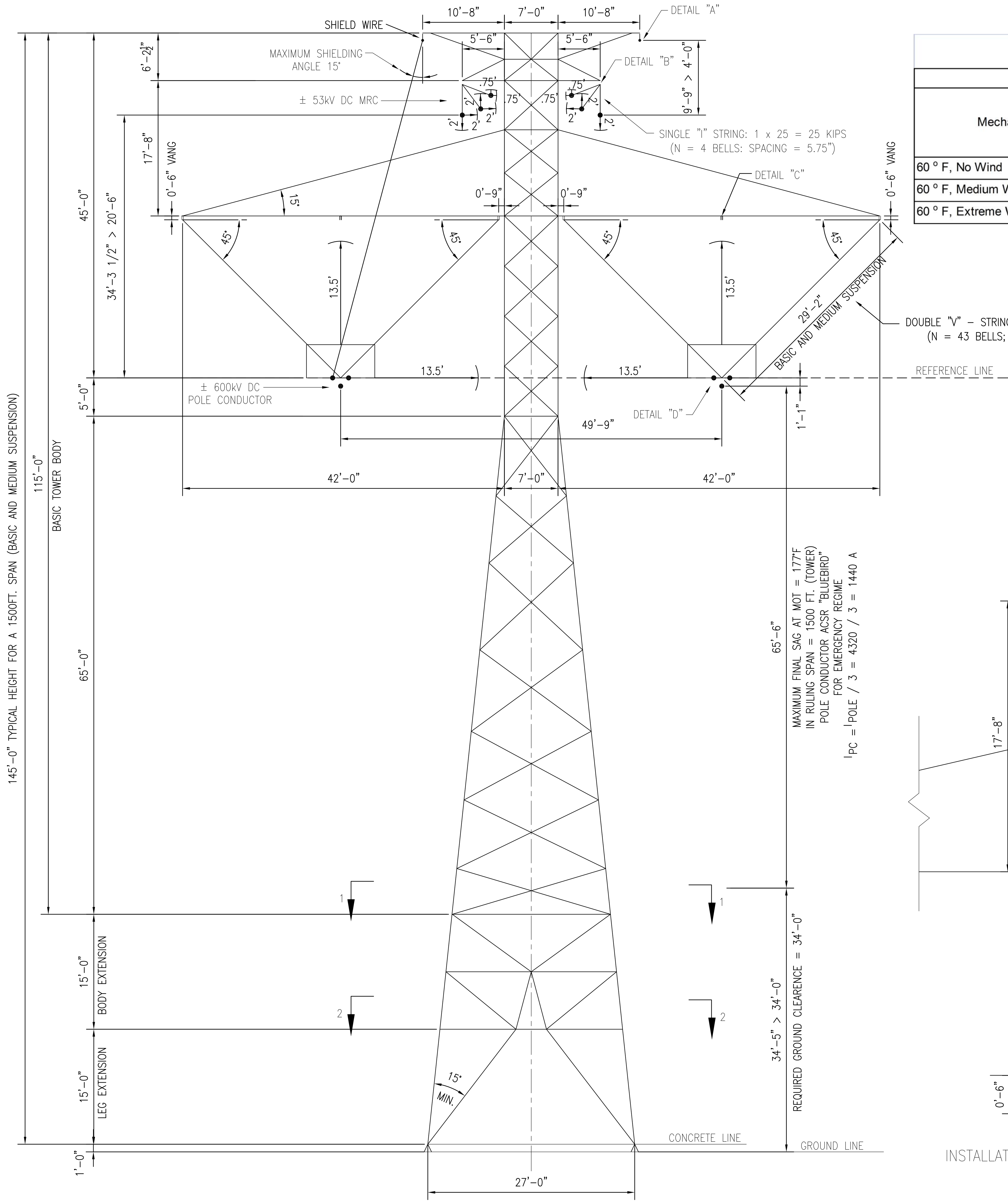
BASIC AND MEDIUM SUSPENSION

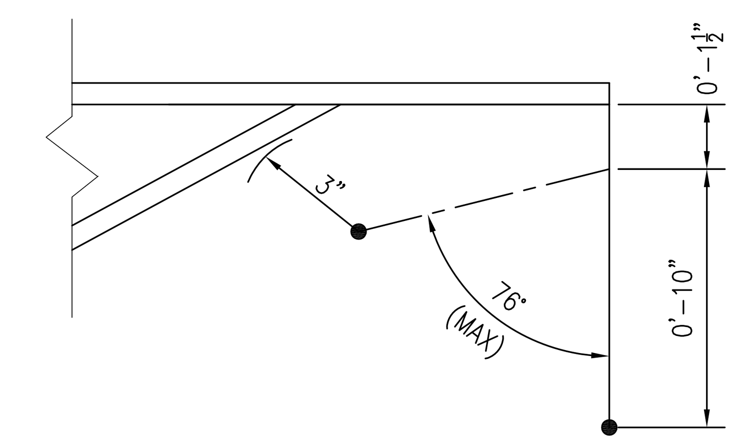
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	37 °	29 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	69 °	66 °

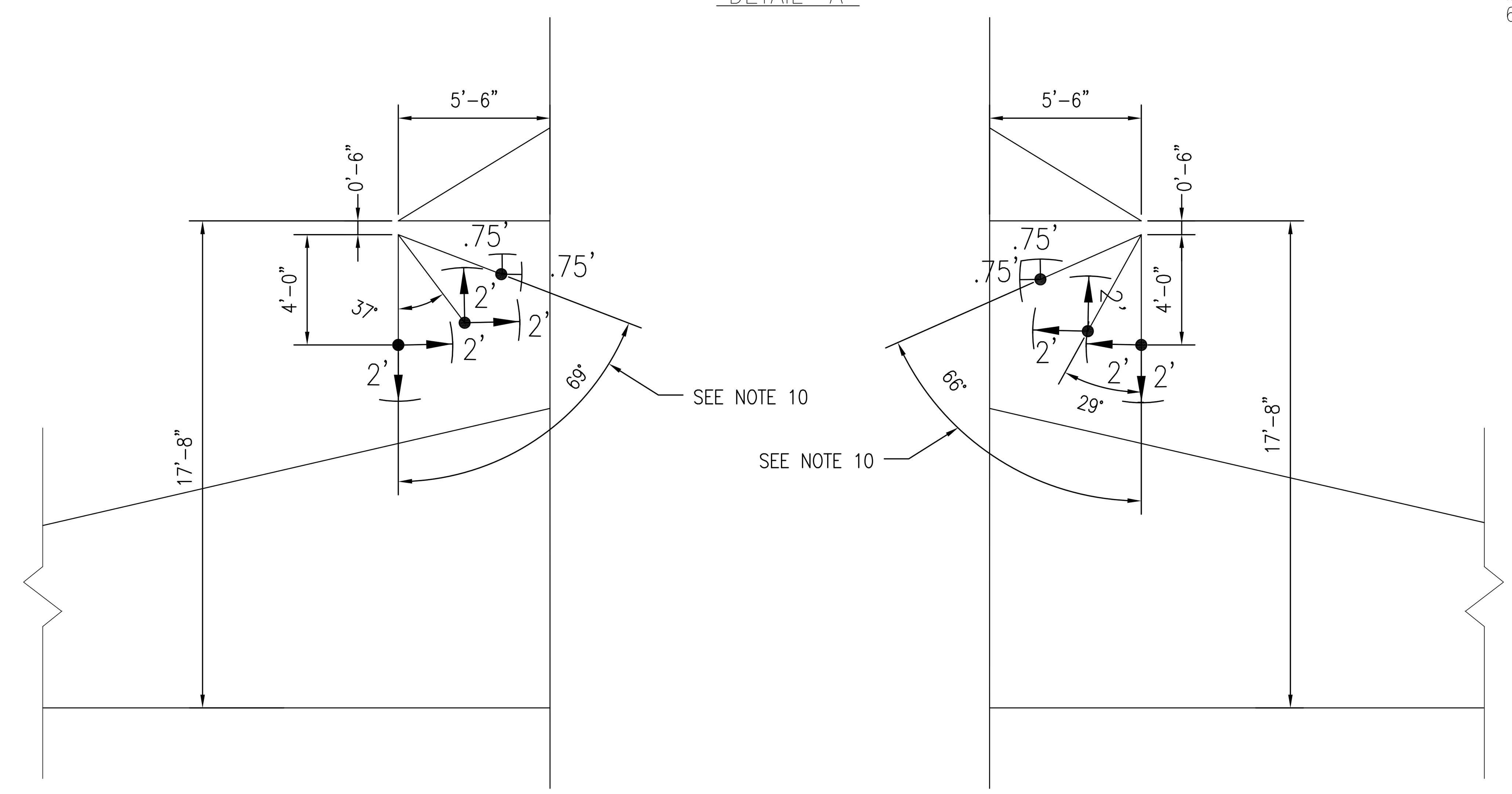
NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES, BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS TO THE CORONA RING HOT BOX OR CONDUCTOR.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
9. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
10. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERYDAY, 60', 6 PSF, & 60', 20.74 PSF CONDITION.

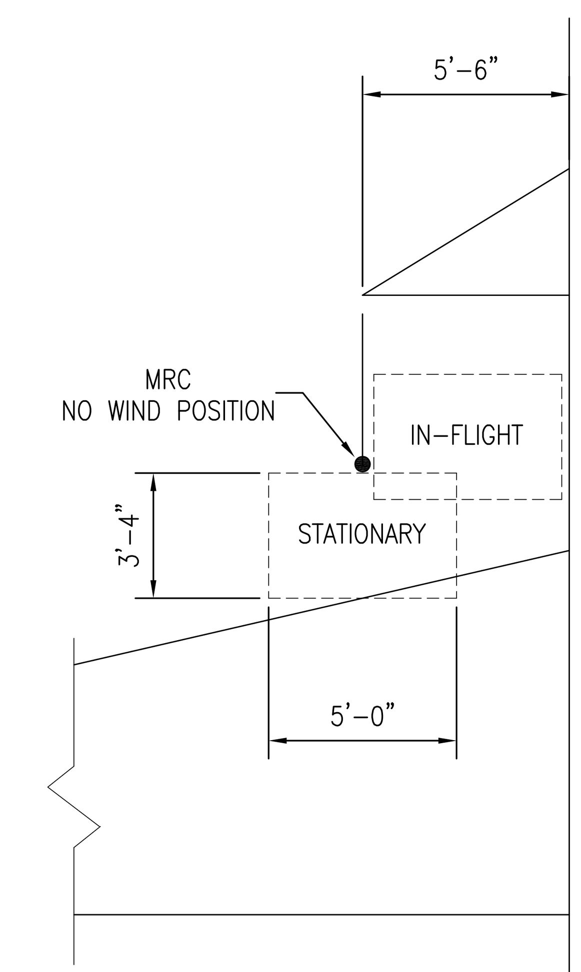


BASIC & MEDIUM TANGENT SUSPENSION TOWER

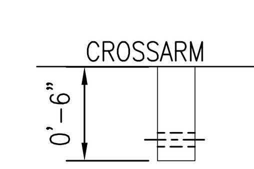

DETAIL "A"



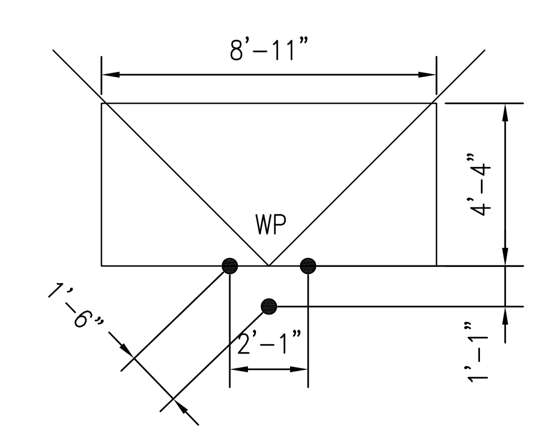
LEFT DETAIL "B" RIGHT



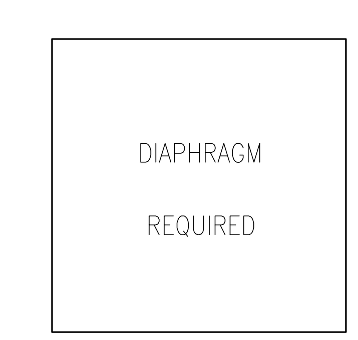
AVIAN HOT BOX
H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE VANG



DETAIL "D"
CORONA RING HOT BOX



SECTION 1-1 & 2-2

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #10	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14

SCALE: NTS

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE BASIC AND MEDIUM SUSPENSION

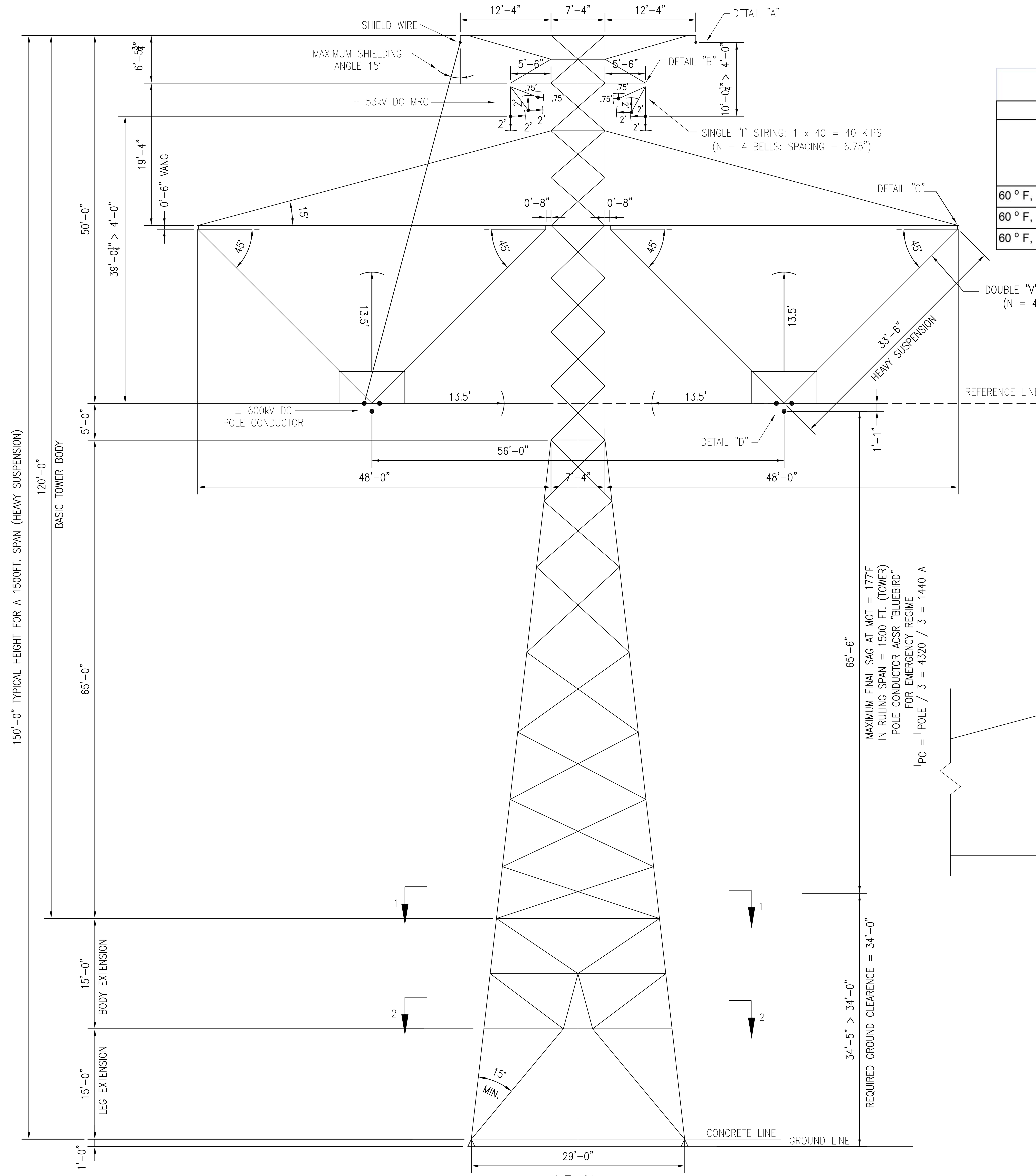
SELF SUPPORTING SUSPENSION TOWER 0"-2" MRC ABOVE (V-STRING)

JOB NUMBER 132836

REV A

DRAWING NUMBER SST-8-1

SST-8-1_B&M_SUSP_0-2.DWG



HEAVY
TANGENT SUSPENSION TOWER

HEAVY SUSPENSION

Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle (Left Crossarm Wind from Left)	+/- 53 KV DC MRC "I" String Insulator Swing Angle (Right Crossarm Wind from Right)
Required Clearances					
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	37 °	29 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	69 °	66 °

NOTES

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5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
9. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
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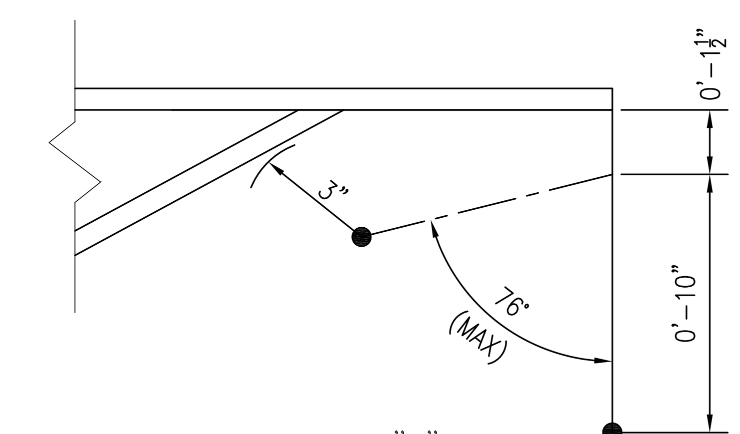
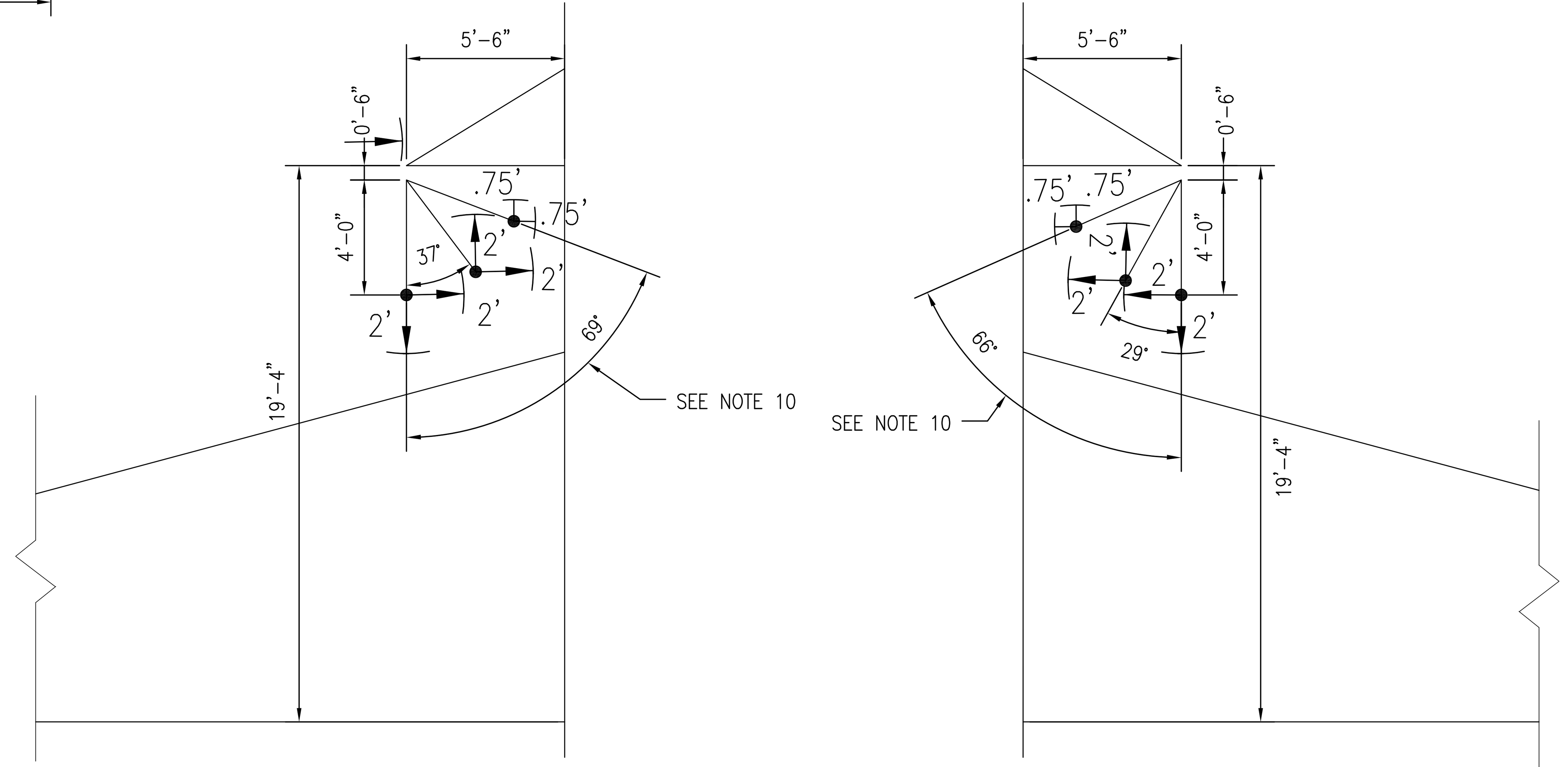
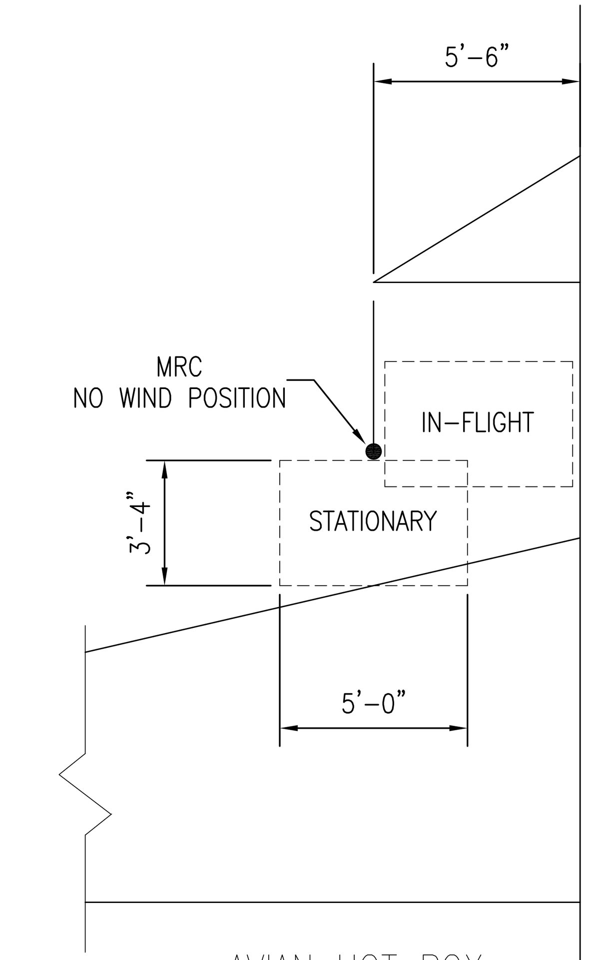


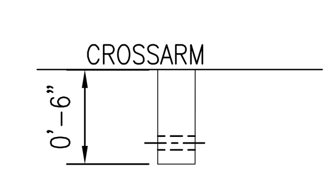
DETAIL "A"



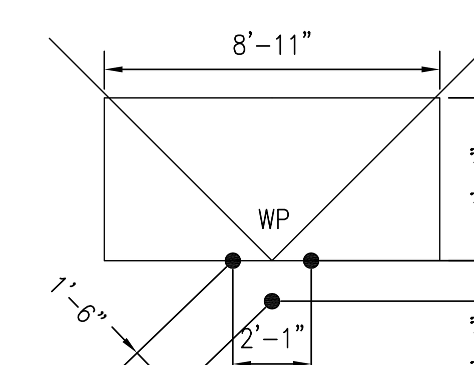
DETAIL "B"



AVIAN HOT BOX
H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE
VANG



DETAIL "D"
CORONA RING HOT BOX

DIAPHRAGM
REQUIRED

SECTION 1-1 & 2-2

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #10	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14

SCALE: NTS

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
HEAVY SUSPENSION

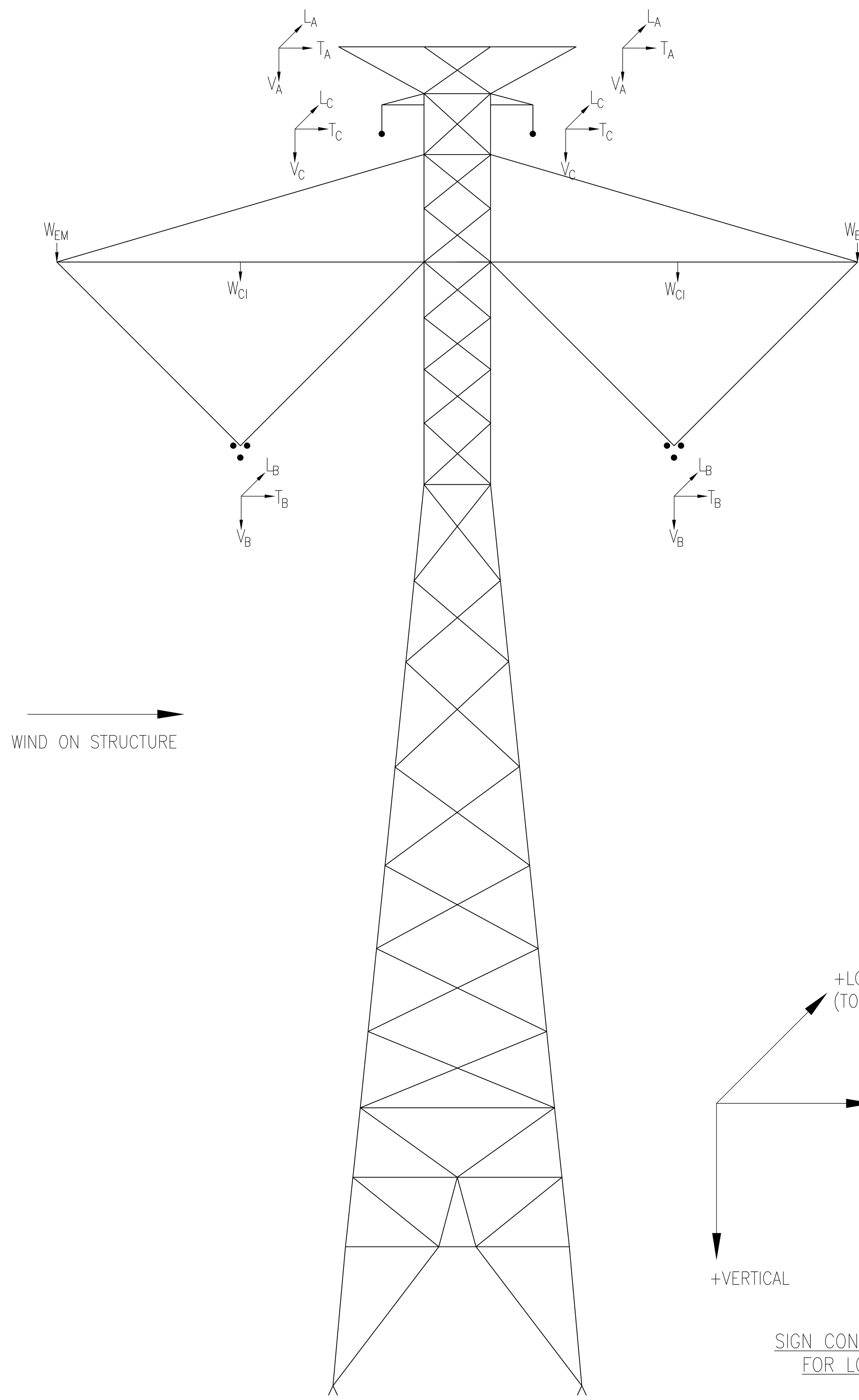
SELF SUPPORTING SUSPENSION TOWER 0'-2' MRC ABOVE (V-STRING)

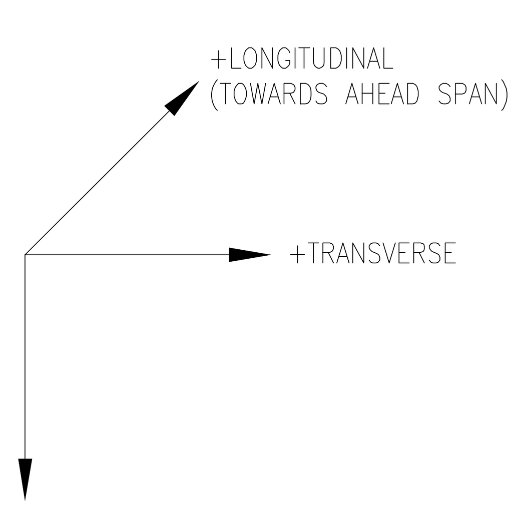
JOB NUMBER: 132836

REV: A

DRAWING NUMBER: SST-8-2

SST-8-2_HEAVY_SUSP_0-2.DWG





SIGN CONVENTION FOR LOADS

DESIGN PARAMETERS									BASIC TANGENT		MEDIUM TANGENT		HEAVY TANGENT	
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	MIN WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	2°	1500	100	1500	2250	1800	2700	2500	3750
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		2°	1500	100	1500	2250	1800	2700	2500	3750
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		2°	1500	100	1500	2250	1800	2700	2500	3750

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (ºF)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
3. NESC EXTREME WIND - YAW 45^0	60	0.00	10.36	1.00	1.00	1.00	4803	16161	14029
4. NESC EXTREME WIND- LONGITUDINAL 90^0	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4088	15627	13349
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4304	15963	13686
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3013 (A) / 0 (B) *	15963	13686
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4304	14367 (A) / 10631 (B) *	13686
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4304	15963	9580 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 12)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662
*(A)= AHEAD SPAN TENSION, (B)= BACK SPAN TENSION									

TABLE 1

CLAMP / INSULATOR PARAMETERS

TOWER TYPE			BASIC, MEDIUM					HEAVY				
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH	DIAMETER	AREA EXPOSED TO WIND	TOTAL WEIGHT (INCLUDING HARDWARE)	UTS	LENGTH	DIAMETER	AREA EXPOSED TO WIND	TOTAL WEIGHT (INCLUDING HARDWARE)	UTS
			[FT]	[IN]	[FT^2]	[LBS]	[KIPS]	[FT]	[IN]	[FT^2]	[LBS]	[KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	Double "V" String Suspension 2x50=100 kips (Basic, Medium) Double "V" String Suspension 2x66=132 kips (Heavy)	29.17 (ONE SIDE)	13 (ONE SIDE)	31.6 (ONE SIDE)	4832 (BOTH SIDES)	100 (ONE SIDE)	33.5 (ONE SIDE)	15 (ONE SIDE)	41.8 (ONE SIDE)	6765 (BOTH SIDES)	132 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	Single "I" String Suspension 1x25 =25 kips (Basic, Medium) Single "I" String Suspension 1x40 =40 kips (Heavy)	4	11	1.83	150	25	4	13	2.2	180	40

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB–CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR FOR THE BASIC, MEDIUM, AND HEAVY SUSPENSION ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9,10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE WIND PRESSURE ON THE STRUCTURE SHALL BE APPLIED WITH THE WIND SHAPE FACTORS PER NESC 2012 RULE 252.B.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   DC–BASIC W_{CI} = 26,650 LBS.
   DC–MEDIUM W_{CI} = 31,750 LBS.
   DC–HEAVY W_{CI} = 43,600 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. ALL TOWER MEMBERS TO WITHSTAND A VERTICAL LOAD OF 350LBS APPLIED AT THEIR MIDPOINT WITH NO OTHER LOADS ACTING.
11. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
12. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
13. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

SST-8-3_B&M_HVY_LOADS_0-2.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE BASIC , MEDIUM AND HEAVY SUSPENSION

SELF SUPPORTING SUSPENSION TOWER 0°–2° MRC ABOVE (V–STRING)–LOAD DRAWING

JOB NUMBER: 132836

REV: A

DRAWING NUMBER: SST–8–3

BASIC SUSPENSION - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.00	2.50	0.00	47.00	14.50	0.00	11.70	4.50	0.00	10.00
2. NESC EXTREME WIND	1.10	1.80	0.00	21.80	15.90	0.00	4.90	4.80	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	1.10	1.00	-0.10	21.80	8.60	-0.10	4.90	2.60	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.10	0.20	-0.10	21.80	1.50	-0.10	4.90	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	5.60	1.80	0.00	45.00	9.00	0.00	12.20	2.80	0.00	4.10
6. EVERYDAY	1.10	0.20	0.00	21.80	1.50	0.00	4.90	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	1.70	0.70	0.00	32.70	6.50	0.00	7.30	2.00	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	1.70	0.60	4.60	32.70	6.50	0.00	7.30	2.00	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	1.70	0.70	0.00	32.70	6.00	16.90	7.30	2.00	0.00	6.00
10b. STRINGING/BROKEN MRC	1.70	0.70	0.00	32.70	6.50	0.00	7.30	1.50	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	2.60	1.80	0.00	39.10	11.80	0.00	9.30	3.60	0.00	10.00

BASIC SUSPENSION - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	0.30	2.50	0.00	9.10	14.50	0.00	0.80	4.50	0.00	10.00
2. NESC EXTREME WIND	0.10	1.80	0.00	5.60	15.90	0.00	0.40	4.80	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	0.10	1.00	-0.10	5.60	8.60	-0.10	0.40	2.60	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.10	0.20	-0.10	5.60	1.50	-0.10	0.40	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	0.30	1.80	0.00	6.70	9.00	0.00	0.80	2.80	0.00	4.10
6. EVERYDAY	0.10	0.20	0.00	5.60	1.50	0.00	0.40	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	0.20	0.70	0.00	8.40	6.50	0.00	0.60	2.00	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	0.20	0.60	4.60	8.40	6.50	0.00	0.60	2.00	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	0.20	0.70	0.00	8.40	6.00	16.90	0.60	2.00	0.00	6.00
10b. STRINGING/BROKEN MRC	0.20	0.70	0.00	8.40	6.50	0.00	0.60	1.50	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	0.20	1.80	0.00	8.70	11.80	0.00	0.70	3.60	0.00	10.00

MEDIUM SUSPENSION - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.70	2.90	0.00	54.90	16.60	0.00	14.00	5.20	0.00	10.00
2. NESC EXTREME WIND	1.30	2.10	0.00	25.20	18.60	0.00	5.80	5.70	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	1.30	1.10	-0.10	25.20	10.00	-0.10	5.80	3.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.30	0.20	-0.10	25.20	1.50	-0.10	5.80	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	6.70	2.10	0.00	53.00	10.10	0.00	14.60	3.20	0.00	4.10
6. EVERYDAY	1.30	0.20	0.00	25.20	1.50	0.00	5.80	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	2.00	0.80	0.00	37.80	7.30	0.00	8.70	2.20	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	2.00	0.70	4.60	37.80	7.30	0.00	8.70	2.20	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	2.00	0.80	0.00	37.80	6.80	16.90	8.70	2.20	0.00	6.00
10b. STRINGING/BROKEN MRC	2.00	0.80	0.00	37.80	7.30	0.00	8.70	1.70	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	3.10	2.10	0.00	45.40	13.50	0.00	11.10	4.20	0.00	10.00

MEDIUM SUSPENSION - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	0.30	2.90	0.00	9.10	16.60	0.00	0.80	5.20	0.00	10.00
2. NESC EXTREME WIND	0.10	2.10	0.00	5.60	18.60	0.00	0.40	5.70	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	0.10	1.10	-0.10	5.60	10.00	-0.10	0.40	3.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.10	0.20	-0.10	5.60	1.50	-0.10	0.40	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	0.30	2.10	0.00	6.70	10.10	0.00	0.80	3.20	0.00	4.10
6. EVERYDAY	0.10	0.20	0.00	5.60	1.50	0.00	0.40	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	0.20	0.80	0.00	8.40	7.30	0.00	0.60	2.20	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	0.20	0.70	4.60	8.40	7.30	0.00	0.60	2.20	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	0.20	0.80	0.00	8.40	6.80	16.90	0.60	2.20	0.00	6.00
10b. STRINGING/BROKEN MRC	0.20	0.80	0.00	8.40	7.30	0.00	0.60	1.70	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	0.20	2.10	0.00	8.70	13.50	0.00	0.70	4.20	0.00	10.00

HEAVY SUSPENSION - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	6.60	3.90	0.00	76.30	21.40	0.00	19.30	6.70	0.00	10.00
2. NESC EXTREME WIND	1.80	2.80	0.00	35.10	25.00	0.00	8.00	7.60	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	1.80	1.50	-0.10	35.10	13.20	-0.10	8.00	4.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.80	0.20	-0.10	35.10	1.50	-0.10	8.00	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	9.30	2.70	0.00	73.70	12.80	0.00	20.10	4.10	0.00	4.10
6. EVERYDAY	1.80	0.20	0.00	35.10	1.50	0.00	8.00	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	2.70	1.00	0.00	52.60	9.20	0.00	12.00	2.80	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	2.70	0.90	4.60	52.60	9.20	0.00	12.00	2.80	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	2.70	1.00	0.00	52.60	8.60	16.90	12.00	2.80	0.00	6.00
10b. STRINGING/BROKEN MRC	2.70	1.00	0.00	52.60	9.20	0.00	12.00	2.30	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	4.20	2.70	0.00	63.10	17.50	0.00	15.20	5.40	0.00	10.00

HEAVY SUSPENSION - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	0.30	3.90	0.00	12.00	21.40	0.00	0.80	6.70	0.00	10.00
2. NESC EXTREME WIND	0.10	2.80	0.00	7.60	25.00	0.00	0.40	7.60	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	0.10	1.50	-0.10	7.60	13.20	-0.10	0.40	4.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.10	0.20	-0.10	7.60	1.50	-0.10	0.40	0.50	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	0.30	2.70	0.00	8.60	12.80	0.00	0.80	4.10	0.00	4.10
6. EVERYDAY	0.10	0.20	0.00	7.60	1.50	0.00	0.40	0.50	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	0.20	1.00	0.00	11.30	9.20	0.00	0.60	2.80	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	0.20	0.90	4.60	11.30	9.20	0.00	0.60	2.80	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	0.20	1.00	0.00	11.30	8.60	16.90	0.60	2.80	0.00	6.00
10b. STRINGING/BROKEN MRC	0.20	1.00	0.00	11.30	9.20	0.00	0.60	2.30	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	0.20	2.70	0.00	11.60	17.50	0.00	0.70	5.40	0.00	10.00

