Alberta Forest Service

STEEL TOWER CONSTRUCTION

It is the intention in this lecture to outline a practical sequence of construction on any standard steel lookout tower. It is not suggested that any method given is the only correct method, or for that matter, anything that follows cannot be accomplished by other means.

ON RECEIPT OF TOWER

You will find that the tower comes in a form of a number of bundles of steel in various shapes and sizes, the cupola is in sections and all small parts such as nuts, bolts, etc., in small wooden boxes. Prior to the receipt of this you should be in possession of a complete listing of material as sent out by the company who manufactured the tower. It is advisable to take this list with you when taking delivery of tower in order to assure yourself that all pieces have been receive. A six-foot steel tape has been found very useful in measuring all the steel rods and irons. This appears to be an unnecessary amount of trouble, however, should one piece be either left out of the shipment or be of the wrong size, the completion of the tower may be impossible until considerable delay and inconvenience has been encountered. It then appears that the proper time to find mistakes is at the point of delivery and not at the construction site. With regard to the contents of the boxes no regard need be attached to checking this as any shortages could be made up from local sources of supply.

When handling the steel truss rods some care should be taken to assure against damaged threads. As a point of information, an 80-foot tower can be hauled at one load on a 2 1/2 to 3-ton truck.

When the tower has been delivered at the site, undo the bundles of rods and steel and by consulting the blueprint lay them on the ground in neat piles by the bent's. This is done in order to avoid confusion later and is a great time saver in the long run. It has also been found that by taking several small boxes and separating all nuts and bolts into individual sizes, considerable time will be saved during construction.

PREPARATION OF FOUNDATION

Always work by the blueprint, if you do not understand portions of the print make enquiries rather than mistakes. Never argue with the blueprint as it has been drawn by engineers who should be in the best position to judge. The depth of the foundation is shown on the print along with advice as to soil types. This should be your first check which may be made by the use of an ordinary 6" post hole auger and should be made to the full depth of the auger. Should sand or loose gravel conditions be encountered it is recommended that you consult your inspector before proceeding with the foundation work as this may necessitate considerable increase in foundation volume or if conditions are severe, a new construction location.

Remember this work is the most vital part of the whole job and the care exercised at this time will more than repay you later. Wherever the soil is of a suitable nature such as soapstone, sandstone, gumbo or ordinary firm clay, it may be used as the form in which to pour the cement. It is obvious that a soil which crumbles cannot be used for the form. Dig the holes for the

