

## E GUYED TOWERS ERECTION

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### 2. PRE-ERECTION CONSIDERATIONS

**2.01** Tower erection should not be started until all required *permits* have been obtained, as outlined in Section AG25.320.

**2.02** The permit issued by the Federal Communications Commission (FCC) to construct and operate a radio system usually indicates whether or not lighting and painting to improve visibility are required. Where only receivers are to be installed and it has been determined that FCC permission is not required, the Federal Aviation Agency (FAA) will determine the necessity for lighting or painting to improve visibility. If lighting is required, arrangements must be made to assure the availability of electric power at the site, and the lighting facilities must be ordered and on hand at the tower site. Note that the standard lighting kit provides only the material which goes on the tower. Conduit and wire from the base of the tower to the lighting control panel in the building should be ordered locally. Methods of lighting and painting towers are described in Sections AG25.230 and AG25.300. Information on temporary warning lights is contained in Part 4 of this section.

**2.03** Section AG25.320 provides information on foundations and anchors for E Guyed Towers. Steel erection should not be started until the results of concrete compression tests are known to be satisfactory. (See Section AG25.130 for a discussion of concrete.)

**2.04** The grounding system at the anchors should be completed and the grounding connections at the foundation should be readily accessible. Installation of the grounding system is described in Section AG25.320.

### 1. GENERAL

**1.01** This section outlines the general considerations involved in erecting E Guyed Towers, and includes recommended procedures and precautions.

**1.02** Erection drawings are normally furnished with the tower, and provide information necessary for the field assembly of the tower, including the location and orientation of every piece and subassembly. All steel (except nuts, bolts, and washers) is identified by stencils, stamps, or metal tags which correspond to the markings shown on the erection drawings. The identifying mark of leg members is located on the outer face near the lower end. These drawings also show the number and length of bolts, nuts, and washers required to join the members. A more than adequate supply of bolts, nuts, and washers is furnished with the tower, but care must be exercised to ensure that the proper size of each is used for each joint, or a shortage of some sizes may develop.

2.05 All equipment to be installed on the tower should be available when required, and its mounting location on the tower should be specified to the contractor in order that hoisting equipment may be positioned to avoid conflict.

2.06 If aerial electric power facilities are in a location that may present a hazard to or interfere with temporary guys, hoisting equipment, tag lines, etc, arrangements should be made to have the power company relocate, de-energize, or insulate its facilities.

2.07 Foundations and anchors should be carefully checked to ensure that they are located correctly and are of the right size. This should include checking the azimuths of the anchors, which in turn fix the transmission blind sectors referred to in Section AG25.310. Details of layout are covered in Section AG25.320.

2.08 It may be desirable to install a talking circuit on the tower to facilitate adjustment of antennas and reflectors during system lineup. Information on this subject is contained in Section AG25.230. A physical circuit can be avoided by use of the walkie-talkie radio, if this equipment is available. This equipment may also prove of value in the erection of the tower itself.

### 3. INSTALLATION OF BASEPLATE ASSEMBLY

3.01 Both the foundation surface and the baseplate should be cleaned of mud, grime, and other foreign matter. The baseplate is then installed (Fig. 1) by placing it on four tapered steel wedges located about midway between the anchor bolts. The plate is leveled by adjusting the wedges. Since the baseplate is symmetrical about the center, it may be installed without regard to its orientation on the pier.

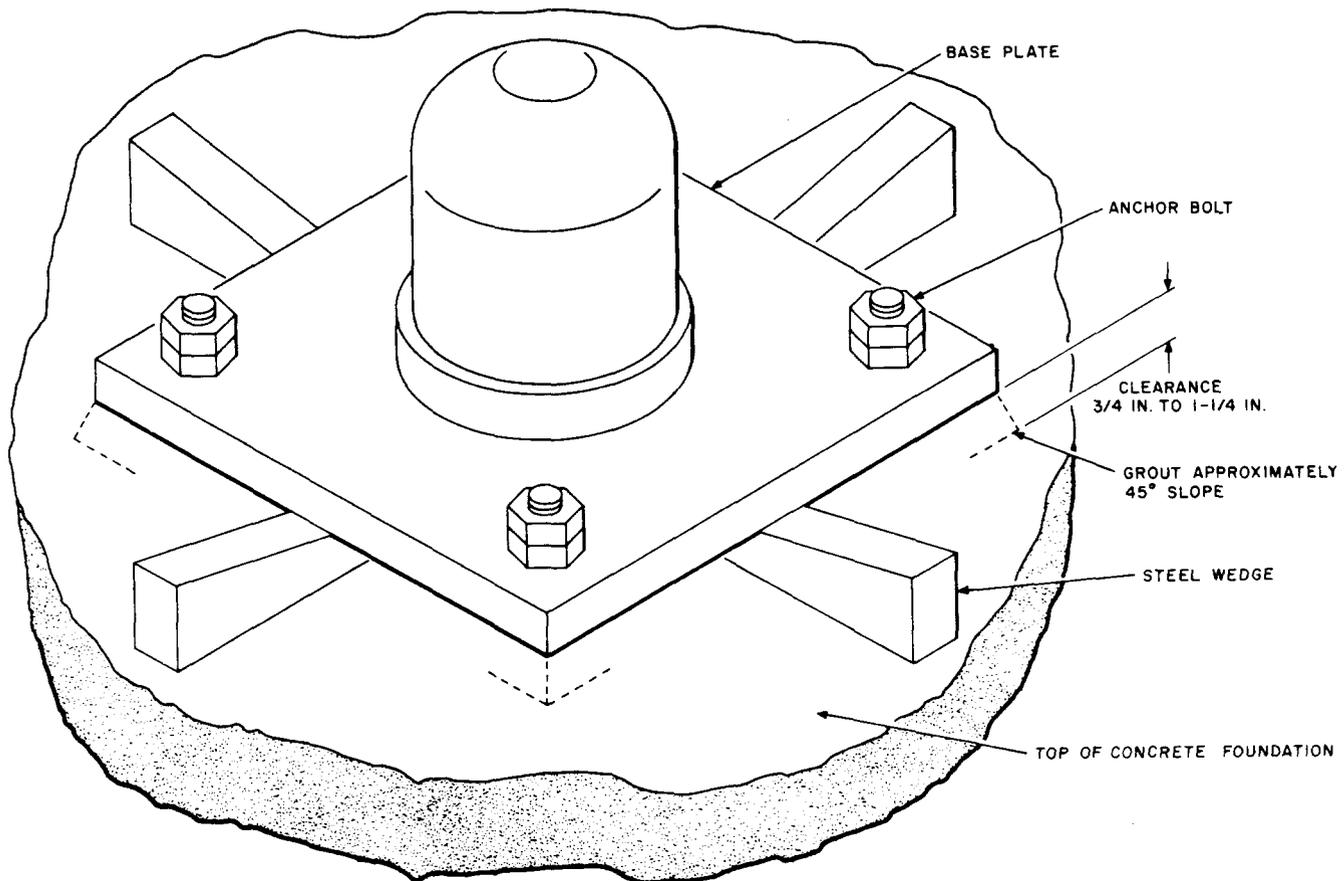


Fig. 1—Installation of Baseplate Assembly

**3.02** After the baseplate has been leveled, the anchor bolt nuts should be tightened. The wedges should provide a clearance of 3/4 to 1-1/4 inches between the baseplate and pier to allow for grout. The baseplate may be installed at any time after the results of the compression tests on the concrete are known to be satisfactory.

**3.03** The grout should consist of one part portland cement (Type I or III) to two parts sand (by volume). Portland cement is described in Section AG25.130. Clean sand from a reliable supplier should be used in the grout. The water should be clean and fit for drinking.

**3.04** The consistency of the grout must be very stiff. The sand and cement should be thoroughly mixed in a dry condition and then water should be added sparingly so that the mixture retains a granular appearance. Grout of the proper consistency will form a lump when squeezed in the hand, and the lump will crumble freely when disturbed.