SST-8-4_B&M_HVY_LOADS_0-2.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
BASIC , MEDIUM AND HEAVY SUSPENSION

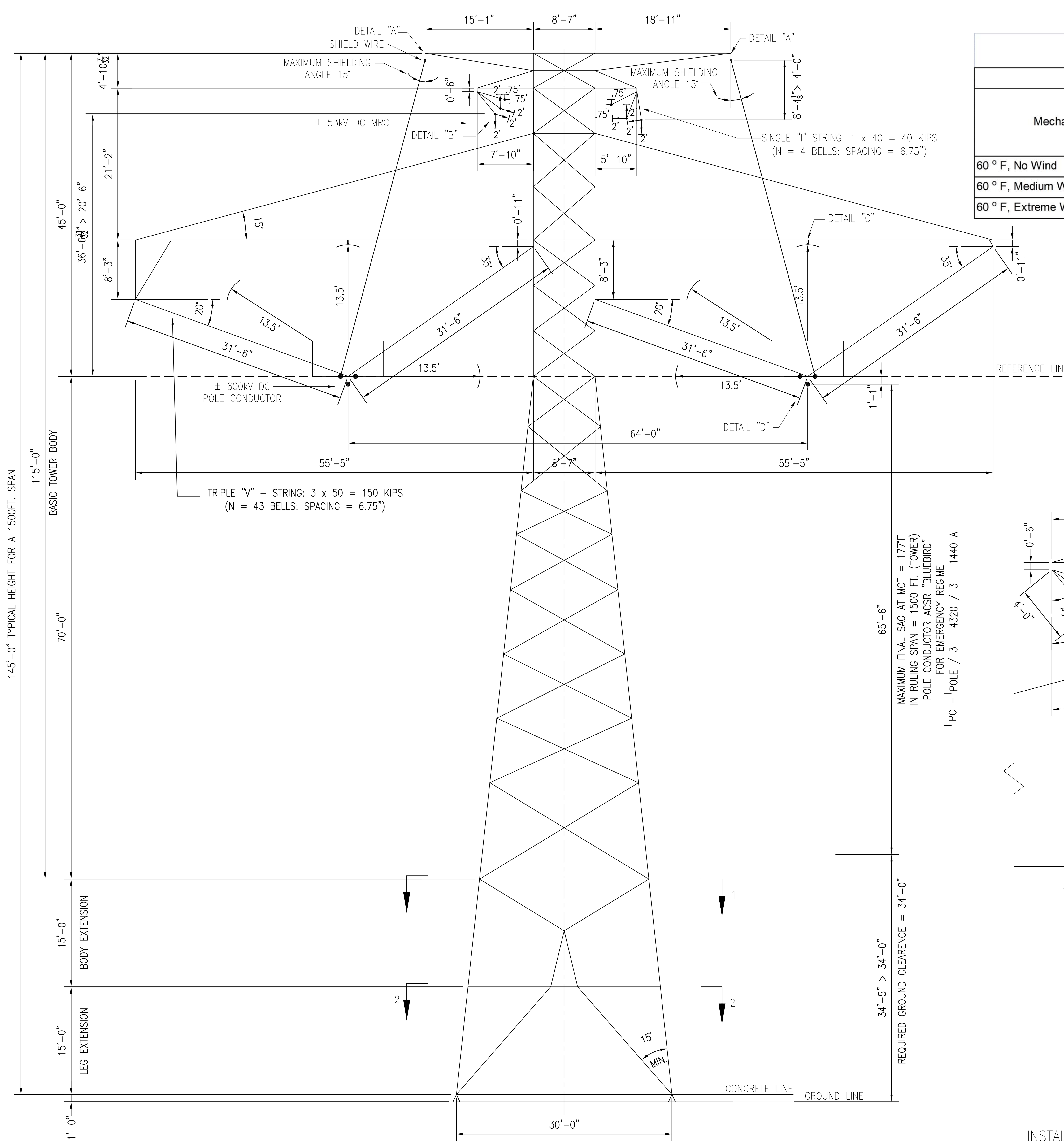
SELF SUPPORTING SUSPENSION TOWER 0'-2'
MRC ABOVE (V-STRING)-LOAD DRAWING

JOB NUMBER: 132836
REV: A

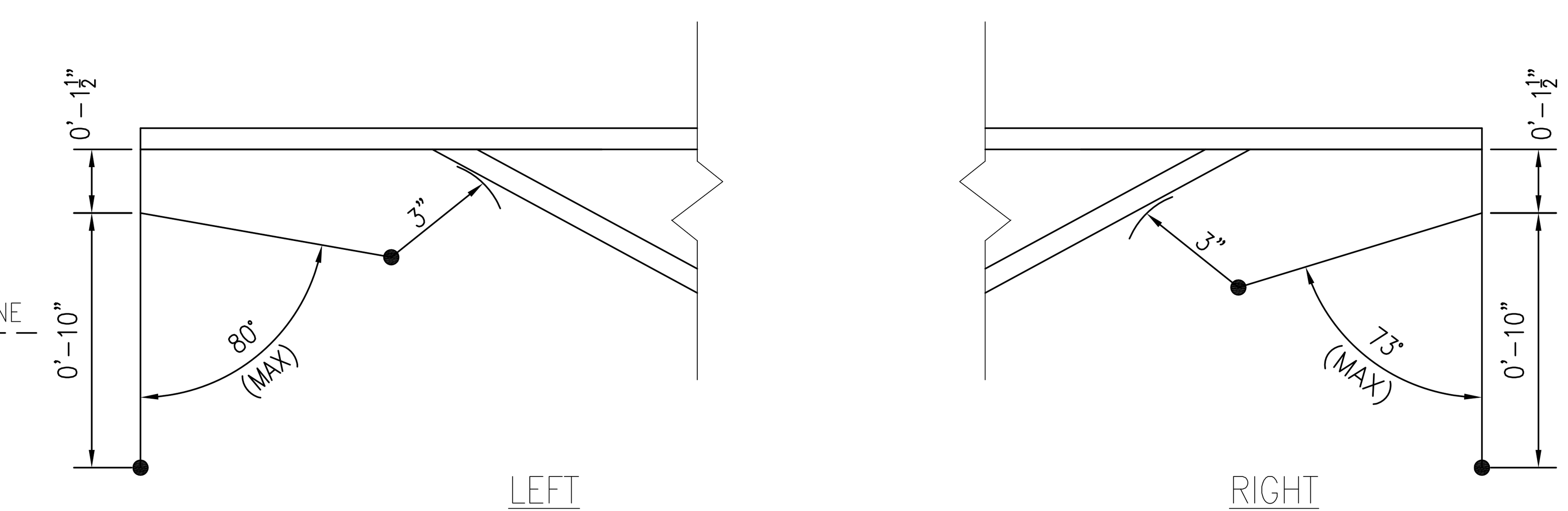
DRAWING NUMBER: SST-8-4

SMALL ANGLE SUSPENSION

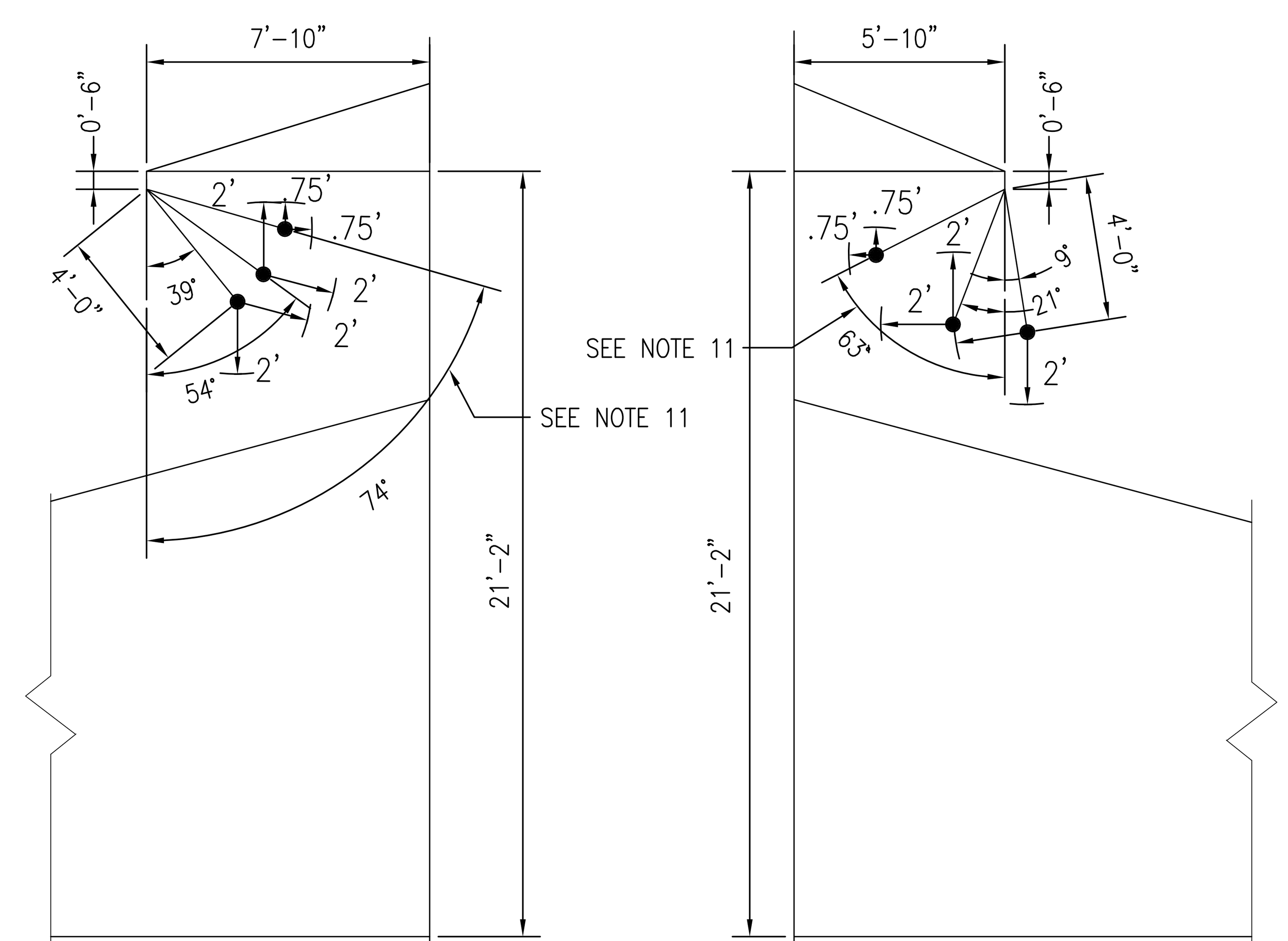
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	39 °	-9 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	54 °	21 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	74 °	63 °



SMALL ANGLE SUSPENSION TOWER



DETAIL "A"



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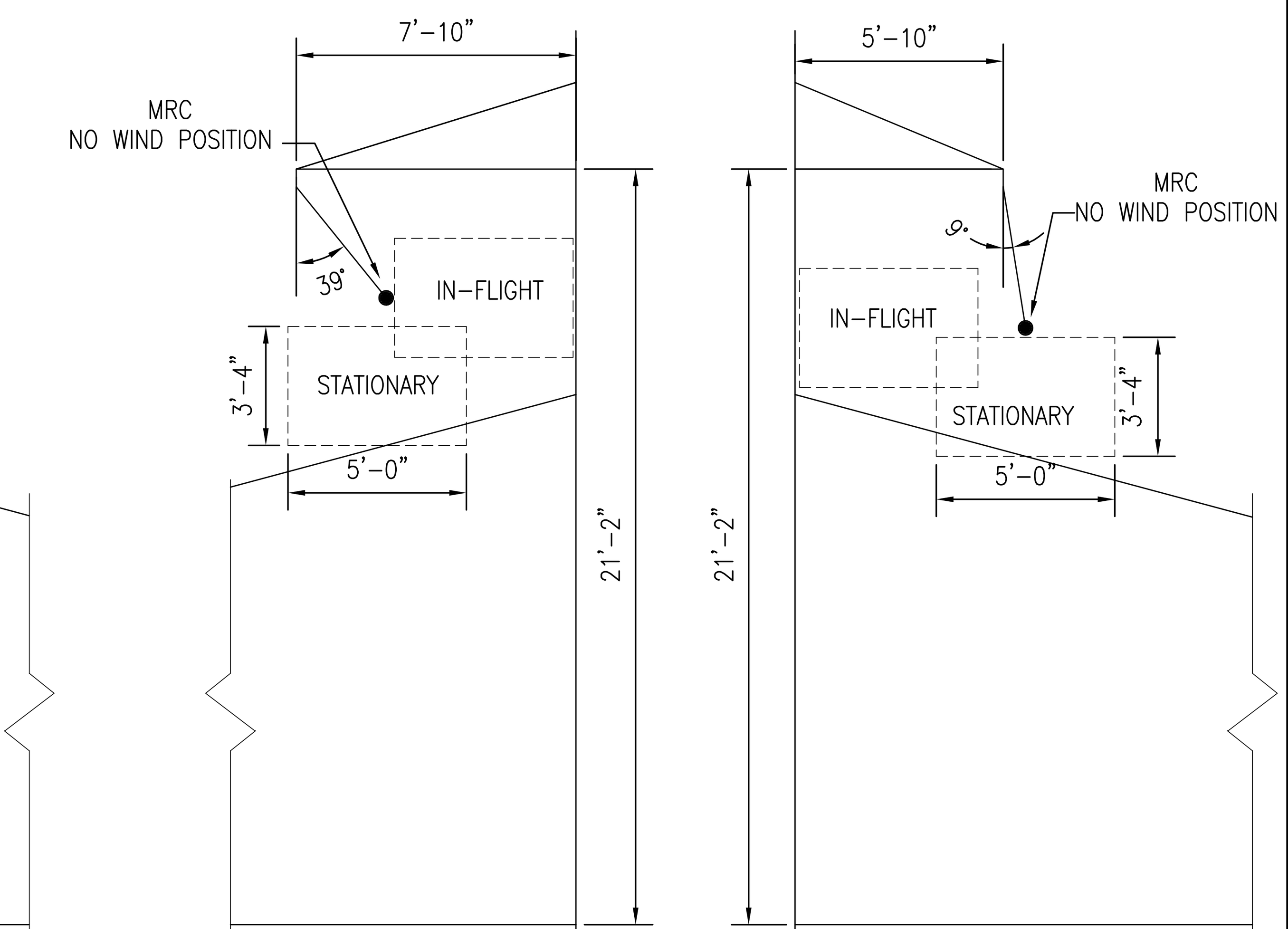
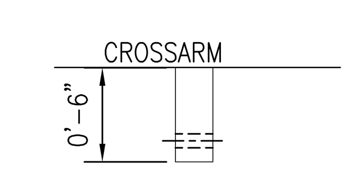
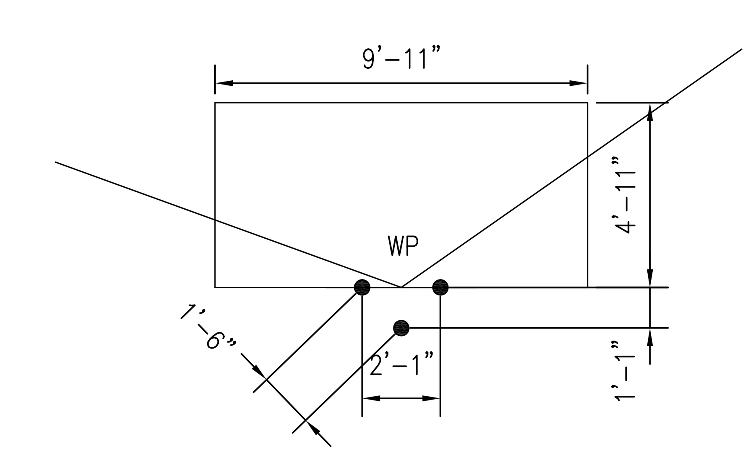


LEFT AVIAN "HOT BOX" H x L = 40" x 60"

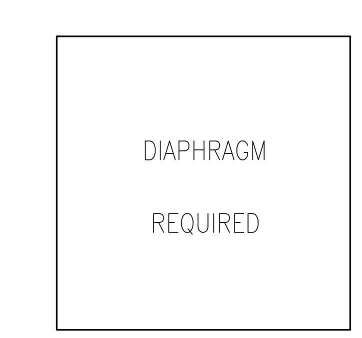
RIGHT AVIAN "HOT BOX" H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE VANG



DETAIL "D"
CORONA RING HOT BOX



SECTION 1-1 & 2-2

NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS TO THE CORONA RING HOT BOX.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE CONDUCTOR PHASE SPACING SHOULD NOT BE LESS THAN THAT OF THE TANGENT V-STRING SUSPENSION TOWER.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERDAY, 60°, NO WIND, 60°, 6 PSF & 60°, 20.74 PSF CONDITION.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #11	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

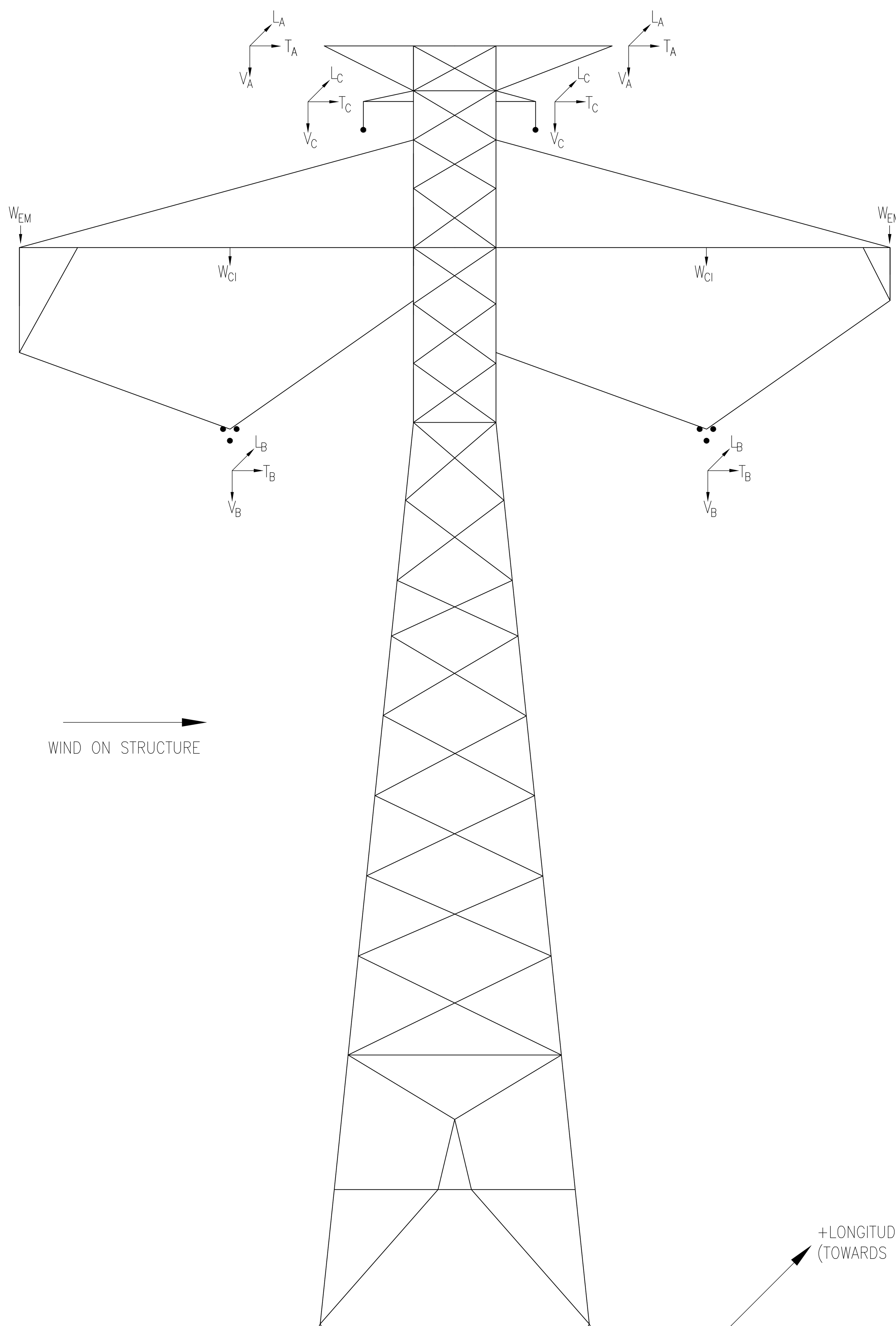
POWER ENGINEERS

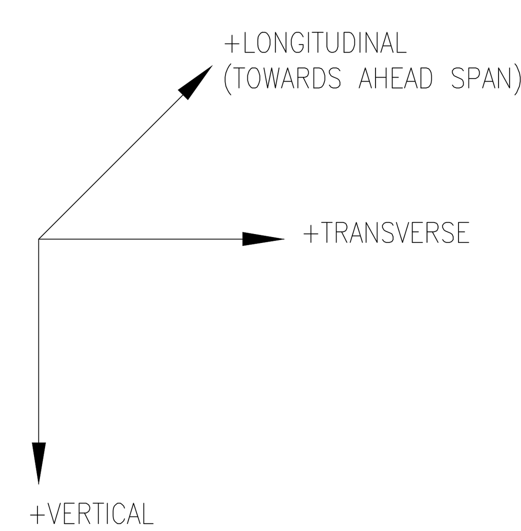
CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE
SMALL ANGLE SUSPENSION
SELF SUPPORTING SUSPENSION TOWER 2°-10°
MRC ABOVE (V-STRING)

JOB NUMBER 132836 REV A

DRAWING NUMBER SST-10-1

SST-10-1_SMALL_SUSP_2-10.DWG





SIGN CONVENTION FOR LOADS

DESIGN PARAMETERS

WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	MIN WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	10°	1500	100	1800	2700
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		10°	1500	100	1800	2700
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		10°	1500	100	1800	2700

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (ºF)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
3. NESC EXTREME WIND - YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4803	16161	14029
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4088	15627	13349
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4304	15963	13686
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3013 (A) / 0 (B) *	15963	13686
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4304	14367 (A) / 10631 (B) *	13686
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4304	15963	9580 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 12)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662

*(A)= AHEAD SPAN TENSION, (B)= BACK SPAN TENSION

SMALL ANGLE SUSPENSION - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.70	5.00	0.00	58.70	33.00	0.00	14.00	10.00	0.00	10.00
2. NESC EXTREME WIND	1.30	3.10	0.00	27.80	27.20	0.00	5.80	8.20	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	1.30	1.80	-0.10	27.80	16.70	-0.20	5.80	5.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.30	0.70	-0.10	27.80	7.50	-0.10	5.80	2.20	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	6.70	3.80	0.00	55.60	22.70	0.00	14.60	6.90	0.00	4.10
6. EVERYDAY	1.30	0.70	0.00	27.80	7.50	0.00	5.80	2.20	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	2.00	1.70	0.00	41.60	17.30	0.00	8.70	5.10	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	2.00	1.00	4.60	41.60	17.30	0.00	8.70	5.10	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	2.00	1.70	0.00	41.60	14.60	16.80	8.70	5.10	0.00	6.00
10b. STRINGING/BROKEN MRC	2.00	1.70	0.00	41.60	17.30	0.00	8.70	2.70	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	3.10	3.50	0.00	49.20	26.70	0.00	11.10	8.00	0.00	10.00

SMALL ANGLE SUSPENSION - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	0.30	5.00	0.00	12.90	33.00	0.00	0.80	10.00	0.00	10.00
2. NESC EXTREME WIND	0.10	3.10	0.00	8.20	27.20	0.00	0.40	8.20	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	0.10	1.80	-0.10	8.20	16.70	-0.20	0.40	5.00	-0.10	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.10	0.70	-0.10	8.20	7.50	-0.10	0.40	2.20	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	0.30	3.80	0.00	9.20	22.70	0.00	0.80	6.90	0.00	4.10
6. EVERYDAY	0.10	0.70	0.00	8.20	7.50	0.00	0.40	2.20	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	0.20	1.70	0.00	12.30	17.30	0.00	0.60	5.10	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	0.20	1.00	4.60	12.30	17.30	0.00	0.60	5.10	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	0.20	1.70	0.00	12.30	14.60	16.80	0.60	5.10	0.00	6.00
10b. STRINGING/BROKEN MRC	0.20	1.70	0.00	12.30	17.30	0.00	0.60	2.70	14.40	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	0.20	3.50	0.00	12.50	26.70	0.00	0.70	8.00	0.00	10.00

TABLE 1

CLAMP / INSULATOR PARAMETERS

WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	Triple "V" String Suspension 3x50=150 kips	31.5 (ONE SIDE)	13 (ONE SIDE)	51.2 (ONE SIDE)	7389 (BOTH SIDES)	150 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	Single "I" String Suspension 1x40 =40 kips	4	13	2.2	180	40

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB-CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. ALL TOWER MEMBERS TO WITHSTAND A VERTICAL LOAD OF 350LBS APPLIED AT THEIR MIDPOINT WITH NO OTHER LOADS ACTING.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9,10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE WIND PRESSURE ON THE STRUCTURE SHALL BE APPLIED WITH THE WIND SHAPE FACTORS PER NESC 2012 RULE 252.B.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   DC-SMALL ANGLE W_{CI} = 31,750 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
11. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND LOAD ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
12. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
13. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
SMALL ANGLE SUSPENSION

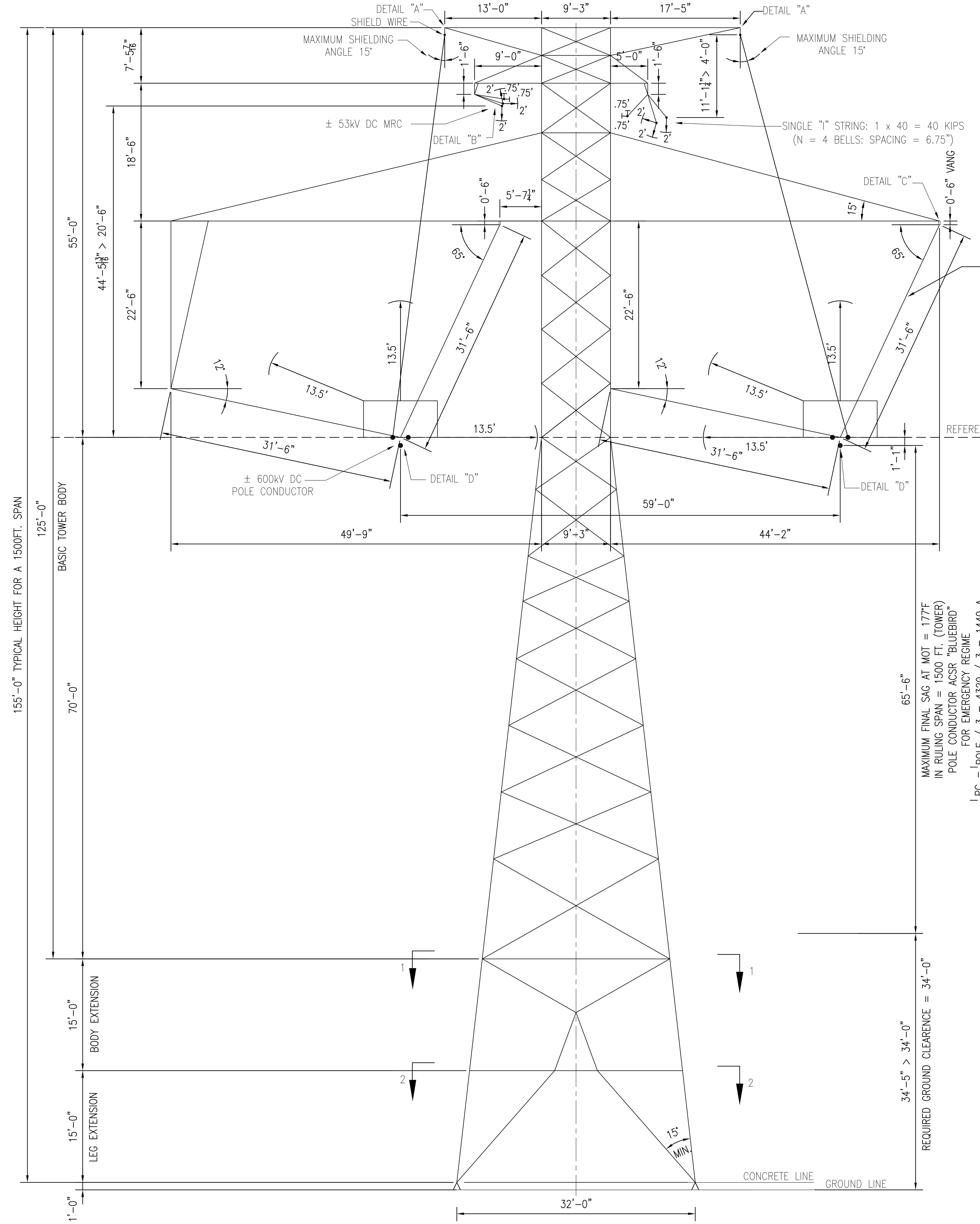
SELF SUPPORTING SUSPENSION TOWER 2°-10°
MRC ABOVE (V-STRING)-LOAD DRAWING

JOB NUMBER 132836

REV A

DRAWING NUMBER SST-10-2

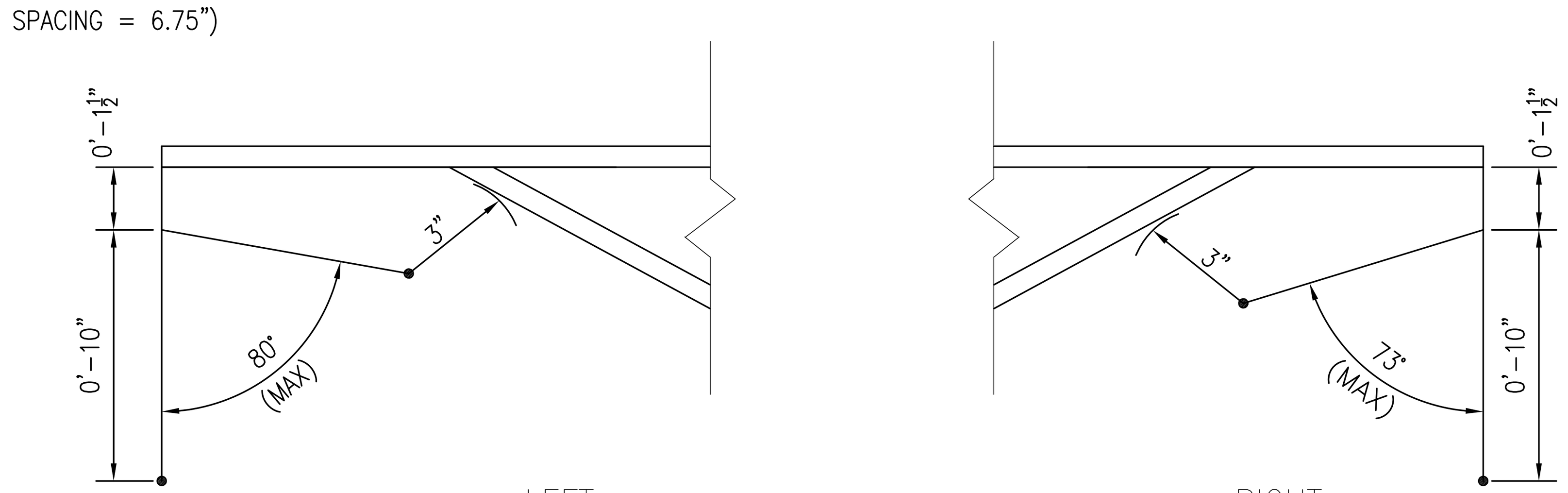
SST-10-2_SMALL_LOADS_2-10.DWG



MEDIUM ANGLE SUSPENSION TOWER

MEDIUM ANGLE SUSPENSION

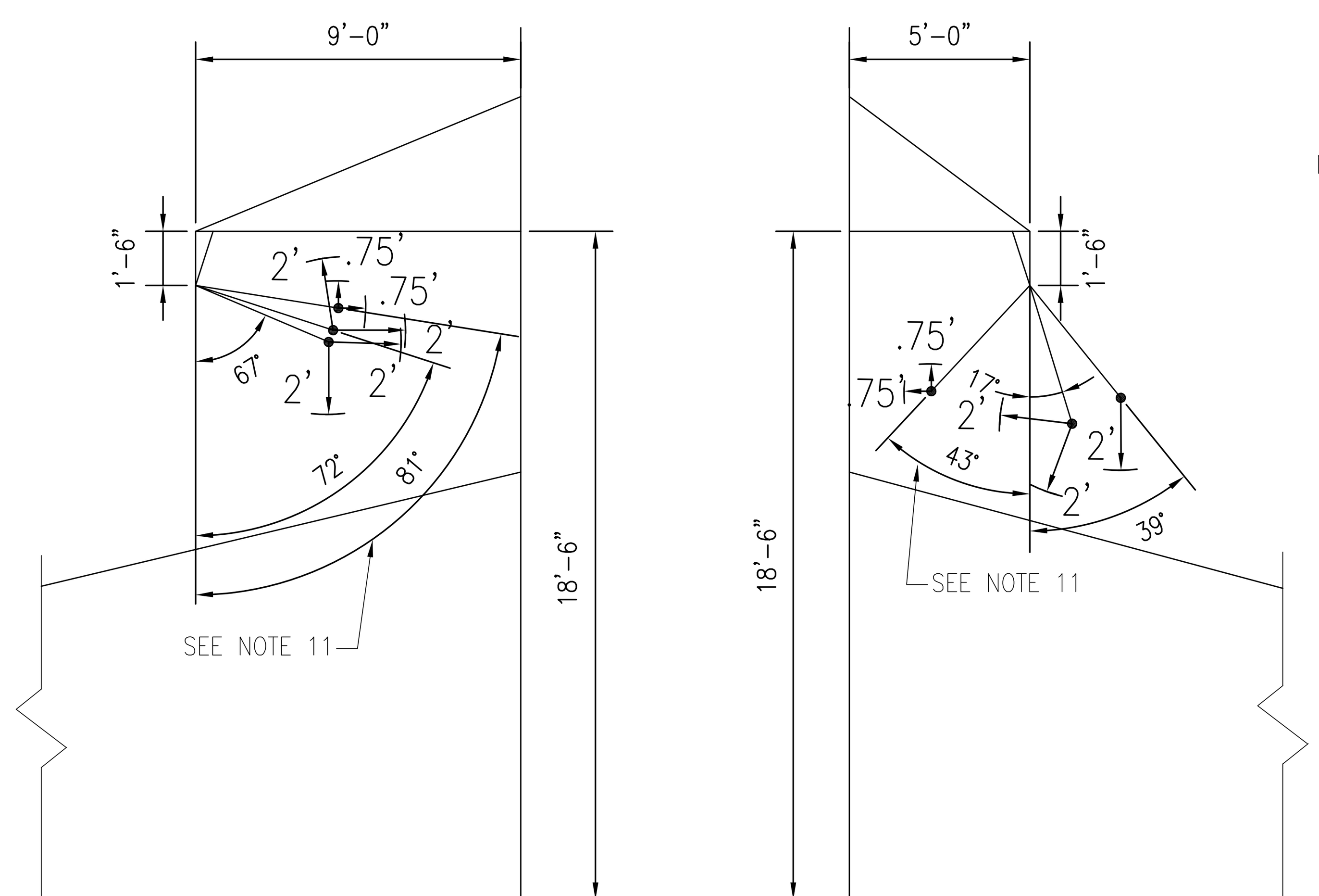
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	67 °	-39 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	72 °	-17 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	81 °	43 °



LEFT

RIGHT

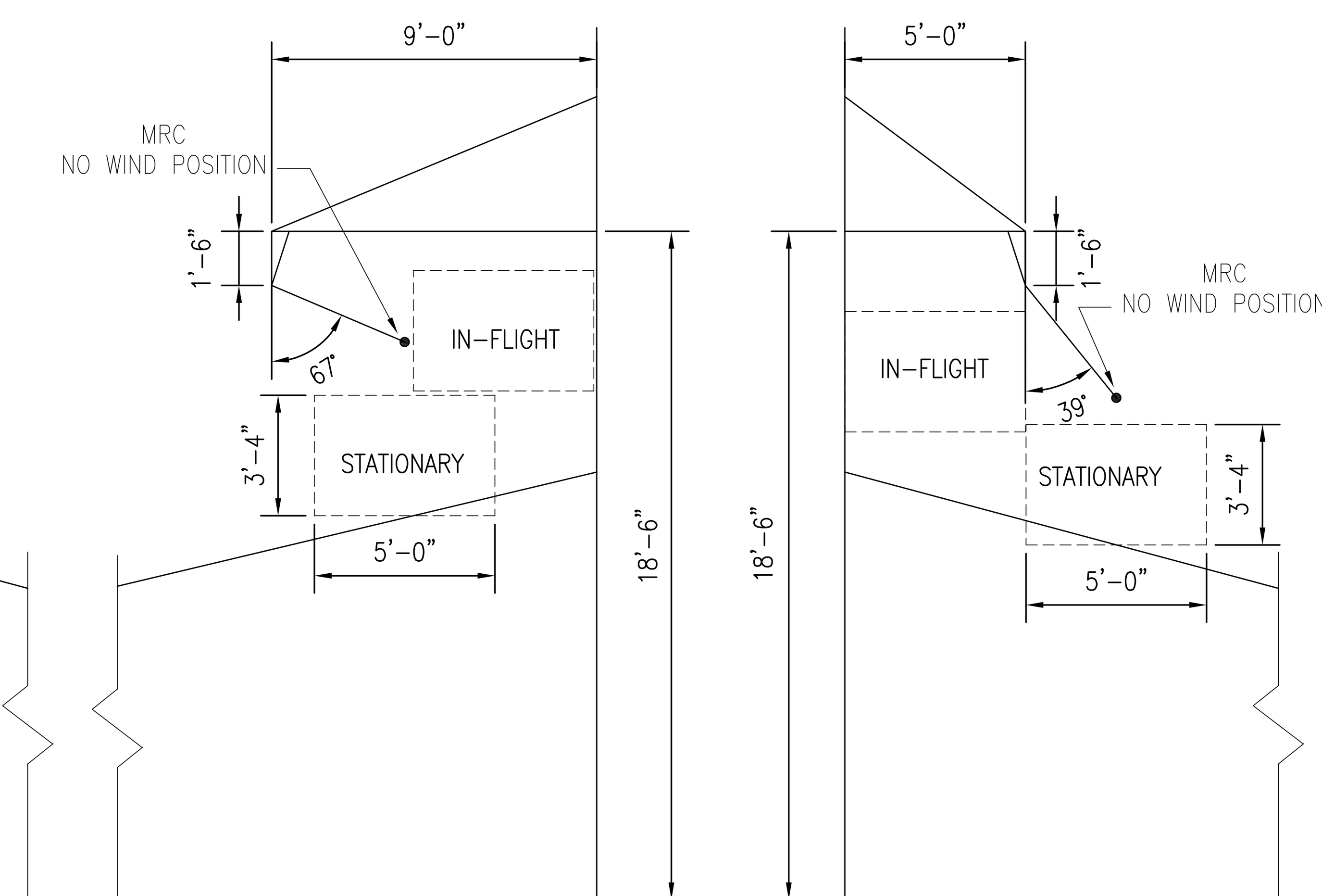
DETAIL "A"



LEFT

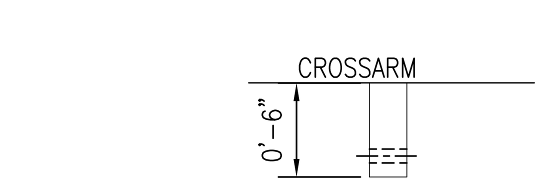
RIGHT

DETAIL "B"

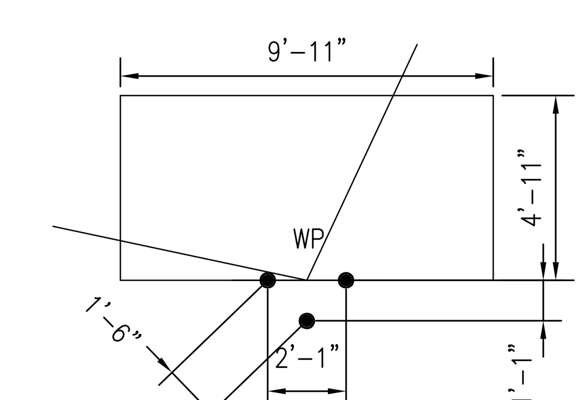


LEFT
AVIAN "HOT BOX"
H x L = 40" x 60"

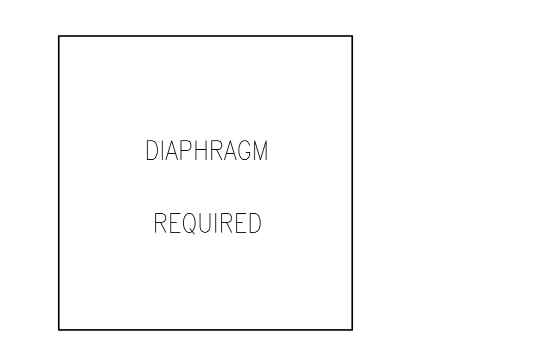
RIGHT
AVIAN "HOT BOX"
H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE VANG