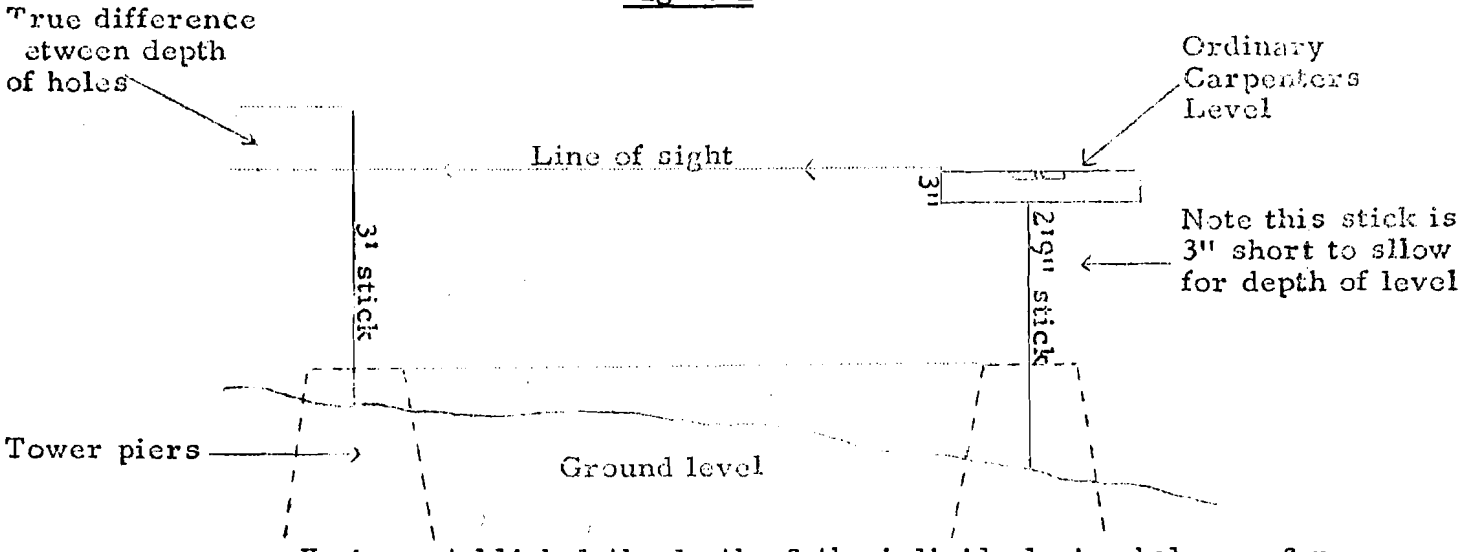
foundation piers as close as possible to the exact size as shown on the blueprint and when two-thirds of the required depth is reached, frequent checks should be made to assure against going too deep. Under no circumstances attempt to fill in dirt in the bottom of a hole which has gone past the proposed depth. Your mistake will now cost you extra gravel and cement. Note: it is virtually impossible to prevent settling of dirt which has been moved. In the case of soil tending to crumble it may be necessary to shore the holes with lumber. Tin is ideal for this purpose as the less material used around the cement piers, the tighter they will fit in the ground after the forms rot away. By way of suggestion heavy lumber may be used if it is arranged in such a manner that it may be raised or gradually pulled out of the hole as the cement is poured in.

In order to establish the proper location of these piers, it is suggested that a long steel tap be used if possible or, failing this, some material which will not stretch. Work from the centre of one pier to centre of another checking the true square by diagonal measurement.

LEVELLING FOUNDATION

There are several methods of levelling the foundation. You must first establish the lowest corner of the tower, then by the use of a carpenters level and a couple of sticks of the same length, for example 3 feet, it is possible to find out to what depth each hole must be dug, as shown on figure 1.

Figure 1



Having established the depth of the individual pier holes or forms, it should be now evident how large the small wooden forms above the ground will have to be. These of course will vary in proportion to the depth of rise and fall of the ground. It is recommended that the piers be at least four inches above the ground level.

The following points may be of value in selecting gravel as far as quality and quantity is concerned; always use gravel that is clean. Use a small glass jar full of water and gravel, shake this well and if water becomes very cloudy try to obtain cleaner material. In all cases try to obtain sharp sand in the gravel. This can be readily felt with the hand. When calculating the volume of material required add 25% to the cubic contents of the pier holes or forms, this should insure against any shortage at a crucial time, once the

job of pouring is commenced it must be completed. One important factor on volumes is, no allowance should be made for cement as its volume does not enter into the picutre. Again it is stressed that the blueprint must be followed as to the correct mix for foundations, if however, you are unable to obtain what is called for, a ratio of one cement to 5 gravel and sand is safe if the gravel contains clean sharp sand. The following information may be of some use, one yard of gravel should require six bags of cement.

GETTING READY TO POUR CEMENT

The most important part of preparing to pour the cement is to correctly position the anchor bolts so that when the tower is set on them they are in perfect alignment. There are probably four different methods which may be used to accomplish this, however, the one that will be dealt with is considered to be most simple and practical. Assemble the first bent (or section) of the tower and with the aid of large wood blocks under the first horizontal steel, position the feet of the tower over the exact centre of the forms. The anchor bolts may now be placed in position by suspending them from the holes in the steel feet. Level the tower section and check for vertical. With the steel feet level with the top edge of the exterior form, the anchor bolts are now in a position to have the cement poured around them. Note: be sure to check if both anchor bolt nuts clear the small bolts on the legs and feet, also leave enough anchor bolt above the foot to accomodate both nuts.