**3.05** Grout should be forced under the baseplate from all sides, and should completely fill all voids. The wedges should then be removed, and the void left by removing the wedges should be filled immediately with additional grout. The grout should be beveled as illustrated in Fig. 1.

#### **4. TEMPORARY WARNING LIGHTS**

**4.01** The rules of the FCC and FAA require that *temporary warning lights* be placed on any tower which is required to have *permanent air obstruction warning lights*. The number of sets (or levels) of temporary lights required will be the same as the number of levels of permanent lighting. Where two or three levels of permanent lights are required, only one temporary set of lights is required (at the top) until the level of the first permanent lights is exceeded. Temporary lights should then be installed at approximately the level of permanent lights and, in addition, a set of temporary lights is always required at the uppermost point of the structure. Even on towers requiring only one level of permanent lighting, a set of temporary lights is required at the top of the

structure, and this applies even though only one section of the tower may have been erected by sunset.

**4.02** Temporary lights are to burn steadily from sunset to sunrise. Top lights are to consist of two 100-, 107-, or 116-watt lamps (A21/TS) enclosed in aviation red obstruction light globes. Two similar lights are required at each level where permanent lights are to be installed. (Permanent lights may be used in lieu of temporary lights.) All side lights are to be positioned so at least one of the two lights at each level will be visible from any angle of approach. Many contractors have temporary warning lights for use during erection, but it is advisable to notify them if temporary lighting will be required, and whether it will be one-, two-, or three-level.

#### **5. ERECTION CONSIDERATIONS**

**5.01** Erection of steel towers is usually performed by contractors rather than by Telephone Company personnel. It should be noted that the contractor is responsible for the job and for the construction methods he chooses to use, and is presumably the best judge of the condition of his equipment and the loads which it can handle. However, the Telephone Company representative should assure normal safeguards and require the contractor to correct any obviously dangerous items such as frayed winch lines and ropes.

**5.02** The general appearance of the base of the tower is shown in Fig. 2. Note the use of 12-inch channels in the base, and 8-inch channels for internal bracing. Four bolts connect the tower baseplate to the flange of each 12-inch channel. A washer is placed under the head of each bolt, in addition to the one used under the nut (Fig. 3).

**5.03** Most structural members of the tower are formed of angles. Legs are 60-degree angles; lacing and horizontal bracing are all 90-degree angles. Note that the legs are double-laced with 1-1/2 by 1-1/2 by 1/8-inch angles, ie, cross-braced, except for the top section. This is a tension-compression system and to get the maximum strength out of these small angles, they are bolted together at

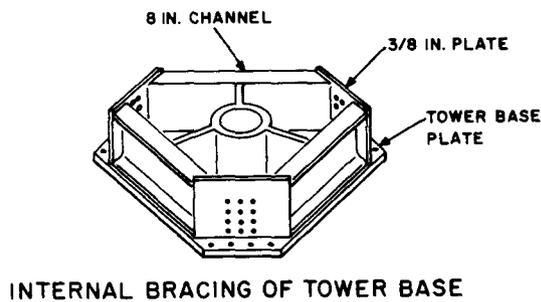
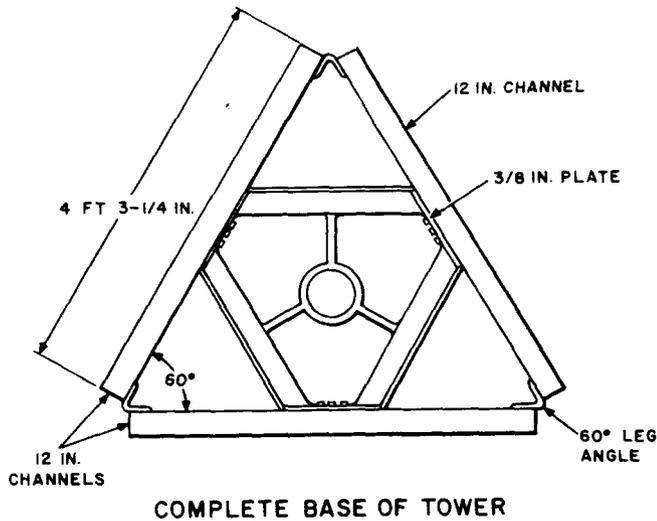


Fig. 2—Base of Tower

the point where they cross. On a given face, since one set of lacing angles is bolted to the inside of the legs and the other is bolted to the outside, angles which cross each other are separated by the thickness of the leg members. As shown in Fig. 4, a *spacer washer* must be installed to avoid the bending of these angles which would result if they were bolted together without the spacer in place. Double washers are required at one location in the top section as discussed in 5.22.

**5.04** It is general practice for contractors to assemble the tower sections on the ground, with the associated splice plates attached loosely at the top of each leg. The lower diagonals are usually left loose to facilitate lining up holes when the section is put in place. The sections should be inspected for such items as correct assembly, spacer washers, tightness of bolts, etc. All bolts should be equipped with a plain washer, hex nut, and PALNUT.

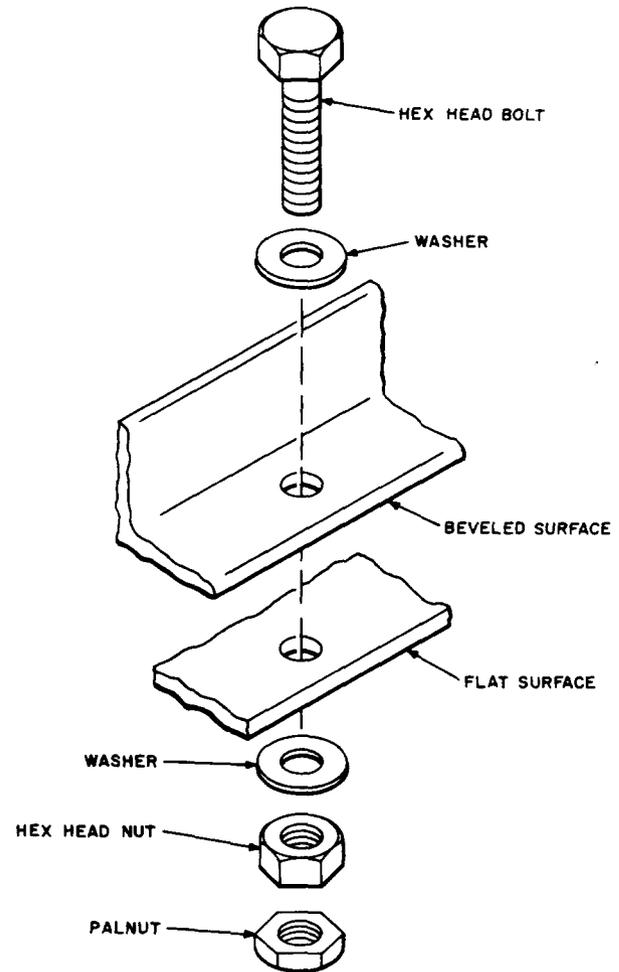


Fig. 3—Use of Washer

**5.05** Contractors will vary in the exact manner in which they assemble the tower. Usually the bottom section, and sometimes the two bottom sections, are bolted together on the ground and lifted onto the baseplate. Because of the ball-and-socket type of connection to the base pier, it is necessary to use temporary guys to prevent the tower from overturning. Selection of the size and type of temporary guys is the responsibility of the erection contractor. Temporary guys are to be moved up with the tower so there is never more than one section (20 feet) extending above the level of the temporary guys. *Guy strand intended for permanent guys should not be used for temporary guys.*

