0°

MODEL NUMBER:
AWP 3.6

MATERIAL:

LEGEND
◇ REVISION ○ ITEM △ NOTE

DRAWN E. DRAPER DATE 07/12/04
CHECKED

ABUNDANT RENEWABLE ENERGY

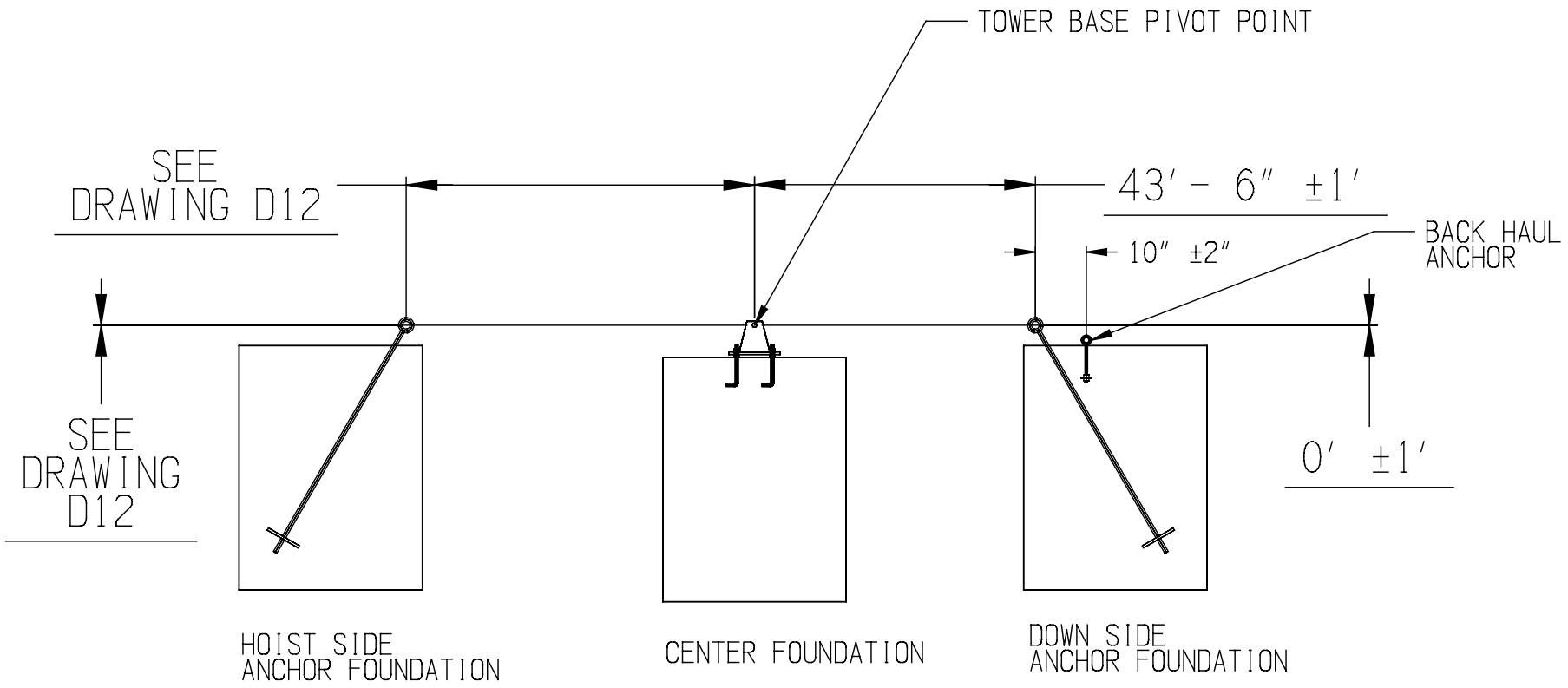
DRAWING TITLE
SIDE ANCHOR ELEVATION (TALL)

SCALE
NONE

DRAWING NO. D7 SHEET 1 OF 1 REV A

DRAWING NO.	D8		REV B
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/12/04	E.DRAPER
B	ADDED BACK HAUL ANCHOR	07/07/05	E.DRAPER

NOTES: UNLESS OTHERWISE SPECIFIED



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
LINEAR
FRACTION ± 1/16"
.XX ± .03
.XXX ± .015
ANGULAR
± 1.0°

MODEL NUMBER: AWP 3.6
MATERIAL:

LEGEND
◇ REVISION ○ ITEM △ NOTE

DRAWN E. DRAPER DATE 07/12/04
CHECKED

ABUNDANT RENEWABLE ENERGY

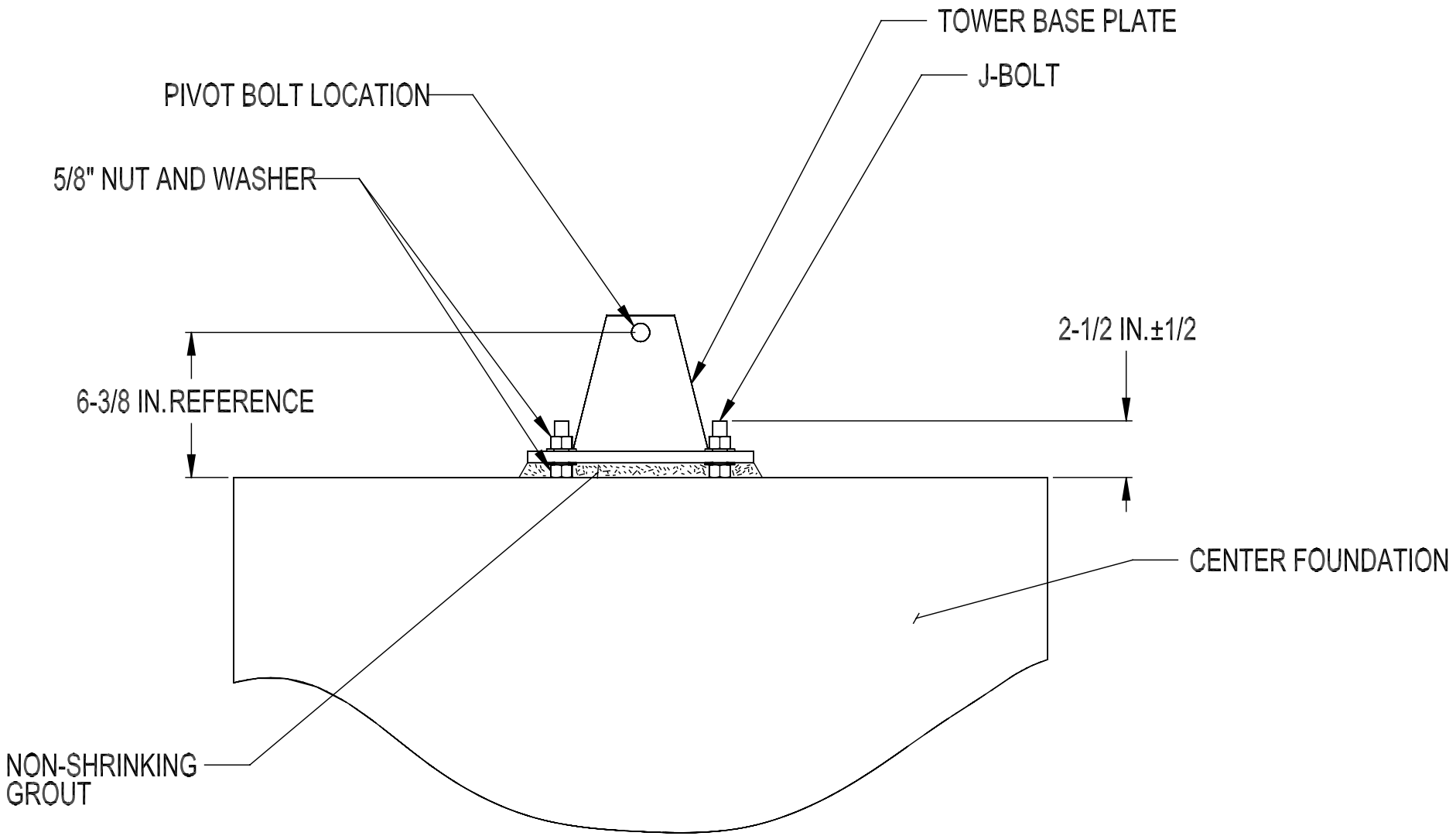
DRAWING TITLE
HOIST AND DOWN SIDE ANCHOR ELEVATION (TALL)

SCALE NONE

DRAWING NO. D8 SHEET 1 OF 1 REV B

DRAWING NO.	D9		REV A
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/014/04	E.DRAPER