DETAIL "D"
CORONA RING HOT BOX



SECTION 1-1 & 2-2

NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS TO THE CORONA RING HOT BOX.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE CONDUCTOR PHASE SPACING SHOULD NOT BE LESS THAN THAT OF THE TANGENT V-STRING SUSPENSION TOWER.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERDAY, 60°, NO WIND, 60°, 6 PSF & 60°, 20.74 PSF CONDITION.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #11	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

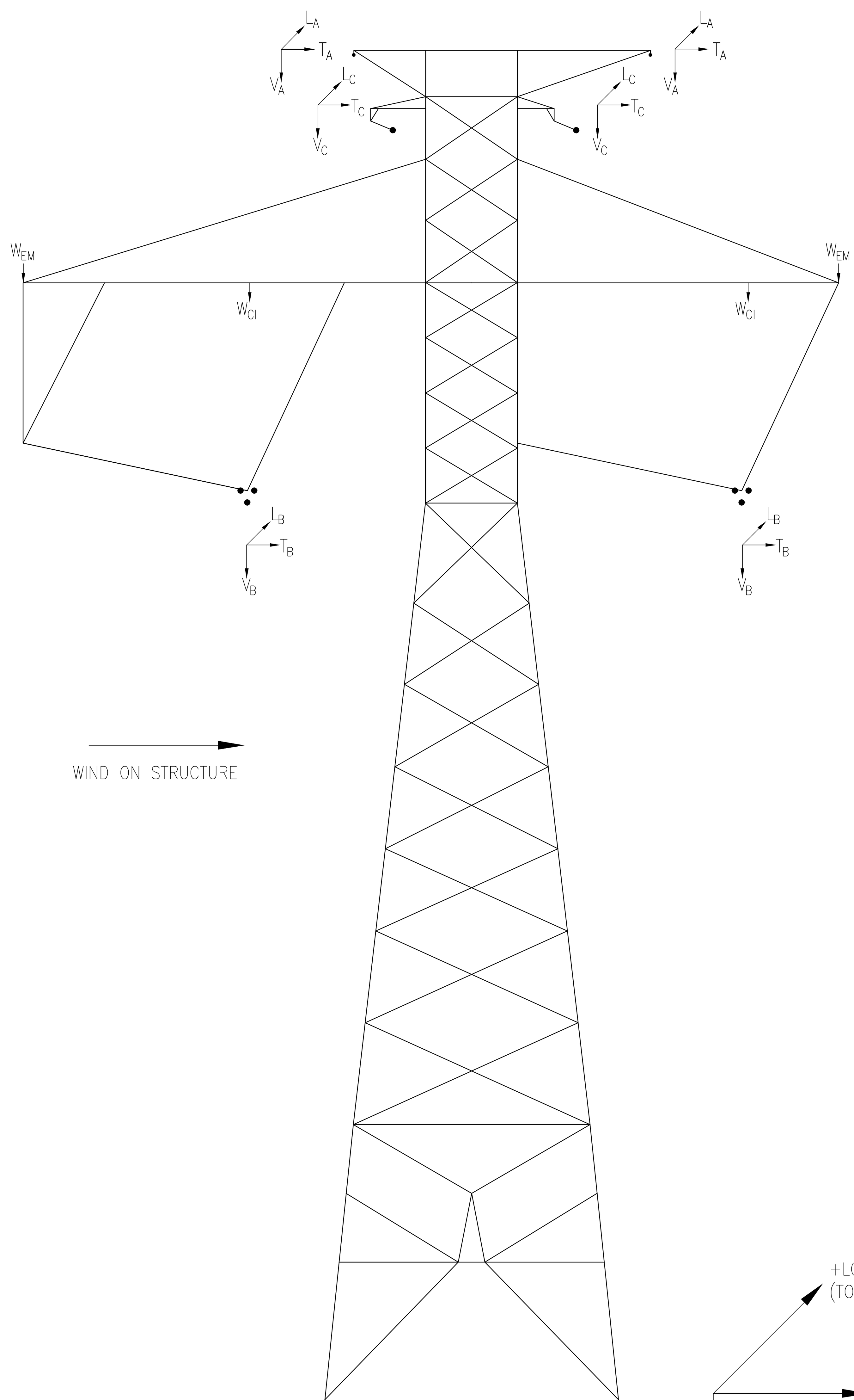
PLAINS AND EASTERN ± 600kV HVDC LINE
MEDIUM ANGLE SUSPENSION

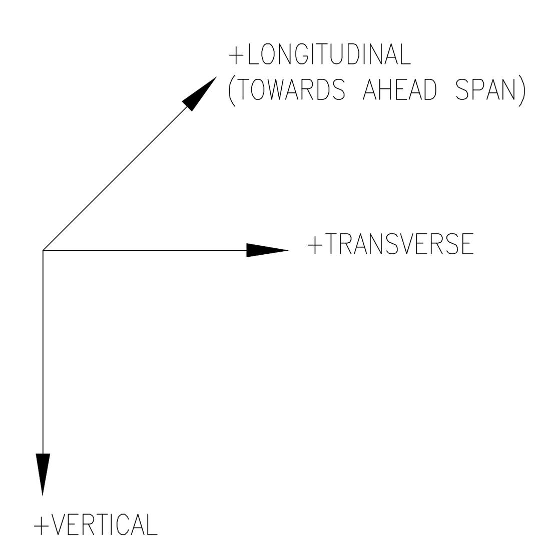
SELF SUPPORTING SUSPENSION TOWER
10'-30' MRC ABOVE (V-STRING)

JOB NUMBER: 132836

REV: A

DRAWING NUMBER: SST-12-1





SIGN CONVENTION FOR LOADS

DESIGN PARAMETERS										
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	MIN WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	30°	1500	100	1800	2700
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		30°	1500	100	1800	2700
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		30°	1500	100	1800	2700

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
3. NESC EXTREME WIND - YAW 45^0	60	0.00	10.36	1.00	1.00	1.00	4803	16161	14029
4. NESC EXTREME WIND- LONGITUDINAL 90^0	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4088	15627	13349
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4304	15963	13686
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3013 (A) / 0 (B) *	15963	13686
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4304	14367 (A) / 10631 (B) *	13686
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4304	15963	9580 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 12)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662
*(A)= AHEAD SPAN TENSION, (B)= BACK SPAN TENSION									

MEDIUM ANGLE SUSPENSION - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.70	10.00	0.00	58.70	73.40	0.00	14.00	21.90	0.00	10.00
2. NESC EXTREME WIND	1.30	5.40	0.00	27.80	48.40	0.00	5.80	14.50	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	1.30	3.40	-0.20	27.80	33.10	-1.10	5.80	9.70	-0.40	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.30	1.90	-0.10	27.80	22.10	-0.30	5.80	6.30	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	6.70	7.90	0.00	55.60	53.60	0.00	14.60	16.10	0.00	4.10
6. EVERYDAY	1.30	1.90	0.00	27.80	22.10	0.00	5.80	6.30	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	2.00	3.90	0.00	41.60	42.00	0.00	8.70	12.10	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	2.00	1.80	4.40	41.60	42.00	0.00	8.70	12.10	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	2.00	3.90	0.00	41.60	33.90	16.30	8.70	12.10	0.00	6.00
10b. STRINGING/BROKEN MRC	2.00	3.90	0.00	41.60	42.00	0.00	8.70	5.20	13.90	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	3.10	7.20	0.00	49.20	59.30	0.00	11.10	17.40	0.00	10.00

MEDIUM ANGLE SUSPENSION - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	0.30	10.00	0.00	12.90	73.40	0.00	0.80	21.90	0.00	10.00
2. NESC EXTREME WIND	0.10	5.40	0.00	8.20	48.40	0.00	0.40	14.50	0.00	23.00
3. NESC EXTREME WIND- YAW 45°	0.10	3.40	-0.20	8.20	33.10	-1.10	0.40	9.70	-0.40	16.30
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.10	1.90	-0.10	8.20	22.10	-0.30	0.40	6.30	-0.10	23.00
5. NESC EXTREME ICE WITH CONCURRENT WIND	0.30	7.90	0.00	9.20	53.60	0.00	0.80	16.10	0.00	4.10
6. EVERYDAY	0.10	1.90	0.00	8.20	22.10	0.00	0.40	6.30	0.00	0.00
7. CONSTRUCTION SNUB OFF 3:1	2.80	-0.30	0.30	34.40	-2.50	2.60	9.80	-0.70	0.80	0.00
8. STRINGING INTACT	0.20	3.90	0.00	12.30	42.00	0.00	0.60	12.10	0.00	6.00
9. STRINGING/BROKEN SHIELDWIRE	0.20	1.80	4.40	12.30	42.00	0.00	0.60	12.10	0.00	6.00
10a. STRINGING/BROKEN CONDUCTOR	0.20	3.90	0.00	12.30	33.90	16.30	0.60	12.10	0.00	6.00
10b. STRINGING/BROKEN MRC	0.20	3.90	0.00	12.30	42.00	0.00	0.60	5.20	13.90	6.00
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.10
12.NESC MEDIUM (SEE NOTE 12)	0.20	7.20	0.00	12.50	59.30	0.00	0.70	17.40	0.00	10.00

TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	Triple "V" String Suspension 3x50=150 kips	31.5 (ONE SIDE)	13 (ONE SIDE)	51.2 (ONE SIDE)	7389 (BOTH SIDES)	150 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	Single "I" String Suspension 1x40 =40 kips	4	13	2.2	180	40

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB-CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. ALL TOWER MEMBERS TO WITHSTAND A VERTICAL LOAD OF 350LBS APPLIED AT THEIR MIDPOINT WITH NO OTHER LOADS ACTING.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9,10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE WIND PRESSURE ON THE STRUCTURE SHALL BE APPLIED WITH THE WIND SHAPE FACTORS PER NESC 2012 RULE 252.B.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   DC-SMALL ANGLE W_{CI} = 31,750 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
11. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND LOAD ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
12. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
13. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45° AND LONGITUDINAL DIRECTIONS.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	DVW	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
MEDIUM ANGLE SUSPENSION

SELF SUPPORTING SUSPENSION TOWER
10°-30° MRC ABOVE(V-STRING)LOAD DRAWING

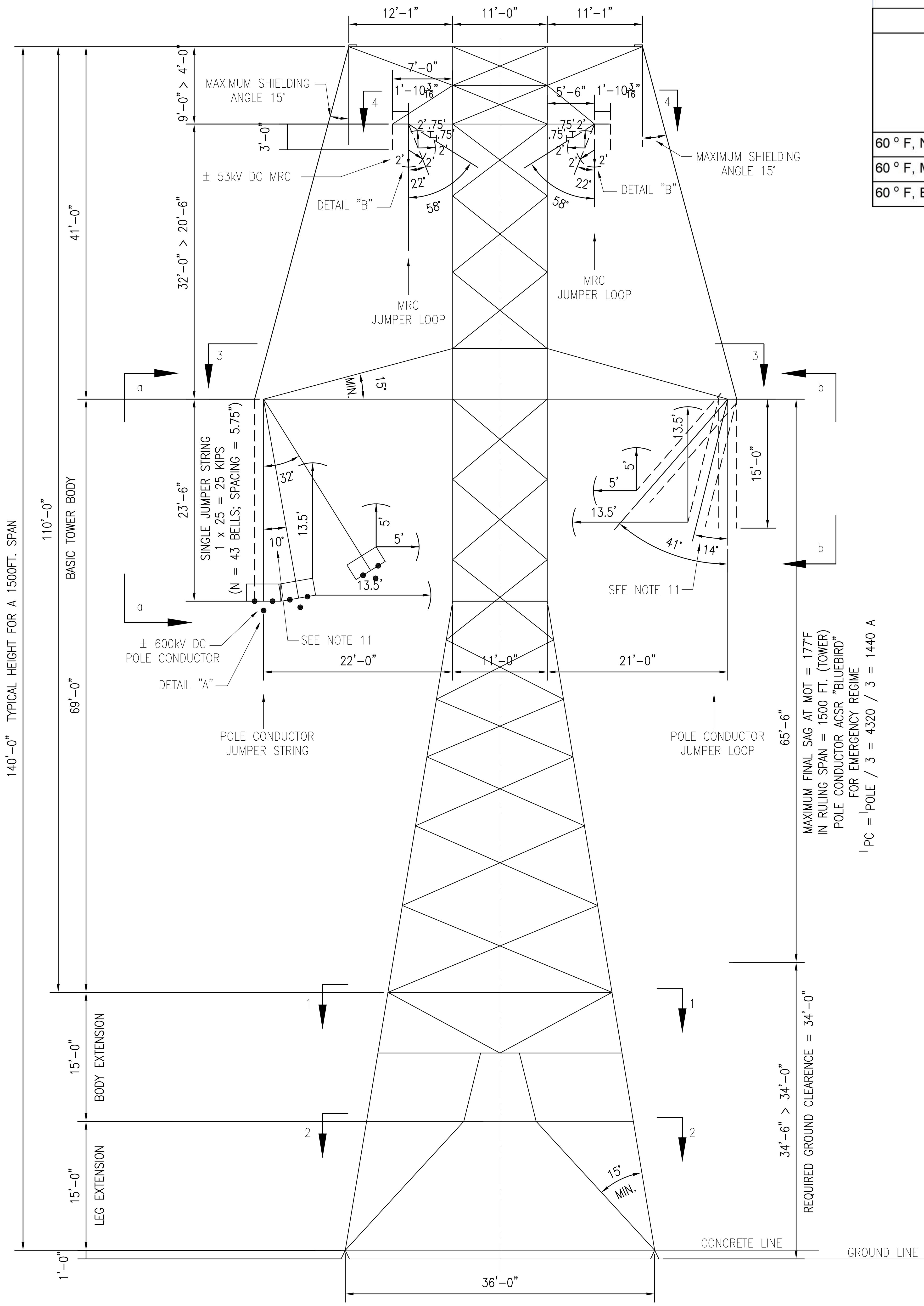
JOB NUMBER: 132836
REV: A

DRAWING NUMBER: SST-12-2

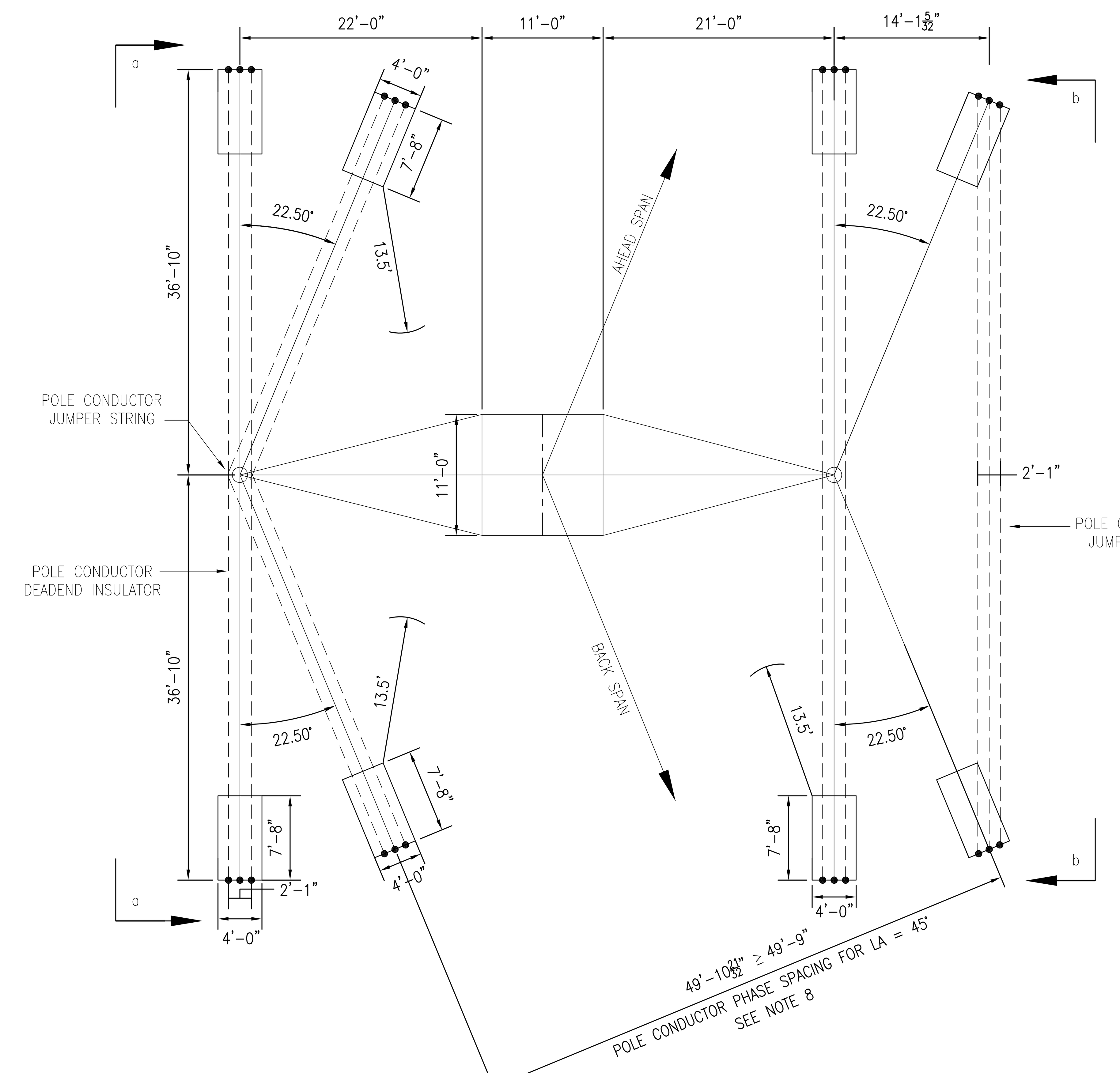
SST-12-2_MED_LOADS_10-30.DWG

DEADEND 0°–45°

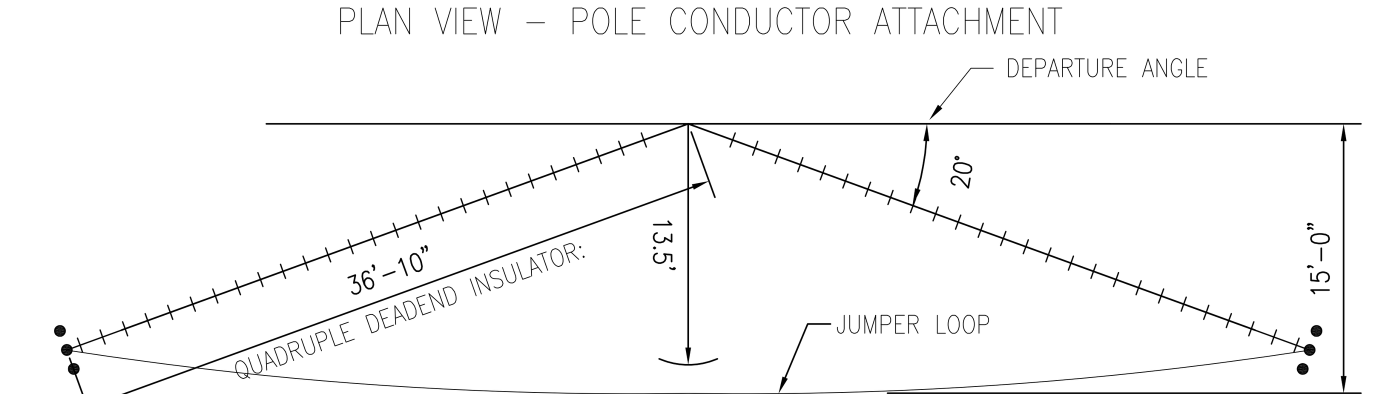
Mechanical	Electrical			Left Crossarm Wind from Left	Right Crossarm Wind from Right	Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances							
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 600 KV DC Pole Conductor "I" Jumper String Insulator Swing Angle	+/- 600 KV DC Pole Conductor Jumper Loop Swing Angle	+/- 53 KV DC MRC "Jumper Loop Swing Angle	+/- 53 KV DC MRC Jumper Loop Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	10 °	14 °	22 °	22 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	32 °	41 °	58 °	58 °



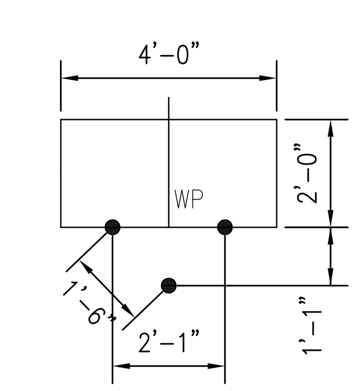
0'–45° DEADEND TOWER



SECTION 3–3
PLAN VIEW – POLE CONDUCTOR ATTACHMENT



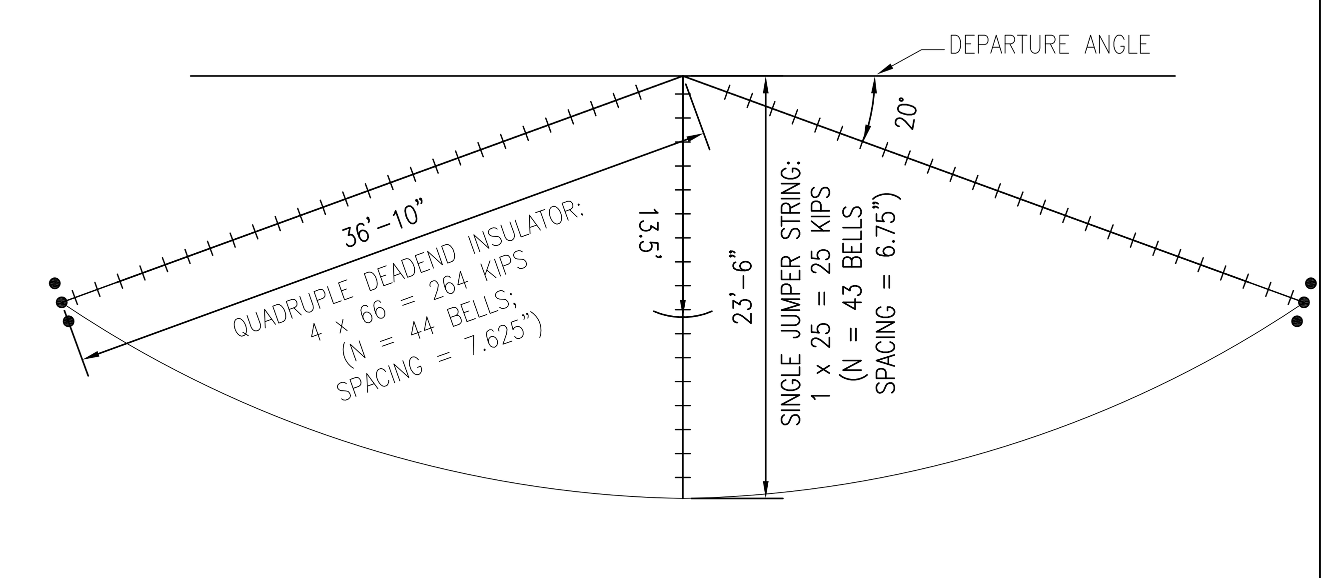
SECTION b–b
SIDE VIEW – JUMPER LOOP POLE CONDUCTOR



DETAIL "A"
CORONA RING HOT BOX
JUMPER STRING
POLE CONDUCTOR

NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS TO THE NEAREST POINT ON THE CONDUCTOR OR CORONA RING HOT BOX. A 20° DEPARTURE ANGLE ON THE TENSION INSULATOR STRING SHALL BE CONSIDERED FOR CLEARANCE CHECKING.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE POLE CONDUCTOR PHASE SPACING SHOULD BE THAT OF THE POLE CONDUCTOR IN THE TANGENT V–STRING SUSPENSION TOWER UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF STEEL.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE JUMPER STRING AND JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITION.



SECTION a–a
SIDE VIEW – JUMPER STRING
POLE CONDUCTOR

SECTION 1–1 & 2–2

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #11	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

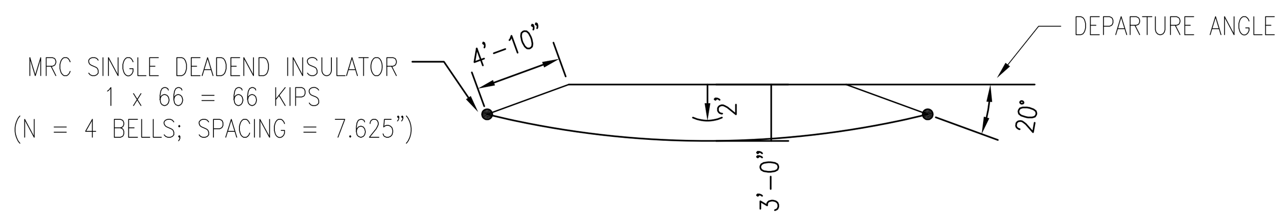
FOR 22x34 DWG ONLY

POWER ENGINEERS

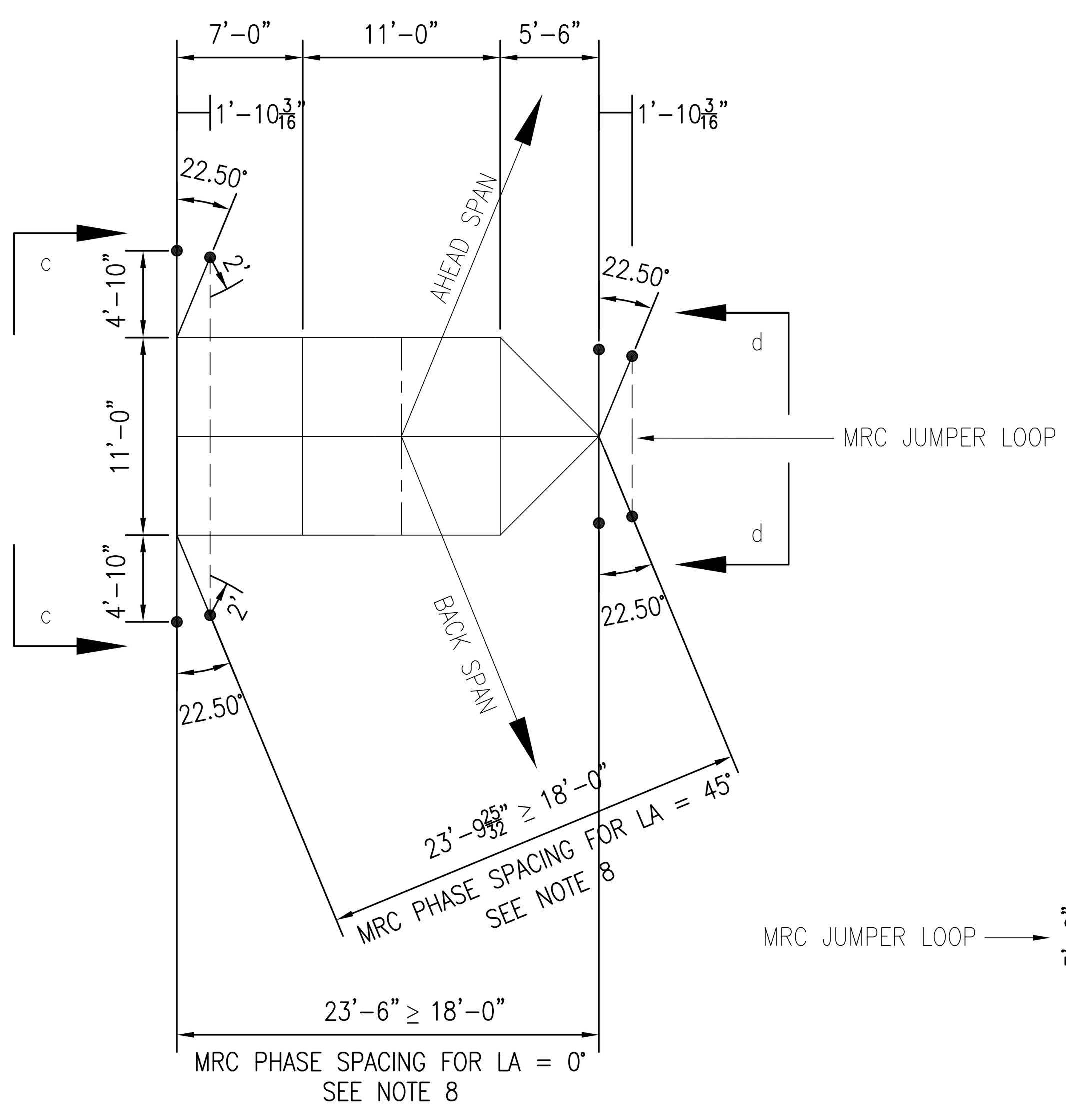
CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND TOWER
SELF SUPPORTING DEADEND TOWER 0°–45° MRC ABOVE

JOB NUMBER 132836
REV A
DRAWING NUMBER SST–14–1

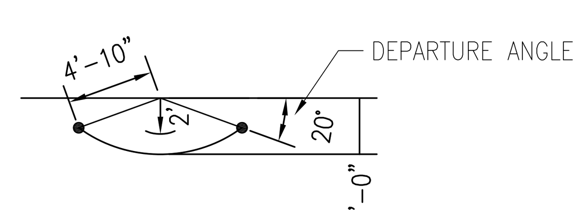
SST-14-1_DE_0-45.DWG



SECTION c-c
SIDE VIEW - MRC JUMPER LOOP



SECTION 4-4
PLAN VIEW - MRC ATTACHMENT

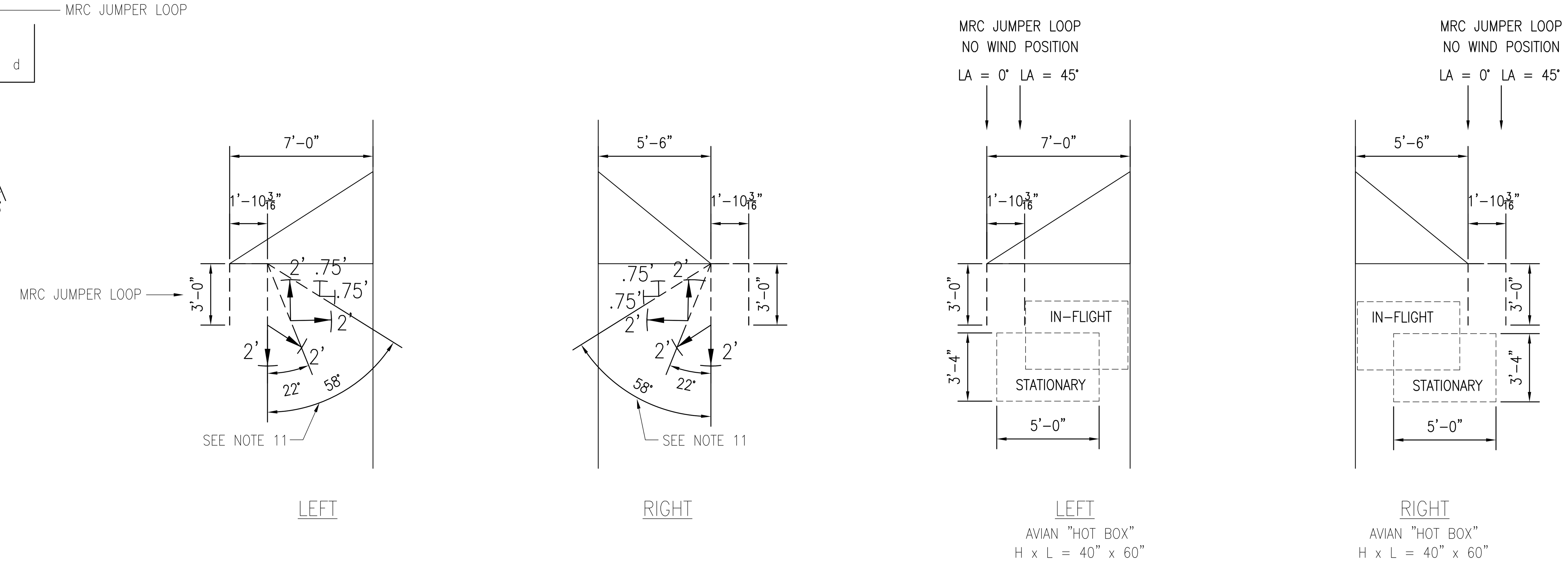


SECTION d-d
SIDE VIEW - MRC JUMPER LOOP

TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH	DIAMETER	AREA EXPOSED TO WIND	TOTAL WEIGHT (INCLUDING HARDWARE)	UTS
			[FT]	[IN]	[FT^2]	[LBS]	[KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Dead-End Clamp	3.18	2.15	0.57	44	25
B	(3) - 2156 KCM ACSR "Bluebird"	**Quadruple** String Dead-End 4x66=264 kips	36.83	15	46.04	6718	264
		Single "I" **Jumper String** Suspension 1x25=25 kips	23.5	11	10.77	1180	25
C	(1) - 1780 KCM ACSR "Chukar"	**Single** String Dead-End 1x66 =66 kips	4.83	15	3.02	190	66

Note: Total Weight of Insulators (including hardware) **applied at end of crossarm:**

WIRE	WIRE TYPE	TOTAL WEIGHT (INCLUDING HARDWARE)
		[LBS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	2 * 44 =88
B	(3) - 2156 KCM ACSR "Bluebird"	2 * 6718 + 1180 = 14616
C	(1) - 1780 KCM ACSR "Chukar"	2 * 190= 380



DETAIL "B"

NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS (NOT FROM CENTER LINES) TO THE NEAREST POINT ON THE CONDUCTOR OR CORONA RING HOT BOX. A 20° DEPARTURE ANGLE ON THE TENSION INSULATOR STRING SHALL BE CONSIDERED FOR CLEARANCE CHECKING.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE MRC PHASE SPACING SHOULD BE THAT OF THE TANGENT MRC IN THE SUSPENSION TOWER UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF STEEL OR AVIAN HOT BOX.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 22.74 PSF CONDITION.
12. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND LOAD ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.

SST-14-2_DE_TABLE 1_0-45.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	DVW	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

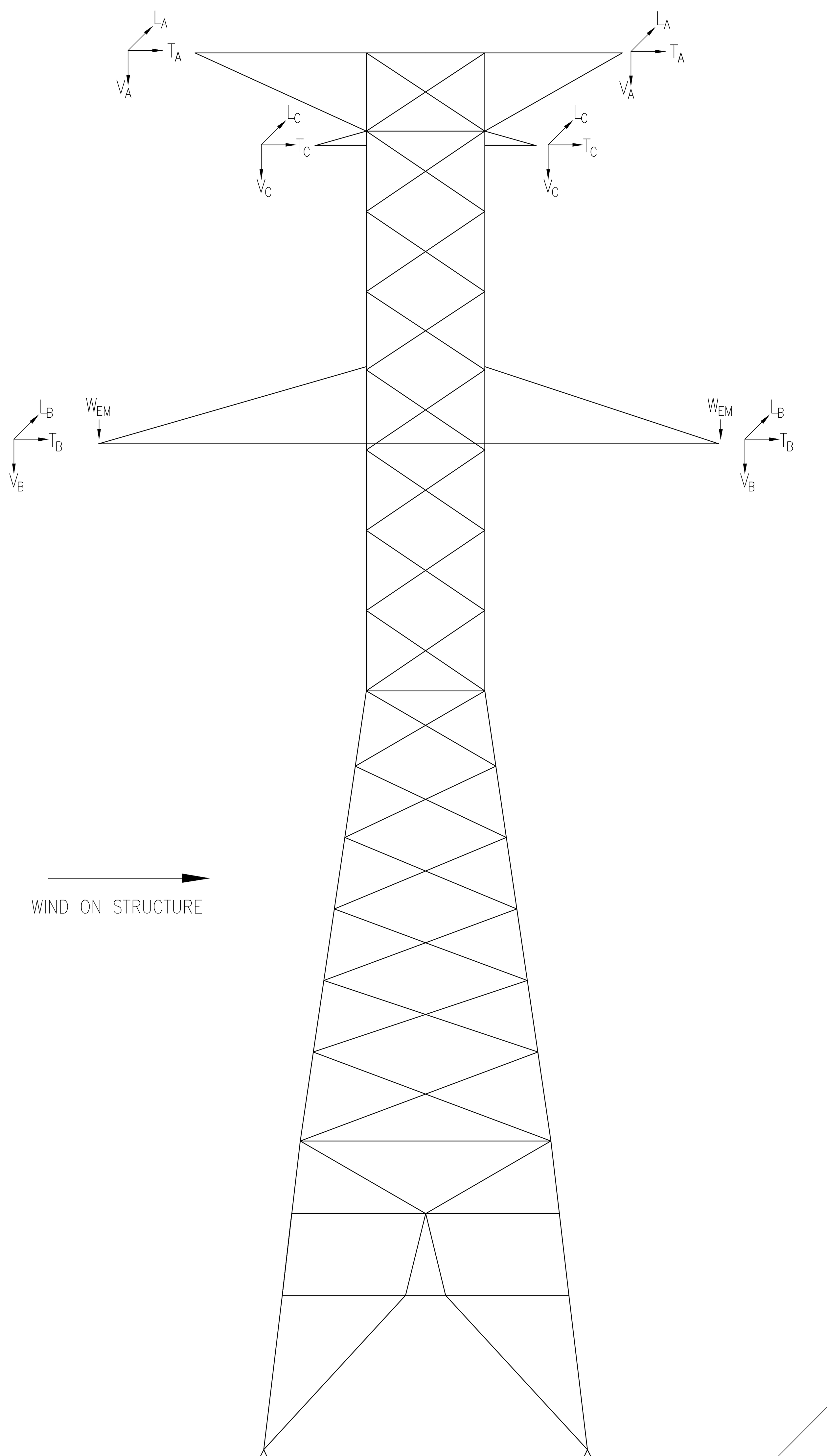
PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND TOWER

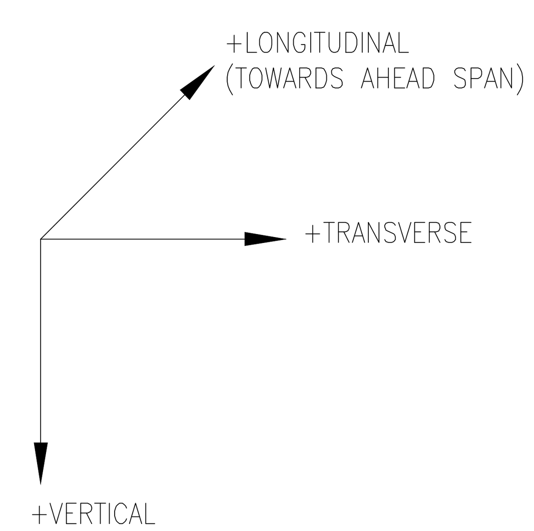
SELF SUPPORTING DEADEND TOWER 0°-45°
MRC ABOVE

JOB NUMBER: 132836

REV: A

DRAWING NUMBER: SST-14-2





SIGN CONVENTION
FOR LOADS

DESIGN PARAMETERS

WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	MIN WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	45°	1500	-1000	2500	3750
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		45°	1500	-1000	2500	3750
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		45°	1500	-1000	2500	3750

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
3. NESC EXTREME WIND- YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4803	16161	14029
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
7. NESC HEAVY DE	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
8. NESC EXTREME WIND DE	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
9. NESC EXTREME ICE W/CONCURRENT WIND DE	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
10. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
11.NESC MEDIUM (SEE NOTE 7)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662
12.NESC MEDIUM DE (SEE NOTE 7)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662

DEADEND 45° - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	6.70	14.60	0.00	87.40	107.30	0.00	19.60	32.00	0.00	10.0
2. NESC EXTREME WIND	1.90	7.70	0.00	42.50	70.10	0.00	8.20	20.90	0.00	23
3. NESC EXTREME WIND- YAW 45°	1.90	4.90	-0.40	42.50	47.70	-3.10	8.20	14.00	-1.00	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.90	2.80	-0.20	42.50	32.60	-1.30	8.20	9.30	-0.40	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	9.30	11.60	0.00	81.10	78.60	0.00	20.30	23.60	0.00	4.1
6. EVERYDAY	1.90	2.80	0.00	42.50	32.60	0.00	8.20	9.30	0.00	0.0
7. NESC HEAVY DE	3.40	7.30	13.60	54.40	53.70	108.70	10.10	16.00	32.00	10.0
8. NESC EXTREME WIND DE	1.00	3.90	6.30	28.30	35.10	57.00	4.30	10.50	16.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	4.70	5.80	11.30	47.70	39.30	83.20	10.40	11.80	24.70	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 7)	4.30	10.50	0.00	74.20	86.70	0.00	15.50	25.50	0.00	10
12.NESC MEDIUM DE (SEE NOTE 7)	2.20	5.30	9.90	47.80	43.40	87.60	8.10	12.80	25.40	10