Pouring the Cement - It is not advisable to make the mix too wet, by using a stiff mix you can speed up operations and the foundation should be safe to work on two days after pouring providing no high winds occur. When pouring the cement avoid disturbing the anchor bolts and make sure they remain vertical. Finish the crown of the pier with a waterproof mix approximately 50-50 cement and sand, this prevents moisture seeping into the new piers and cracking them during the winter.

ERECTING THE TOWER

The assembly of the tower is a relatively simple matter if care and common sense are exercised. Past experience has shown that inexperienced men can with care make a first class job of assembly. However, there are a few points which if cleared up here, may assist in avoiding small errors. It should be noted that there are two kinds of steel lugs (corner irons through which the truss rods pass) and care to use these in their correct places will save considerable delay and trouble. On the average steel tower the first 8 corner lugs are single sided as are the last 8 on top of the tower. A check with the blueprint will show the obvious necessities of the difference between these lugs and the remainder. When installing the truss rods it has been found that the usual tower rattle can be considerably eliminated by passing the rod on the inside of the horizontal steel bent.

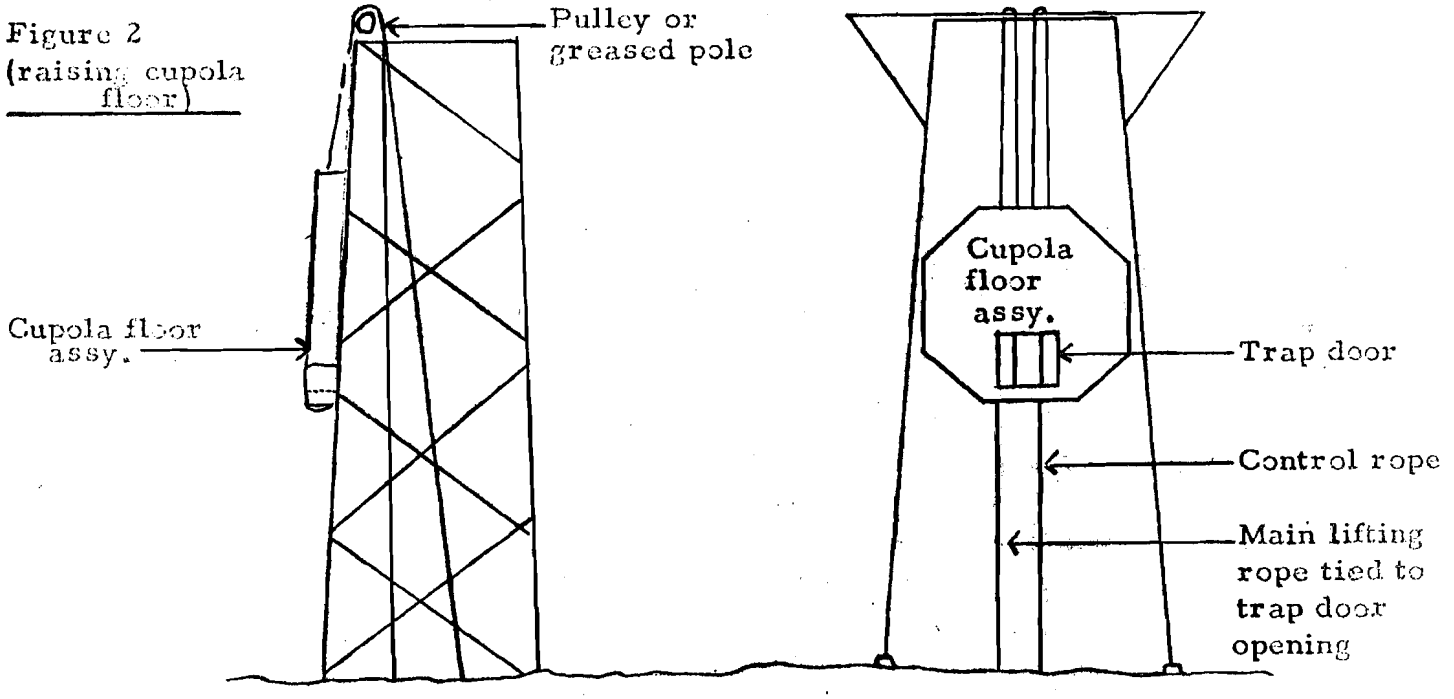
A word of caution at this point appears in order, no matter what system you may use to hoist the metal and bolt it into place or how the man working aloft manages to keep his position, never take any unnecessary chances. A safety rope around the waist of those working above the ground will enable a man to work more efficiently and in all probability may save a serious accident.