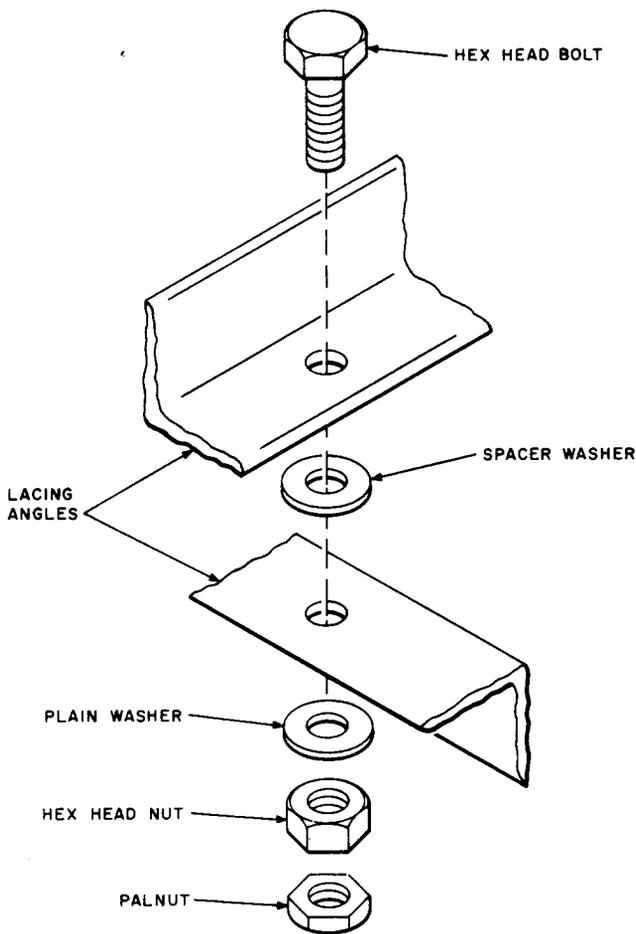


Fig. 4—Use of Space Washers

**5.06** As soon as the first section (or sections) is in place and stabilized with temporary guys, the grounding connections should be established. Each of the three 12-inch channels in the base of the tower has two 9/16-inch holes for a 1/2-inch machine bolt. Only one hole in two of the three faces is used. The ground wire is secured under a grooved washer which is held in place by the 1/2-inch machine bolt. Since the wire is tinned copper and the baseplate is galvanized, the presence of water in the joint will cause galvanic action between the dissimilar metals. The bolt should be drawn up tightly and painted with hot pitch or other waterproofing material in order to prevent this galvanic action.

**5.07** Permanent guys should be installed at their appropriate level and correct tension as soon as the tower reaches the height at which they are required. The structure should be made plumb before adding any more sections. Guy strand is

furnished in quantities sufficient to make up all guys with each anchor on a minus 6-degree (ground) slope, ie, a drop of about 10-1/2 feet per hundred feet.

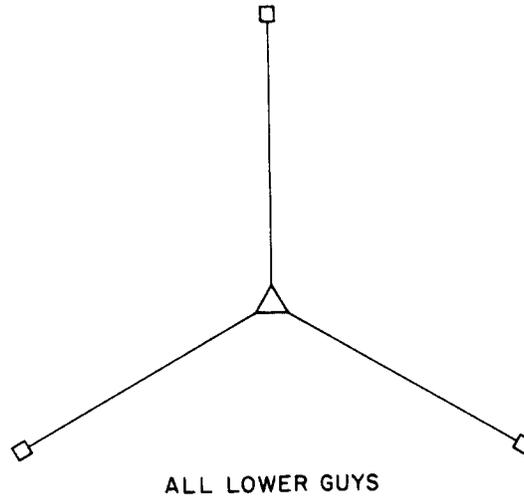
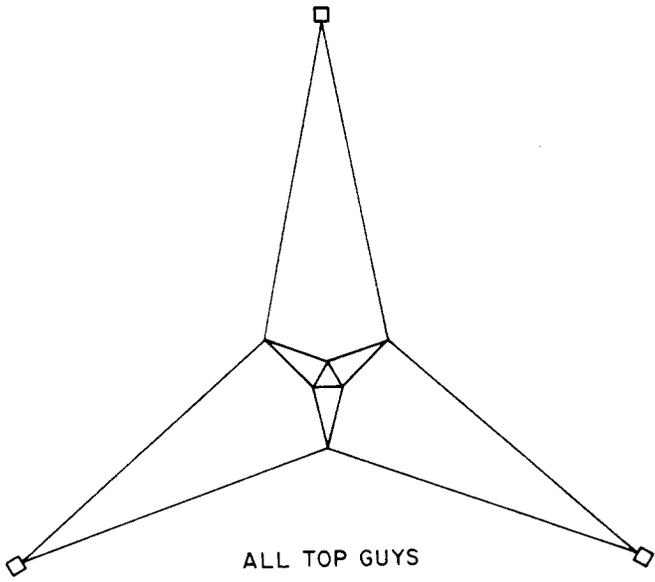
**5.08** The E Guyed Tower uses four different sizes of guy strand as follows:

DIAMETER (INCHES)	WEIGHT/FOOT (LBS)	ULTIMATE STRENGTH (LBS)
1/2	.504	26,700
9/16	.637	33,700
5/8	.796	40,200
3/4	1.155	58,300

The 80-, and 100-foot towers employ only one size of guy strand (9/16 inch); all other heights use two sizes of strand. Fig. 5 and 6 show the size and location of guys for all sizes of towers. Information on guy tensions is contained in Part 6 of this section.

**5.09** A typical setup for erecting guyed towers is shown in Fig. 7. The gin pole is mounted on one face of the tower and is fastened at two points. The use of a wooden gin pole for erecting towers is not recommended. The bottom of the gin pole is usually hung by two short lengths of cable, shackled to each leg (Fig. 7A). The lower cables support the dead load of the gin pole plus the loads imposed by hoisting. The upper set of shackles (Fig. 7B) serves to support the gin pole in a vertical position. Normally, the lengths of both sets of shackling cables are calculated so that the pole will not deviate from a vertical plane by more than 10 degrees. This restricts the bending moment imposed on the tower and the gin pole.

**5.10** Usually a gin pole will extend about 2 or 3 feet above the top of the hoisted section. This is necessary in order to provide headroom when a section is being set in place. The top of the gin pole is equipped with a pivoted head. When a section is being hoisted, the top of the gin pole will lean out to the limit of its top shackles. When the section reaches the upper block, hoisting is halted and the section is pivoted (Fig. 7, Sec. A-A) around the pole. With this transfer of weight, the top of the pole will kick-in, and the bottom will kick-out. This action will put the center of the hoisted section near the center of the tower, and it can be lowered into place and bolted. It is recommended that all bolts be installed and tightened before progressing.



NOTE:  
ALL TOP SECTIONS ARE IDENTICAL  
LEGS ARE 4 X 4 X 5/16 IN.