DEADEND 45° - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	-1.60	14.60	0.00	3.70	107.30	0.00	-4.60	32.00	0.00	10.0
2. NESC EXTREME WIND	-0.40	7.70	0.00	6.70	70.10	0.00	-1.70	20.90	0.00	23
3. NESC EXTREME WIND- YAW 45°	-0.40	4.90	-0.40	6.70	47.70	-3.10	-1.70	14.00	-1.00	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	-0.40	2.80	-0.20	6.70	32.60	-1.30	-1.70	9.30	-0.40	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	-2.40	11.60	0.00	-3.70	78.60	0.00	-5.00	23.60	0.00	4.1
6. EVERYDAY	-0.40	2.80	0.00	6.70	32.60	0.00	-1.70	9.30	0.00	0.0
7. NESC HEAVY DE	-0.80	7.30	13.60	12.50	53.70	108.70	-2.00	16.00	32.00	10.0
8. NESC EXTREME WIND DE	-0.20	3.90	6.30	10.40	35.10	57.00	-0.70	10.50	16.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	-1.20	5.80	11.30	5.30	39.30	83.20	-2.30	11.80	24.70	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 7)	-1.00	10.50	0.00	7.20	86.70	0.00	-3.50	25.50	0.00	10
12.NESC MEDIUM DE (SEE NOTE 7)	-0.50	5.30	9.90	14.20	43.40	87.60	-1.50	12.80	25.40	10

DEADEND 0° - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	3.40	1.70	14.70	54.40	8.70	117.70	10.10	2.80	34.70	10.0
8. NESC EXTREME WIND DE	1.00	1.30	6.80	28.30	11.50	61.70	4.30	3.50	18.30	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	4.70	1.20	12.20	47.70	4.90	90.00	10.40	1.60	26.70	4.1
12.NESC MEDIUM DE (SEE NOTE 7)	2.20	1.20	10.70	47.80	7.10	94.80	8.10	2.20	27.50	10.0

DEADEND 0° - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	-0.80	1.70	14.70	12.50	8.70	117.70	-2.00	2.80	34.70	10.0
8. NESC EXTREME WIND DE	-0.20	1.30	6.80	10.40	11.50	61.70	-0.70	3.50	18.30	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	-1.20	1.20	12.20	5.30	4.90	90.00	-2.30	1.60	26.70	4.1
12.NESC MEDIUM DE (SEE NOTE 7)	-0.50	1.20	10.70	14.20	7.10	94.80	-1.50	2.20	27.50	10.0

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
3. ALL TOWER MEMBERS TO WITHSTAND A VERTICAL LOAD OF 350LBS APPLIED AT THEIR MIDPOINT WITH NO OTHER LOADS ACTING.
4. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,11 & 12.
5. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6,7,8,9, & 10.
6. THE WIND PRESSURE ON THE STRUCTURE SHALL BE APPLIED WITH THE WIND SHAPE FACTORS PER NESC 2012 RULE 252.B.
7. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY" AND LOADING CASE 7 "NESC HEAVY DE". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 11 "NESC MEDIUM" AND LOADING CASE 7 "NESC HEAVY DE" WILL BE REPLACED BY LOADING CASE 12 "NESC HEAVY DE".
8. LOADING CASE 10 WILL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIR	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND TOWER

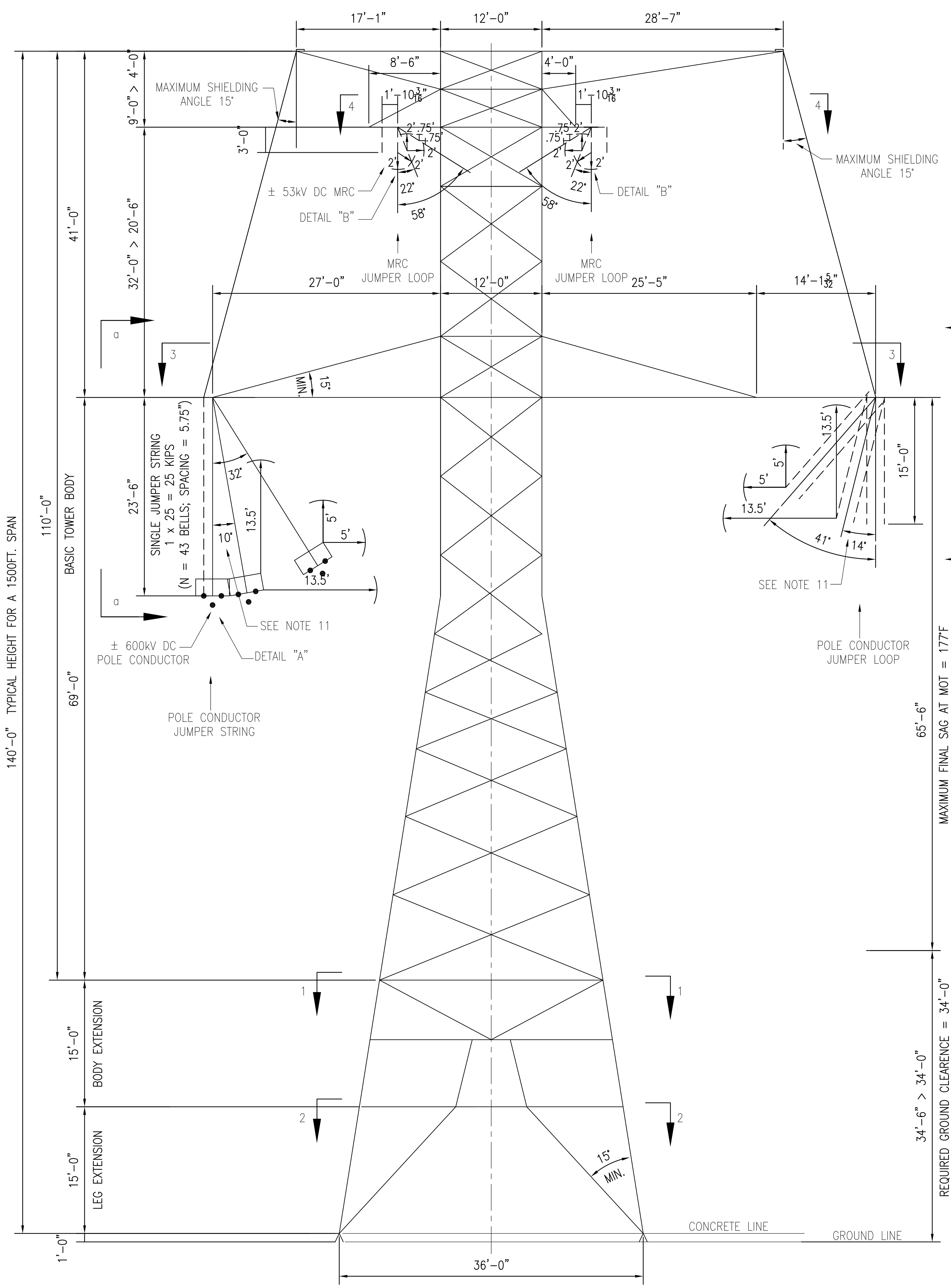
SELF SUPPORTING DEADEND TOWER 0°-45° MRC ABOVE-LOAD DRAWING

JOB NUMBER: 132836 | REV: A

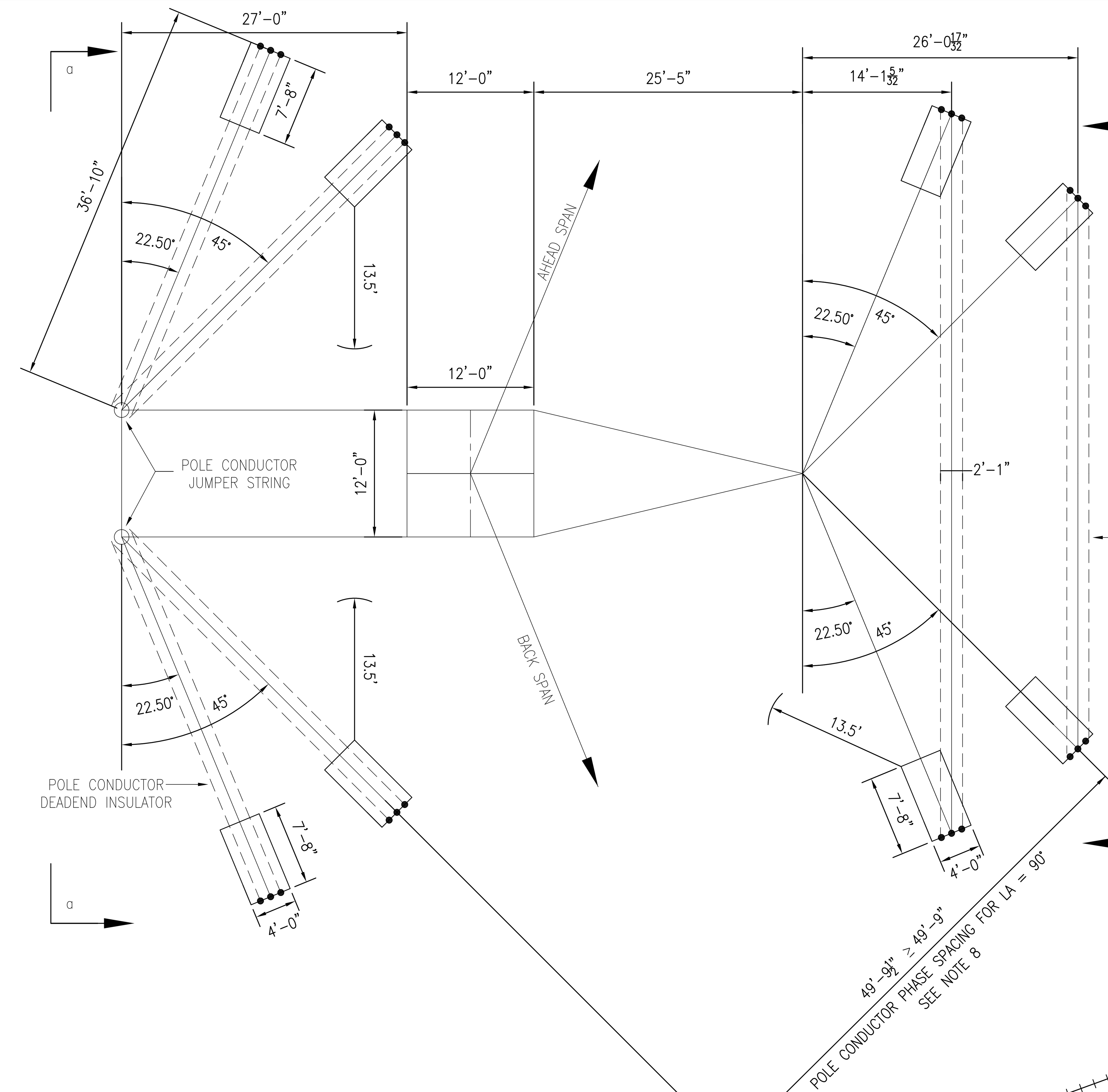
DRAWING NUMBER: SST-14-3

DEADEND 45°-90°

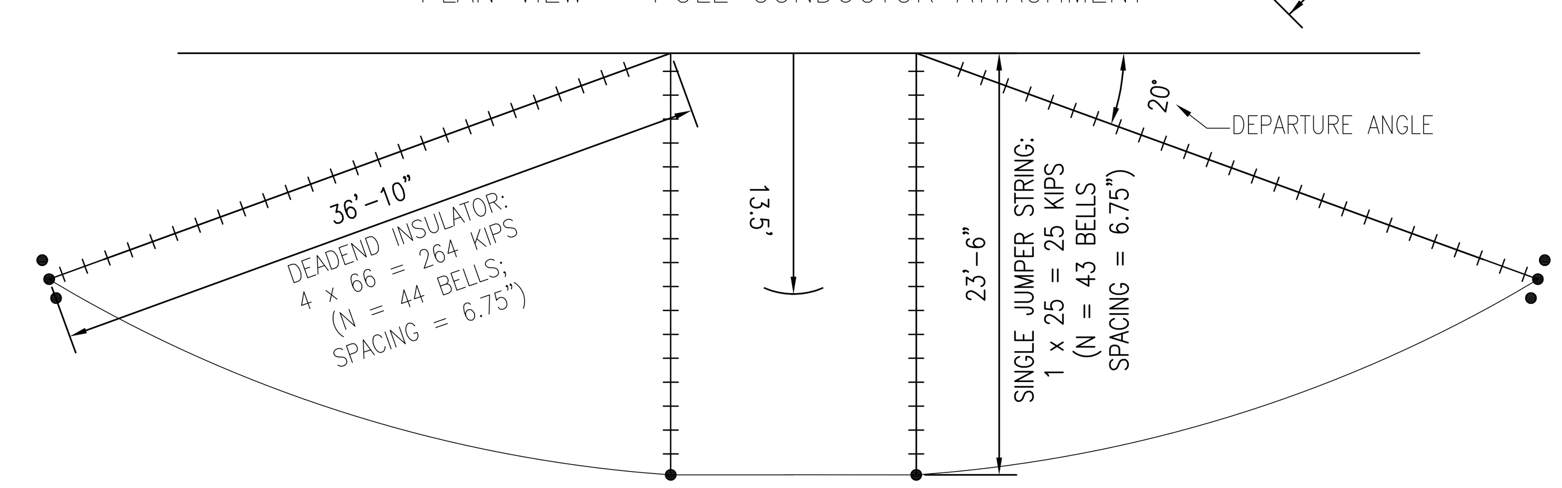
				Left Crossarm Wind from Left	Right Crossarm Wind from Right	Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances							
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 600 KV DC Pole Conductor "I" Jumper String Insulator Swing Angle	+/- 600 KV DC Pole Conductor Jumper Loop Swing Angle	+/- 53 KV DC MRC "Jumper Loop Swing Angle	+/- 53 KV DC MRC Jumper Loop Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	10 °	14 °	22 °	22 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	32 °	41 °	58 °	58 °



45°-90° DEADEND TOWER



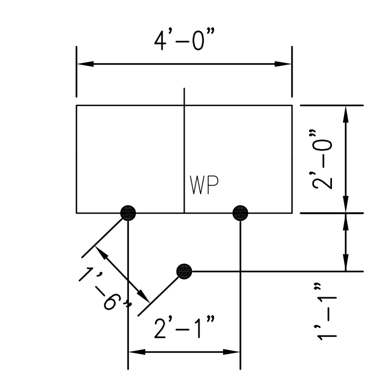
SECTION 3-3
PLAN VIEW - POLE CONDUCTOR ATTACHMENT



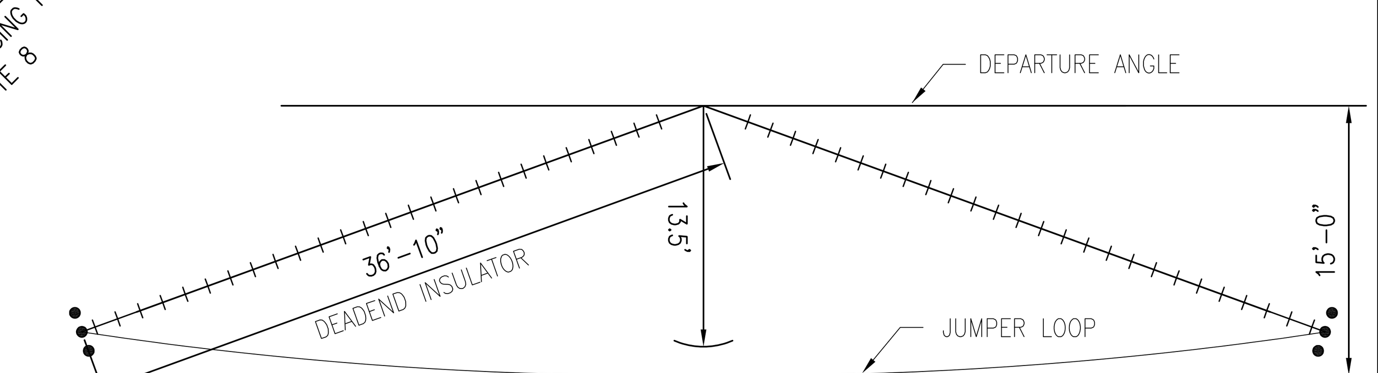
SECTION a-a
SIDE VIEW - JUMPER STRING
POLE CONDUCTOR

NOTES

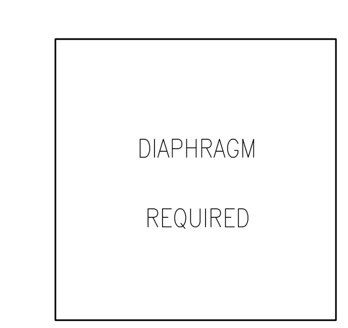
1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS TO THE NEAREST POINT ON THE CONDUCTOR OR CORONA RING HOT BOX. A 20° DEPARTURE ANGLE ON THE TENSION INSULATOR STRING SHALL BE CONSIDERED FOR CLEARANCE CHECKING.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE POLE CONDUCTOR PHASE SPACING SHOULD BE THAT OF THE POLE CONDUCTOR IN THE TANGENT V-STRING SUSPENSION TOWER UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF STEEL.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE JUMPER STRING AND JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITION.



DETAIL "A"
CORONA RING HOT BOX
JUMPER STRING POLE CONDUCTOR



SECTION b-b
SIDE VIEW - JUMPER LOOP POLE CONDUCTOR



SECTION 1-1 & 2-2

SST-16-1_DE_45-90.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	UPDATED NOTE #11	6/16/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

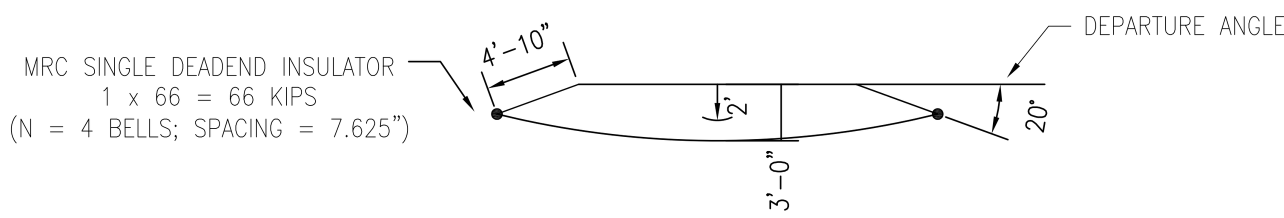
DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND TOWER
SELF SUPPORTING DEADEND TOWER 45°-90° MRC ABOVE

JOB NUMBER 132836
REV A
DRAWING NUMBER SST-16-1

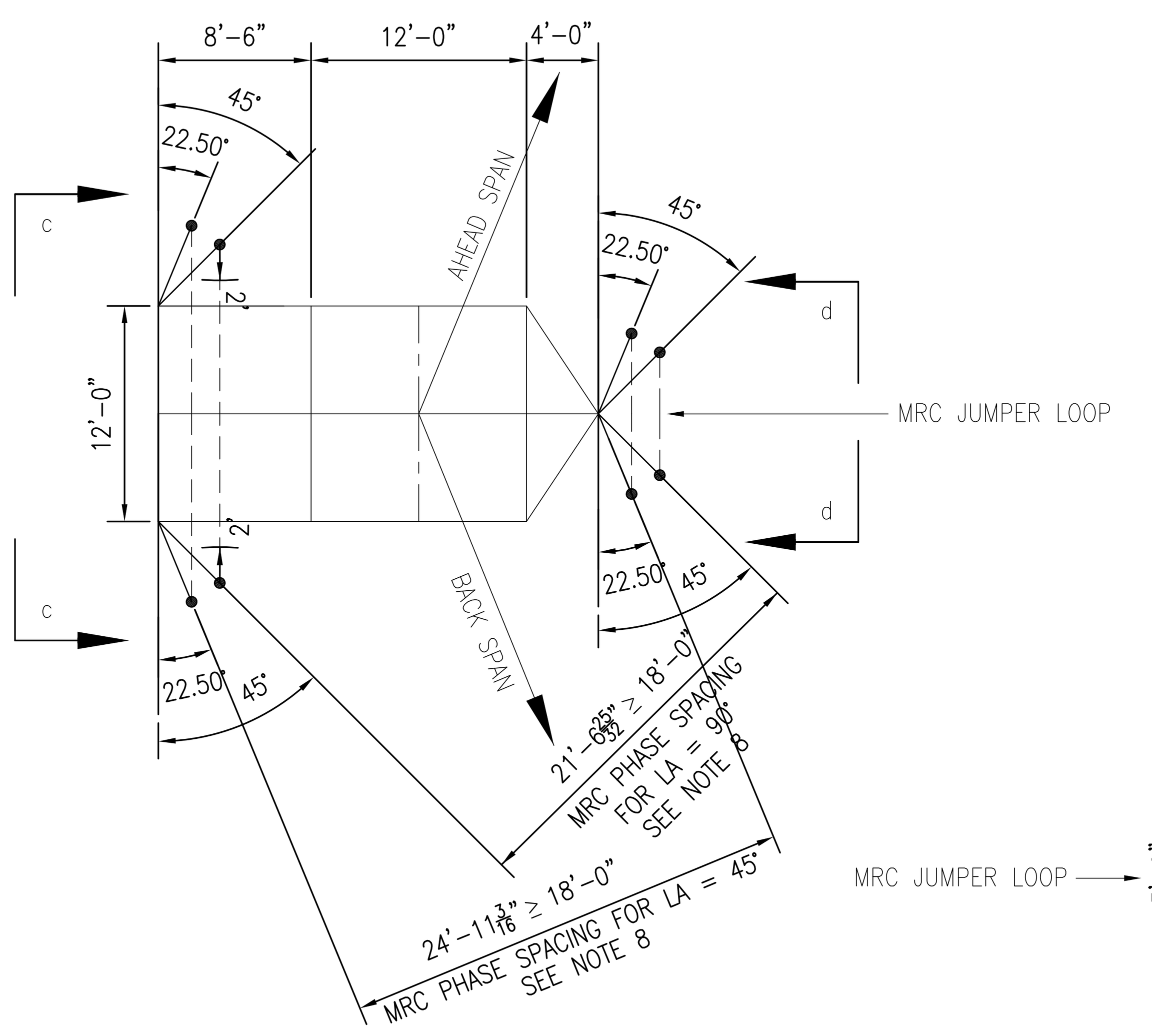


SECTION c-c
SIDE VIEW - MRC JUMPER LOOP

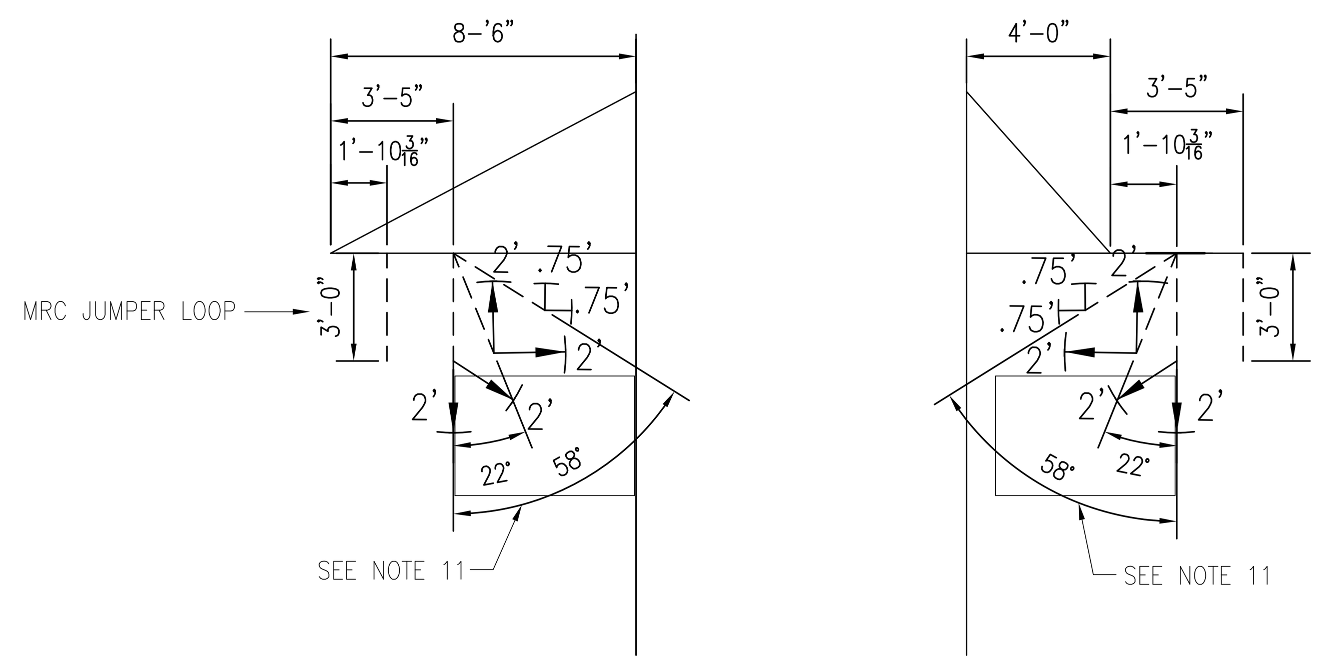
TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Dead-End Clamp	3.18	2.15	0.57	44	25
B	(3) - 2156 KCM ACSR "Bluebird"	**Quadruple** String Dead-End 4x66=264 kips	36.83	15	46.04	6718	264
		Single "I" **Jumper String** Suspension 1x25=25 kips	23.5	11	10.77	1180	25
C	(1) - 1780 KCM ACSR "Chukar"	**Single** String Dead-End 1x66 =66 kips	4.83	15	3.02	190	66

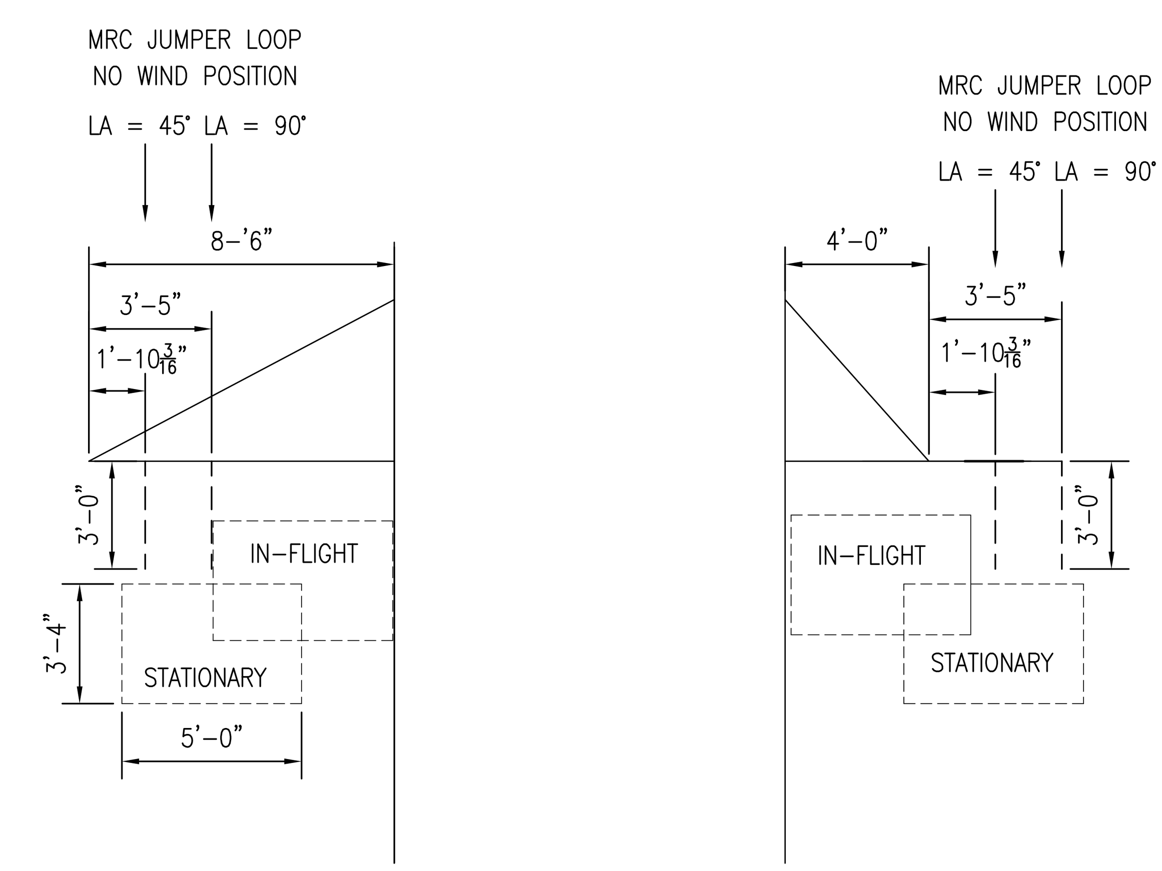
Note: Total Weight of Insulators (including hardware) **applied at end of crossarm:**

WIRE	WIRE TYPE	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	2 * 44 =88
B	(3) - 2156 KCM ACSR "Bluebird"	2 * 6718 +2* 1180 = 15790
C	(1) - 1780 KCM ACSR "Chukar"	2 * 190= 380

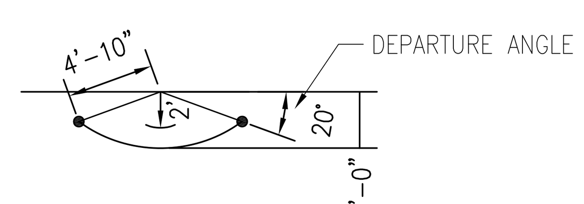


SECTION 4-4
PLAN VIEW - MRC ATTACHMENT





DETAIL "B"



SECTION d-d
SIDE VIEW - MRC JUMPER LOOP

NOTES

1. HORIZONTAL SECTION OF TOWER SHALL BE SQUARE ; FROM THE WAIST DOWN BRACING MEMBERS SHALL BE THE SAME ON BOTH THE TRANSVERSAL AND LONGITUDINAL FACES BUT THE ANGLE SIZES OF MEMBERS MAY DIFFER.
2. THE WIDTH OF THE TOWER BODY IN DIFFERENT SECTIONS IS SUBJECT TO OPTIMIZATION.
3. CLEARANCE DIMENSIONS SHOWN ON TOWER DRAWING ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL AND OUTSTANDING LEGS OF WEBS (NOT FROM CENTER LINES) TO THE NEAREST POINT ON THE CONDUCTOR OR CORONA RING HOT BOX. A 20° DEPARTURE ANGLE ON THE TENSION INSULATOR STRING SHALL BE CONSIDERED FOR CLEARANCE CHECKING.
4. ALL TOWER TYPES SHALL BE DESIGNED TAKING INTO CONSIDERATION THAT ANY COMBINATION (OF ADJACENT OR DIAGONAL OPPOSITE LEGS) OF MINIMUM AND MAXIMUM HEIGHT CAN BE USED WITH A COMMON PART OR WITH ANY TOWER BODY EXTENSION.
5. ALL DIMENSIONS ARE IN FEET.
6. SWING ANGLES, LINE ANGLES, DEPARTURE ANGLES, ETC. ARE BASED ON 360 DEGREES CIRCLES.
7. STEEL WORK CONSTRUCTION IS INFORMATIVE ONLY FOR ESTIMATING PURPOSES.
8. THE MRC PHASE SPACING SHOULD BE THAT OF THE TANGENT MRC IN THE SUSPENSION TOWER UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF STEEL OR AVIAN HOT BOX.
9. BODY EXTENSIONS: +15FT, +30FT, +45FT, +60FT LEG EXTENSIONS: +5FT TO +30FT, IN INCREMENTS OF: 5FT
10. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
11. THE ANGLES SHOWN REFLECT THE JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 22.74 PSF CONDITION.
12. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND LOAD ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.

SST-16-2_DE_TABLE 1_45-90.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

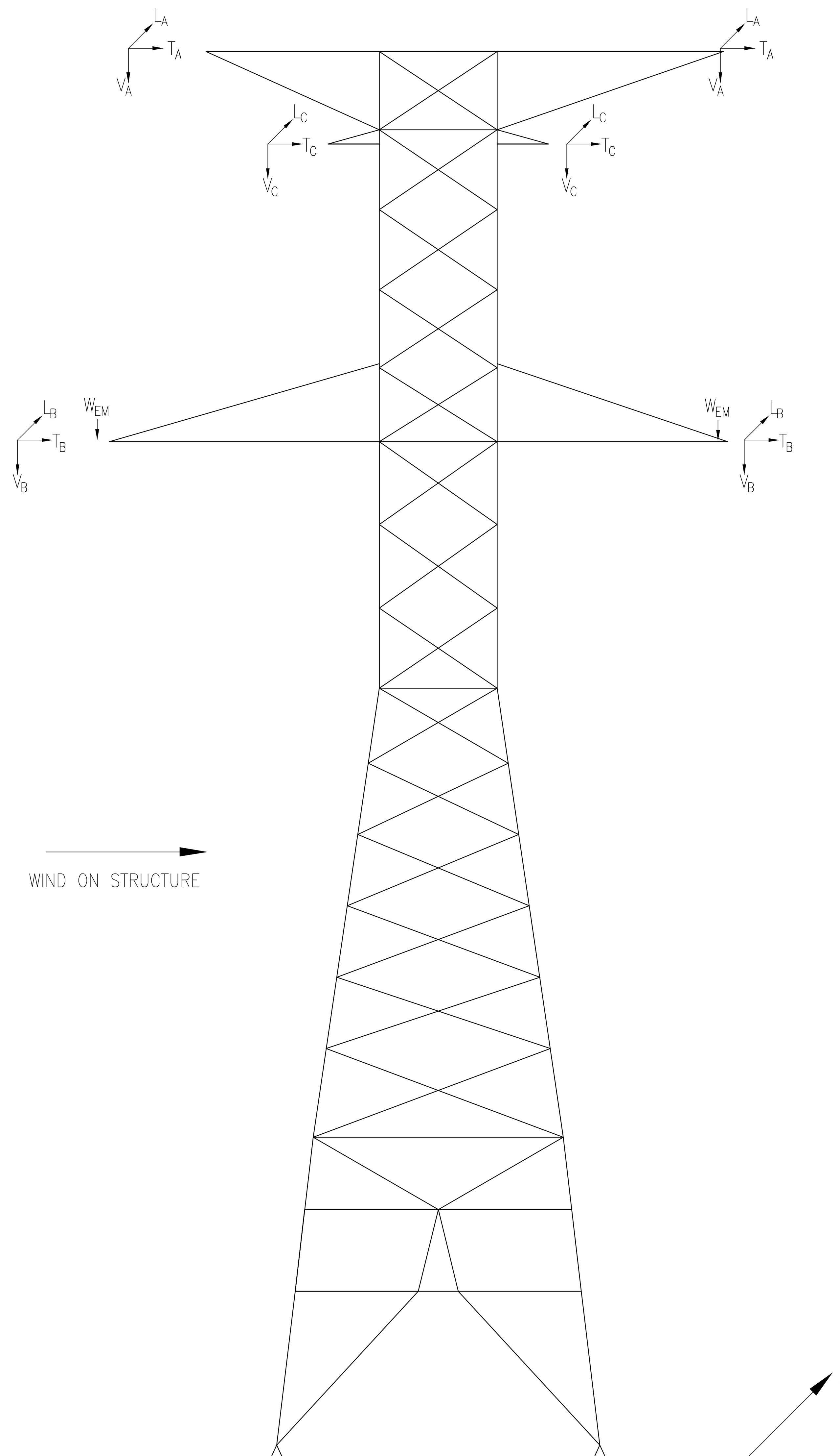
DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	DVW	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND TOWER
SELF SUPPORTING DEADEND TOWER 45°-90° MRC ABOVE

JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SST-16-2



DESIGN PARAMETERS

WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	MIN WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	90°	1500	-1000	2500	3750
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		90°	1500	-1000	2500	3750
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		90°	1500	-1000	2500	3750

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
3. NESC EXTREME WIND- YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4803	16161	14029
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3647	14176	12057
7. NESC HEAVY DE	0	0.50	4.00	2.50	1.65	1.50	8860	23761	20982
8. NESC EXTREME WIND DE	60	0.00	20.74	1.00	1.00	1.00	6716	20564	18208
9. NESC EXTREME ICE W/CONCURRENT WIND DE	15	1.00	4.10	1.00	1.00	1.00	12166	29993	26697
10. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
11.NESC MEDIUM (SEE NOTE 7)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662
12.NESC MEDIUM DE (SEE NOTE 7)	15	0.25	4.00	2.50	1.65	1.50	6446	19147	16662

DEADEND 90° - MAX WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	6.70	24.00	0.00	94.20	183.60	0.00	19.60	54.40	0.00	10.0
2. NESC EXTREME WIND	1.90	12.10	0.00	47.00	110.10	0.00	8.20	32.70	0.00	23
3. NESC EXTREME WIND- YAW 45°	1.90	7.70	-1.00	47.00	76.70	-8.10	8.20	22.30	-2.50	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.90	5.20	-1.00	47.00	60.20	-8.10	8.20	17.10	-2.50	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	9.30	19.50	0.00	85.70	136.90	0.00	20.30	40.90	0.00	4.1
6. EVERYDAY	1.90	5.20	0.00	47.00	60.20	0.00	8.20	17.10	0.00	0.0
7. NESC HEAVY DE	3.40	12.00	10.40	61.20	91.80	83.20	10.10	27.20	24.50	10.0
8. NESC EXTREME WIND DE	1.00	6.10	4.80	32.90	55.10	43.70	4.30	16.40	12.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	4.70	9.80	8.70	52.20	68.50	63.70	10.40	20.50	18.90	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 7)	4.30	17.40	0.00	81.10	148.20	0.00	15.50	43.30	0.00	10
12.NESC MEDIUM DE (SEE NOTE 7)	2.20	8.70	7.60	54.60	74.10	67.10	8.10	21.70	19.50	10

DEADEND 90° - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	-1.60	24.00	0.00	10.50	183.60	0.00	-4.60	54.40	0.00	10.0
2. NESC EXTREME WIND	-0.40	12.10	0.00	11.20	110.10	0.00	-1.70	32.70	0.00	23
3. NESC EXTREME WIND- YAW 45°	-0.40	7.70	-1.00	11.20	76.70	-8.10	-1.70	22.30	-2.50	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	-0.40	5.20	-1.00	11.20	60.20	-8.10	-1.70	17.10	-2.50	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	-2.40	19.50	0.00	0.90	136.90	0.00	-5.00	40.90	0.00	4.1
6. EVERYDAY	-0.40	5.20	0.00	11.20	60.20	0.00	-1.70	17.10	0.00	0.0
7. NESC HEAVY DE	-0.80	12.00	-10.40	19.30	91.80	-83.20	-2.00	27.20	-24.50	10.0
8. NESC EXTREME WIND DE	-0.20	6.10	-4.80	15.00	55.10	-43.70	-0.70	16.40	-12.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	-1.20	9.80	-8.70	9.90	68.50	-63.70	-2.30	20.50	-18.90	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 7)	-1.00	17.40	0.00	14.00	148.20	0.00	-3.50	43.30	0.00	10
12.NESC MEDIUM DE (SEE NOTE 7)	-0.50	8.70	7.60	21.10	74.10	67.10	-1.50	21.70	19.50	10