The suggestion which was made on page one in regard to laying out the tower in bents will now be justified, if you have done this, the work should go forward in a straightforward manner with no need for tearing down parts of the tower later on because of a small mistake. As the work progresses upwards, keep a constant check on the truss rods since by their correct use you can maintain the proper shape of the structure. Do not however attempt to tighten the truss rods to any great degree until the tower has been completely assembled (less the cupola), a check made at that time from the top of the tower should reveal any tendency for the whole structure to twist or individual legs to kink. Suitable adjustment of the truss rods will correct this trouble. It has been found useful to bolt on ladder sections as the construction progresses, thereby making the ascent and the descent of the worker easier. Note: in some cases the ladder sections are not the same length, care should be taken to assure correct placement.

THE CUPOLAR

It is the opinion of some that the floor of the cupola is the most difficult portion of the tower construction, this undoubtedly has some justification when the cupola floor comes in one piece prefabricated. Fig. 2 indicates one practical method of raising the floor into position with the minimum of equipment and danger.

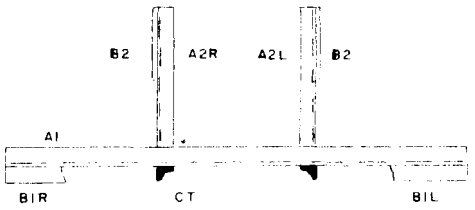
Figure 2
(raising cupola floor)

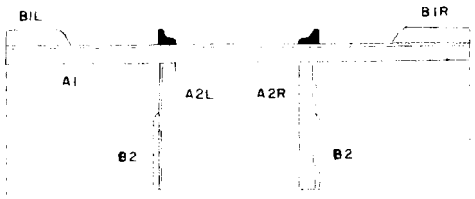


After the floor is properly in position, little trouble should be encountered in raising each of the 8 side sections. Remember you cannot tell when a wind may spring up and cause considerable trouble. With this in mind be sure that each section is well braced when in position; once all eight sides are positioned and joined the structure is relatively safe. Note: it has been found necessary to use light strap iron re-enforcements on the corners of the cupola floor assembly, this should be done before raising it into position if necessary.

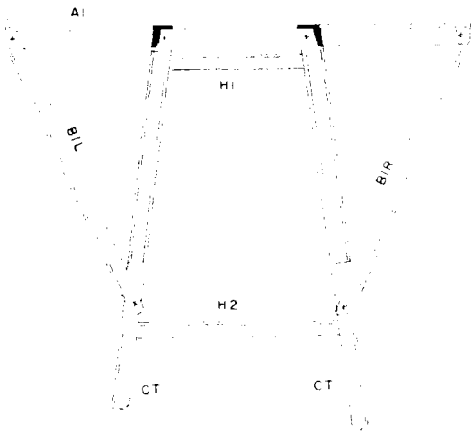
FINAL TOUCHES

By using cross strings on the base and top of the tower and by suspending a weight on a string from top centre to bottom centre you can now tell if the tower structure is perfectly vertical. If any adjustment is required steel shims between the cement and the feet of the tower could be employed. Now tighten all anchor and foot bolts, when this is done take a small centre punch and damage just one thread on the large anchor bolt next to the locking must so that all will stay tight. Your fundamental tower construction is now completed, paint and miscellaneous jobs may be carried on from here.