NOTES: UNLESS OTHERWISE SPECIFIED



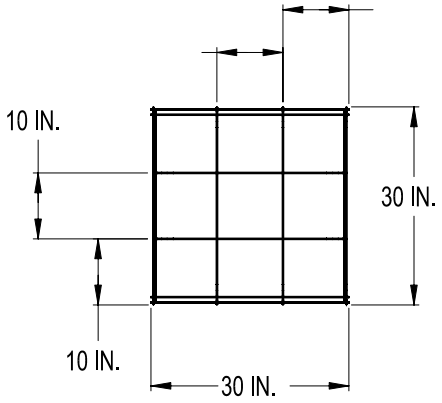
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: LINEAR FRACTION ± 1/16" .XX ± .03 .XXX ± .015 ANGULAR ± 1.0°	MODEL NUMBER: AWP 3.6 MATERIAL:		**ABUNDANT RENEWABLE ENERGY**
	LEGEND ⬡ REVISION ○ ITEM △ NOTE	DRAWN E. DRAPER DATE 07/14/04 CHECKED	DRAWING TITLE J-BOLT AND TOWER BASE INSTALLATION SCALE NONE
			DRAWING NO. D9 SHEET 1 OF 1 REV A

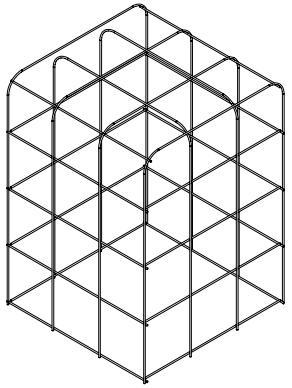
DRAWING NO.	D10	REV A

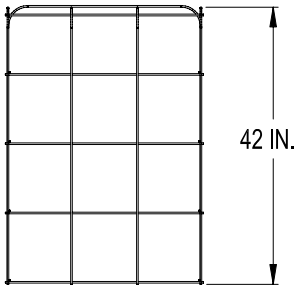
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/14/04	E.DRAPER

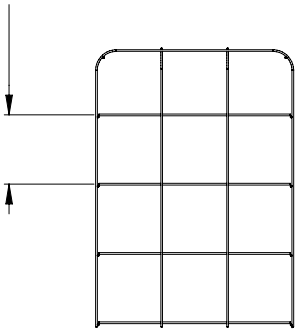
NOTES: UNLESS OTHERWISE SPECIFIED

1. MAXIMUM DIMENSIONS FOR A 4 FOOT DEEP, 3 FOOT SQUARE HOLE ADJUST FOR LARGER HOLES ENSURING THE REINFORCEMENT IS LOCATED 3 TO 5 INCEHS FROM ANY SURFACE









TYPICAL REINFORCEMENT

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DRAWING NO.	D11		REV A
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/14/04	E.DRAPER

NOTES: UNLESS OTHERWISE SPECIFIED

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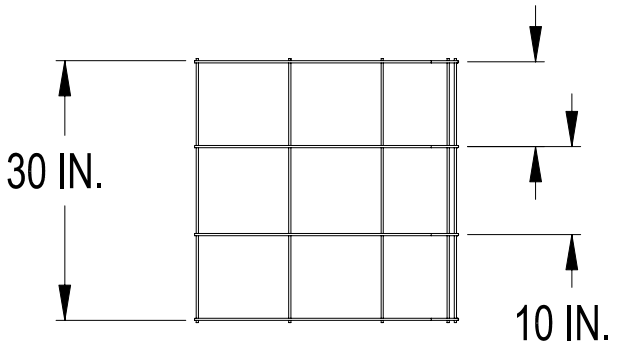
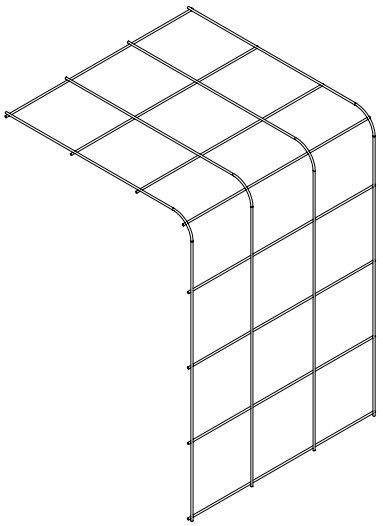
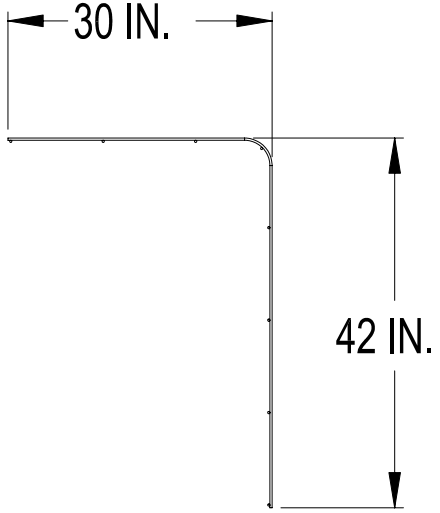
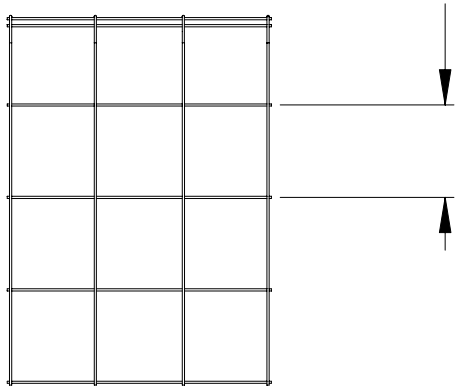