DEADEND 45° - MAX WEIGHT

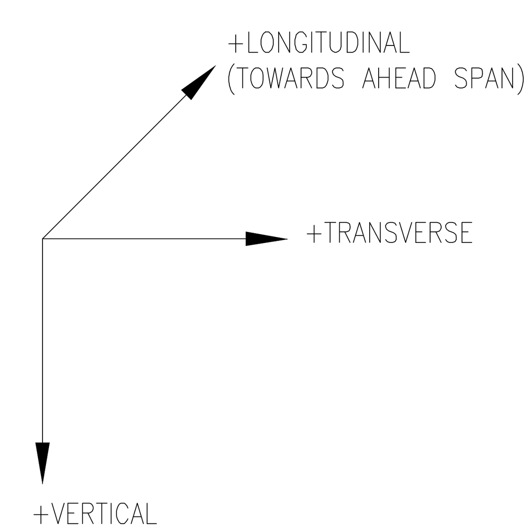
LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	3.40	7.30	13.60	61.20	53.70	108.70	10.10	16.00	32.00	10.0
8. NESC EXTREME WIND DE	1.00	3.90	6.30	32.90	35.10	57.00	4.30	10.50	16.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	4.70	5.80	11.30	52.20	39.30	83.20	10.40	11.80	24.70	4.1
12.NESC MEDIUM DE (SEE NOTE 7)	2.20	5.30	9.90	54.60	43.40	87.60	8.10	12.80	25.40	10.0

DEADEND 45° - MIN WEIGHT

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	-0.80	7.30	13.60	19.30	53.70	108.70	-2.00	16.00	32.00	10.0
8. NESC EXTREME WIND DE	-0.20	3.90	6.30	15.00	35.10	57.00	-0.70	10.50	16.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	-1.20	5.80	11.30	9.90	39.30	83.20	-2.30	11.80	24.70	4.1
12.NESC MEDIUM DE (SEE NOTE 7)	-0.50	5.30	9.90	21.10	43.40	87.60	-1.50	12.80	25.40	10.0



SIGN CONVENTION
FOR LOADS

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
3. ALL TOWER MEMBERS TO WITHSTAND A VERTICAL LOAD OF 350LBS APPLIED AT THEIR MIDPOINT WITH NO OTHER LOADS ACTING.
4. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,11 & 12.
5. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6,7,8,9 & 10.
6. THE WIND PRESSURE ON THE STRUCTURE SHALL BE APPLIED WITH THE WIND SHAPE FACTORS PER NESC 2012 RULE 252.B.
7. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY" AND LOADING CASE 7 "NESC HEAVY DE". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 11 "NESC MEDIUM" AND LOADING CASE 7 "NESC HEAVY DE" WILL BE REPLACED BY LOADING CASE 12 "NESC HEAVY DE".
8. LOADING CASE 10 WILL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

SST-16-3_DE_LOADS_45-90.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/6/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	5/21/14
DRN	DVW	5/21/14
CKD	CIM	5/21/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND TOWER

SELF SUPPORTING DEADEND TOWER 45°-90°
MRC ABOVE-LOAD DRAWING

JOB NUMBER: 132836

REV: A

DRAWING NUMBER: SST-16-3

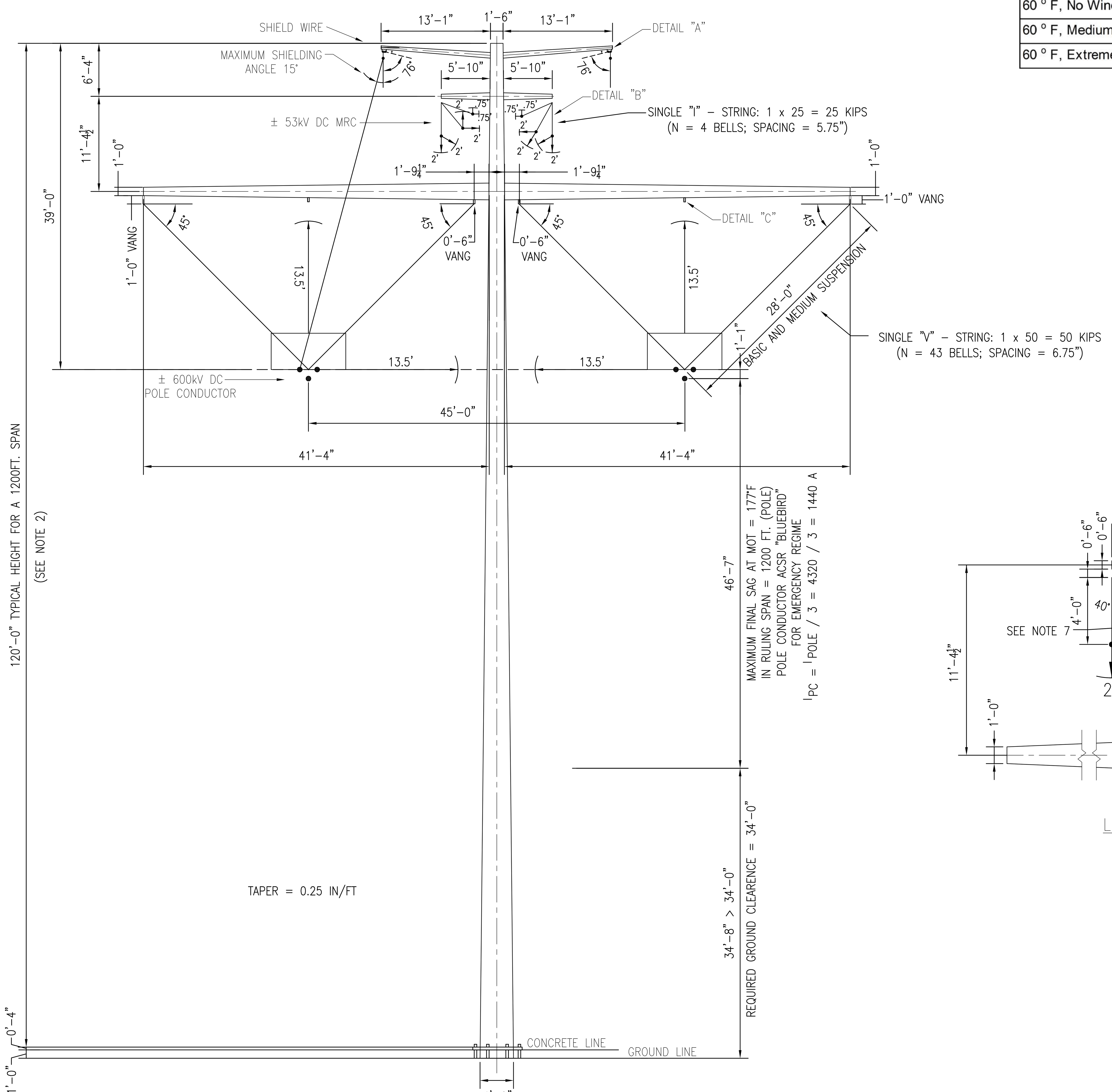
BASIC AND MEDIUM SUSPENSION

				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	40 °	29 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	70 °	66 °

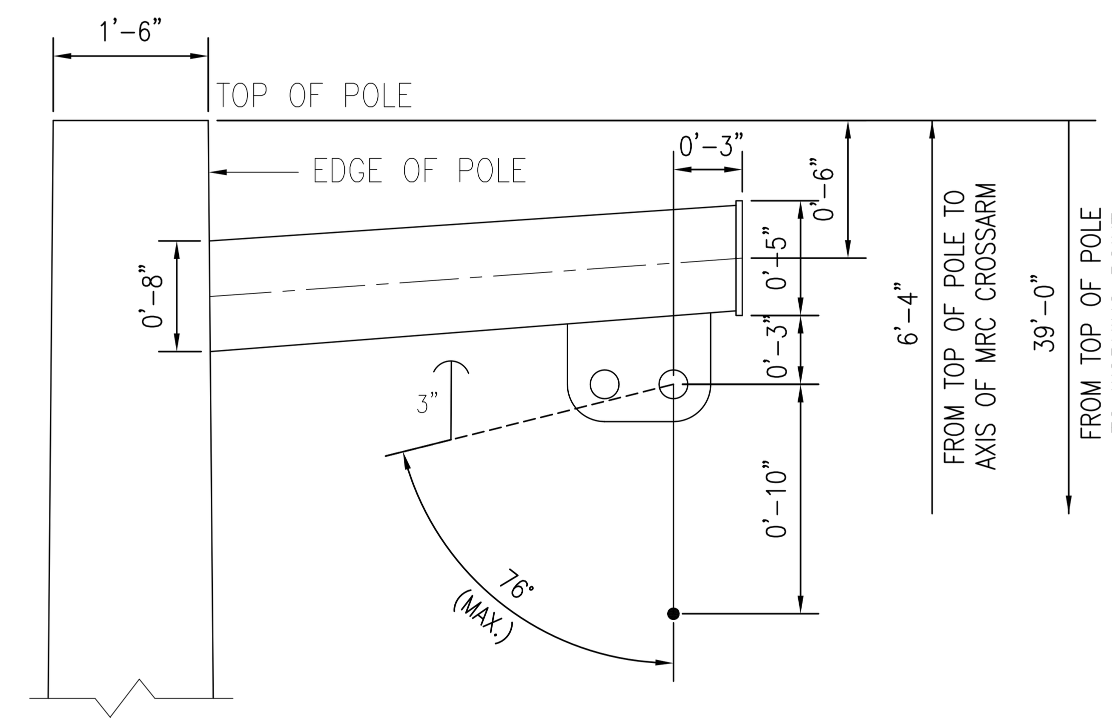
NOTES

1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: IN INCREMENTS OF 5'

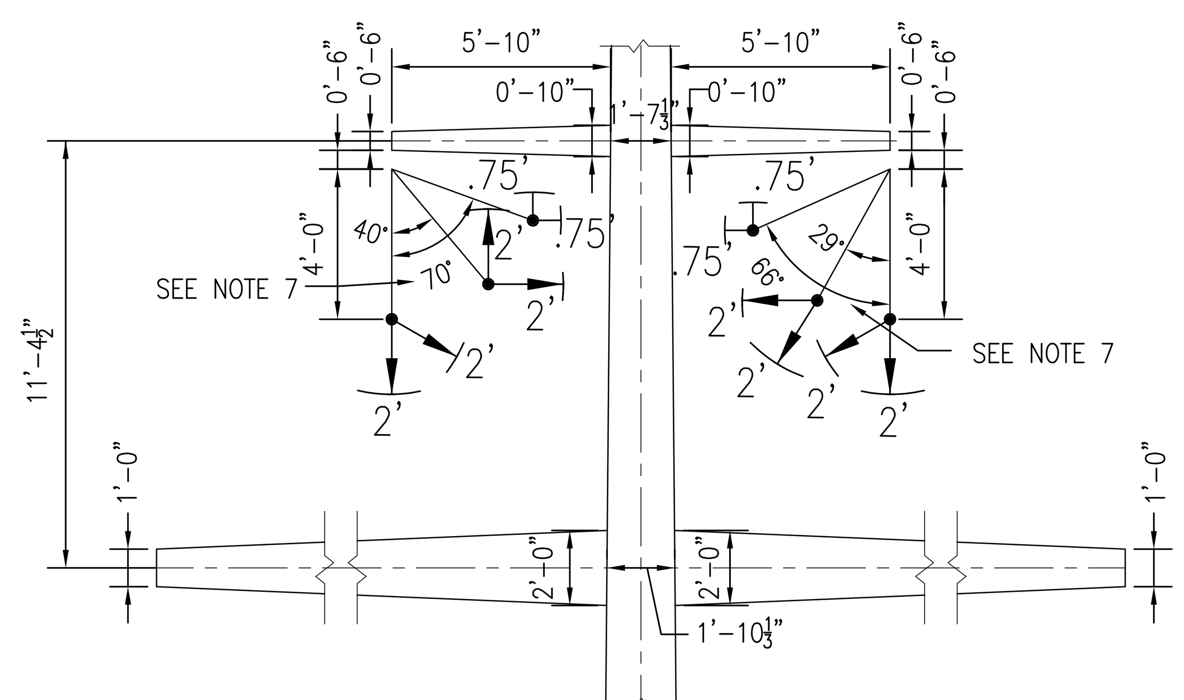
   BASIC: 90'–140'
   MEDIUM: 90'–175'
   HEAVY: 125'–190'
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT OF THE ASSEMBLY TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
7. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERYDAY, 60°, 6PSF, & 60°, 20.74 PSF CONDITIONS.



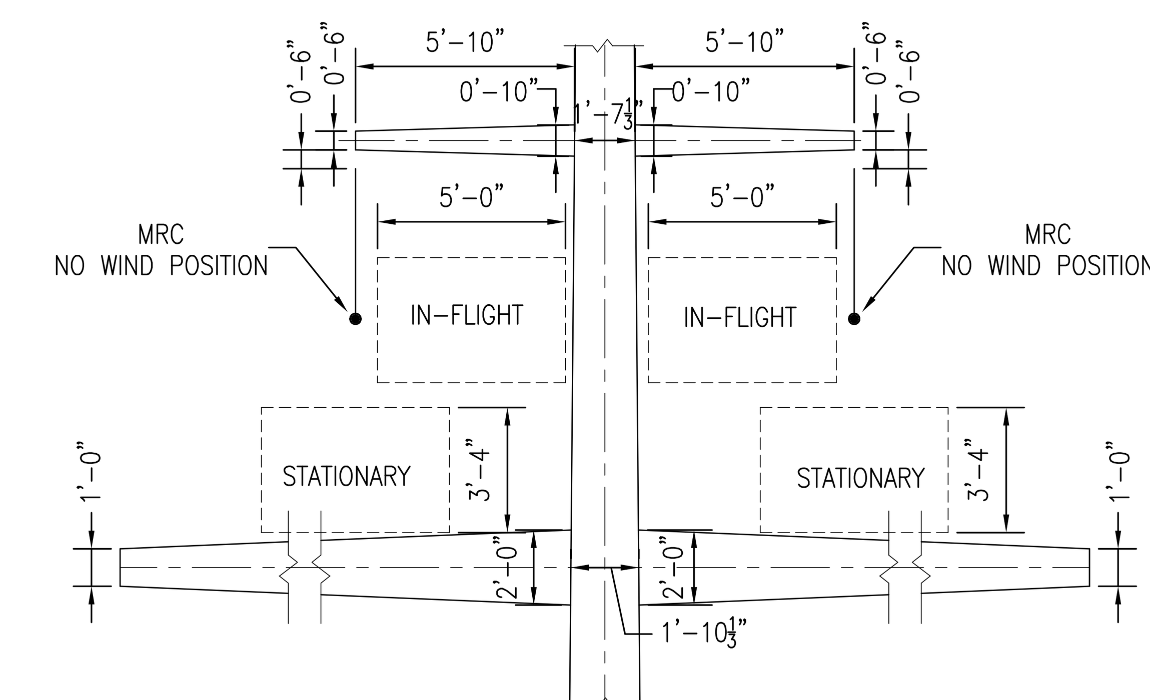
BASIC & MEDIUM
TANGENT SUSPENSION STEEL POLE



DETAIL "A"

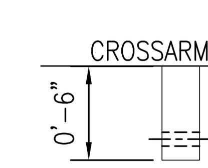


DETAIL "B"

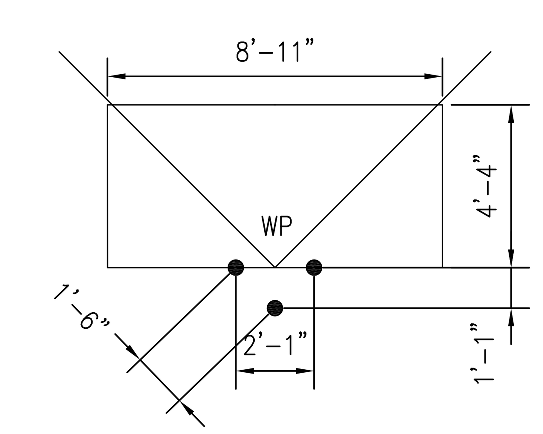


LEFT
AVIAN HOT BOX
H x L = 40" x 60"

RIGHT
AVIAN HOT BOX
H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE
VANG



DETAIL "D"
CORONA RING HOT BOX

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
B	SHIELD WIRE CROSSARM LENGTH	6/17/14	DVW	CIM	CIM	CIM
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14

SCALE: NTS

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE
BASIC AND MEDIUM SUSPENSION
SELF SUPPORTING SUSPENSION POLE 0'-2' MRC ABOVE (V-STRING)

JOB NUMBER 132836
REV B
DRAWING NUMBER SSP-8-1

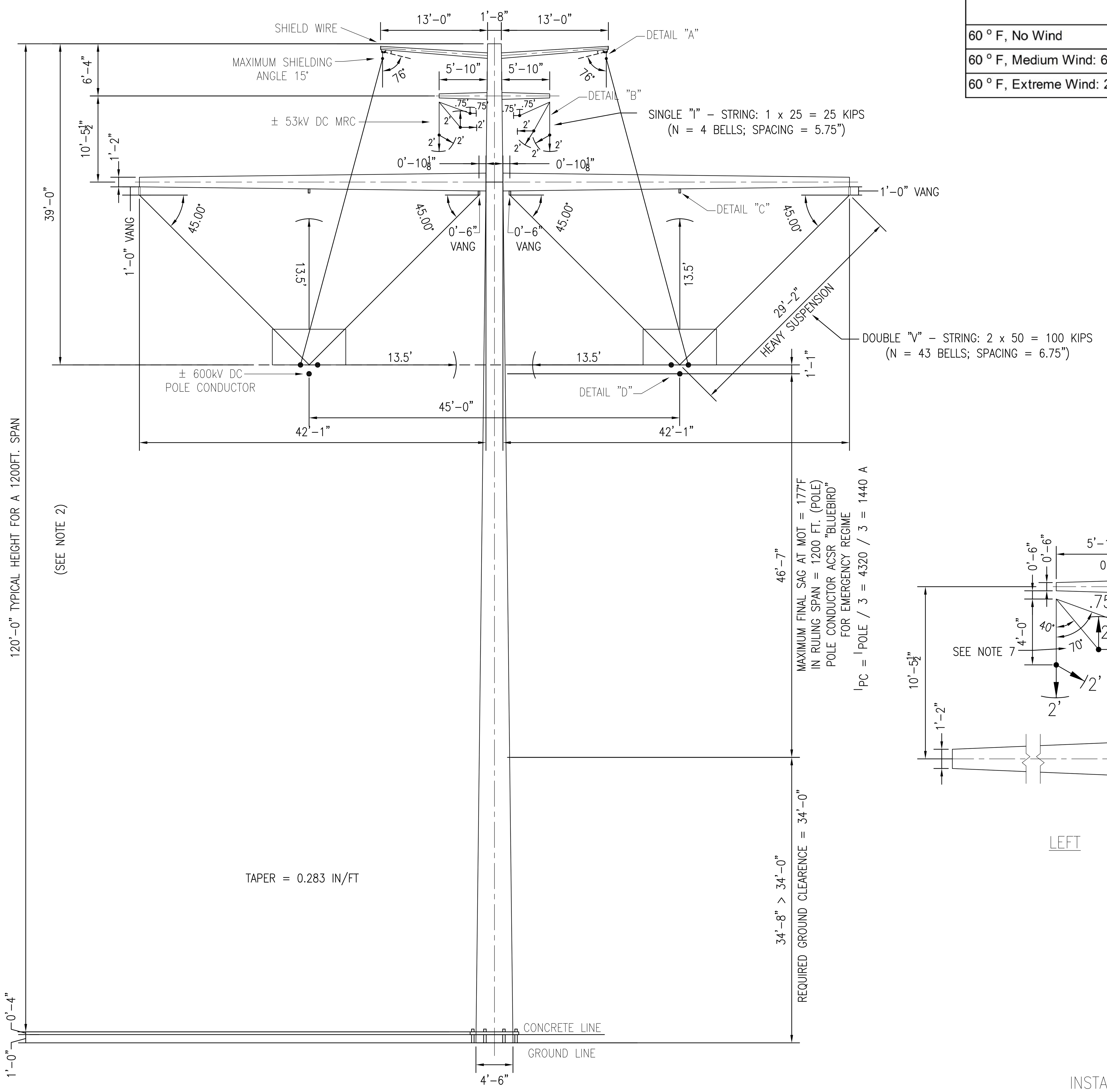
SSP-8-1_B&M_SUSP_0-2.DWG

HEAVY SUSPENSION

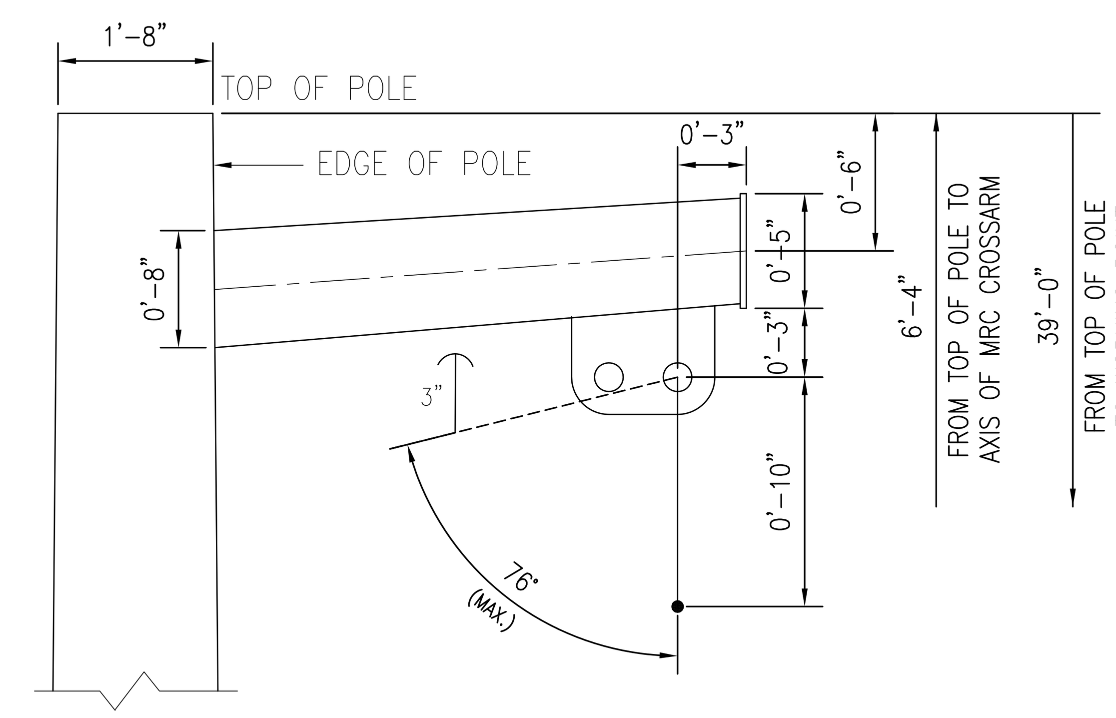
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	40 °	29 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	70 °	66 °

NOTES

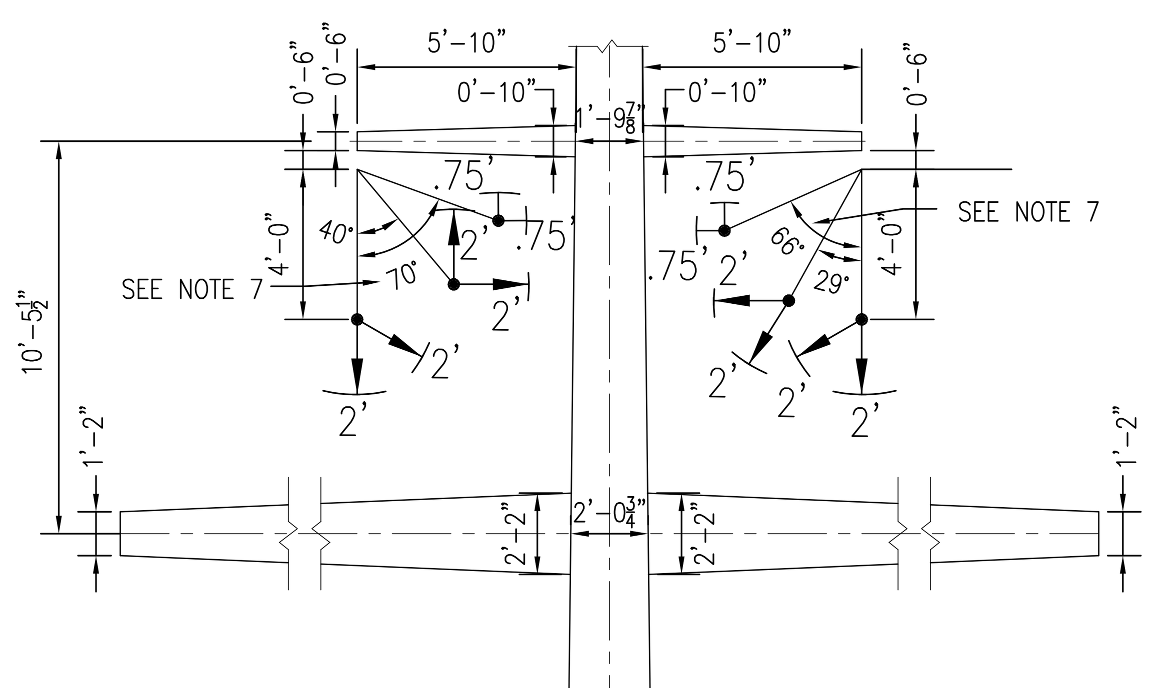
1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: IN INCREMENTS OF 5'
   BASIC: 90'–140'
   MEDIUM: 90'–175'
   HEAVY: 125'–190'
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT OF THE ASSEMBLY TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
7. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERYDAY, 60°, 6PSF, & 60°, 20.74 PSF CONDITIONS.



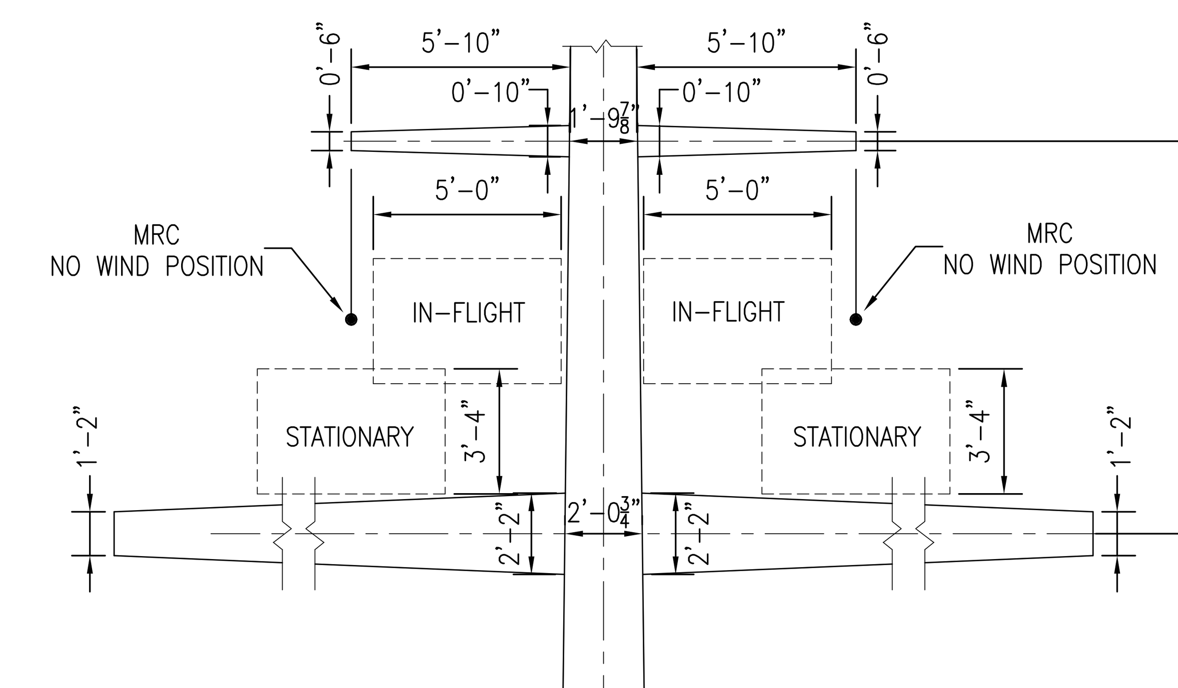
HEAVY
TANGENT SUSPENSION STEEL POLE



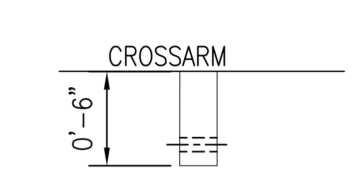
DETAIL "A"



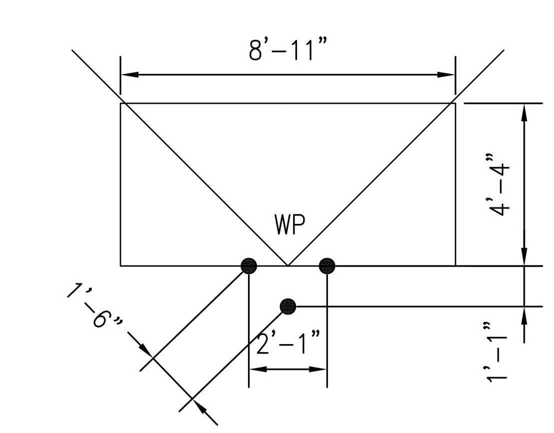
DETAIL "B"



LEFT
AVIAN HOT BOX
H x L = 40" x 60"
RIGHT
AVIAN HOT BOX
H x L = 40" x 60"



DETAIL "C"
INSTALLATION & MAINTENANCE
VANG



DETAIL "D"
CORONA RING HOT BOX

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

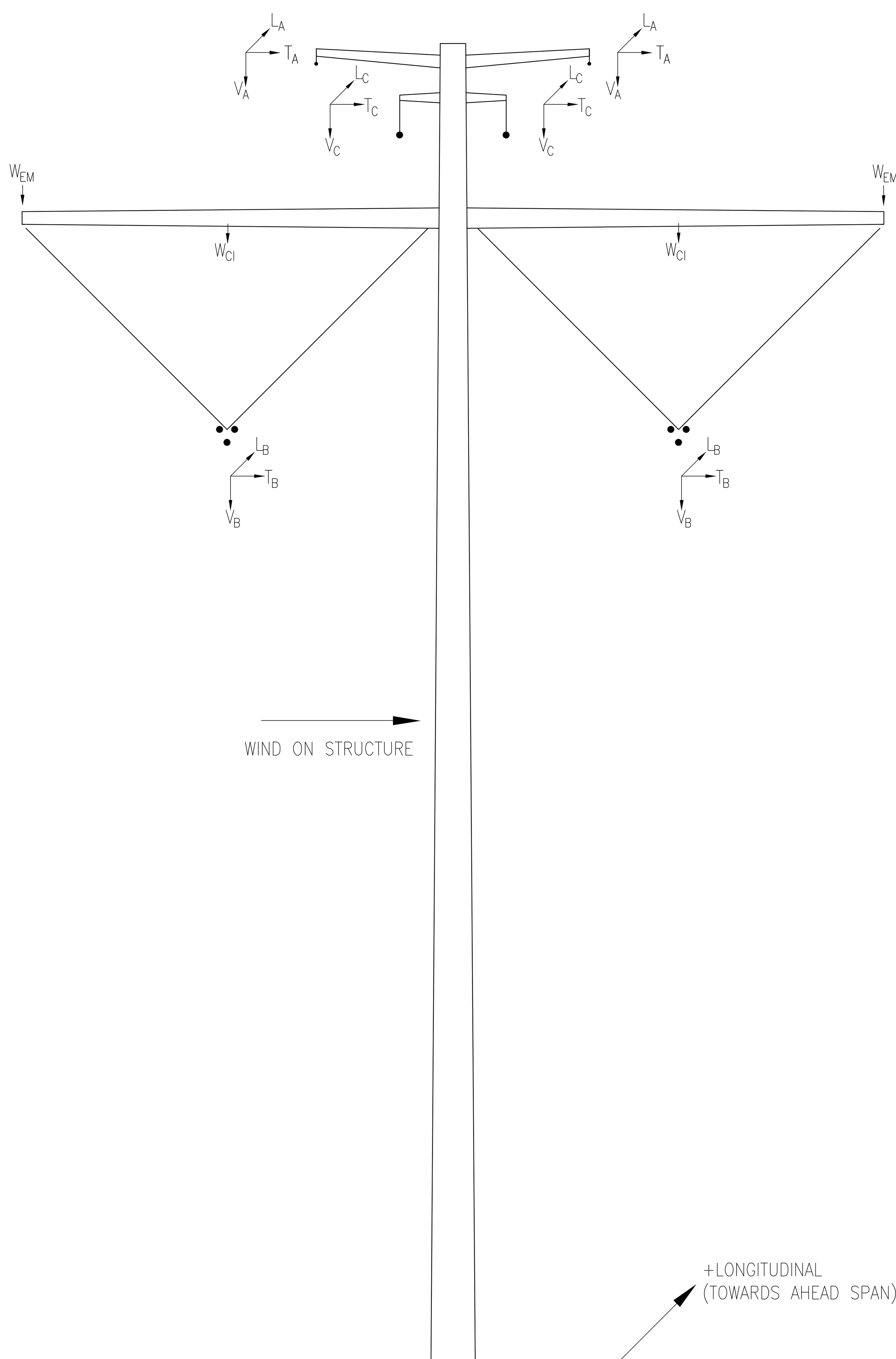
CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
BASIC AND MEDIUM SUSPENSION

SELF SUPPORTING SUSPENSION POLE 0'-2' MRC ABOVE (V-STRING)

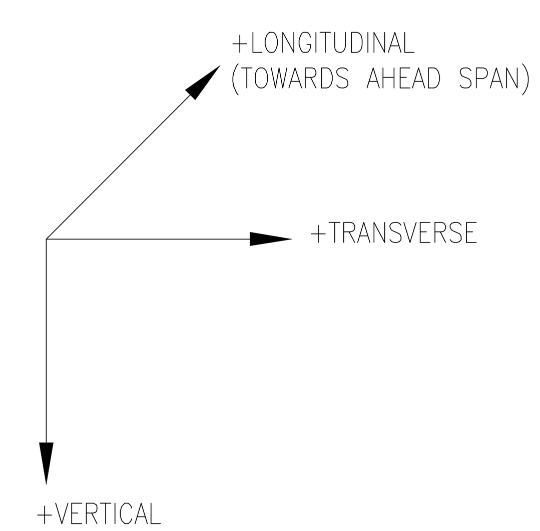
JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP-8-2

SSP-8-2_HEAVY_SUSP_0-2.DWG



DESIGN PARAMETERS								BASIC TANGENT		MEDIUM TANGENT		HEAVY TANGENT	
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)	WIND SPAN (ft.)	MAX WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	2°	1200	1000	1500	1200	1800	1500	2250
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		2°	1200	1000	1500	1200	1800	1500	2250
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		2°	1200	1000	1500	1200	1800	1500	2250

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
3. NESC EXTREME WIND - YAW 45^0	60	0.00	10.36	1.00	1.00	1.00	4896	15548	13479
4. NESC EXTREME WIND- LONGITUDINAL 90^0	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4592	15770	13494
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4761	16071	13791
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3333 (A) / 0 (B) *	16071	13791
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4761	14464 (A) / 10703 (B) *	13791
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4761	16071	9654 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 14)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142
*(A)= AHEAD SPAN TENSION, (B)= BACK SPAN TENSION									



SIGN CONVENTION FOR LOADS

TABLE 1

CLAMP / INSULATOR PARAMETERS

TOWER TYPE			BASIC, MEDIUM					HEAVY				
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	**Single** "V" String Suspension 1x50=50 kips (Basic, Medium) **Double** "V" String Suspension 2x50=100 kips (Heavy)	28.0 (ONE SIDE)	13 (ONE SIDE)	15.2 (ONE SIDE)	2537 (BOTH SIDES)	50 (ONE SIDE)	29.17 (ONE SIDE)	13 (ONE SIDE)	31.6 (ONE SIDE)	4832 (BOTH SIDES)	100 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	**Single** "I" String Suspension 1x25 =25 kips (Basic, Medium, Heavy)	4	11	1.83	150	25	4	11	1.83	150	25

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB-CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR FOR THE BASIC, MEDIUM, AND HEAVY SUSPENSION ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9.10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE VALUES SHOWN FOR WIND PRESSURE ON STRUCTURE ARE FOR ROUND OR 12 SIDED MEMBERS. FOR 8 SIDED MEMBERS, MULTIPLY BY 1.4. FOR FLAT SURFACES, MULTIPLY BY 1.6.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   BASIC W_{CI} = 18,150 LBS.
   MEDIUM W_{CI} = 21,550 LBS.
   HEAVY W_{CI} = 26,650 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (2) TO 9% OF THE TOTAL STRUCTURE HEIGHT, WHICH INCLUDES 1.72 DEG (3%) FOUNDATION ROTATION.
11. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (6) TO ONE POLE TIP DIAMETER.
12. LOAD CASES 1–5 AND 11 SHALL BE ANALYZED ASSUMING A FOUNDATION ROTATION OF 1.72 DEG (3%).
13. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
14. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
15. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

SSP-8-3_B&M_HVY_TABLE 1_0-2.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE BASIC AND MEDIUM SUSPENSION

SELF SUPPORTING SUSPENSION POLE 0°-2° MRC ABOVE (V-STRING)-LOAD DRAWING

JOB NUMBER 132836

REV A

DRAWING NUMBER SSP-8-3

BASIC SUSPENSION

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	2.70	1.90	0.00	30.30	10.90	0.00	7.90	3.40	0.00	10.0
2. NESC EXTREME WIND	0.80	1.30	0.00	13.90	11.20	0.00	3.30	3.40	0.00	23
3. NESC EXTREME WIND- YAW 45°	0.80	0.70	-0.10	13.90	6.20	-0.10	3.30	1.90	-0.10	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.80	0.20	-0.10	13.90	1.50	-0.10	3.30	0.50	-0.10	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	3.70	1.30	0.00	29.30	6.90	0.00	8.20	2.20	0.00	4.1
6. EVERYDAY	0.80	0.20	0.00	13.90	1.50	0.00	3.30	0.50	0.00	0.0
7. CONSTRUCTION SNUB OFF 3:1	3.10	-0.30	0.30	9.50	-0.70	0.80	33.40	-2.50	2.80	0.0
8. STRINGING INTACT	1.10	0.60	0.00	20.80	5.20	0.00	4.90	1.60	0.00	6.0
9. STRINGING/BROKEN SHIELDWIRE	1.10	0.40	5.00	20.80	5.20	0.00	4.90	1.60	0.00	6.0
10a. STRINGING/BROKEN CONDUCTOR	1.10	0.60	0.00	20.80	4.70	17.00	4.90	1.60	0.00	6.0
10b. STRINGING/BROKEN MRC	1.10	0.60	0.00	20.80	5.20	0.00	4.90	1.10	14.50	6.0
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
12.NESC MEDIUM (SEE NOTE 14)	1.70	1.30	0.00	25.00	8.90	0.00	6.20	2.70	0.00	10

MEDIUM SUSPENSION

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	3.20	2.10	0.00	35.60	12.30	0.00	9.40	3.80	0.00	10.0
2. NESC EXTREME WIND	0.90	1.50	0.00	16.10	13.10	0.00	3.90	4.00	0.00	23
3. NESC EXTREME WIND- YAW 45°	0.90	0.80	-0.10	16.10	7.20	-0.10	3.90	2.20	-0.10	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.90	0.20	-0.10	16.10	1.50	-0.10	3.90	0.50	-0.10	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	4.50	1.50	0.00	34.70	7.60	0.00	9.80	2.40	0.00	4.1
6. EVERYDAY	0.90	0.20	0.00	16.10	1.50	0.00	3.90	0.50	0.00	0.0
7. CONSTRUCTION SNUB OFF 3:1	3.10	-0.30	0.30	9.50	-0.70	0.80	33.40	-2.50	2.80	0.0
8. STRINGING INTACT	1.40	0.70	0.00	24.20	5.70	0.00	5.90	1.70	0.00	6.0
9. STRINGING/BROKEN SHIELDWIRE	1.40	0.50	5.00	24.20	5.70	0.00	5.90	1.70	0.00	6.0
10a. STRINGING/BROKEN CONDUCTOR	1.40	0.70	0.00	24.20	5.20	17.00	5.90	1.70	0.00	6.0
10b. STRINGING/BROKEN MRC	1.40	0.70	0.00	24.20	5.70	0.00	5.90	1.30	14.50	6.0
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
12.NESC MEDIUM (SEE NOTE 14)	2.10	1.50	0.00	29.30	10.10	0.00	7.40	3.10	0.00	10