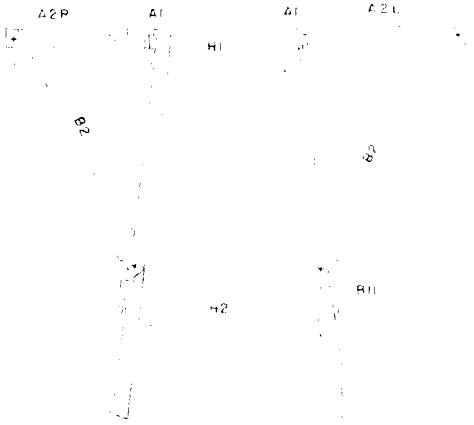




PLAN AT TOP



FACE A



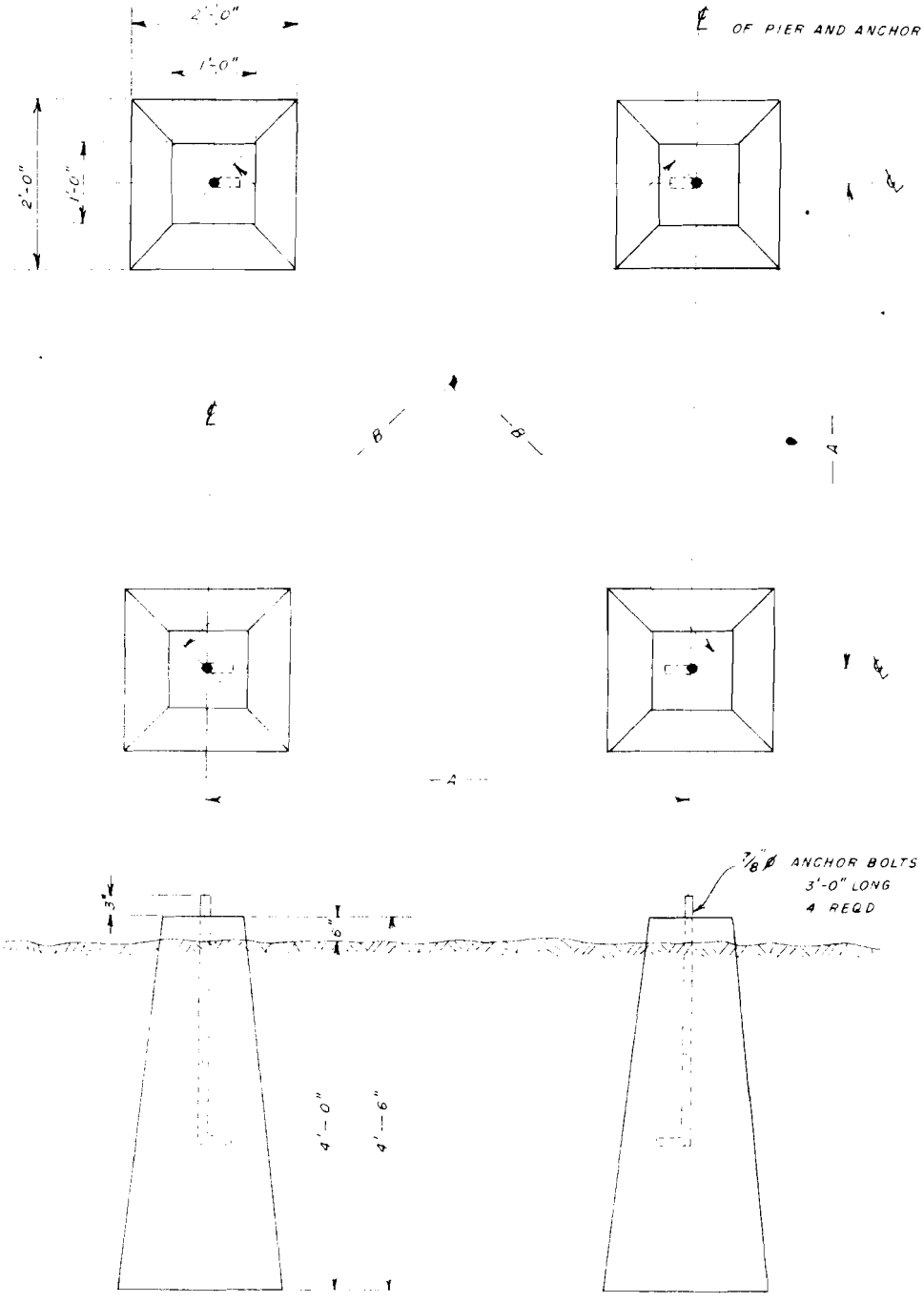
FACE B

ELAVATION AT TOP OF TOWER
(WIND BRACING OMITTED)