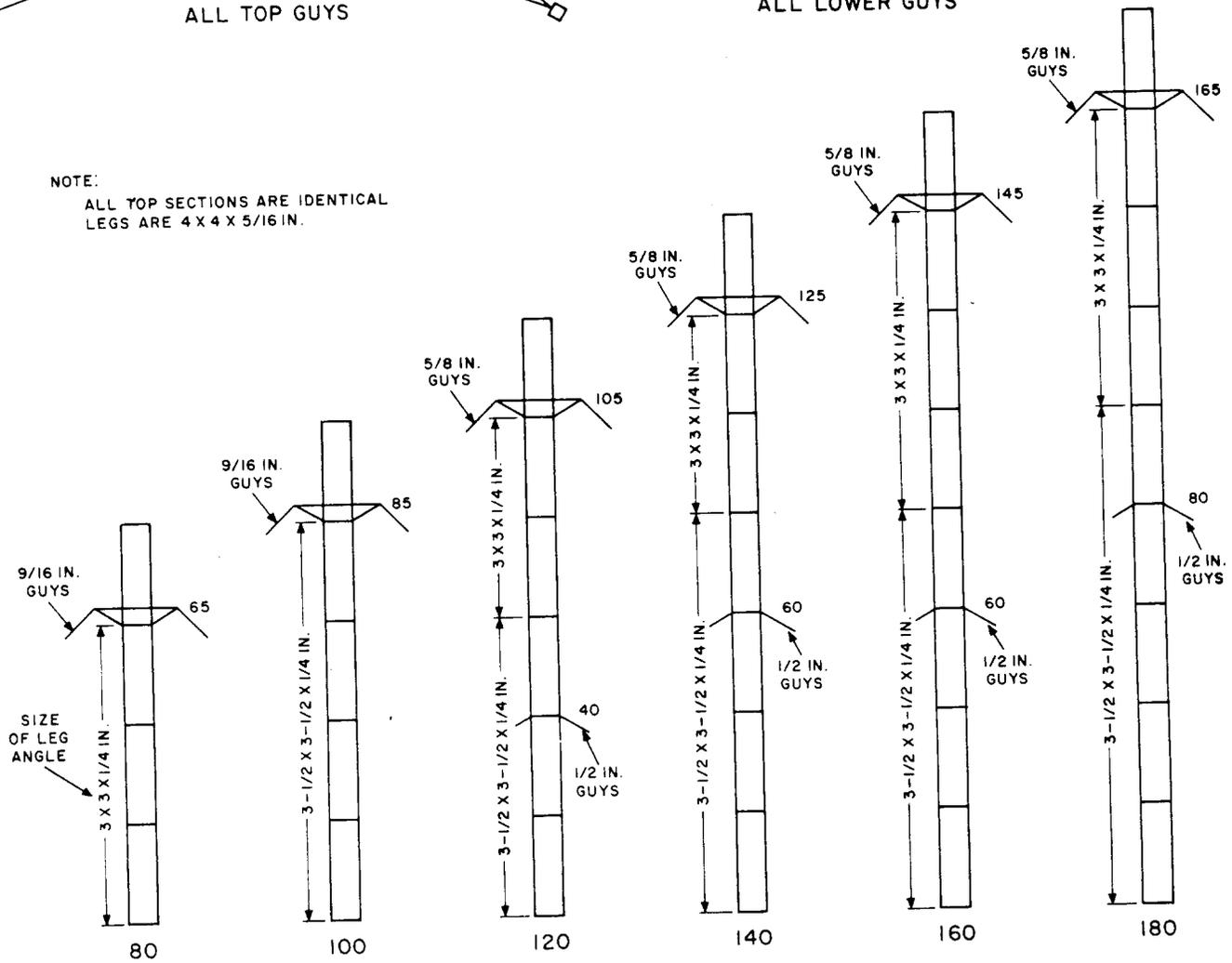


Fig. 5—180-Foot and Smaller Towers

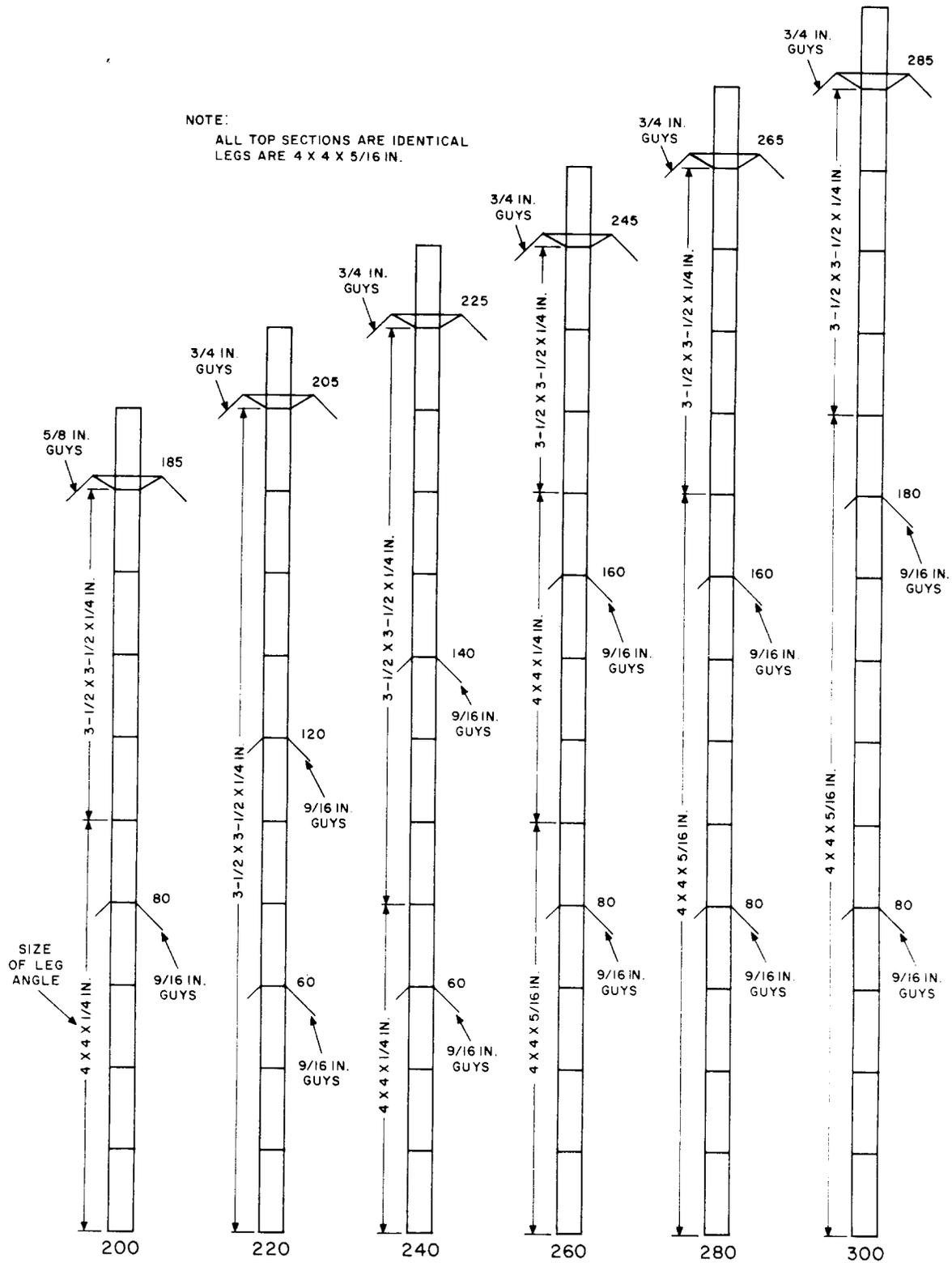


Fig. 6—200- to 300-Foot Towers

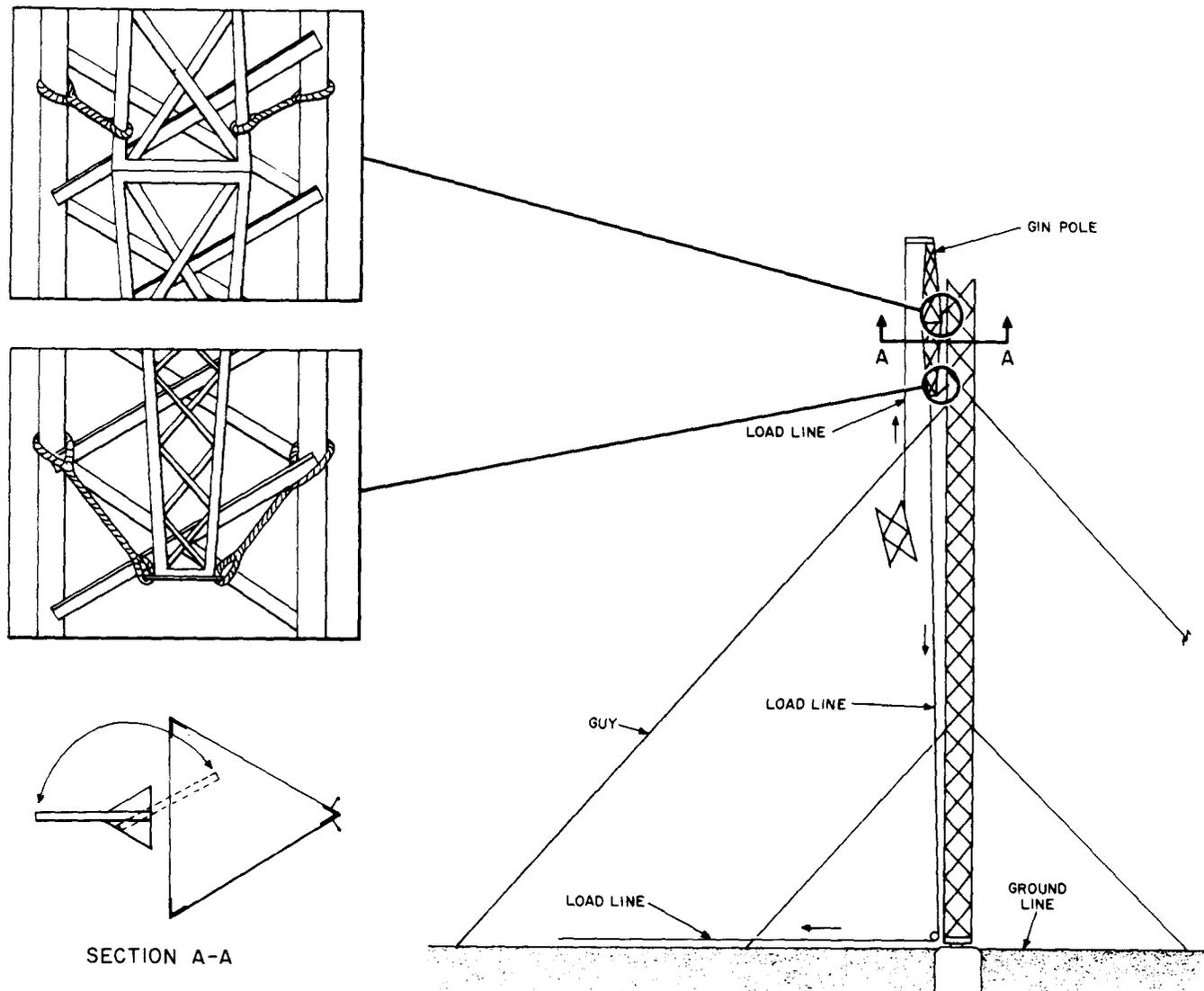


Fig. 7—Typical Gin Pole Setup for Hoisting Tower Sections

5.11 The gin pole is then raised to the next highest position, and the next section installed. Normally, antennas or reflectors are hoisted only after the tower is completely erected, all permanent guys have been installed at their proper tension, and the tower plumbed.

5.12 The gin pole method, when properly used, is capable of hoisting any single assembled tower section, System Standard antenna or reflector (or comparable weights) without exceeding the design criteria of the tower. There are other satisfactory construction methods used, such as

boom cranes, which are used quite frequently. Some contractors erect supplementary portable towers on the site for use in hoisting tower sections and equipment items.

5.13 The ends of the guys are made up with pre-formed guy grips (Fig. 8), which are in turn connected to the tower and to their respective turnbuckles. Care should be taken to install these grips properly so that the full strength of the connection is developed. If it is necessary to remove the grip from the strand, it should be discarded **and not re-used**.