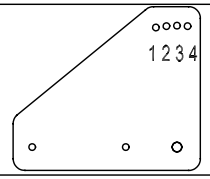
TYPICAL REINFORCEMENT

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: LINEAR FRACTION ± 1/16" .XX ± .03 .XXX ± .015 ANGULAR ± 1.0°	MODEL NUMBER: MATERIAL: #2 OR #3 REBAR (Ø1/2" OR Ø3/8")		DRAWING TITLE OUTER ANCHOR FOUNDATION REINFORCEMENT
	LEGEND ⬡ REVISION ○ ITEM △ NOTE	DRAWN E. DRAPER DATE 07/14/04 CHECKED	SCALE NONE DRAWING NO. D11 SHEET 1 OF 1 REV A

DRAWING NO.	D12		REV A
REV	DESCRIPTION	DATE	REV. BY
A	NEW RELEASE	07/12/04	E.DRAPER

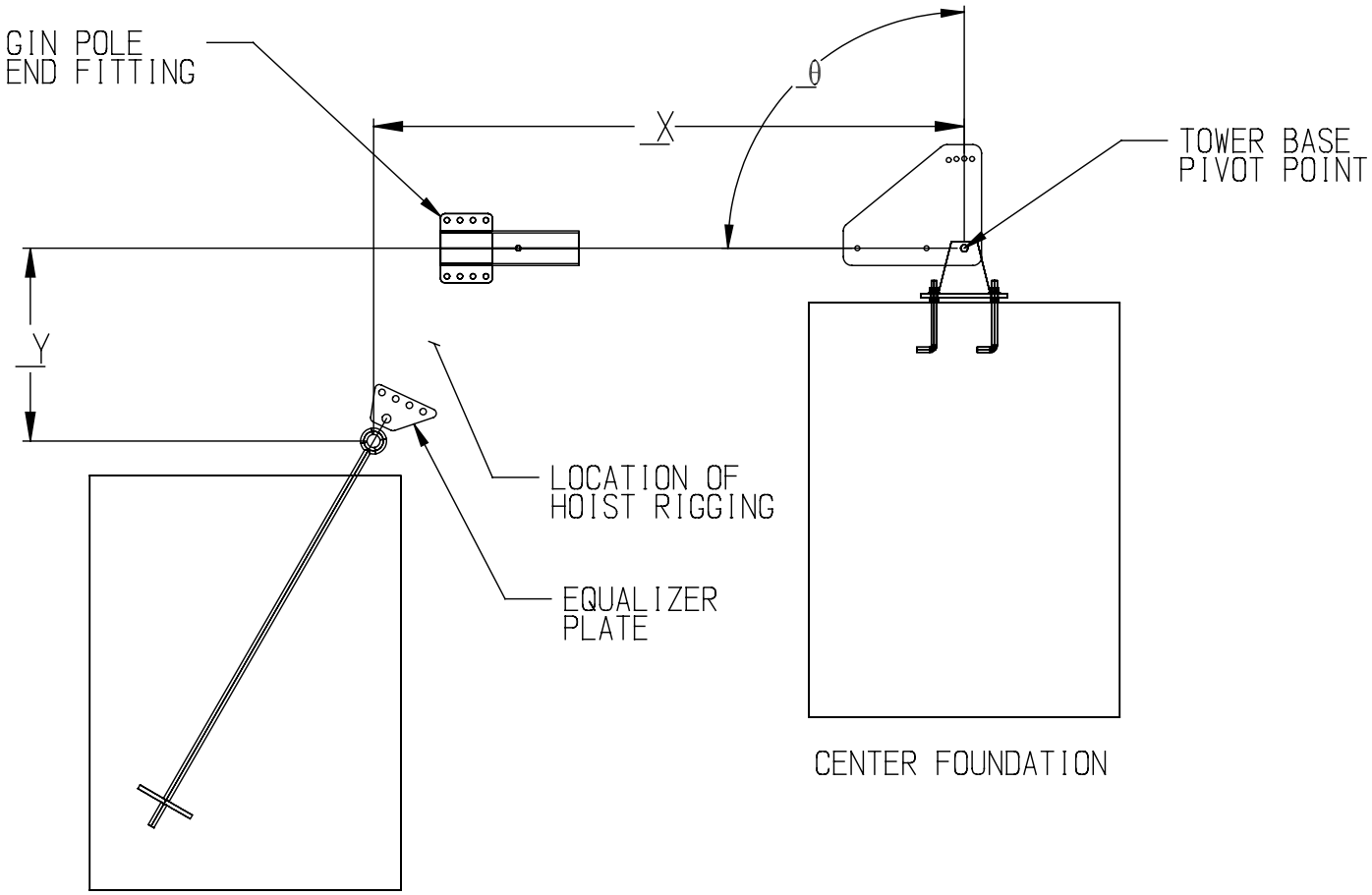
POSSIBLE LOCATIONS FOR HOIST ANCHOR

X ±2"	Y ±2"	GIN POLE GUSSET HOLE	θ
42' 8-3/8"	+5' 6-1/4"	1	80°
43' 2-3/4"	+1' 10"	2	85°
43' 4-3/4"	-1' 10-1/2"	3	90°
43' 2-1/8"	-5' 6-7/8"	4	95°