FOOT OBSERVATION TOWER
LAYOUT OF STEEL SUPPORTING CABIN

AJAX ENGINEERS LIMITED
TORONTO, ONT

FILE No.



MIX 3000 lb CONCRETE
1 PART PORTLAND CEMENT
2 " CLEAN SHARP SAND
4 " BROKEN STONE OR SCREENED GRAVEL TO PASS 1¼" RING

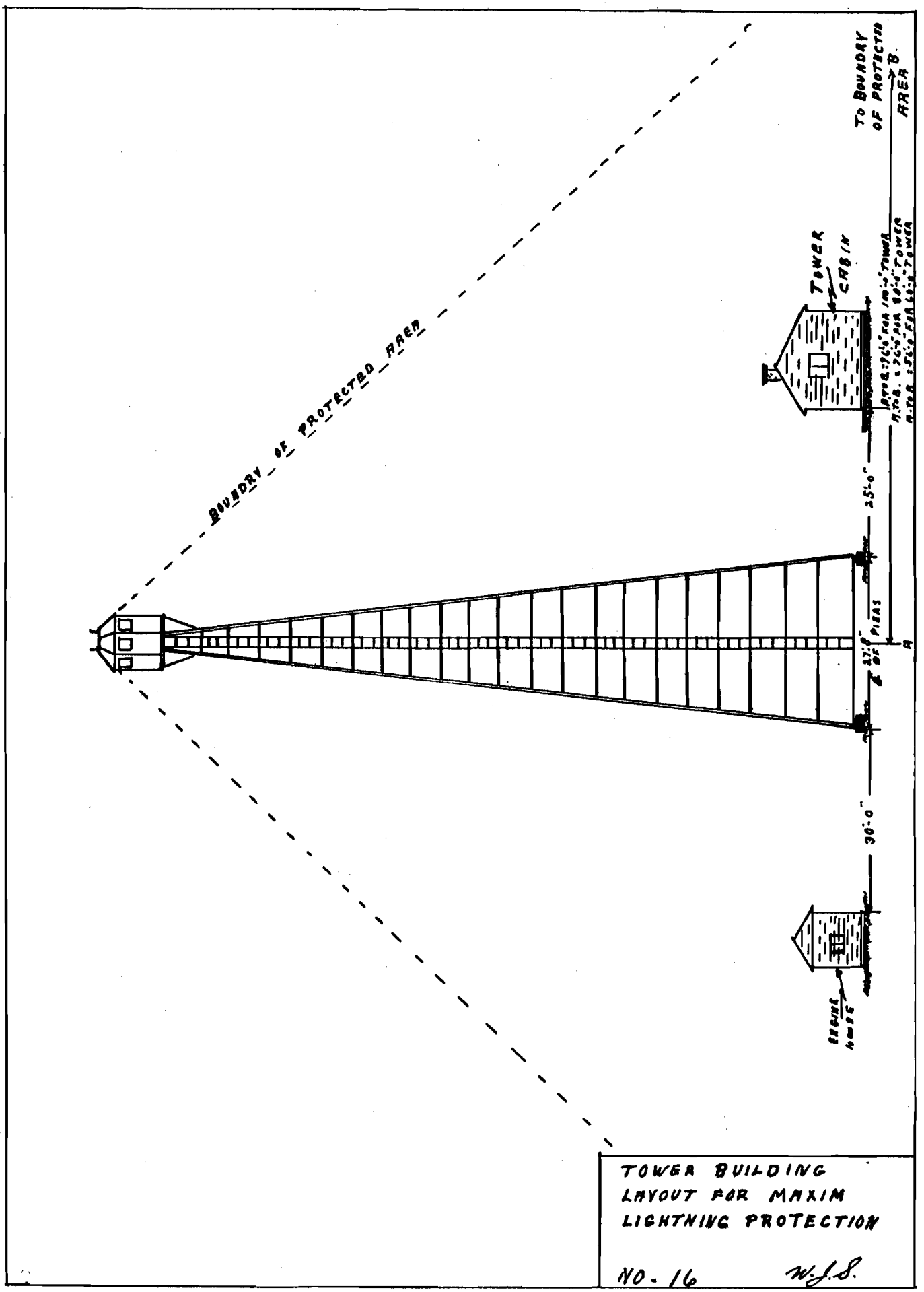
HEIGHT OF TOWER	VALUES FOR A	B
40 FOOT	12'-7⅝"	17'-10½"
50 "	15'-1⅝"	21'-4⅞"
60 "	17'-7⅝"	24'-11⅜"
70 "	20'-1⅝"	28'-5¾"
80 "	22'-7⅝"	32'-0⅛"
100 "	27'-7⅝"	39'-1"