HEAVY SUSPENSION

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS

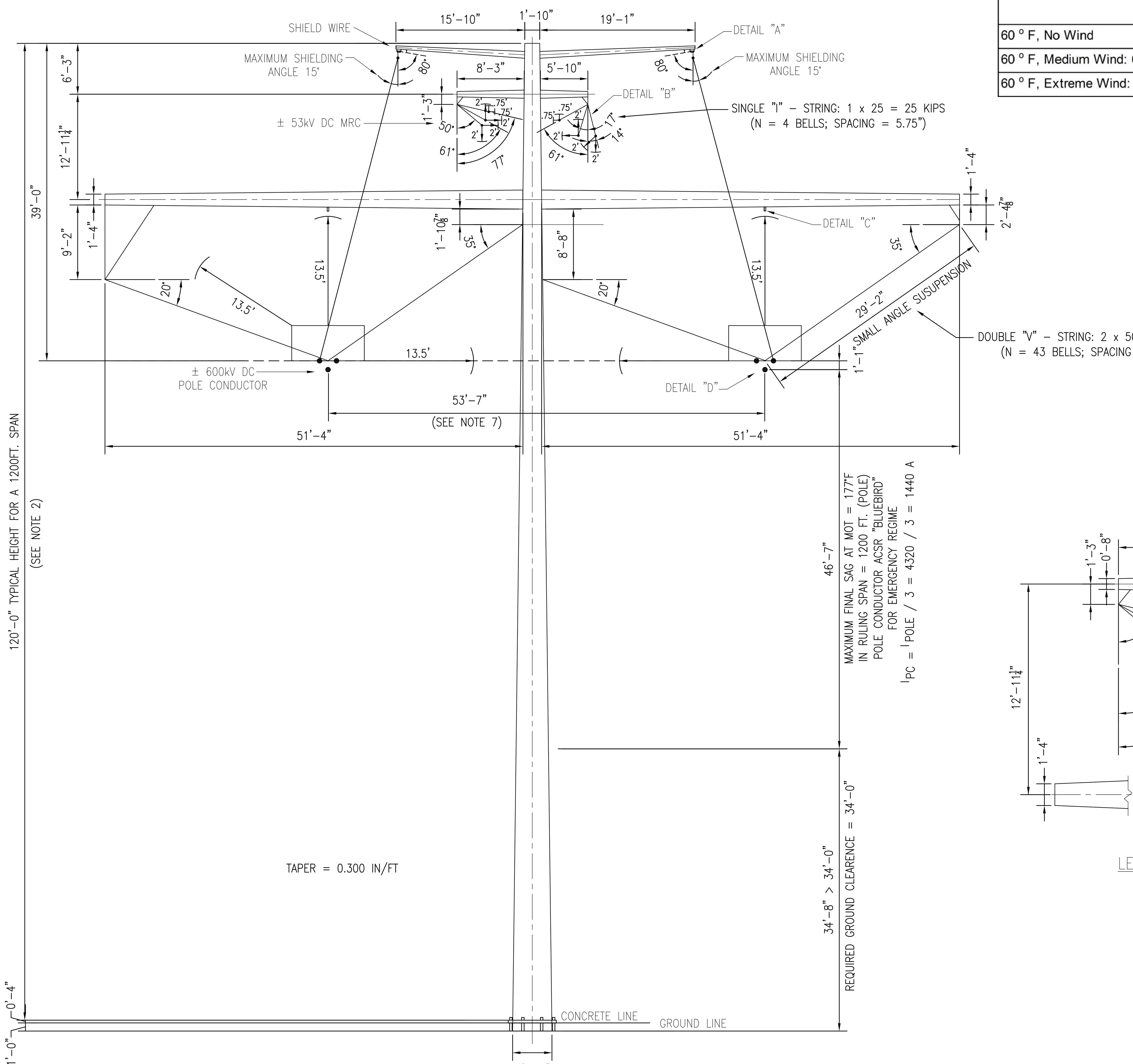
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.00	2.50	0.00	47.00	14.40	0.00	11.70	4.50	0.00	10.0
2. NESC EXTREME WIND	1.10	1.80	0.00	21.80	15.80	0.00	4.90	4.80	0.00	23
3. NESC EXTREME WIND- YAW 45°	1.10	1.00	-0.10	21.80	8.50	-0.10	4.90	2.60	-0.10	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.10	0.20	-0.10	21.80	1.50	-0.10	4.90	0.50	-0.10	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	5.60	1.80	0.00	45.00	8.80	0.00	12.10	2.80	0.00	4.1
6. EVERYDAY	1.10	0.20	0.00	21.80	1.50	0.00	4.90	0.50	0.00	0.0
7. CONSTRUCTION SNUB OFF 3:1	3.10	-0.30	0.30	9.50	-0.70	0.80	33.40	-2.50	2.80	0.0
8. STRINGING INTACT	1.70	0.70	0.00	32.70	6.50	0.00	7.30	2.00	0.00	6.0
9. STRINGING/BROKEN SHIELDWIRE	1.70	0.60	5.00	32.70	6.50	0.00	7.30	2.00	0.00	6.0
10a. STRINGING/BROKEN CONDUCTOR	1.70	0.70	0.00	32.70	6.00	17.00	7.30	2.00	0.00	6.0
10b. STRINGING/BROKEN MRC	1.70	0.70	0.00	32.70	6.50	0.00	7.30	1.50	14.50	6.0
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
12.NESC MEDIUM (SEE NOTE 14)	2.60	1.80	0.00	39.10	11.70	0.00	9.20	3.60	0.00	10

SMALL ANGLE SUSPENSION

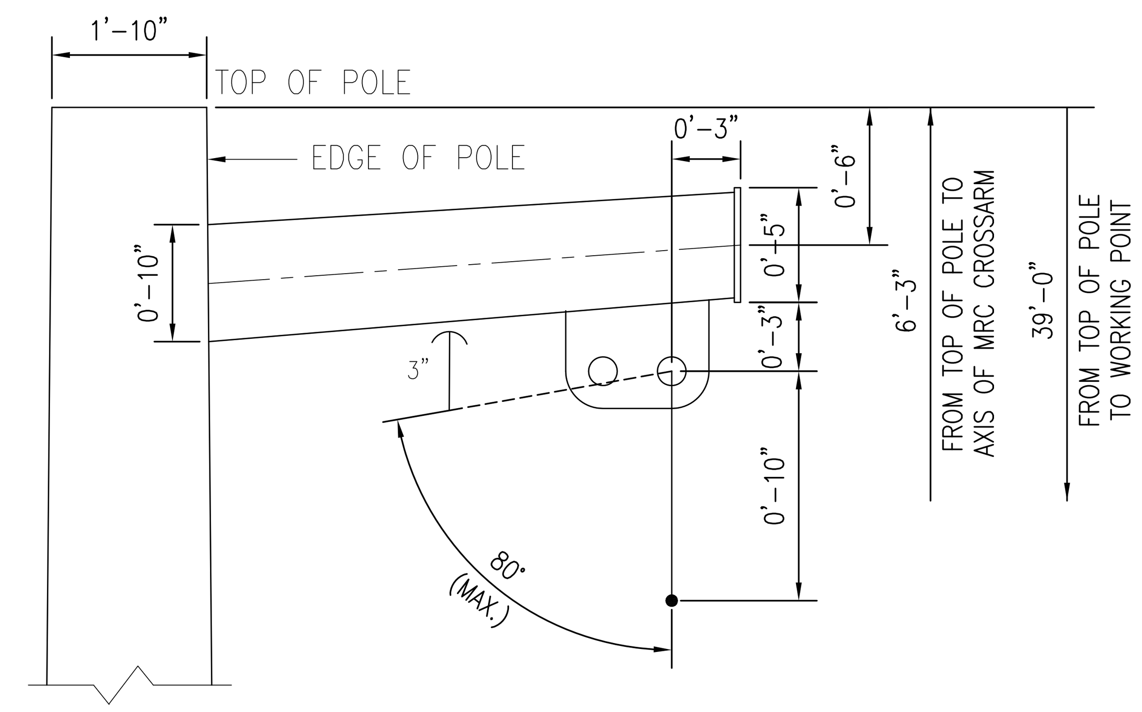
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	50 °	-14 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	61 °	17 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	77 °	61 °

NOTES

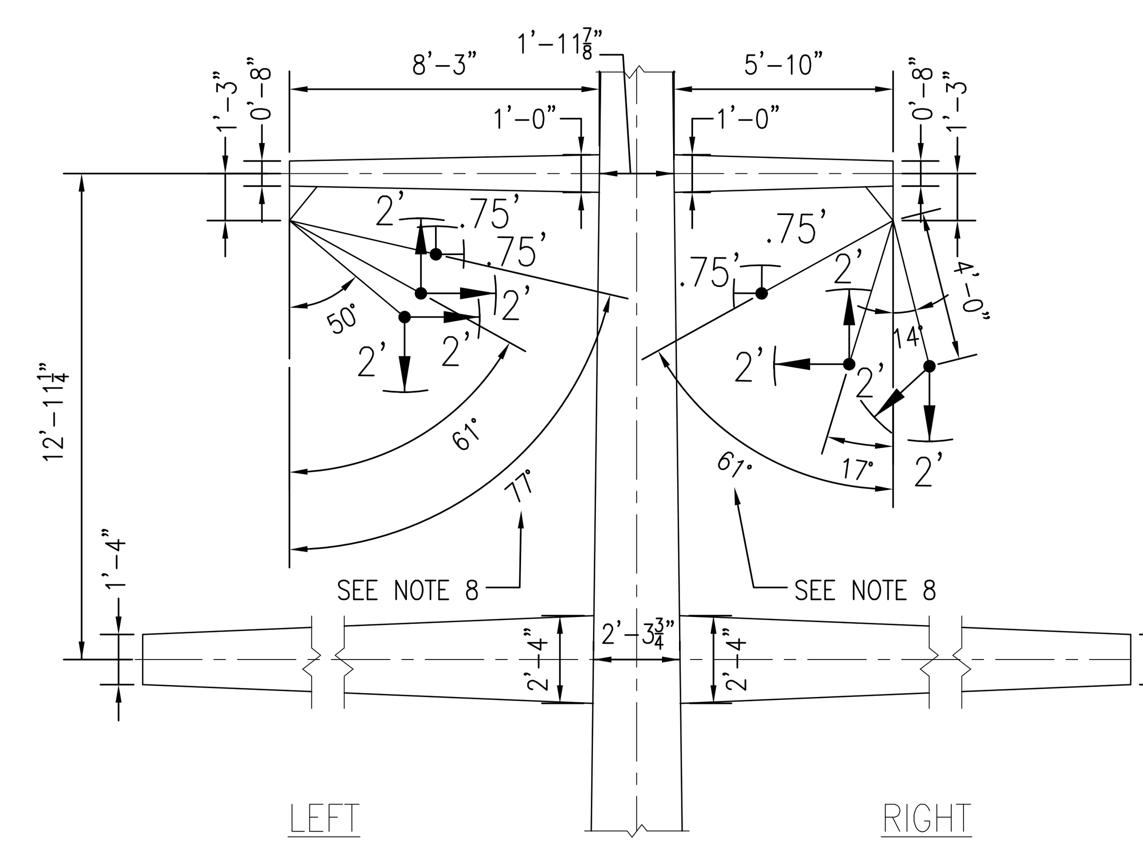
1. CLEARANCE DIMENSIONS SHOWN ON ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'-190' IN INCREMENTS OF 5'
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT OF THE ASSEMBLY TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
7. THE CONDUCTOR PHASE SPACING SHOULD NOT BE LESS THAN THAT OF THE TANGENT V-STRING SUSPENSION POLE.
8. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERYDAY, 60°, NO WIND, 60°F, 6 PSF & 60°, 20.74 PSF CONDITIONS.



SMALL ANGLE SUSPENSION STEEL POLE



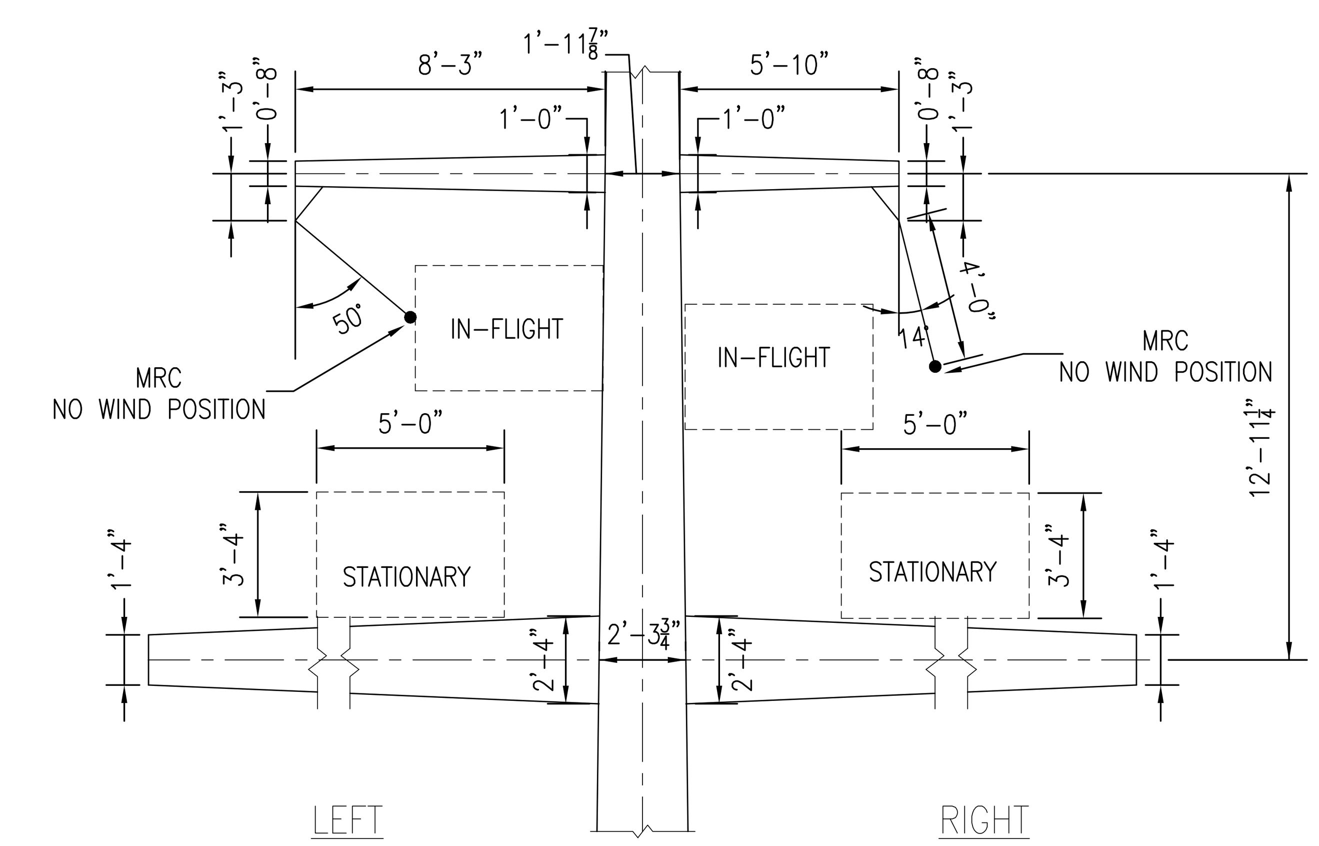
DETAIL "A"



LEFT

RIGHT

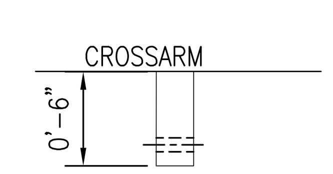
DETAIL "B"



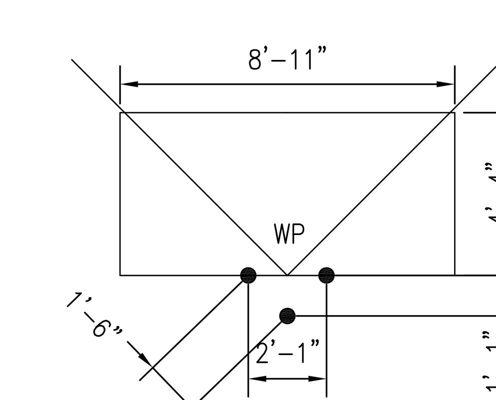
LEFT AVIAN HOT BOX H x L = 40" x 60"

RIGHT AVIAN HOT BOX H x L = 40" x 60"

DETAIL "B"



DETAIL "C" INSTALLATION & MAINTENANCE VANG



DETAIL "D" CORONA RING HOT BOX

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE SMALL ANGLE SUSPENSION

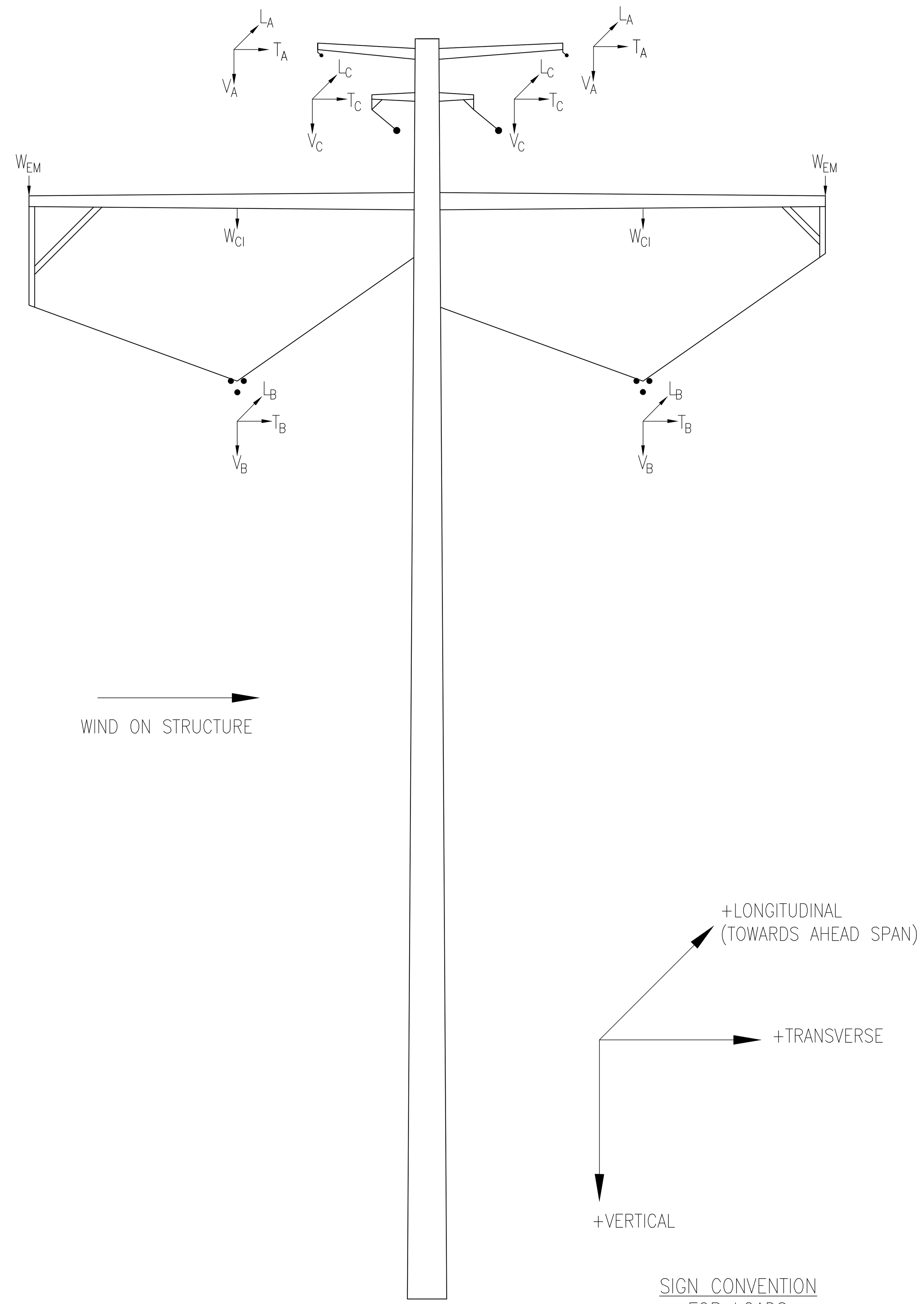
SELF SUPPORTING SUSPENSION POLE 2'-10" MRC ABOVE (V-STRING)

JOB NUMBER 132836

REV A

DRAWING NUMBER SSP-10-1

SSP-10-1_SMALL_SUSPENSION_2-10.DWG



SIGN CONVENTION FOR LOADS

DESIGN PARAMETERS									
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	WIND SPAN (ft.)	WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	10°	1200	1200	1800
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		10°	1200	1200	1800
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		10°	1200	1200	1800

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
3. NESC EXTREME WIND - YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4896	15548	13479
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4592	15770	13494
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4761	16071	13791
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3333 (A) / 0 (B) *	16071	13791
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4761	14464 (A) / 10703 (B) *	13791
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4761	16071	9654 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 14)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142

*(A)= AHEAD SPAN TENSION, (B)= BACK SPAN TENSION

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	3.20	4.10	0.00	39.00	28.20	0.00	9.40	8.50	0.00	10.0
2. NESC EXTREME WIND	0.90	2.40	0.00	18.40	21.20	0.00	3.90	6.40	0.00	23
3. NESC EXTREME WIND- YAW 45°	0.90	1.50	-0.10	18.40	13.60	-0.10	3.90	4.10	-0.10	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.90	0.70	-0.10	18.40	7.20	-0.10	3.90	2.10	-0.10	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	4.50	3.10	0.00	37.00	19.50	0.00	9.80	5.90	0.00	4.1
6. EVERYDAY	0.90	0.70	0.00	18.40	7.20	0.00	3.90	2.10	0.00	0.0
7. CONSTRUCTION SNUB OFF 3:1	3.10	-0.30	0.30	9.50	-0.70	0.80	33.40	-2.50	2.80	0.0
8. STRINGING INTACT	1.40	1.60	0.00	27.60	15.80	0.00	5.90	4.60	0.00	6.0
9. STRINGING/BROKEN SHIELDWIRE	1.40	0.80	5.00	27.60	15.80	0.00	5.90	4.60	0.00	6.0
10a. STRINGING/BROKEN CONDUCTOR	1.40	1.60	0.00	27.60	13.10	16.90	5.90	4.60	0.00	6.0
10b. STRINGING/BROKEN MRC	1.40	1.60	0.00	27.60	15.80	0.00	5.90	2.30	14.50	6.0
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
12.NESC MEDIUM (SEE NOTE 14)	2.10	3.00	0.00	32.00	22.90	0.00	7.40	6.80	0.00	10

TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	**Double** "V" String Suspension 2x50=100 kips	29.17 (ONE SIDE)	13 (ONE SIDE)	31.6 (ONE SIDE)	4832 (BOTH SIDES)	100 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	**Single** "I" String Suspension 1x25 =25 kips	4	11	1.83	150	25

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB-CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR FOR THE BASIC, MEDIUM, AND HEAVY SUSPENSION ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9.10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE VALUES SHOWN FOR WIND PRESSURE ON STRUCTURE ARE FOR ROUND OR 12 SIDED MEMBERS. FOR 8 SIDED MEMBERS, MULTIPLY BY 1.4. FOR FLAT SURFACES, MULTIPLY BY 1.6.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   BASIC W_{CI} = 18,150 LBS.
   MEDIUM W_{CI} = 21,550 LBS.
   HEAVY W_{CI} = 26,650 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (2) TO 9% OF THE TOTAL STRUCTURE HEIGHT, WHICH INCLUDES 1.72 DEG (3%) FOUNDATION ROTATION.
11. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (6) TO ONE POLE TIP DIAMETER.
12. LOAD CASES 1-5 AND 11 SHALL BE ANALYZED ASSUMING A FOUNDATION ROTATION OF 1.72 DEG (3%).
13. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
14. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
15. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

SSP-10-2_SMALL_LOADS_2-10.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
SMALL ANGLE SUSPENSION

SELF SUPPORTING SUSPENSION POLE 2"-10" MRC ABOVE (V-STRING)-LOAD DRAWING

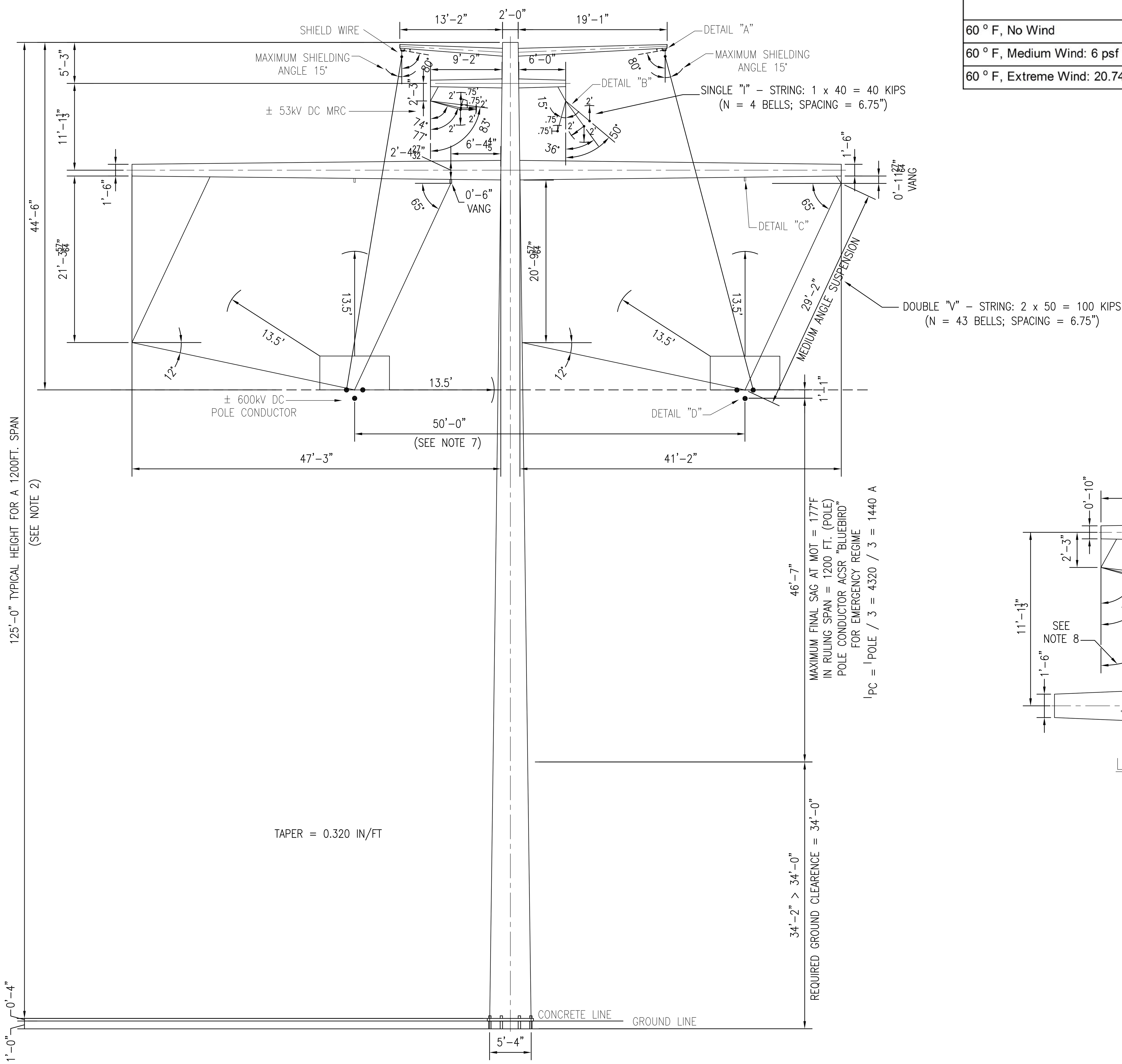
JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP-10-2

MEDIUM ANGLE SUSPENSION

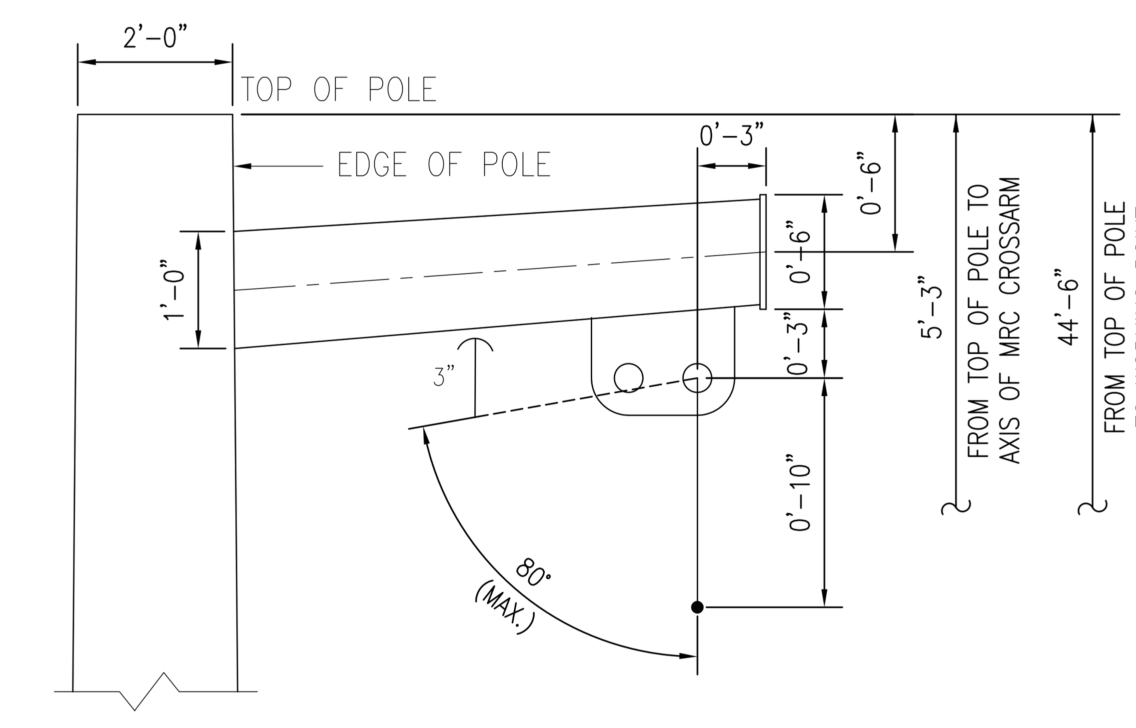
				Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances					
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 53 KV DC MRC "I" String Insulator Swing Angle	+/- 53 KV DC MRC "I" String Insulator Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	74 °	-50 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	77 °	-36 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	83 °	15 °

NOTES

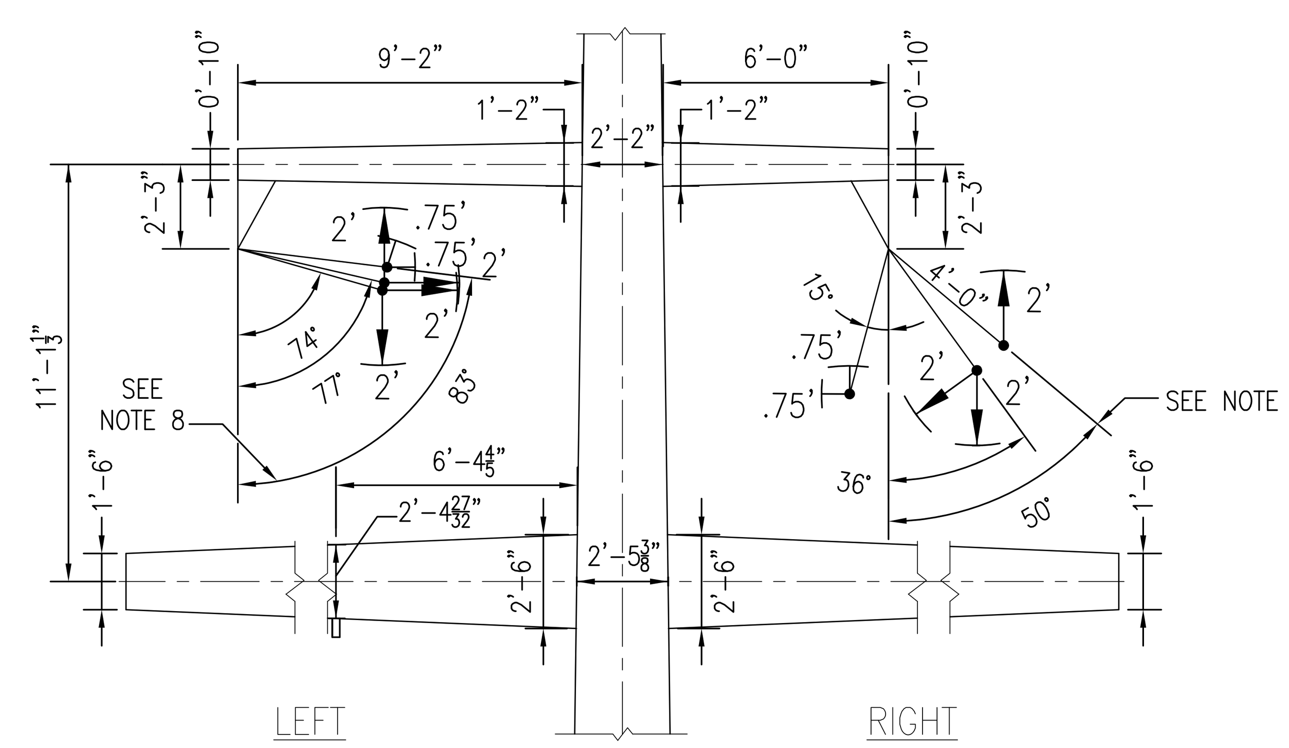
1. CLEARANCE DIMENSIONS SHOWN ON ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'-190' IN INCREMENTS OF 5'
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT OF THE ASSEMBLY TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
7. THE CONDUCTOR PHASE SPACING SHOWN SHOULD NOT BE LESS THAN THAT OF THE TANGENT V-STRING SUSPENSION POLE.
8. THE ANGLES SHOWN REFLECT THE MINIMUM AND MAXIMUM INSULATOR POSITION UNDER AN EVERYDAY, 60°, NO WIND, 60°F 6PSF, & 60°, 20.74 PSF CONDITIONS.