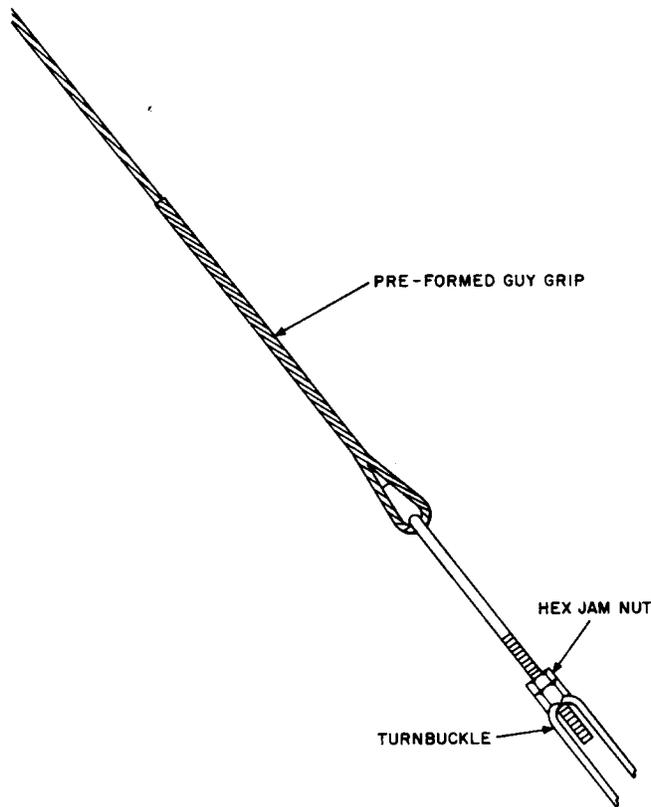


Fig. 8—Lower End of Guy

5.14 The tower is erected by joining abutting leg angles using bolts and splice plates. For economy in fabrication, only two sizes of splice plates are used. One is 1-1/2 inches wider than the other, and has an extra hole for a step bolt. Both plates are the same length and each provides two groups of seven bolt holes. Fig. 9 shows the standard plate used at all leg splice locations where step bolts do not occur.

5.15 Bolt requirements at leg splices are as follows:

LEG SIZE (INCHES)	NO. OF BOLTS AT EACH END (EACH SPLICE PLATE)
4 x 4 x 5/16	7
4 x 4 x 1/4	6
3-1/2 x 3-1/2 x 1/4	5
3 x 3 x 1/4	4

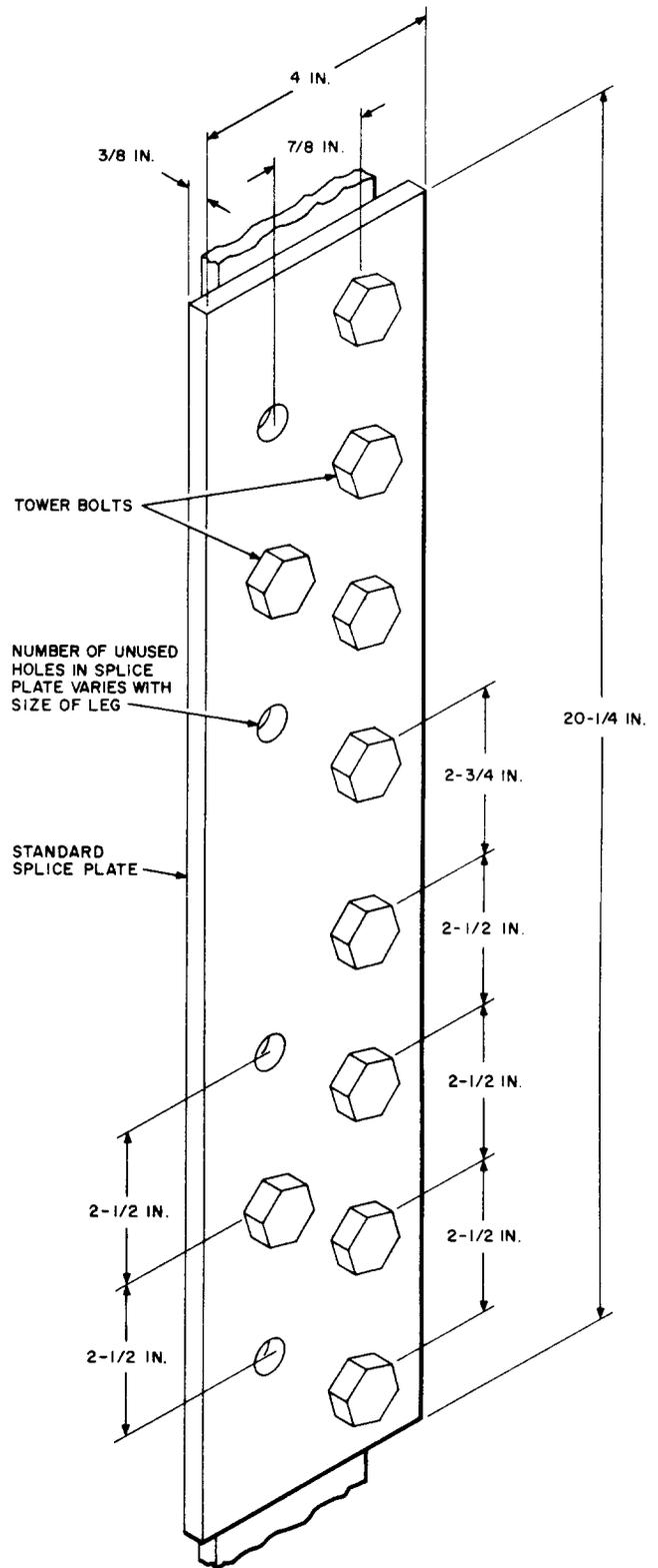


Fig. 9—Standard Splice Plate

Note that only the largest size leg members use all fourteen bolt holes, while the smallest size legs are spliced with only eight bolts, thus leaving six unused holes in the *splice plate*. **All holes in leg members must contain bolts at splices.** All top sections are made with 4- by 4- by 5/16-inch angles, regardless of tower height. Details on size of leg members in other parts of these towers are shown in Fig. 5 and 6.