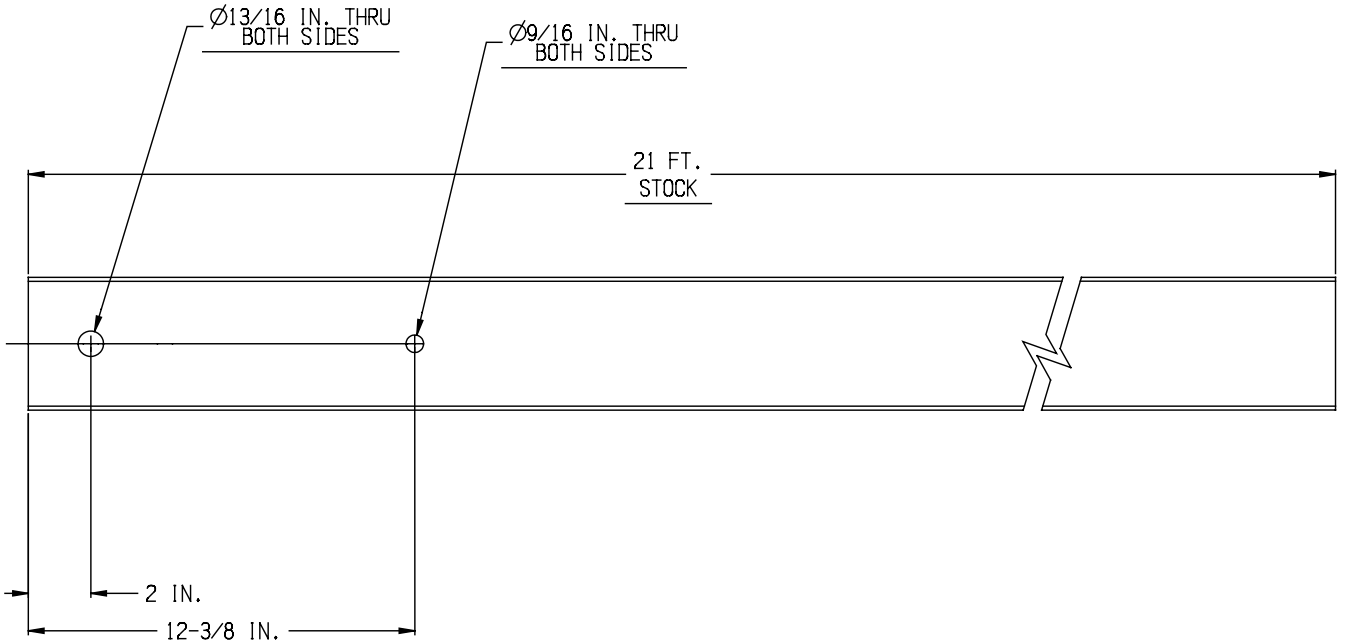
NOTES: UNLESS OTHERWISE SPECIFIED

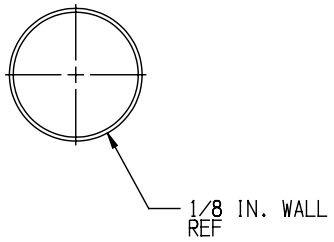
1. GUSSET HOLE #3 CREATES A 90° ANGLE BETWEEN THE GIN POLE AND THE TOWER BASE SECTION (SHOWN)



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: LINEAR FRACTION ± 1/16" .XX ± .03 .XXX ± .015 ANGULAR ± 1.0°	MODEL NUMBER: AWP 3.6 MATERIAL:		**ABUNDANT RENEWABLE ENERGY** DRAWING TITLE HOIST AND DOWN SIDE ANCHOR ELEVATION (TALL)