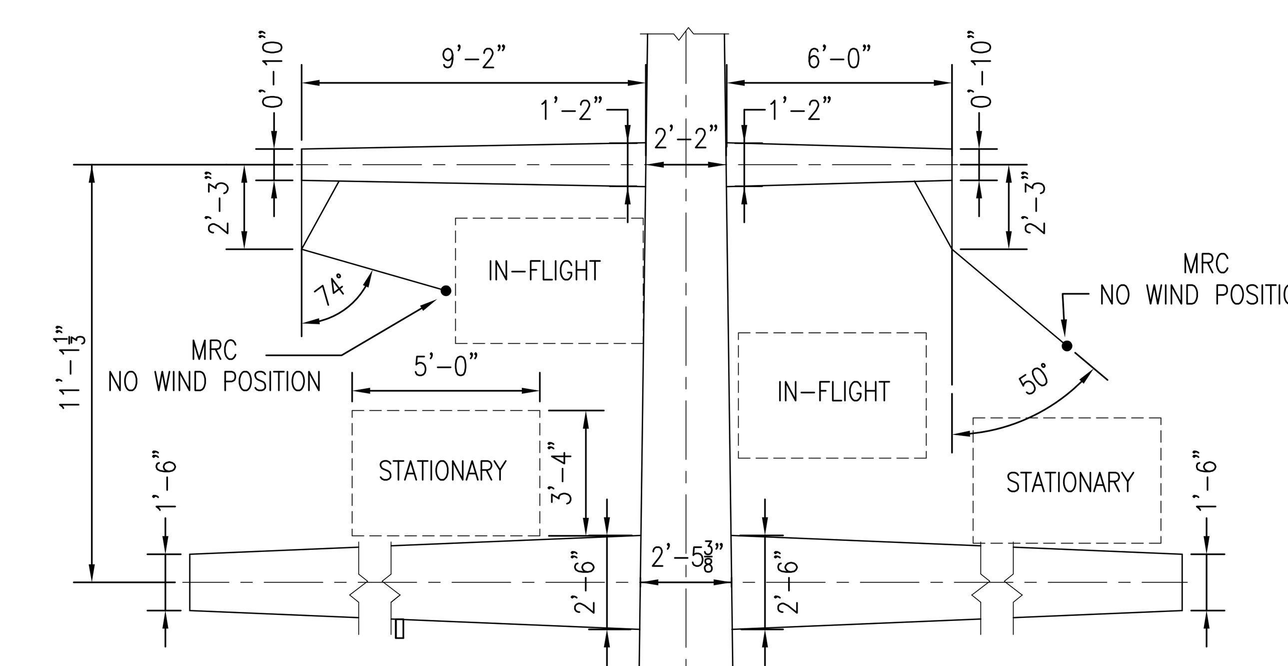
MEDIUM ANGLE SUSPENSION
STEEL POLE



DETAIL "A"



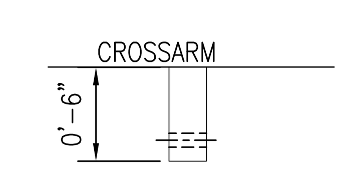
LEFT RIGHT
DETAIL "B"



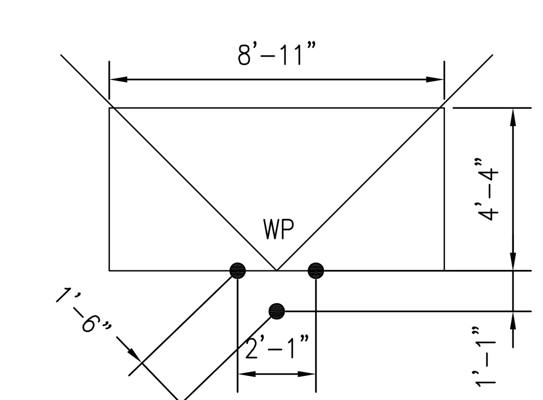
LEFT
AVIAN HOT BOX
H x L = 40" x 60"

RIGHT
AVIAN HOT BOX
H x L = 40" x 60"

DETAIL "B"



DETAIL "C"
INSTALLATION & MAINTENANCE
VANG



DETAIL "D"
CORONA RING HOT BOX

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

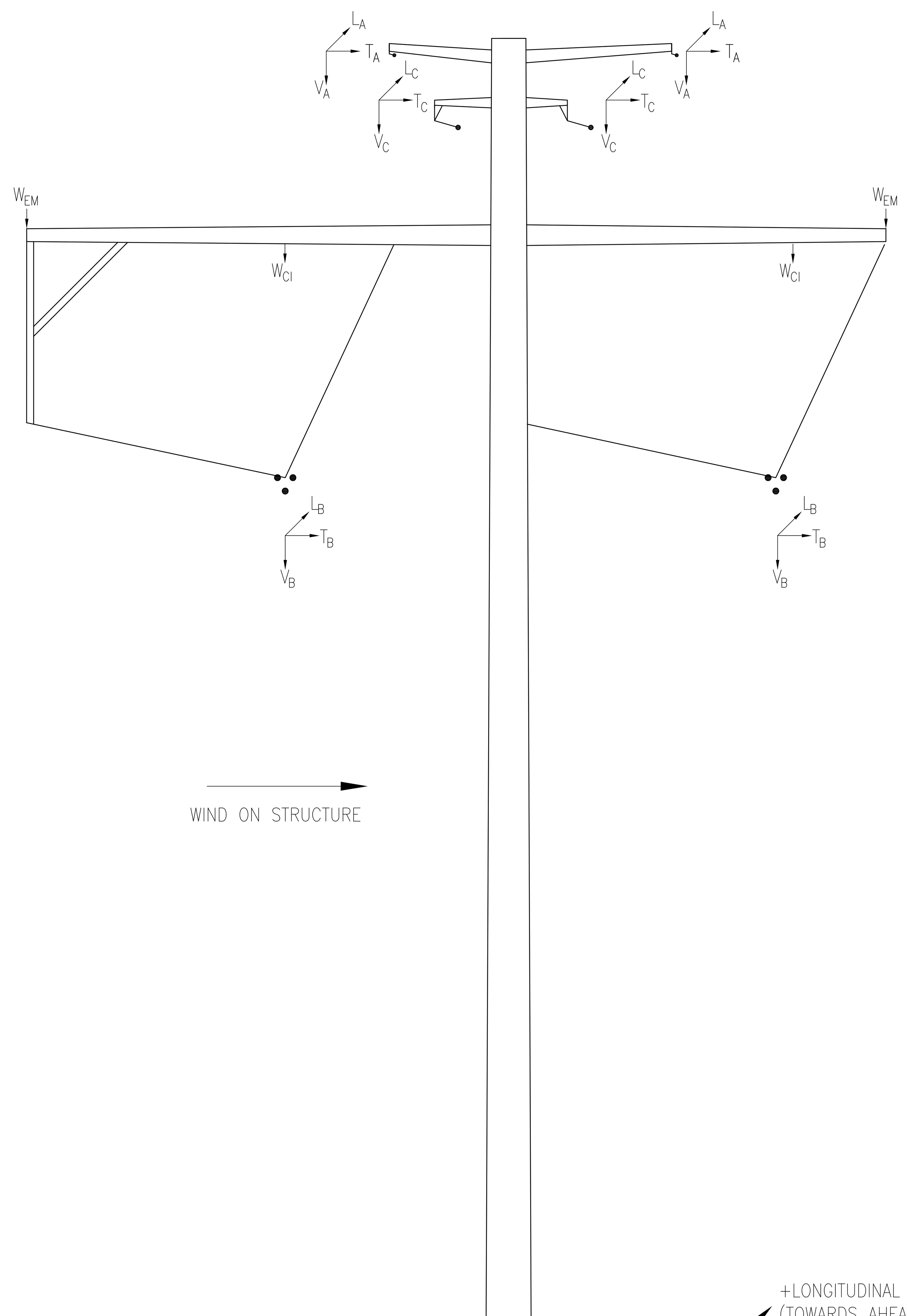
FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE
MEDIUM ANGLE SUSPENSION
SELF SUPPORTING SUSPENSION POLE
10'-30' MRC ABOVE (V-STRING)

JOB NUMBER 132836 REV A
DRAWING NUMBER SSP-12-1

SSP-12-1_MED_SUSP_10-30.DWG

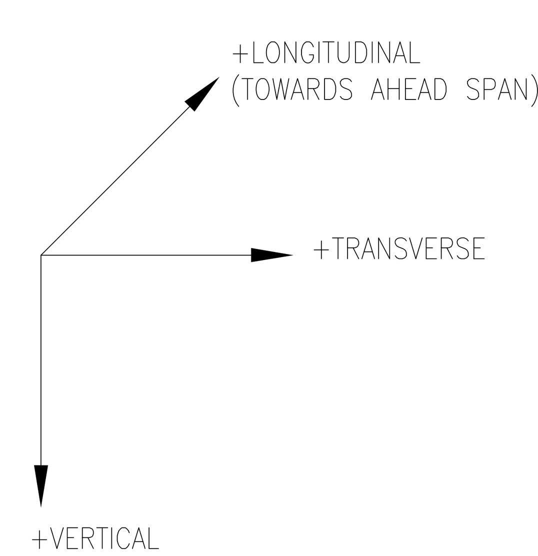


DESIGN PARAMETERS									
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	WIND SPAN (ft.)	WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	30°	1200	1200	1800
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		30°	1200	1200	1800
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		30°	1200	1200	1800

WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
3. NESC EXTREME WIND - YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4896	15548	13479
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
7. CONSTRUCTION SNUB OFF 3:1	0	0.00	0.00	1.50	1.50	1.50	4592	15770	13494
8. STRINGING INTACT	0	0.00	4.00	1.50	1.50	1.50	4761	16071	13791
9. STRINGING/BROKEN SHIELDWIRE	0	0.00	4.00	1.50	1.50	1.50	3333 (A) / 0 (B) *	16071	13791
10a. STRINGING/BROKEN CONDUCTOR	0	0.00	4.00	1.50	1.50	1.50	4761	14464 (A) / 10703 (B) *	13791
10b. STRINGING/BROKEN MRC	0	0.00	4.00	1.50	1.50	1.50	4761	16071	9654 (A) / 0 (B) *
11. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
12. NESC MEDIUM (SEE NOTE 14)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142

MEDIUM ANGLE SUSPENSION

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	3.20	8.90	0.00	39.00	67.20	0.00	9.40	19.90	0.00	10.0
2. NESC EXTREME WIND	0.90	4.70	0.00	18.40	41.30	0.00	3.90	12.30	0.00	23
3. NESC EXTREME WIND- YAW 45°	0.90	3.20	-0.10	18.40	29.50	-0.80	3.90	8.60	-0.30	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	0.90	2.10	-0.10	18.40	21.40	-0.20	3.90	6.10	-0.10	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	4.50	7.00	0.00	37.00	48.60	0.00	9.80	14.50	0.00	4.1
6. EVERYDAY	0.90	2.10	0.00	18.40	21.40	0.00	3.90	6.10	0.00	0.0
7. CONSTRUCTION SNUB OFF 3:1	3.10	-0.30	0.30	9.50	-0.70	0.80	33.40	-2.50	2.80	0.0
8. STRINGING INTACT	1.40	4.10	0.00	27.60	40.70	0.00	5.90	11.70	0.00	6.0
9. STRINGING/BROKEN SHIELDWIRE	1.40	1.70	4.90	27.60	40.70	0.00	5.90	11.70	0.00	6.0
10a. STRINGING/BROKEN CONDUCTOR	1.40	4.10	0.00	27.60	32.50	16.40	5.90	11.70	0.00	6.0
10b. STRINGING/BROKEN MRC	1.40	4.10	0.00	27.60	40.70	0.00	5.90	4.80	14.00	6.0
11. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
12.NESC MEDIUM (SEE NOTE 14)	2.10	6.60	0.00	32.00	54.50	0.00	7.40	15.90	0.00	10



SIGN CONVENTION
FOR LOADS

TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Suspension Clamp	0.83	2	0.14	22	15.75
B	(3) - 2156 KCM ACSR "Bluebird"	**Double** "V" String Suspension 2x50=100 kips	29.17 (ONE SIDE)	13 (ONE SIDE)	31.6 (ONE SIDE)	4832 (BOTH SIDES)	100 (ONE SIDE)
C	(1) - 1780 KCM ACSR "Chukar"	**Single** "I" String Suspension 1x40 =40 kips	4	13	2.2	180	40

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. LOAD CASE (9) TO BE APPLIED TO ONLY 1 SHIELD WIRE ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
3. LOAD CASE (10A) TO BE APPLIED TO ONLY 1 SUB-CONDUCTOR (IN THE BUNDLE) AT ATTACHMENT POINT (MOST SEVERE) OF ONE POLE (POSITIVE OR NEGATIVE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
4. LOAD CASE (10B) TO BE APPLIED TO ONLY 1 MRC ATTACHMENT POINT (MOST SEVERE). APPLY LOAD CASE (8) TO ALL OTHER ATTACHMENT POINTS.
5. THE WEIGHT OF CLAMP FOR SHIELD WIRE AND INSULATOR FOR POLE CONDUCTOR AND METAL RETURN CONDUCTOR FOR THE BASIC, MEDIUM, AND HEAVY SUSPENSION ARE PROVIDED IN TABLE 1. THESE WEIGHTS HAVE BEEN INCLUDED IN THE LOADING TREE FORCES. FOR WIND ON CLAMPS / INSULATORS, USE AREA EXPOSED TO WIND FROM TABLE 1.
6. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,8,9.10 & 12.
7. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6 & 11.
8. THE VALUES SHOWN FOR WIND PRESSURE ON STRUCTURE ARE FOR ROUND OR 12 SIDED MEMBERS. FOR 8 SIDED MEMBERS, MULTIPLY BY 1.4. FOR FLAT SURFACES, MULTIPLY BY 1.6.
9. THE STRUCTURE SHALL BE DESIGNED FOR AN ADDITIONAL LOAD CASE 13, FOR LOADS ANTICIPATED DUE TO RIGGING FOR WIRE CLIP IN DURING CONSTRUCTION. LOADS SHALL BE APPLIED AS FOLLOWS;

   AT ONE PHASE LOCATION, APPLY LOAD (W_{CI}) DIRECTLY ABOVE THE WORKPOINT. EACH LOCATION SHOULD BE ANALYZED SEPARATELY;

   BASIC W_{CI} = 18,150 LBS.
   MEDIUM W_{CI} = 21,550 LBS.
   HEAVY W_{CI} = 26,650 LBS.

   APPLY LOAD CASE (6) TO ALL OTHER ATTACHMENT POINTS.
10. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (2) TO 9% OF THE TOTAL STRUCTURE HEIGHT, WHICH INCLUDES 1.72 DEG (3%) FOUNDATION ROTATION.
11. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (6) TO ONE POLE TIP DIAMETER.
12. LOAD CASES 1–5 AND 11 SHALL BE ANALYZED ASSUMING A FOUNDATION ROTATION OF 1.72 DEG (3%).
13. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT.
14. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 12 "NESC MEDIUM".
15. LOAD CASE 11 SHALL BE APPLIED ON STRUCTURE ONLY, IN TRANSVERSE, 45°, LONGITUDINAL DIRECTIONS.

SSP-12-2_MEDIUM_LOADS_10-30.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD	REFERENCE DRAWINGS
A	CONCEPTUAL DESIGN	6/16/14	DVW	CIM	CIM	CIM	

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
MEDIUM ANGLE SUSPENSION

SELF SUPPORTING SUSPENSION POLE 10°–30°
MRC ABOVE (V-STRING)–LOAD DRAWING

JOB NUMBER 132836

REV A

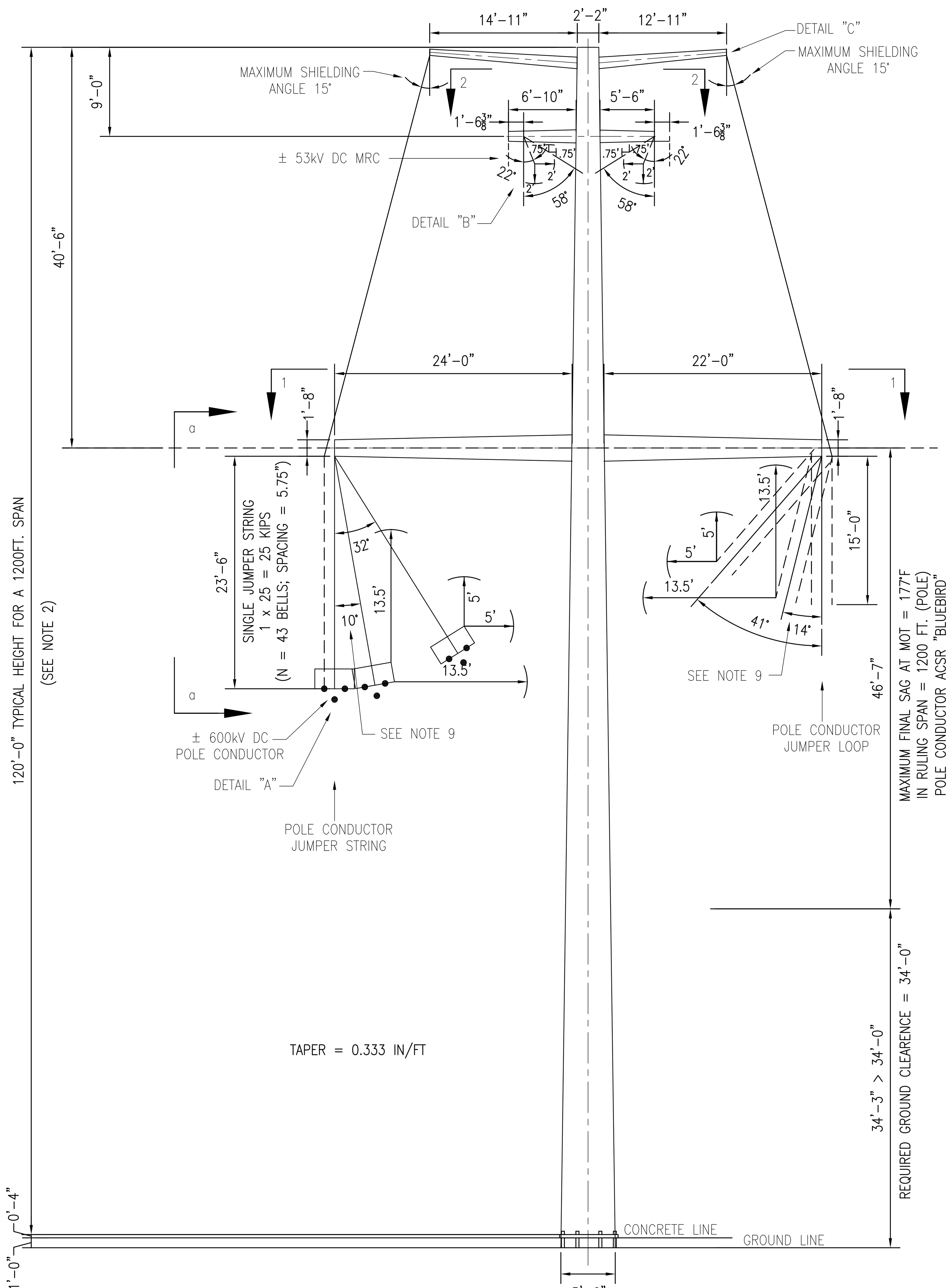
DRAWING NUMBER SSP-12-2

DEADEND 0°–45°

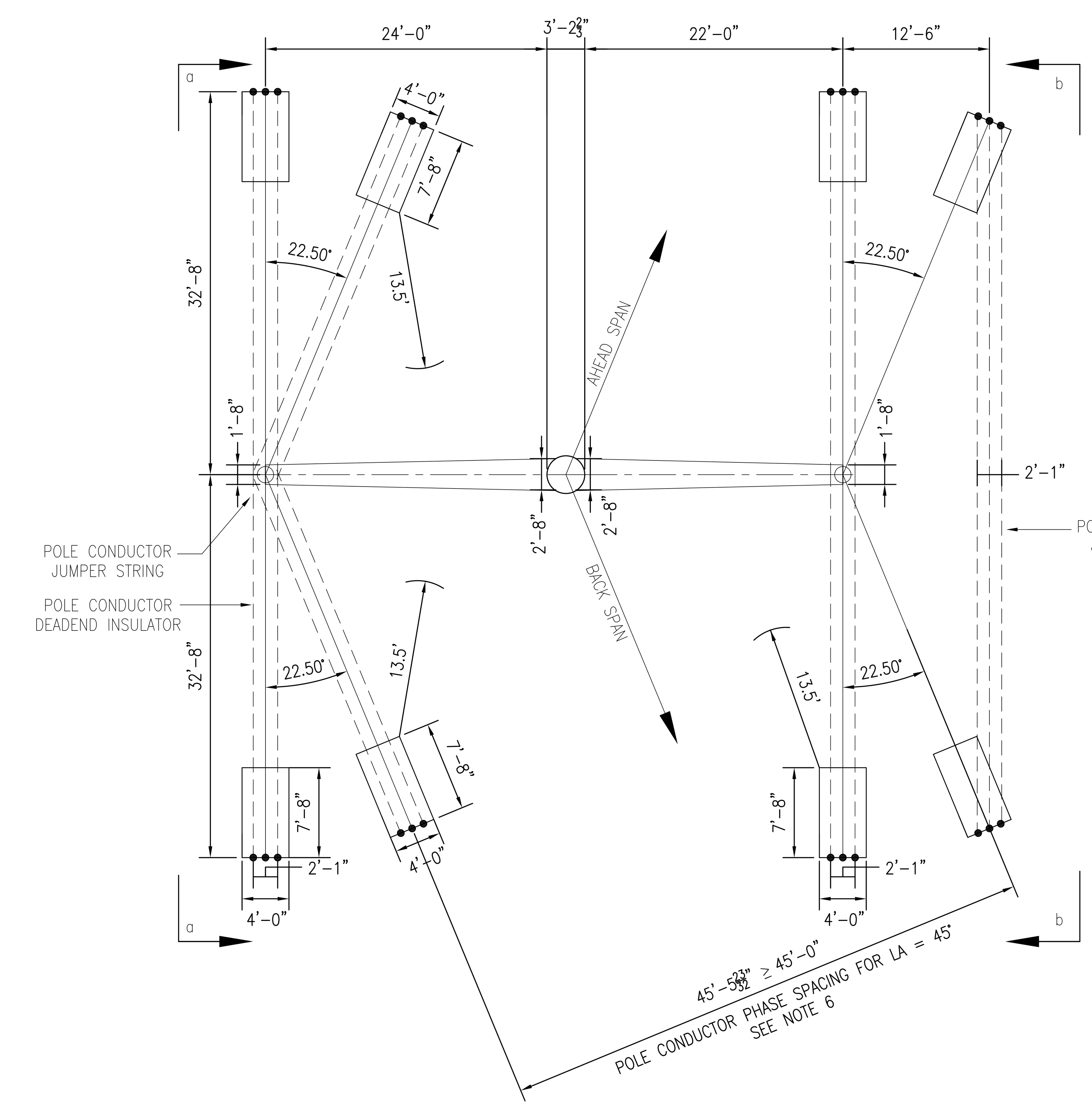
				Left Crossarm Wind from Left	Right Crossarm Wind from Right	Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances							
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 600 KV DC Pole Conductor "I" Jumper String Insulator Swing Angle	+/- 600 KV DC Pole Conductor Jumper Loop Swing Angle	+/- 53 KV DC MRC "Jumper Loop Swing Angle	+/- 53 KV DC MRC Jumper Loop Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	10 °	14 °	22 °	22 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	32 °	41 °	58 °	58 °

NOTES

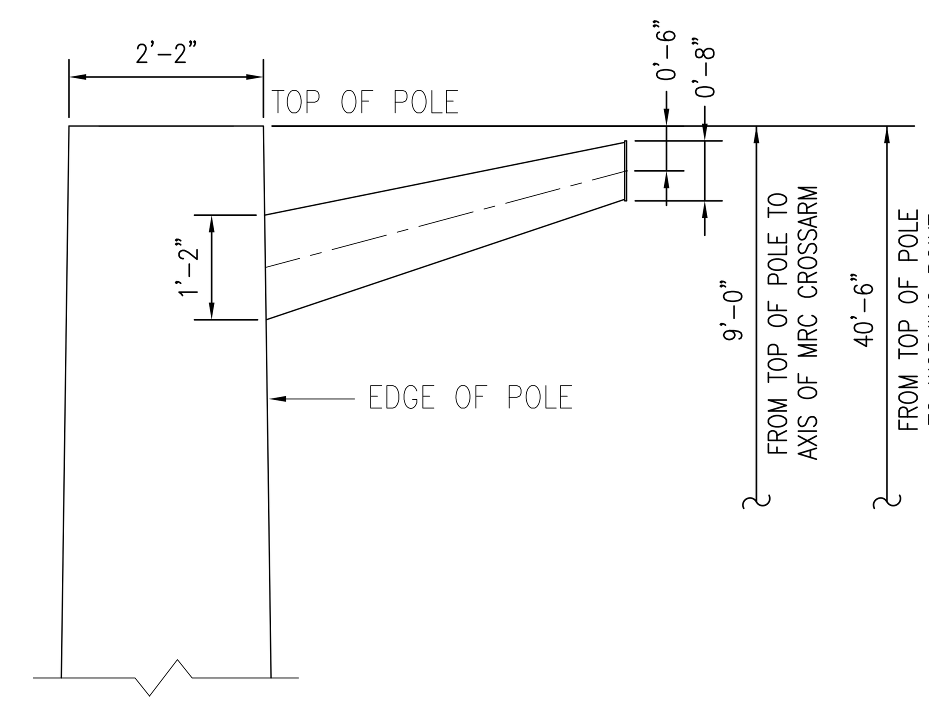
1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'–190' IN INCREMENTS OF 5'.
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. THE POLE CONDUCTOR PHASE SPACING SHOULD BE THAT OF THE POLE CONDUCTOR IN THE TANGENT V-STRING SUSPENSION POLE UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF THE STEEL.
7. ALL POLE SHAFT SECTIONS SHALL BE SPLICED USING A BOLTED FLANGE CONNECTION.
8. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
9. THE ANGLES SHOWN REFLECT THE JUMPER STRING AND JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITIONS.



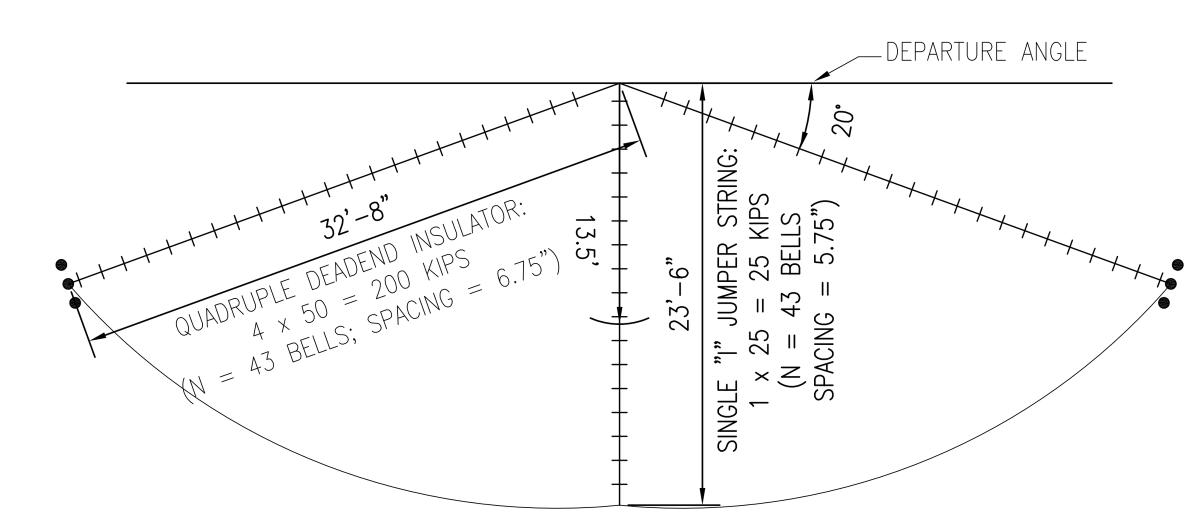
0°–45° DEADEND STEEL POLE



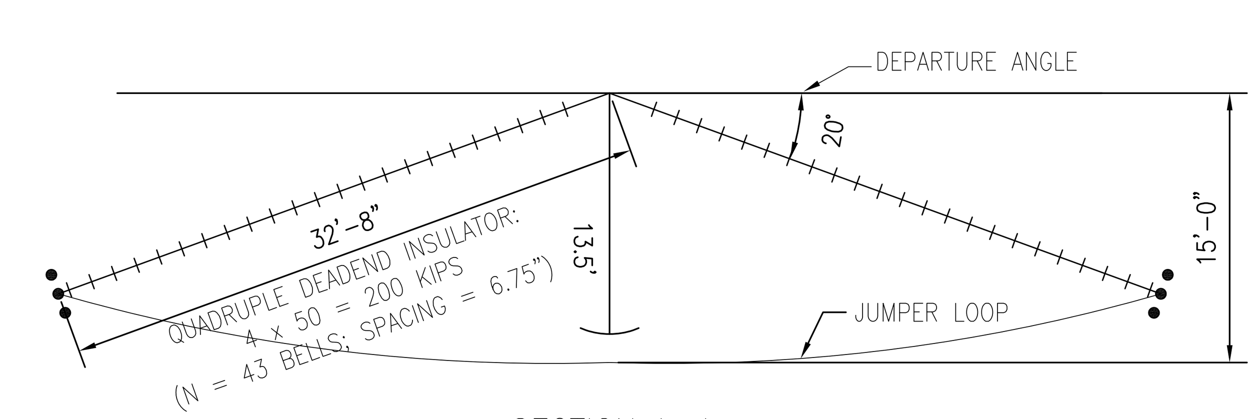
SECTION 1–1
PLAN VIEW – CONDUCTOR ATTACHMENT



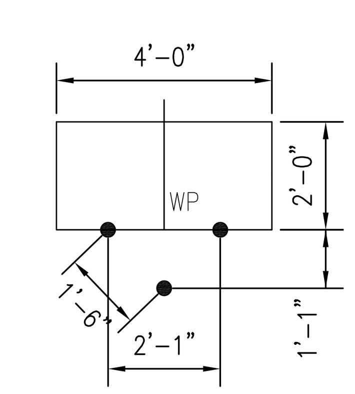
DETAIL "C"



SECTION a–a
SIDE VIEW – JUMPER STRING POLE CONDUCTOR



SECTION b–b
SIDE VIEW – JUMPER LOOP POLE CONDUCTOR



DETAIL "A"
CORONA RING HOT BOX
JUMPER STRING
POLE CONDUCTOR

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

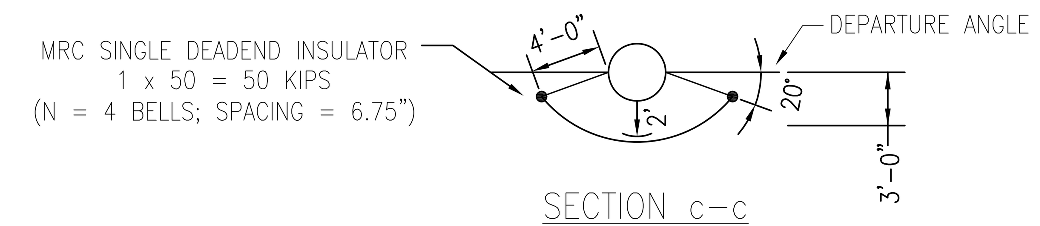
FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND STEEL POLE
SELF SUPPORTING DEADEND POLE 0°–45° MRC ABOVE

JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP–14–1

SSP-14-1_DEADEND_0-45.DWG



SECTION c-c
SIDE VIEW – MRC JUMPER LOOP

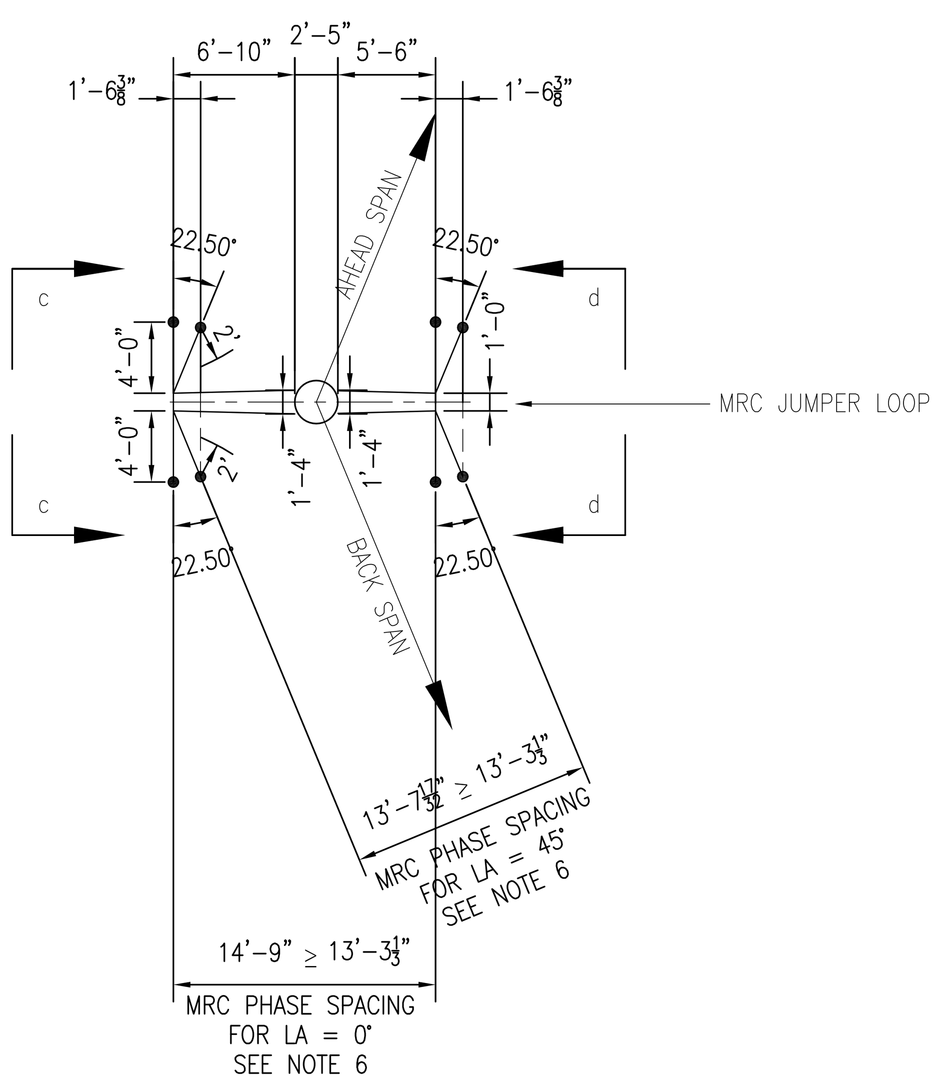
TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH [FT]	DIAMETER [IN]	AREA EXPOSED TO WIND [FT^2]	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]	UTS [KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Dead-End Clamp	3.18	2.15	0.57	44	25
B	(3) - 2156 KCM ACSR "Bluebird"	**Quadruple** String Dead-End 4x50=200 kips	32.67	13	35.39	5150	200
		Single "I" **Jumper String** Suspension 1x25=25 kips	23.5	11	10.77	1180	25
C	(1) - 1780 KCM ACSR "Chukar"	**Single** String Dead-End 1x50 =50 kips	4	13	2.17	185	50

Note: Total Weight of Insulators (including hardware) **applied at end of crossarm:**

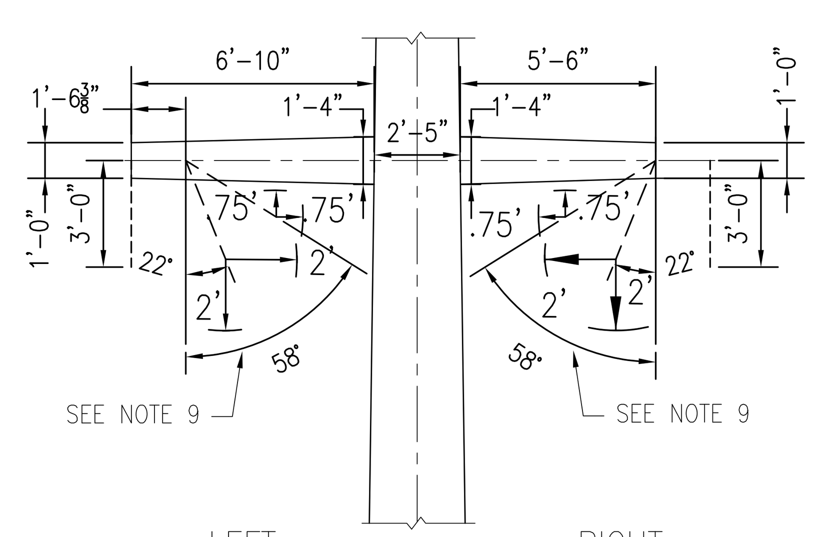
WIRE	WIRE TYPE	TOTAL WEIGHT (INCLUDING HARDWARE) [LBS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	2 * 44 =88
B	(3) - 2156 KCM ACSR "Bluebird"	2 * 5150 + 1180 = 11480
C	(1) - 1780 KCM ACSR "Chukar"	2 * 185= 370

NOTES

1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'–190' IN INCREMENTS OF 5'.
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. THE MRC PHASE SPACING SHOULD BE THAT OF THE TANGENT MRC IN THE SUSPENSION POLE UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF THE STEEL.
7. ALL POLE SHAFT SECTIONS SHALL BE SPLICED USING A BOLTED FLANGE CONNECTION.
8. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
9. THE ANGLES SHOWN REFLECT THE JUMPER POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITIONS.

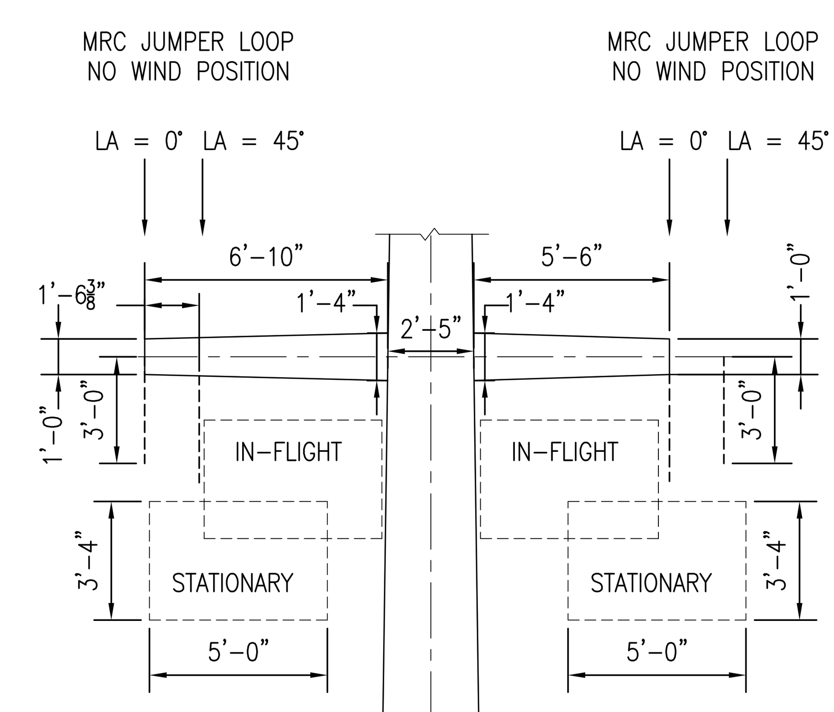


SECTION 2-2
PLAN VIEW – MRC ATTACHMENT



LEFT RIGHT

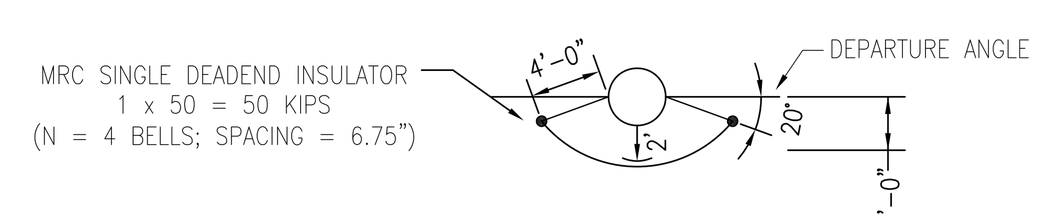
DETAIL "B"



LEFT
AVIAN HOT BOX
H x L = 40" x 60"

RIGHT
AVIAN HOT BOX
H x L = 40" x 60"

DETAIL "B"



SECTION d-d
SIDE VIEW – MRC JUMPER LOOP

SSP-14-2_DEADEND_TABLE 1_0-45.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD	REFERENCE DRAWINGS
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM	

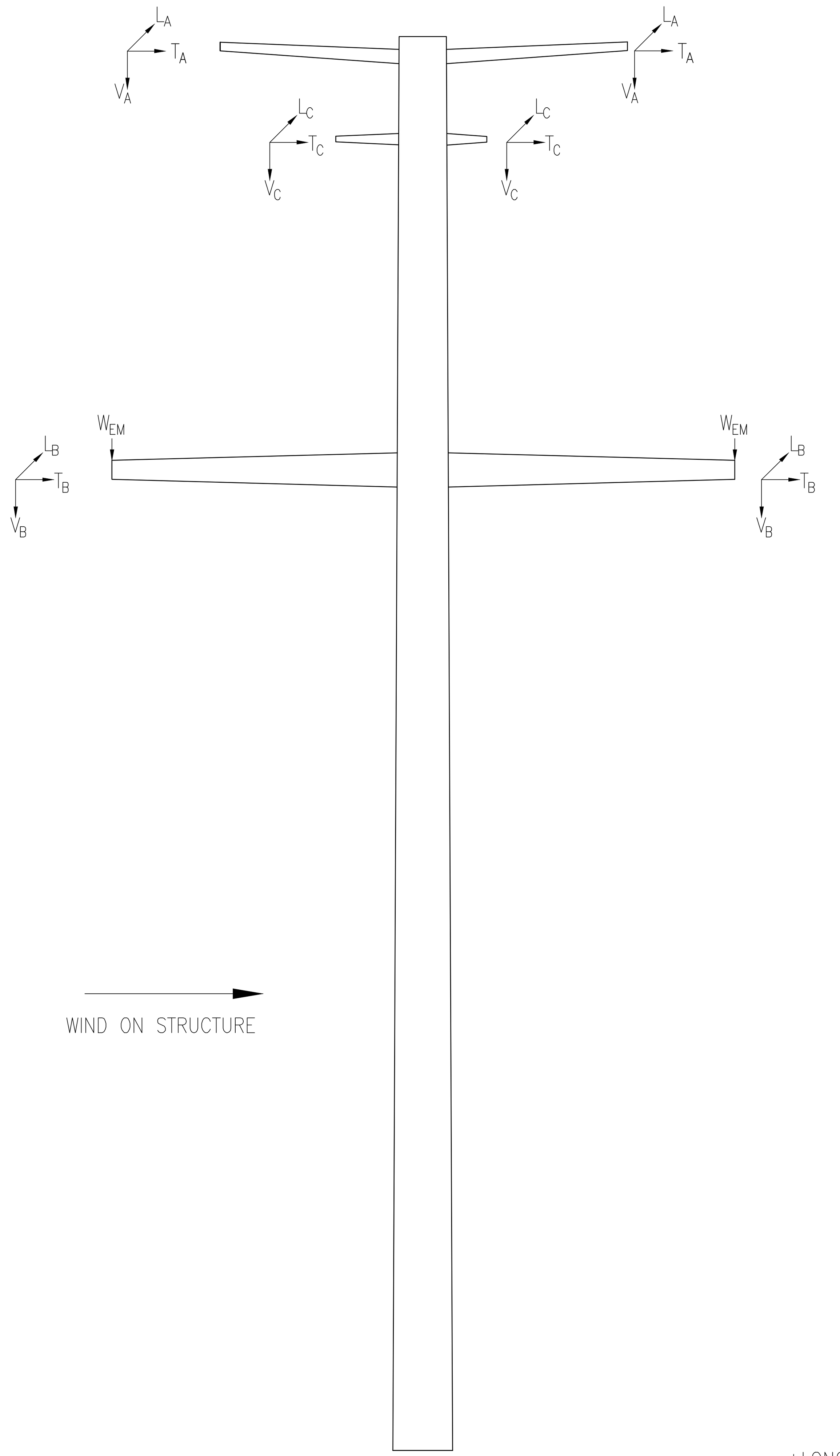
DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND STEEL POLE
SELF SUPPORTING DEADEND POLE 0°-45° MRC ABOVE

JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP-14-2



DESIGN PARAMETERS									
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	WIND SPAN (ft.)	WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	45°	1200	1500	2250
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		45°	1200	1500	2250
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		45°	1200	1500	2250

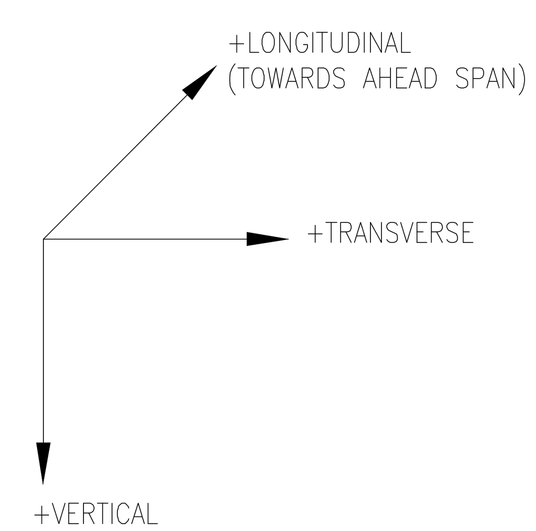
WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
3. NESC EXTREME WIND- YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4896	15548	13479
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
7. NESC HEAVY DE	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
8. NESC EXTREME WIND DE	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
9. NESC EXTREME ICE W/CONCURRENT WIND DE	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
10. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
11.NESC MEDIUM (SEE NOTE 9)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142
12.NESC MEDIUM DE (SEE NOTE 9)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142

DEADEND 45°

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.10	12.80	0.00	56.90	97.50	0.00	12.00	28.80	0.00	10.0
2. NESC EXTREME WIND	1.20	6.60	0.00	28.50	58.50	0.00	5.10	17.40	0.00	23
3. NESC EXTREME WIND- YAW 45°	1.20	4.50	-0.30	28.50	42.10	-1.90	5.10	12.30	-0.60	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.20	3.00	-0.10	28.50	31.60	-0.80	5.10	9.00	-0.30	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	5.70	10.00	0.00	51.70	70.80	0.00	12.40	21.10	0.00	4.1
6. EVERYDAY	1.20	3.00	0.00	28.50	31.60	0.00	5.10	9.00	0.00	0.0
7. NESC HEAVY DE	2.10	6.40	13.10	37.10	48.80	105.20	6.30	14.40	30.90	10.0
8. NESC EXTREME WIND DE	0.70	3.30	6.10	20.00	29.30	54.10	2.80	8.70	15.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	2.90	5.00	10.50	31.60	35.40	78.50	6.40	10.60	23.20	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 9)	2.70	9.50	0.00	49.00	79.00	0.00	9.60	23.10	0.00	10
12.NESC MEDIUM DE (SEE NOTE 9)	1.40	4.80	9.80	33.10	39.50	85.10	5.10	11.60	24.70	10

DEADEND 0°

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	2.10	1.00	14.10	37.10	5.20	113.80	6.30	1.70	33.40	10.0
8. NESC EXTREME WIND DE	0.70	0.80	6.60	20.00	6.90	58.50	2.80	2.10	17.30	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	2.90	0.70	11.40	31.60	2.90	85.00	6.40	1.00	25.10	4.1
12.NESC MEDIUM DE (SEE NOTE 9)	1.40	0.70	10.60	33.10	4.30	92.20	5.10	1.40	26.70	10.0



SIGN CONVENTION
FOR LOADS

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT. APPROPRIATE OLF SHALL BE APPLIED.
3. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,11 & 12.
4. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6,7,8,9, & 10.
5. THE VALUES SHOWN FOR WIND PRESSURE ON STRUCTURE ARE FOR ROUND OR 12 SIDED MEMBERS. FOR 8 SIDED MEMBERS, MULTIPLY BY 1.4. FOR FLAT SURFACES, MULTIPLY BY 1.6.
6. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (2) TO 9% OF THE TOTAL STRUCTURE HEIGHT, WHICH INCLUDES 1.72 DEG (3%) FOUNDATION ROTATION.
7. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (6) TO 1½% OF THE TOTAL STRUCTURE HEIGHT. POLES SHALL BE CAMBERED WHEN THIS LIMIT IS EXCEEDED.
8. LOAD CASES 1-5 AND 10 SHALL BE ANALYZED ASSUMING A FOUNDATION ROTATION OF 1.72 DEG (3%).
9. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY" AND LOADING CASE 7 "NESC HEAVY DE". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 11 "NESC MEDIUM" AND LOADING CASE 7 "NESC HEAVY DE" WILL BE REPLACED BY LOADING CASE 12 "NESC HEAVY DE".
10. LOADING CASE 10 WILL BE APPLIED ON STRUCTURE ONLY, IN TRANVERSE, 45°, LONGITUDINAL DIRECTIONS.