**5.16** Members which have been bent or buckled should be replaced. Occasionally it will be found that holes do not line up closely enough to permit bolting without drifting of holes. There is no objection to removing excess zinc (galvanizing) which may have unduly reduced hole size. Members which cannot be joined without further field fabrication should not be installed without checking dimensions to determine the nature of the mistake in fabrication. Members which are merely too long may be cut to proper length, provided distances between bolt holes are correct and edge distances will be correct after cutting. Grinding may be permitted in lieu of cutting; cutting by torch should not be allowed.

**5.17** Freshly cut surfaces, or any surface where galvanizing has been damaged should be painted immediately. The best protection is probably provided by the zinc-rich type of paint. These paints are 90 percent (or more) powdered zinc and will provide some galvanic protection in the same fashion as galvanizing. They also have the property of preventing rust from creeping under the paint film. They should not be applied to steel which is damp or wet, or coated with mud, oil, grease, mill scale, bird droppings, etc. To be effective, paint of this kind should not have a spreading rate which exceeds 350 square feet/gallon. If this type of paint is not available, zinc oxide—zinc dust paint—is an acceptable substitute. It should be applied over clean, dry metal and should conform to Federal Specification TT-P-6410 Type I or Type II.

**5.18** The tower has a series of 9/16-inch holes spaced 16 inches apart on alternate sides of one leg to accommodate step bolts which provide access to the structure. All step bolts are to be installed with a plain washer, a hex nut, and a PALNUT. Step bolts usually extend from the bottom of the tower to a point 5 feet above the grating platform at the lower end of the top section. However, they may be omitted in the bottom 8

feet of the tower to discourage unauthorized climbing. This precaution is unnecessary if the tower base is surrounded by a fence with a locked gate.

**5.19** Each leg member has also been punched with three 9/16-inch holes in the same flange. Facing the tower, these holes are on the right leg of the tower face, are located 3, 13, and 18 feet, respectively, above horizontal bracing members of each panel, and have been provided to accommodate wave guide restrainers. These holes will normally be left unfilled unless wave guide is to be installed on the tower.

**5.20** An extra hole is provided in each leg of the tower to accommodate a 6M safety strand. (See Section 081-725-200.) These holes are located 4 feet above the horizontal bracing members in all but the top panel. The strand is ordinarily used only at the level having side obstruction lights, and is intended to provide protection for workmen who have occasion to service those lights.

**5.21** A platform consisting of three pieces of steel grating (16 by 32 inches) is provided at the lower end of the top section in all towers. Each piece of grating is fastened in place by four grating clips equipped with 3/8- by 1-3/4 inch bolts with nuts, washers, and PALNUTS. The general appearance of the platform is shown in Fig. 10.

**5.22** The general appearance of the top section is shown in Fig. 11, which also shows the location of mounting holes used with various kinds of radio equipment. Note that the second horizontal member above the star mount is skewed, ie, not horizontal. This is deliberately done to accommodate the backstay of 8- and 10-foot parabolic antennas. Note also the requirement for **double** spacer washers at the crossing of the lacing angles marked A-A.

## 6. GUY TENSIONS

**6.01** Measurement of guy tensions should be undertaken only under relatively calm or windless conditions. Since ambient temperatures have an appreciable effect on tension, Tables A, B, C, and D show the correct tension (T), and the corresponding time (S) for 20 oscillations at different temperatures for the four sizes of guys. Tensions should be set within  $\pm 5$  percent of the specified values.

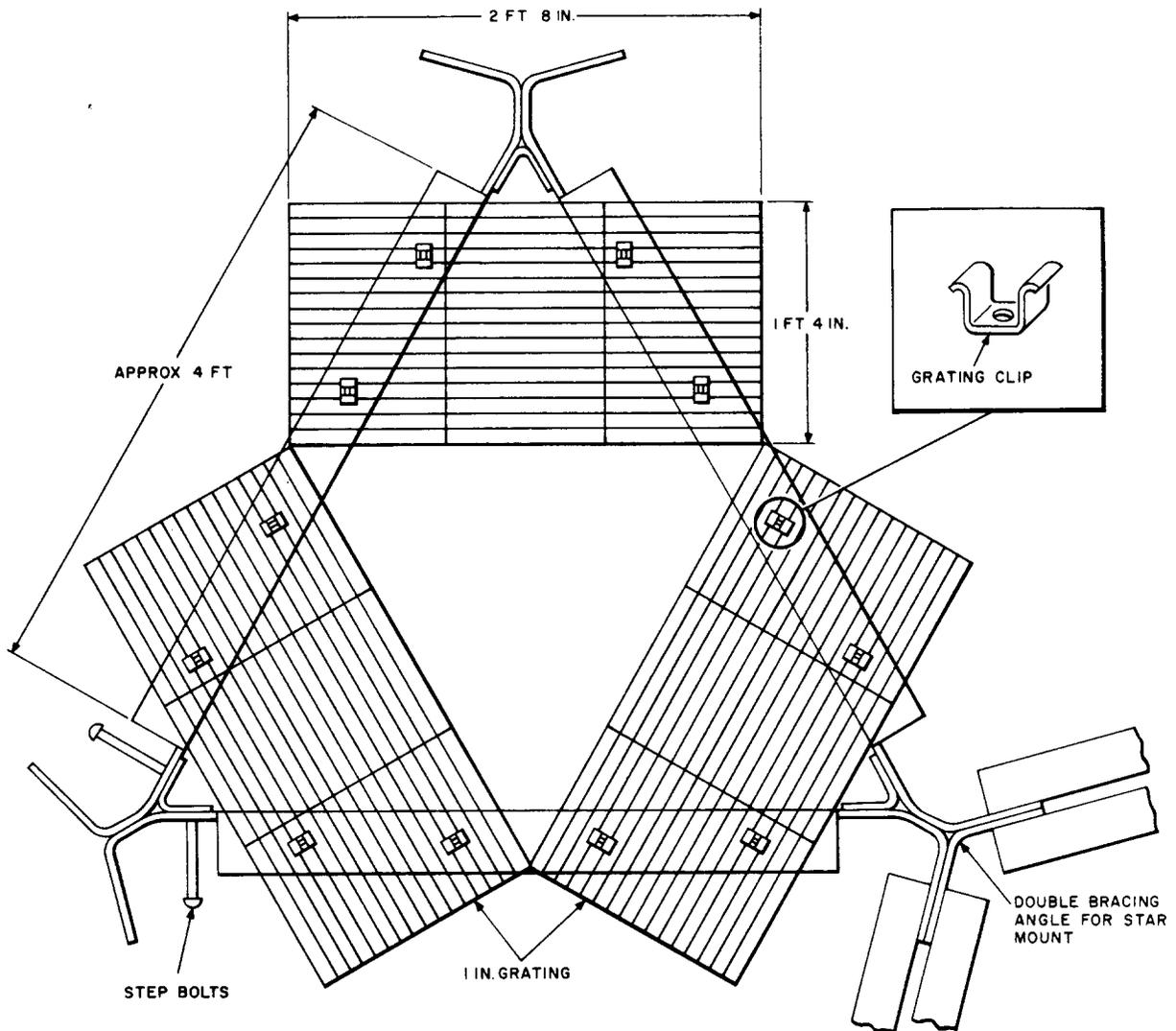


Fig. 10—Tower Platform

**6.02** It may be desirable to use a greater number of oscillations to improve the accuracy of measurements. This may be done by adjusting the indicated time in proportion to the oscillations, eg, time for 30 oscillations would be 1-1/2 times the value for 20 oscillations.