NOTE

ABOVE PIERS ARE DESIGNED ON THE ASSUMPTION THAT GOOD BEARING WILL BE FOUND AT THE DEPTH SHOWN ABOVE. IN CASE WATER, QUICKSAND ETC. IS ENCOUNTERED AT THIS DEPTH, OR BOTTOM OF PIER DOES NOT GO BELOW FROST LINE, SIZE OF PIER MUST BE ALTERED TO SUIT LOCAL CONDITIONS.

FOUNDATION PLAN
STEEL OBSERVATION TOWER

AJAX ENGINEERS LIMITED
TORONTO ONT.



TOWER BUILDING
LAYOUT FOR MAXIM
LIGHTNING PROTECTION

NO. 16 W.J.S.

AJAX ENGINEERS LIMITED
BILL OF MATERIAL

SUBJECT ONE 100 FOOT OBSERVATION TOWER, LESS CABIN

CUSTOMER DEPARTMENT OF LANDS AND FORESTS - ALBERTA

OUR ORDER NO. 0141 DRAWING NO. 21M3-4A & 43 & -3B

Item No.	Ck.	Mark	Pcs.	Description	Detail	Assembly
1		CT	4	2 1/2 x 2 1/2 x 3/16" angle	-4A	-1B
2		CM	32	"	"	"
3		CB	4	"	"	"
4		H1	4	2 x 2 x 1/8 angle	"	"
5		H2	4	"	"	"
6		H3	4	"	"	"
7		H4	4	"	"	"
8		H5	4	"	"	"
9		H6	4	"	"	"
10		H7	4	"	"	"
11		H8	4	"	"	"
12		H9	4	"	"	"
13		H10	4	"	"	"
14		H11	4	"	"	"
15		H12	4	"	"	"
16		H13	4	"	"	"
17		H14	4	"	"	"
18		H15	4	2 1/2 x 2 1/2 x 1/8 angle	"	"
19		H16	4	"	"	"
20		H17	4	"	"	"
21		HM	16	"	-43A	"
22		H18L	4	"	"	"
23		H18R	4	"	"	"
24		H19L	4	"	"	"
25		H19R	4	"	"	"
26		H20L	4	"	"	"