	LEGEND ◇ REVISION ○ ITEM △ NOTE	DRAWN E. DRAPER DATE 07/12/04 CHECKED	SCALE NONE
			DRAWING NO. D12 SHEET 1 OF 1 REV A

101011 REV A				
R	DATE	ECN #	CHANGE	DR





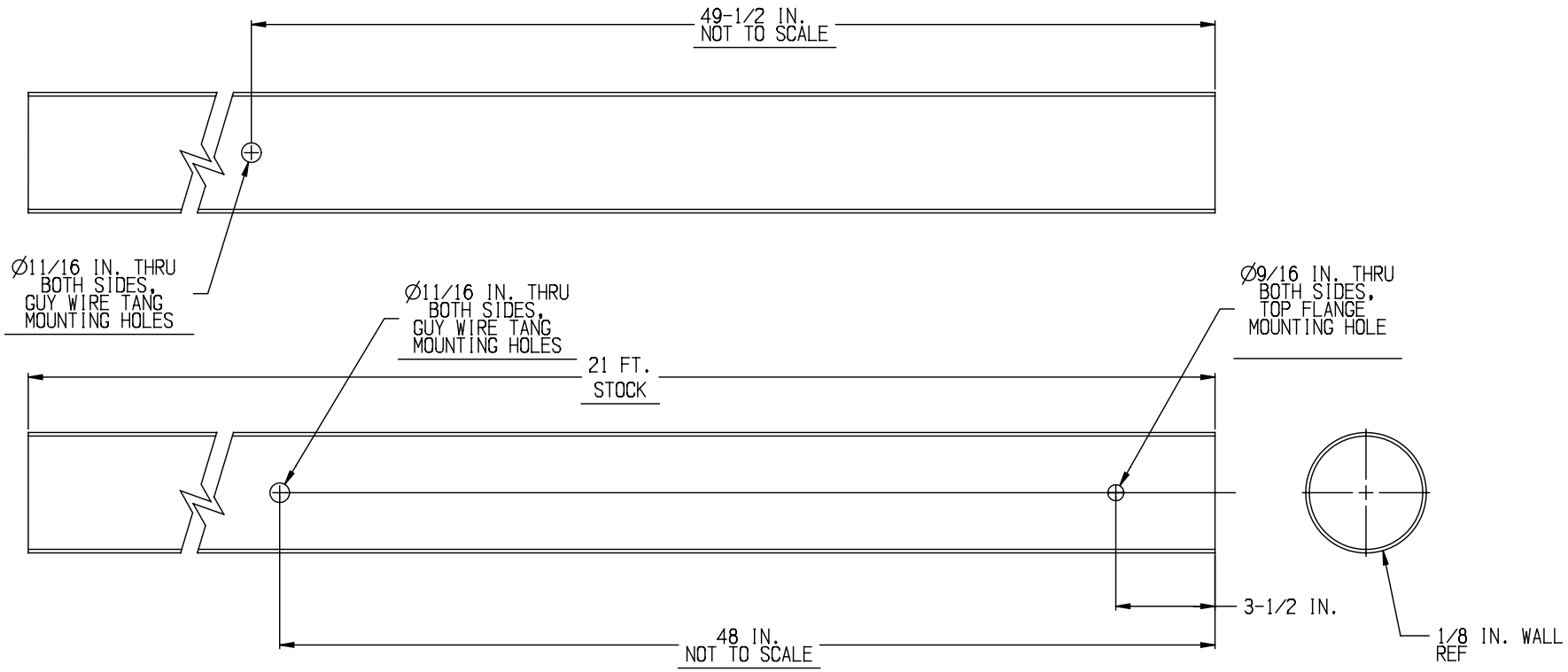
NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE INCHES
2. MAT'L: 4 INCH SCHEDULE 10 PIPE
3. BREAK SHARP EDGES
4. FINISH: GALVANIZED