**6.03** The formula for determining the elapsed time for any number of oscillations for any length of guy of any material at any tension is:

$$S = 0.352 NL \sqrt{W/T}$$

where

S = time in seconds

N = number of oscillations

L = length of guy in feet

W = weight of guy in pounds per foot

T = tension of guy in pounds

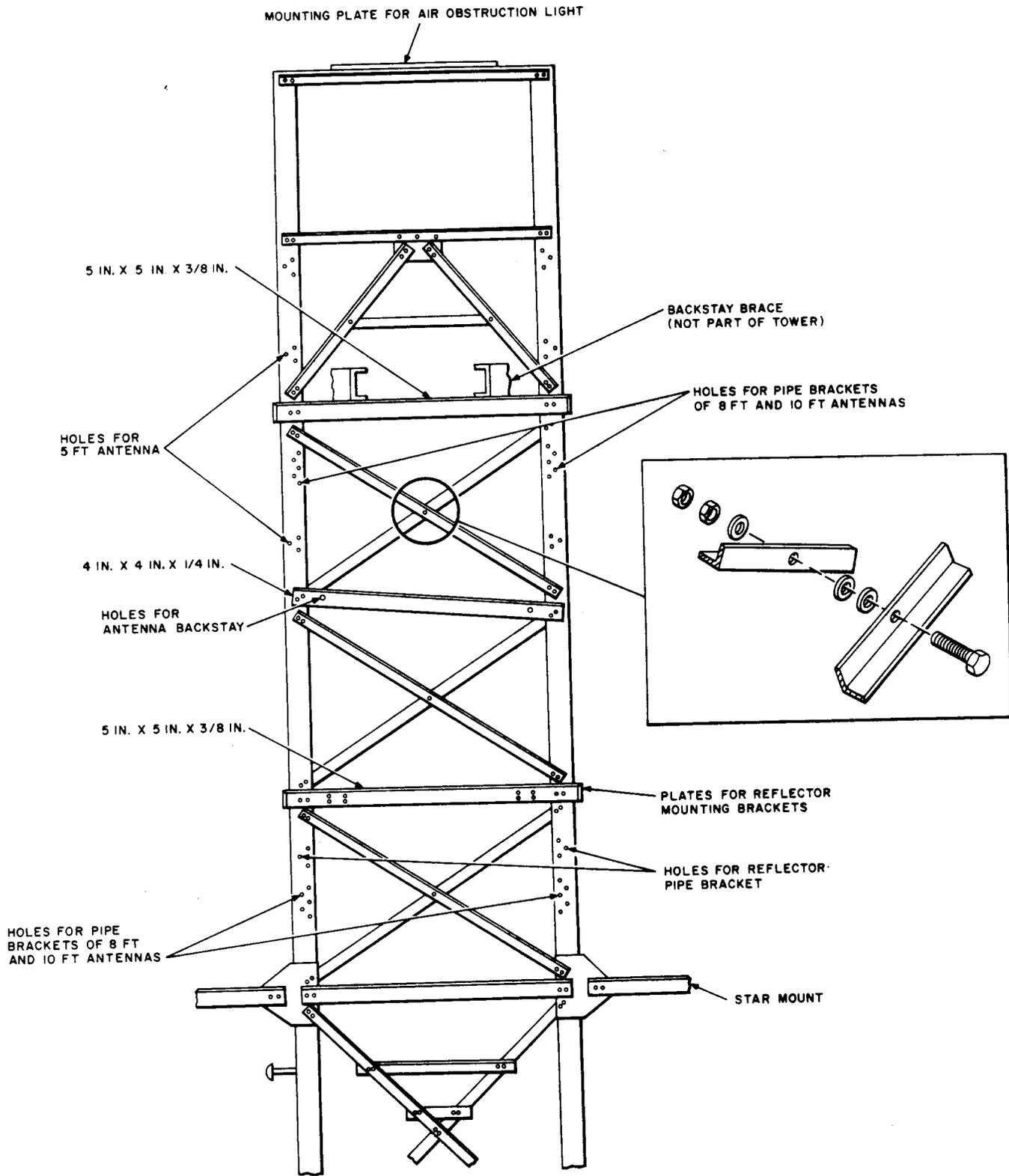


Fig. 11—Location of Mounting Holes for Equipment

Since the design tension is given, the formula for the time for a predetermined number of oscillations will reduce to:

$$S = KL$$

where

S = time in seconds

K = a constant,  $(0.352 N \sqrt{W/T})$

L = length of guy in feet

Tables A, B, C and D also show the values of K for the specified tension at each temperature range. Table E shows the length of the oscillating section of the guy for each height of tower on *level ground*.

**6.04** If there is a difference in ground elevation between the location of the pier and the anchors, the length of the oscillating section will be different from the values shown in Table E and the time periods shown in Tables A, B, C, and D will not apply. In the case of top and middle guys, each foot of elevation difference will cause a difference of 1.41 feet in the length of the guy. In the case of bottom guys, each foot of difference in elevation will cause 2.0 feet of

difference in the length of guy. The lengths shown in Table E should be increased if the ground elevation at the anchor location is lower than the ground elevation at the base pier, and decreased if the ground elevation at the anchor is located above the ground elevation at the base pier. The length of oscillating section, as adjusted for difference in elevation, should then be multiplied by the K factor (corresponding to the height of tower, guy size, and temperature involved) to obtain the time, S, for 20 oscillations.

**6.05** The tower should be checked to see that it is plumb after the correct guy tensions have been reached. It is preferable to make observations for plumbness with the aid of a transit. The tower should not deviate from vertical by more than its total height divided by 720. The maximum allowable deviation between guy points is obtained by dividing the distance between the two guy points by 720. Section AG25.300 discusses procedures for observing tower plumb and bow.

**6.06** After the tower has been plumbed and the correct guy tensions have been set, the jam nuts of the turnbuckles should be tightened. As a further means of discouraging tampering, turnbuckles at any anchor may be locked together by a loop of strand. This precaution is unnecessary if the anchors are enclosed by fences with locked gates.

TABLE A — TIME FOR 20 OSCILLATIONS IN SECONDS

## 1/2-INCH GUYS

TEMPERATURE		TOWER HEIGHT														
		220 FEET			180 FEET			160 FEET			140 FEET			120 FEET		
		T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K
Below -10°	M	5540	11.4	.0671	—	—	—	—	—	—	—	—	—	—	—	—
	L	5860	8.8	.0653	4870	13.2	.0716	4920	11.3	.0713	4880	10.0	.0715	4940	8.1	.0711
-10° to +10°	M	5360	11.6	.0683	—	—	—	—	—	—	—	—	—	—	—	—
	L	5570	9.0	.0670	4580	13.6	.0739	4610	11.6	.0736	4580	10.3	.0739	4630	8.3	.0735
10° to 30°	M	5180	11.8	.0694	—	—	—	—	—	—	—	—	—	—	—	—
	L	5290	9.2	.0687	4290	14.1	.0763	4310	12.0	.0761	4290	10.7	.0763	4310	8.6	.0761
30° to 50°	M	5000	12.0	.0707	—	—	—	—	—	—	—	—	—	—	—	—
	L	5000	9.5	.0707	4000	14.6	.0790	4000	12.5	.0790	4000	11.0	.0790	4000	9.0	.0790
50° to 70°	M	4820	12.2	.0720	—	—	—	—	—	—	—	—	—	—	—	—
	L	4710	9.8	.0728	3710	15.1	.0821	3690	13.0	.0823	3710	11.5	.0821	3690	9.3	.0823
70° to 90°	M	4640	12.5	.0734	—	—	—	—	—	—	—	—	—	—	—	—
	L	4430	10.1	.0751	3420	15.8	.0855	3390	13.6	.0858	3420	12.0	.0855	3370	9.8	.0861
Above 90°	M	4460	12.7	.0748	—	—	—	—	—	—	—	—	—	—	—	—
	L	4140	10.4	.0777	3130	16.5	.0893	3010	14.4	.0911	3120	12.5	.0895	3060	10.3	.0903