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BILL OF MATERIAL

SUBJECT ONE 100 FOOT OBSERVATION TOWER, LESS CABIN

CUSTOMER

OUR ORDER NO. 0141 DRAWING NO. 21M3-4A & 43 & -3B

Item No.	Ck.	Mark	Pcs.	Description	Detail	Assembly
1		H20R	4	2 1/2 x 2 1/2 x 1/8 angle	-43A	-1B
2		H21L	4	"	"	"
3		H21R	4	"	"	"
4		V1	20	1 1/4 x 1/8 Flat	"	"
5		V2	3	1 1/4 x 1/8 "	- 4A	"
6		V3	3	1 1/2 x 1 1/2 x 1/8 angle	-43A	"
7		V4	8	"	"	"
8		V5	4	2 x 2 x 1/8 angle	"	"
9		V6	4	"	"	"
10		V7	8	"	"	"
11		HO	2	2 1/2 x 2 1/2 x 1/4 angle	"	" & -5
12		HL	2	" (with 2 1/4 x 1/4 Flat 8")	"	" "
13		HR	2	" "	"	" "
14		X1L	2	2 1/2 x 2 1/2 x 3/16 angle	- 4A	" "
15		X1R	2	"	"	" "
16		X2	4	"	"	" "
17		CX	306	2 1/2 x 2 1/2 x 1/4 angle	"	" "
18		S	36	2 x 2 x 3/16 angle	"	" "
19			1	LADDER 99 1/3 LONG, consisting of:	- 4A	-4A
20				2 pcs. 1 1/4 x 1 1/4 x 1/8 angle	"	"
21				86 " 1" x 1" x 1/8 angle - 1'0"	"	"
22		SH	38	1 1/2 x 3/16 Flat		
23		SS	1	1 1/4 x 1/8 "		
24		X3	8	3/8" diam. x 10'3		
25		X4	8	" x 11'1"		
26		X5	8	" x 11'6 1/4		

Made by LHM Date 5/18/60

AJAX ENGINEERS LIMITED
BILL OF MATERIAL

SUBJECT ONE 100 FOOT OBSERVATION TOWER

CUSTOMER

OUR ORDER NO. 0141 DRAWING NO. 21M3-4A & 43 & -3B

Item No.	Ck.	Mark	Pcs.	Description	Detail	Assembly
1		X6	8	3/8" diam. x 12'3		
2		X7	8	" x 13'0 1/2		
3		X8	8	" x 13'11		
4		X9	8	" x 14'10		
5		X10	8	" x 15'9 3/4		
6		X11	8	" x 16'9 3/4		
7		X12	8	" x 17'10		
8		X13	8	" x 18'11		
9		X14	8	" x 20'0		
10		X15	8	" x 21'1" (with couplings)		
11		X16	8	" x 22'3 "		
12		X17	8	" x 23'4 "		
13		X18	8	" x 24'6 "		
14		X19	8	" x 25'8 "		
15		X20	8	" x 26'10 "		
16		X21	8	" x 28'0 "		
17			110	3/8" galv. rod couplings		
18		CF	4	C.I. Feet for 2 1/2" angle - Batter 1 1/2, 12		
19			5	5/8 x 1 1/2 galv. mach. bolts		
20			20	1/2 x 1 1/2 "		
21			675	1/2 x 1 1/4 "		
22			20	3/8 x 1 1/4 "		
23			375	3/8 x 1 "		
24			250	3/8 x 3/4 " (ladder)		
25			330	3/8" galv. nuts (brace rods)		
26			5	5/8" galv. lockwashers		

AJAX ENGINEERS LIMITED
BILL OF MATERIAL

SUBJECT ONE 100 FOOT OBSERVATION TOWER

CUSTOMER DEPARTMENT OF LANDS AND FORESTS - ALBERTA

OUR ORDER NO. 0141 DRAWING NO. 21M3-4A &43 & -3B

Item No.	Ck.	Mark	Pcs.	Description	Detail	Assembly
1			700	1/2" Galv. Lock Washers		
2			750	3/8" " " "		
3				ANCHOR STEEL & GUYS:		
4		TC	4	7/8" diam. x 3'0" hook bolts with 2 nuts	-3B	
5			4	5/8" rod - 14'0" U-bolts with 4 nuts		
6		E2	4	12 Channel 20.7 - 1'0"		
7		WT	16	2 x 1/4 Flat - 0'6 1/2"	-3B	
8			8	1/2 x 6" galv. Turnbuckles - Jaw & Eye		
9			50	5/16 galv. D.F.E. Clips		
10			8	5/16 thimbles (galv.)		
11			4	5/16" diam. - 80' galv. cruc. guy strand (2 immersion)		
12			4	5/16" " -120' " " " " "		
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