TOLERANCES:	DR	CK	SCALE:	ABUNDANT RENEWABLE ENERGY	
.X=± 0.25	CW		1:1		
.XX=± .030	DATE 09-18-02			TITLE	
.XXX=± .010	APP'D			TOWER, BASE SECTION	
DO NOT SCALE DRAWING					

CUST RWP	PROJ TOWERS	SIZE	DWG#	REV
		A	101011	A

101013	REV B			
R	DATE	ECN #	CHANGE	DR



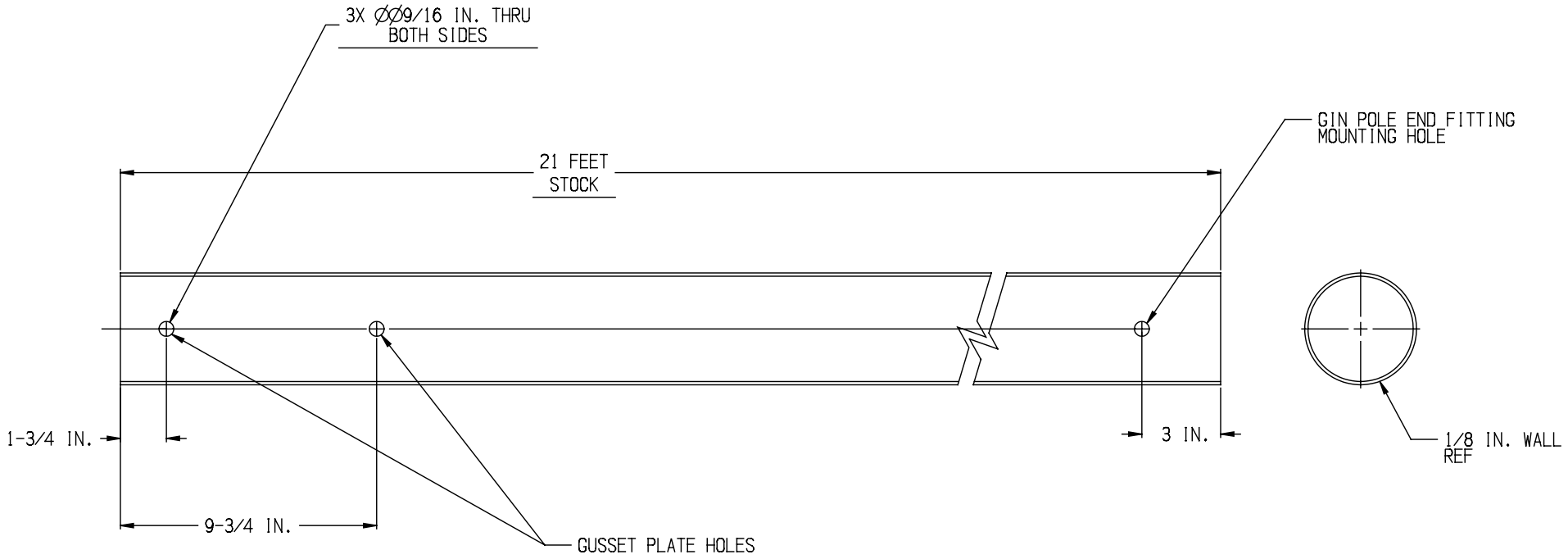
NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE INCHES
2. MAT'L: 4 INCH SCHEDULE 10 SEAMLESS PIPE
3. BREAK SHARP EDGES
4. FINISH: GALVANIZED