M = Middle Guys

L = Lower Guys

$$K = .352N \sqrt{\frac{W}{T}} = 4.998 / \sqrt{T}$$

TABLE B — TIME FOR 20 OSCILLATIONS IN SECONDS

9/16-INCH GUYS

TEMPERATURE		TOWER HEIGHT																			
		280 FEET			260 FEET			240 FEET			200 FEET			100 FEET			80 FEET				
		T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K		
Below -10°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4680	9.9	.0821	4680	7.6	.0821
	M	7680	14.5	.0641	6680	15.5	.0687	6680	13.6	.0687	—	—	—	—	—	—	—	—	—	—	—
	L	8090	11.2	.0625	7090	11.9	.0667	7150	10.1	.0665	7090	13.5	.0667	—	—	—	—	—	—	—	—
-10° to +10°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4450	10.1	.0842	4450	7.7	.0842
	M	7450	14.7	.0651	6450	15.8	.0700	6450	13.9	.0700	—	—	—	—	—	—	—	—	—	—	—
	L	7730	14.4	.0640	6730	12.3	.0685	6770	10.4	.0683	6730	13.9	.0685	—	—	—	—	—	—	—	—
10° to 30°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4230	10.4	.0864	4230	7.9	.0864
	M	7230	14.9	.0661	6230	16.1	.0712	6230	14.1	.0712	—	—	—	—	—	—	—	—	—	—	—
	L	7360	11.7	.0655	6360	12.6	.0705	6380	10.7	.0703	5360	15.6	.0767	—	—	—	—	—	—	—	—
30° to 50°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4000	10.7	.0888	4000	8.2	.0888
	M	7000	15.2	.0672	6000	16.4	.0725	6000	14.4	.0725	—	—	—	—	—	—	—	—	—	—	—
	L	7000	12.0	.0672	6000	13.0	.0725	6000	11.0	.0725	5000	16.1	.0795	—	—	—	—	—	—	—	—
50° to 70°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3770	11.0	.0915	3770	8.4	.0915
	M	6770	15.4	.0683	5770	16.7	.0740	5770	14.6	.0740	—	—	—	—	—	—	—	—	—	—	—
	L	6640	12.3	.0690	5640	13.4	.0748	5620	11.4	.0750	5640	15.2	.0748	—	—	—	—	—	—	—	—
70° to 90°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3550	11.3	.0943	3550	8.7	.0943
	M	6550	15.7	.0694	5550	17.0	.0754	5550	14.9	.0754	—	—	—	—	—	—	—	—	—	—	—
	L	6270	12.7	.0710	5270	13.9	.0774	5230	11.8	.0777	5270	15.7	.0774	—	—	—	—	—	—	—	—
Above 90°	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3320	11.7	.0975	3320	9.0	.0975
	M	6320	16.0	.0707	5320	17.4	.0770	5320	15.3	.0770	—	—	—	—	—	—	—	—	—	—	—
	L	5910	13.1	.0731	4910	14.4	.0802	4850	12.3	.0807	4910	16.3	.0802	—	—	—	—	—	—	—	—

U = Upper Guys

M = Middle Guys

L = Lower Guys

$$K = .352N \sqrt{\frac{W}{T}} = .5619 / \sqrt{T}$$

TABLE C — TIME FOR 20 OSCILLATIONS IN SECONDS

5/8-INCH GUYS

TEMPERATURE		TOWER HEIGHT																	
		300 FEET			200 FEET			180 FEET			160 FEET			140 FEET			120 FEET		
		T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K
Below -10°	U	—	—	—	5840	21.5	.0822	4840	21.0	.0903	4840	18.5	.0903	4840	16.0	.0903	4840	13.5	.0903
	M	8840	17.0	.0668	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	9410	12.8	.0647	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
-10° to +10°	U	—	—	—	5560	22.1	.0842	4560	21.7	.0930	4560	19.1	.0930	4560	16.5	.0930	4560	13.9	.0930
	M	8560	17.3	.0679	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	8940	13.1	.0664	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10° to 30°	U	—	—	—	5280	22.6	.0864	4280	22.4	.0960	4280	19.7	.0960	4280	17.0	.0960	4280	14.3	.0960
	M	8280	17.6	.0690	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	8470	13.4	.0682	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30° to 50°	U	—	—	—	5000	23.3	.0888	4000	23.1	.0993	4000	20.4	.0993	4000	17.6	.0993	4000	14.8	.0993
	M	8000	17.9	.0702	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	8000	13.8	.0702	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
50° to 70°	U	—	—	—	4720	24.0	.0914	3720	24.0	.1030	3720	21.1	.1030	3720	18.2	.1030	3720	15.3	.1030
	M	7720	18.2	.0715	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	7530	14.3	.0724	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
70° to 90°	U	—	—	—	4440	24.7	.0943	3440	25.0	.1071	3440	22.0	.1071	3440	19.0	.1071	3440	16.0	.1071
	M	7440	18.6	.0728	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	7060	14.7	.0748	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Above 90°	U	—	—	—	4160	25.5	.0974	3160	26.0	.1117	3160	22.9	.1117	3160	19.8	.1117	3160	16.6	.1117
	M	7160	18.9	.0742	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	L	6590	15.2	.0774	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

U = Upper Guys

M = Middle Guys

L = Lower Guys

$$K = .352N \sqrt{\frac{W}{T}} = 6.28 / \sqrt{T}$$

**TABLE D — TIME FOR 20 OSCILLATIONS IN SECONDS**

**3/4-INCH GUYS**

TEMPERATURE		TOWER HEIGHT														
		300 FEET			280 FEET			260 FEET			240 FEET			220 FEET		
		T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K	T (LBS)	S (SEC)	K
Below -10°	U	9200	31.8	.0789	8200	31.3	.0836	7200	30.9	.0892	7200	28.4	.0892	6200	27.9	.0961
-10° to +10°	U	8800	32.5	.0807	7800	32.1	.0857	6800	31.7	.0918	6800	29.2	.0918	5800	28.8	.0993
10° to 30°	U	8400	33.3	.0826	7400	33.0	.0880	6400	32.7	.0946	6400	30.1	.0946	5400	29.9	.1030
30° to 50°	U	8000	34.1	.0846	7000	33.9	.0904	6000	33.4	.0977	6000	31.1	.0977	5000	31.0	.1070
50° to 70°	U	7600	35.0	.0868	6600	34.9	.0931	5600	35.0	.1011	5600	32.2	.1011	4600	32.4	.1116
70° to 90°	U	7200	35.9	.0892	6200	36.0	.0961	5200	36.3	.1049	5200	33.4	.1049	4200	33.9	.1167
Above 90°	U	6800	37.0	.0918	5800	37.3	.0993	4800	37.8	.1092	4800	34.7	.1092	3800	35.6	.1227

U = Upper Guys

$$K = .352N \sqrt{\frac{W}{T}} = 7.566 / \sqrt{T}$$

TABLE E — APPROXIMATE LENGTH OF GUY IN OSCILLATION — LEVEL GROUND			
TOWER HEIGHT (FT)	TOP GUYS (FT)	BOTTOM GUYS (FT)	MIDDLE GUYS (FT)
80	92	—	—
100	120	—	—
120	149	114	—
140	177	140	—
160	205	158	—
180	233	185	—
200	262	203	—
220	290	134	170
240	318	152	198
260	346	179	227
280	375	179	227
300	403	197	255