TOLERANCES:	DR	CK	SCALE:	ABUNDANT RENEWABLE ENERGY	
.X=± 0.25	CW		None		
.XX=± .030	DATE 09-18-02				
.XXX=± .010	APP'D			TITLE Tower, Top Section	
DO NOT SCALE DRAWING					
THIS DRAWING IS PROPRIATARY. THE INFORMATION HEREIN IS CONFIDENTIAL AND REQUIRES Abundant Renewable Energy's APPROVAL FOR USE OR DUPLICATION				SIZE A	DWG# 101013 REV B
CUST RWP	PROJ TOWERS				

101014 REV A

R	DATE	ECN #	CHANGE	DR



NOTES: UNLESS OTHERWISE SPECIFIED

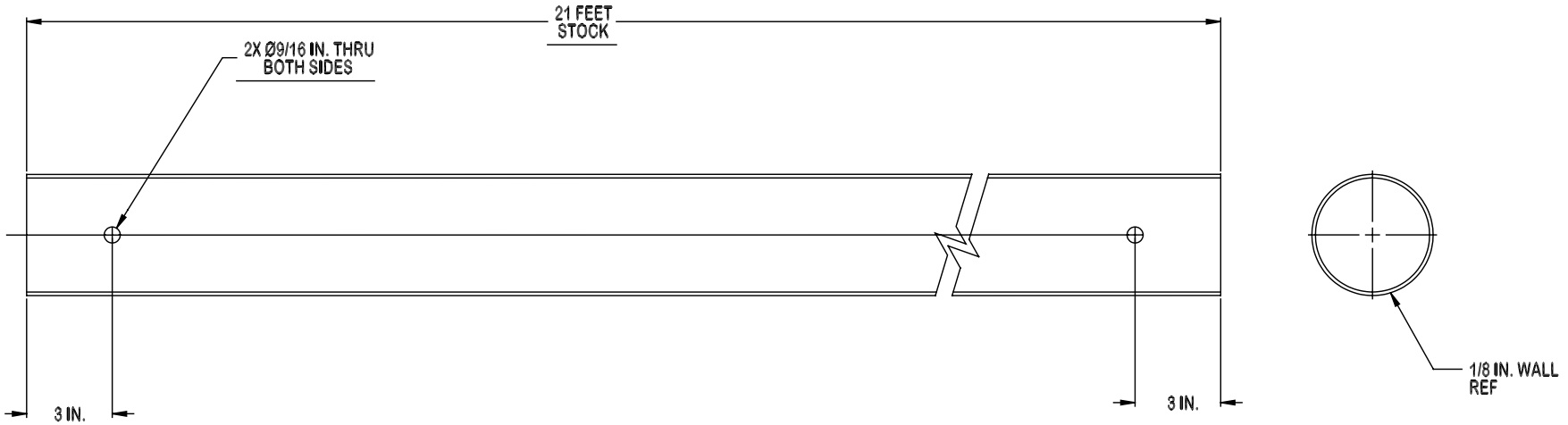
1. ALL DIMENSIONS ARE INCHES
2. MAT'L: 4 INCH SCHEDULE 10 PIPE
3. BREAK SHARP EDGES
4. FINISH: GALVANIZED

TOLERANCES:	DR	CK	SCALE:	ABUNDANT RENEWABLE ENERGY
.X=± 0.25	CW			
.XX=± .030	DATE 09-20-02			
.XXX=± .010	APP'D			TITLE: GIN POLE, BASE SECTION
DO NOT SCALE DRAWING				

CUST RWP	PROJ TOWERS	SIZE	DWG#	REV
		A	101014	A

101015	REV A

R	DATE	ECN #	CHANGE	DR



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE INCHES
2. MAT'L: 4 INCH SCHEDULE 10 PIPE
3. BREAK SHARP EDGES
4. FINISH: GALVANIZED

TOLERANCES:	DR	CK	SCALE:	ABUNDANT RENEWABLE ENERGY
.X=± 0.25	CW		1:1	
.XX=± .030	DATE 09-20-02			
.XXX=± .010	APP'D			TITLE: GIN POLE, END SECTION
DO NOT SCALE DRAWING				

CUST RWP	PROJ TOWERS

SIZE	DWG#	REV
A	101015	A