A B C D

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND STEEL POLE

SELF SUPPORTING DEADEND POLE 0°-45°
MRC ABOVE-LOAD DRAWING

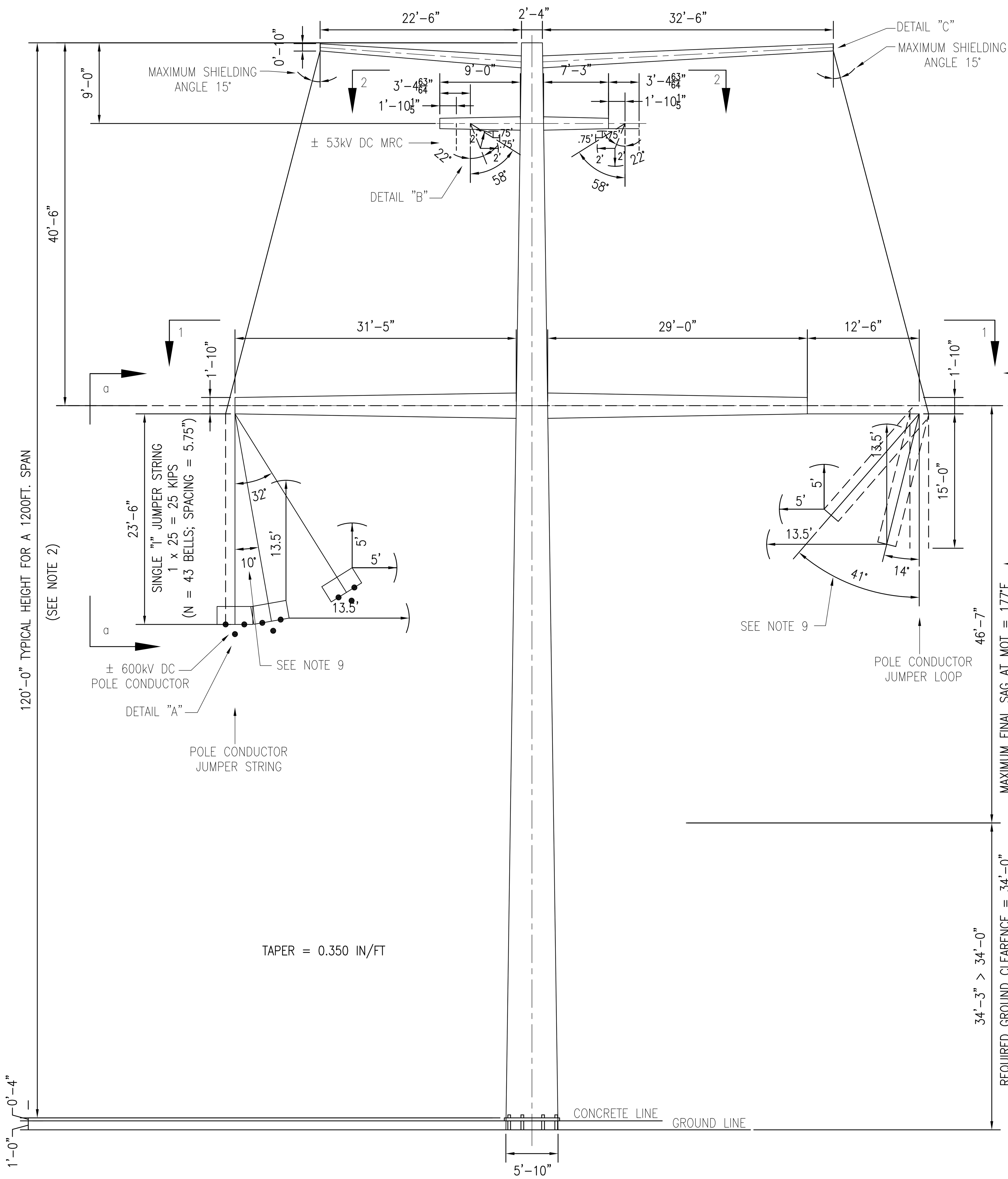
JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP-14-3

DEADEND 45°–90°

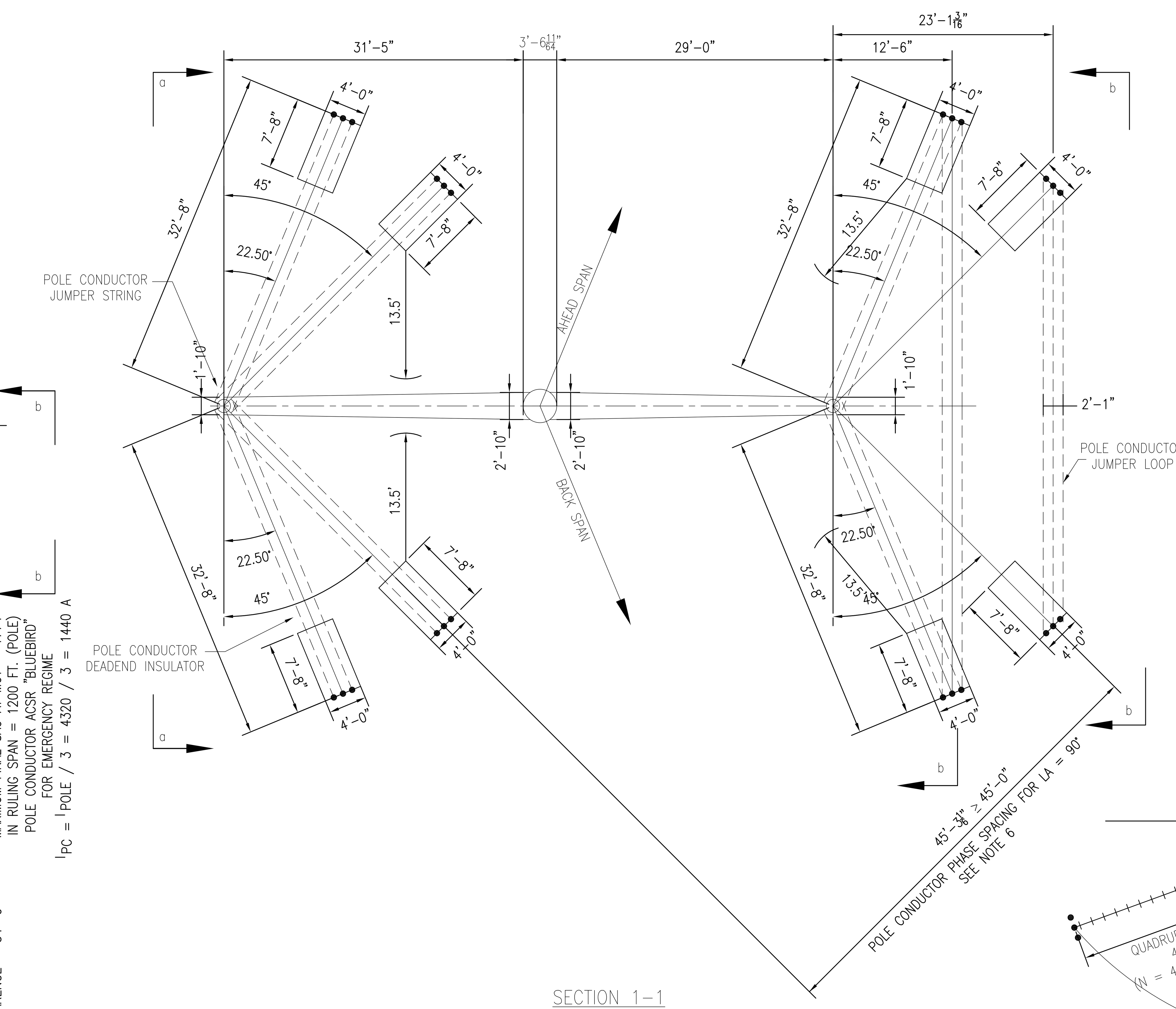
				Left Crossarm Wind from Left	Right Crossarm Wind from Right	Left Crossarm Wind from Left	Right Crossarm Wind from Right
Required Clearances							
Mechanical	Electrical	+/- 600 kV DC Pole Conductor	+/- 53 KV DC Metal Return Conductor	+/- 600 KV DC Pole Conductor "I" Jumper String Insulator Swing Angle	+/- 600 KV DC Pole Conductor Jumper Loop Swing Angle	+/- 53 KV DC MRC "Jumper Loop Swing Angle	+/- 53 KV DC MRC Jumper Loop Swing Angle
60 ° F, No Wind	Lightning Impulse Withstand Voltage	13.5'	2'	0 °	0 °	0 °	0 °
60 ° F, Medium Wind: 6 psf	Switching Impulse Withstand Voltage	13.5'	2'	10 °	14 °	22 °	22 °
60 ° F, Extreme Wind: 20.74 psf	Steady State, Normal Regime	5'	0.75'	32 °	41 °	58 °	58 °

NOTES

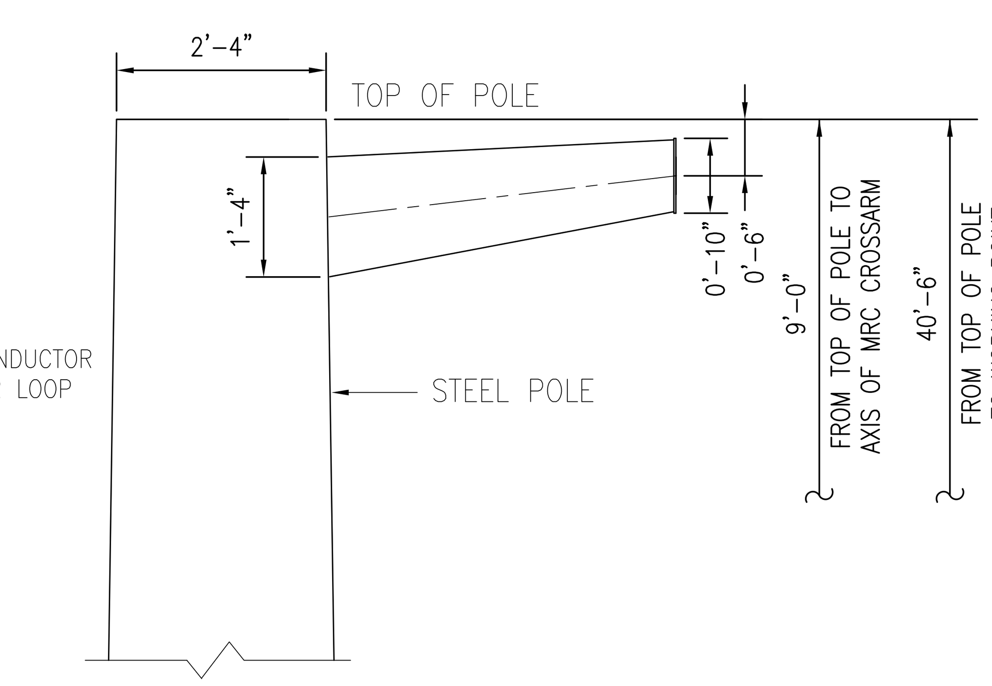
1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'–190' IN INCREMENTS OF 5'.
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. THE POLE CONDUCTOR PHASE SPACING SHOULD BE THAT OF THE POLE CONDUCTOR IN THE TANGENT V–STRING SUSPENSION POLE UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF THE STEEL.
7. ALL POLE SHAFT SECTIONS SHALL BE SPLICED USING A BOLTED FLANGE CONNECTION.
8. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
9. THE ANGLES SHOWN REFLECT THE JUMPER STRING AND JUMPER LOOP POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITIONS.



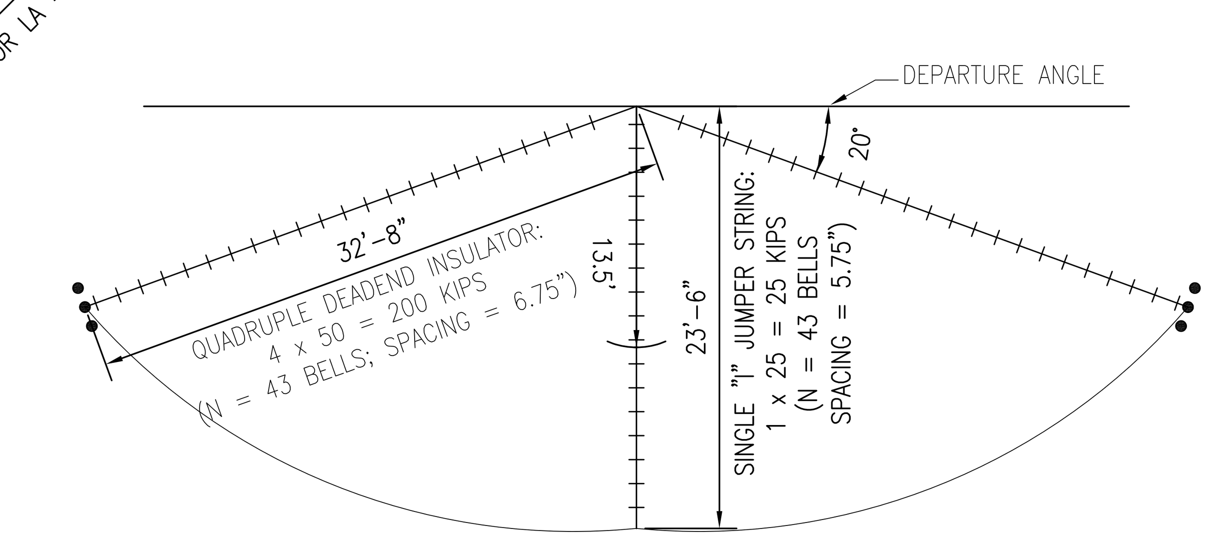
45°–90° DEADEND STEEL POLE



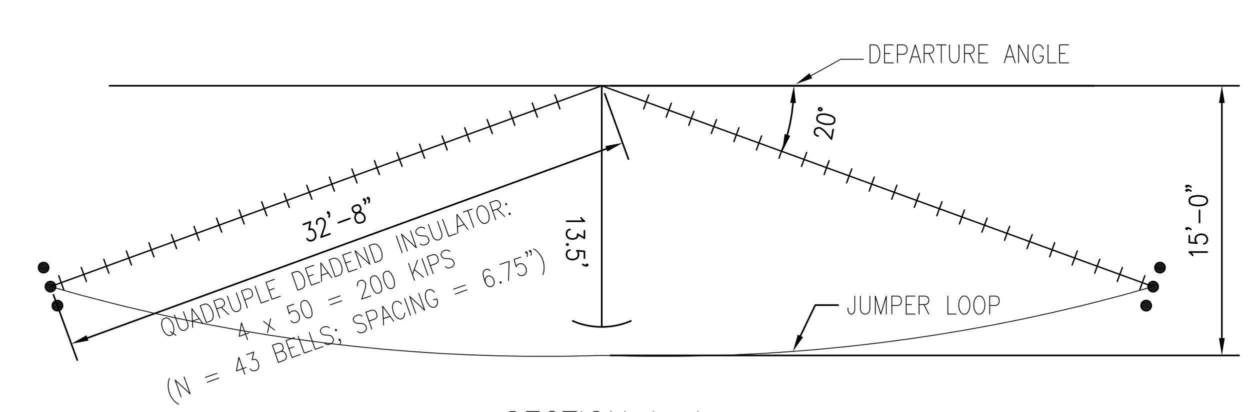
SECTION 1–1
PLAN VIEW – CONDUCTOR ATTACHMENT



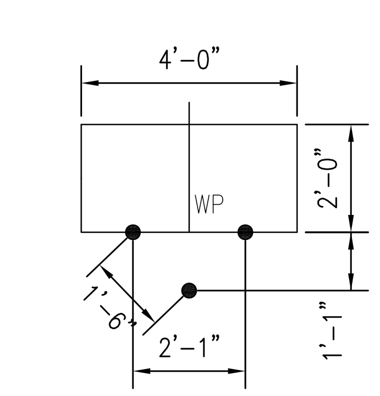
DETAIL "C"



SECTION a–a
SIDE VIEW – JUMPER STRING POLE CONDUCTOR



SECTION b–b
SIDE VIEW – JUMPER LOOP POLE CONDUCTOR



DETAIL "A"
CORONA RING HOT BOX
JUMPER STRING POLE CONDUCTOR

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

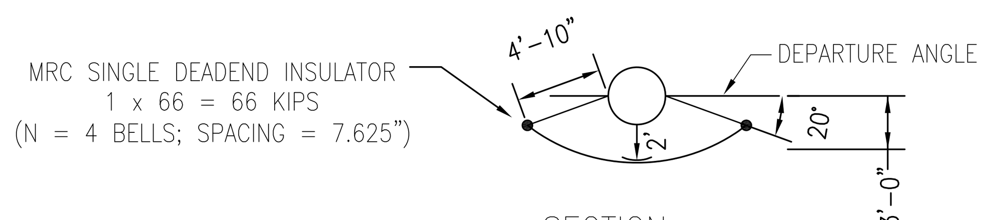
FOR 22x34 DWG ONLY

POWER ENGINEERS

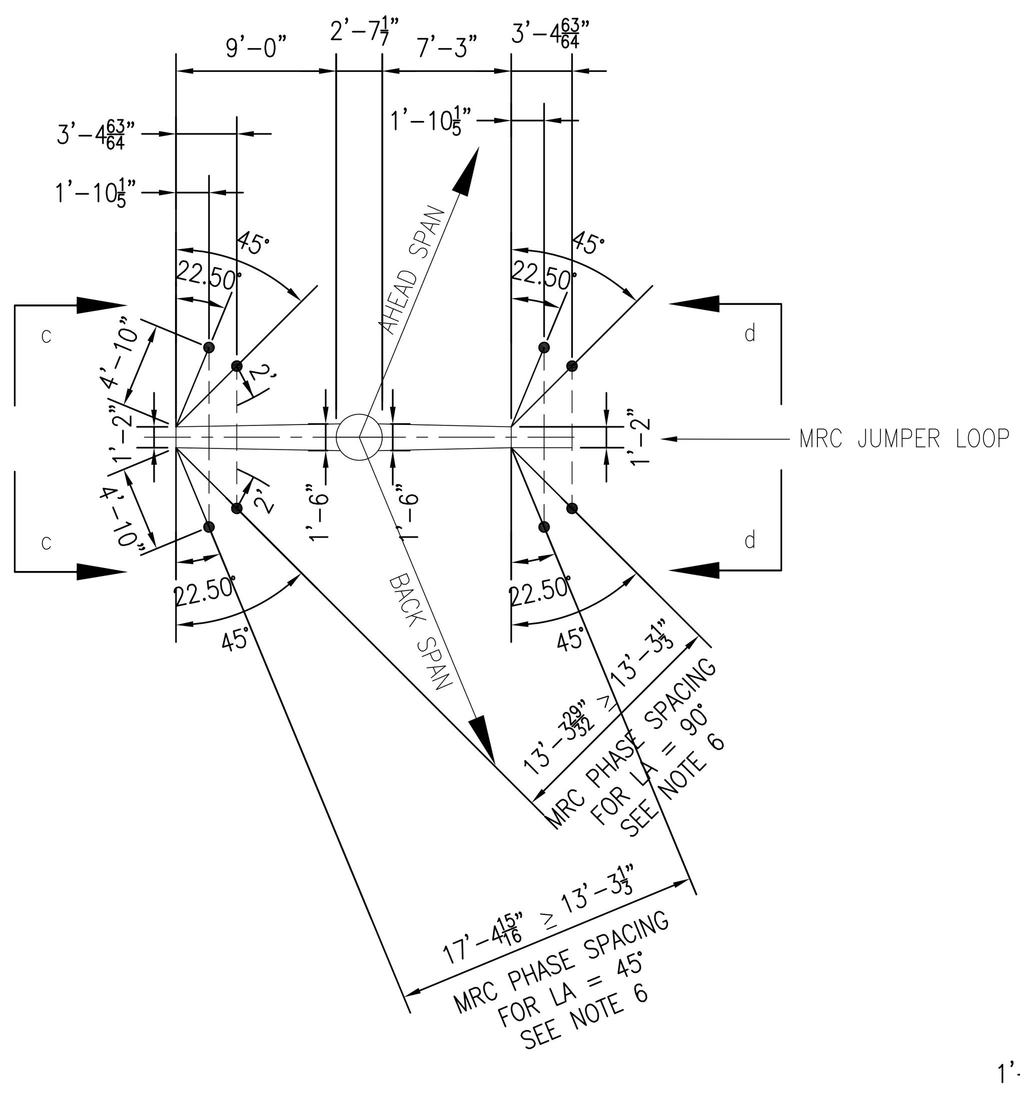
CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND STEEL POLE
SELF SUPPORTING DEADEND POLE 45°–90° MRC ABOVE

JOB NUMBER 132836
REV A
DRAWING NUMBER SSP–16–1

SSP–16–1_DEADEND_45–90.DWG



SECTION c–c
SIDE VIEW – MRC JUMPER LOOP



SECTION 2–2
PLAN VIEW – MRC ATTACHMENT

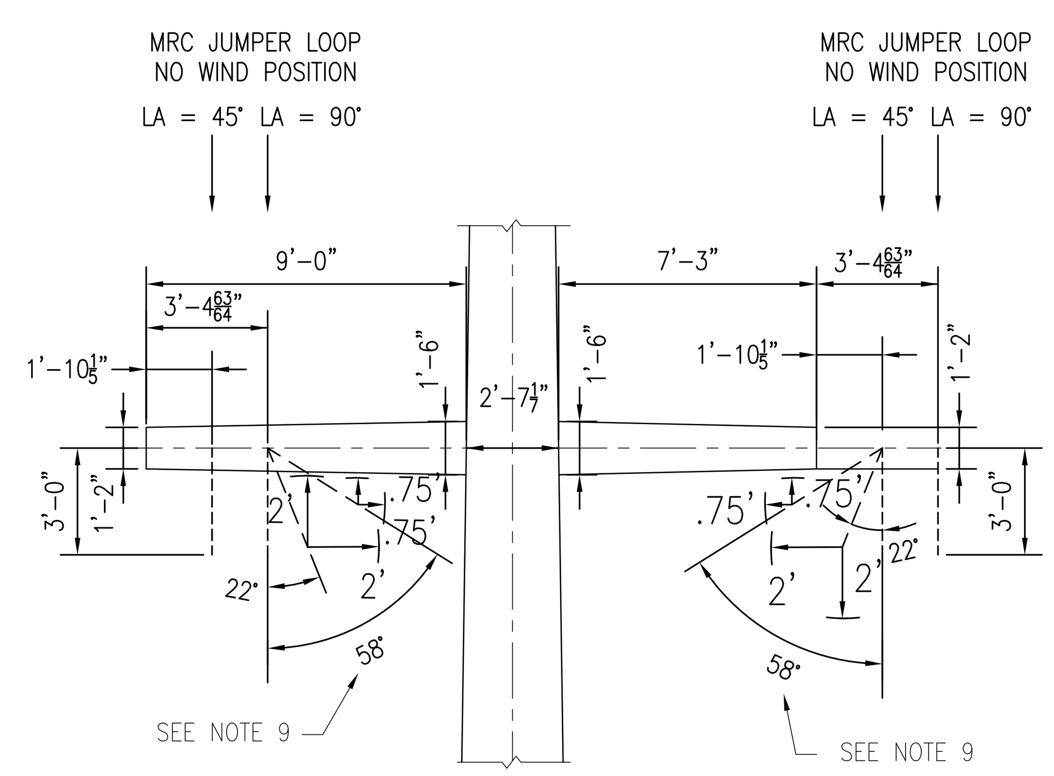
TABLE 1							
CLAMP / INSULATOR PARAMETERS							
WIRE	WIRE TYPE	CLAMP / INSULATOR TYPE	LENGTH	DIAMETER	AREA EXPOSED TO WIND	TOTAL WEIGHT (INCLUDING HARDWARE)	UTS
			[FT]	[IN]	[FT^2]	[LBS]	[KIPS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	Dead-End Clamp	3.18	2.15	0.57	44	25
B	(3) - 2156 KCM ACSR "Bluebird"	**Quadruple** String Dead-End 4x50=200 kips	32.67	13	35.39	5150	200
		Single "I" **Jumper String** Suspension 1x25=25 kips	23.5	11	10.77	1180	25
C	(1) - 1780 KCM ACSR "Chukar"	**Single** String Dead-End 1x66 =66 kips	4.83	15	3.02	190	66

Note: Total Weight of Insulators (including hardware) **applied at end of crossarm:**

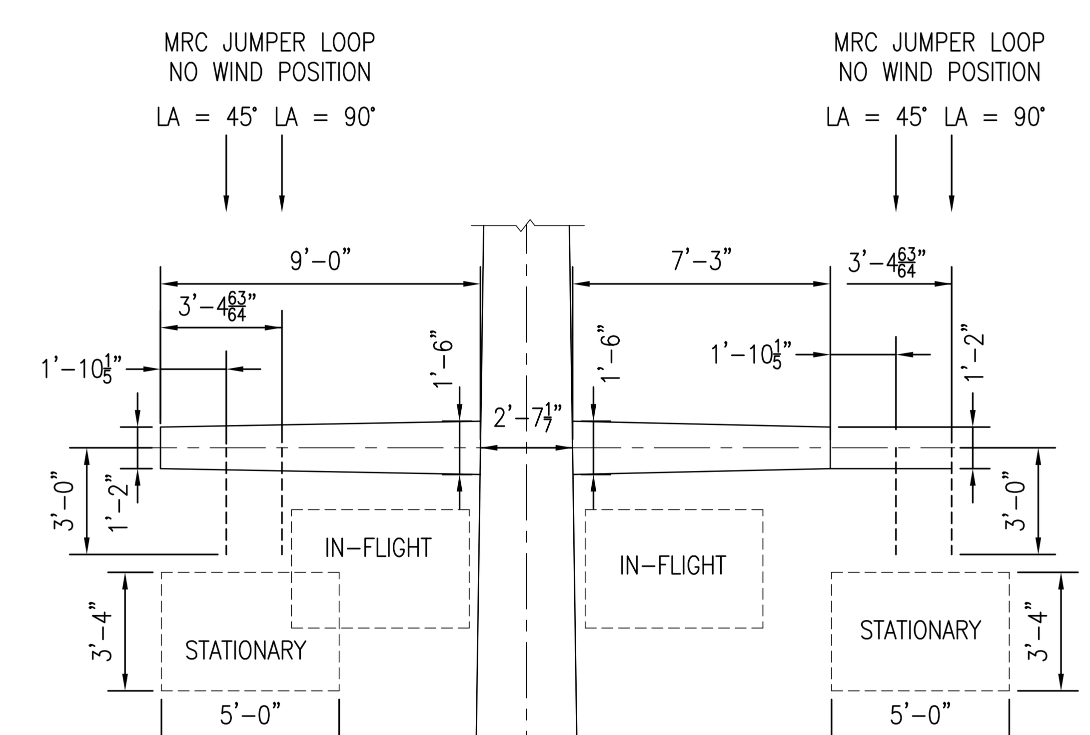
WIRE	WIRE TYPE	TOTAL WEIGHT (INCLUDING HARDWARE)
		[LBS]
A	(1) - OPGW (49ay 85acs-2c 1-1427)	2 * 44 =88
B	(3) - 2156 KCM ACSR "Bluebird"	2 * 5150 +2* 1180 = 12660
C	(1) - 1780 KCM ACSR "Chukar"	2 * 190= 380

NOTES

1. CLEARANCE DIMENSIONS SHOWN ARE THE MINIMUMS TO BE PROVIDED FROM THE SURFACE OF SUPPORTING STEEL TO THE CORONA RING HOT BOX, (FOR POLE CONDUCTOR) OR TO CONDUCTOR (FOR MRC).
2. HEIGHT RANGE: 90'–190' IN INCREMENTS OF 5'.
3. ALL DIMENSIONS ARE IN FEET.
4. INSULATOR DIMENSIONS ARE MEASURED FROM THE WORKPOINT TO THE CENTER OF THE ATTACHMENT VANG HOLE.
5. FABRICATOR SHALL DEVELOP AND OPTIMIZE THE GEOMETRY AND WEIGHT FOR THE GENERAL DIMENSIONS, CLEARANCES, MAX SHIELD ANGLE, AND LOADS PROVIDED WHILE KEEPING THE ANCHOR BOLT CAGE DIAMETER TO A MINIMUM.
6. THE MRC PHASE SPACING SHOULD BE THAT OF THE TANGENT MRC IN THE SUSPENSION POLE UNLESS A GREATER SPACING IS REQUIRED TO MAINTAIN CLEARANCE TO THE SURFACE OF THE STEEL.
7. ALL POLE SHAFT SECTIONS SHALL BE SPLICED USING A BOLTED FLANGE CONNECTION.
8. DETAILED VANG ATTACHMENT INFORMATION WILL BE PROVIDED AT FINAL DESIGN.
9. THE ANGLES SHOWN REFLECT THE JUMPER POSITIONS UNDER AN EVERYDAY, 60°, 6 PSF, & 60°, 20.74 PSF CONDITIONS.



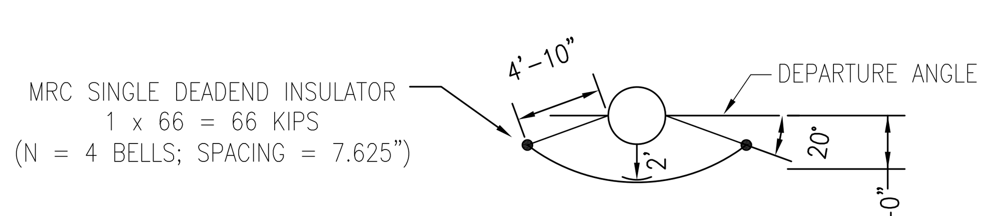
LEFT RIGHT
DETAIL "B"



LEFT
AVIAN HOT BOX
H x L = 40" x 60"

RIGHT
AVIAN HOT BOX
H x L = 40" x 60"

DETAIL "B"



SECTION d–d
SIDE VIEW – MRC JUMPER LOOP

SSP–16–2_DEADEND_TABLE 1_45–90.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

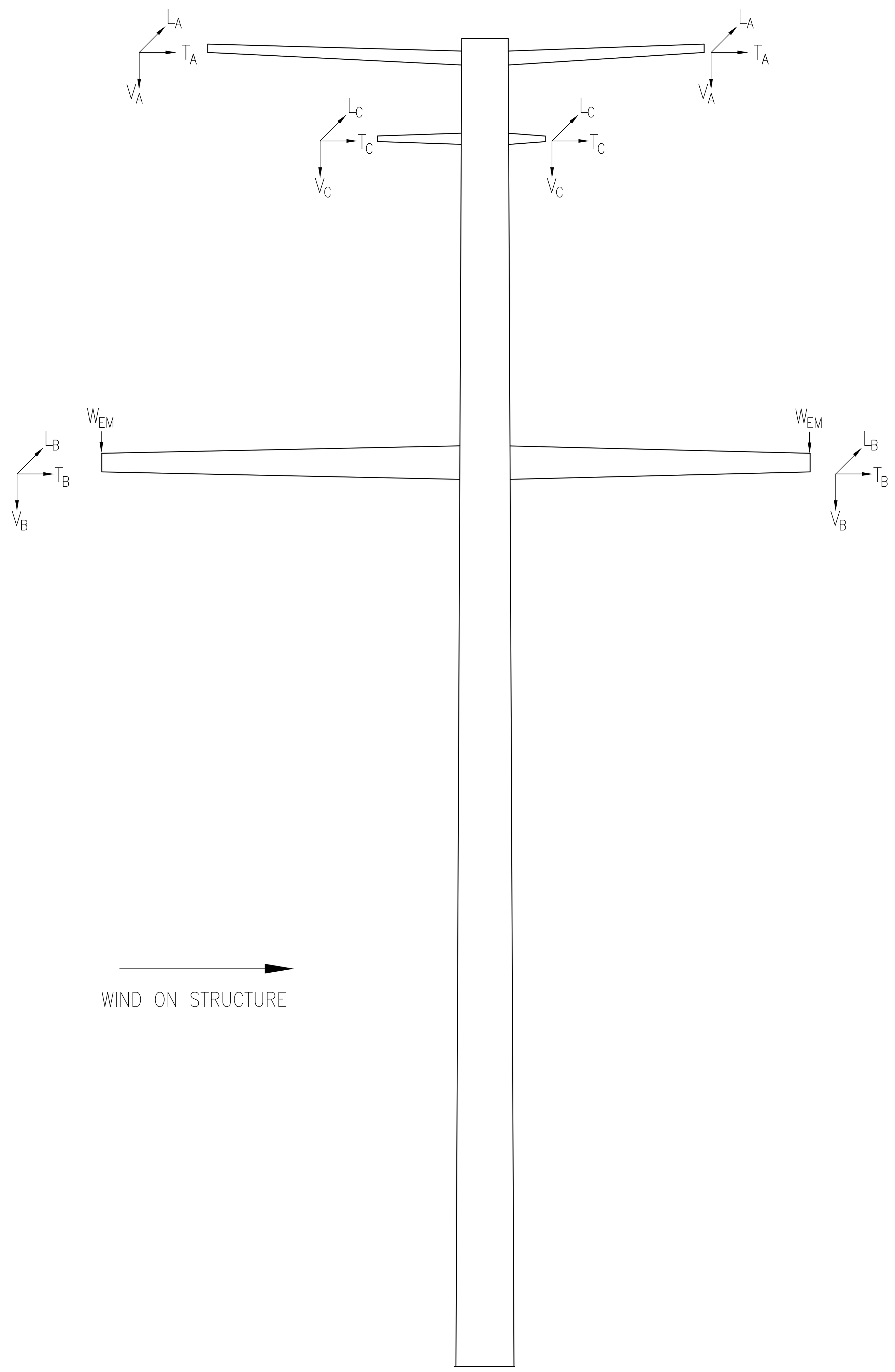
DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY
PLAINS AND EASTERN ± 600kV HVDC LINE DEADEND STEEL POLE
SELF SUPPORTING DEADEND POLE 45°–90° MRC ABOVE

JOB NUMBER: 132836
REV: A
DRAWING NUMBER: SSP–16–2



DESIGN PARAMETERS									
WIRE	WIRE TYPE	STRAND (al/st)	WEIGHT (lbs./ft.)	DIA. (in.)	INS. WT (lbs.)	ANGLE (deg)	RULING SPAN (ft.)	WIND SPAN (ft.)	WT SPAN (ft.)
A	(1) - OPGW (49ay 85acs-2c 1-1427)	NA	0.473	0.591	SEE TABLE 1	90°	1200	1500	2250
B	(3) - 2156 KCM ACSR "Bluebird"	84/19	2.511	1.762		90°	1200	1500	2250
C	(1) - 1780 KCM ACSR "Chukar"	84/19	2.075	1.602		90°	1200	1500	2250

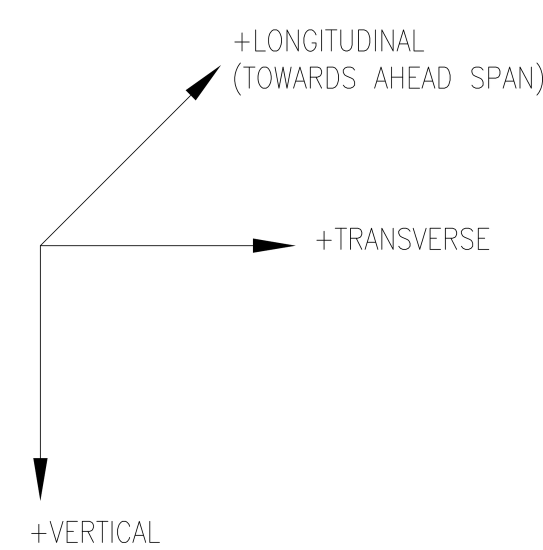
WEATHER CASES				OVERLOAD FACTORS			WIRE TENSIONS		
DESCRIPTION	TEMP (°F)	RADIAL ICE (in.)	WIND (psf)	WIND OLF	TENSION OLF	VERTICAL OLF	A (lbs.)	B (lbs.)	C (lbs.)
1. NESC HEAVY	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
2. NESC EXTREME WIND	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
3. NESC EXTREME WIND- YAW 45°	60	0.00	10.36	1.00	1.00	1.00	4896	15548	13479
4. NESC EXTREME WIND- LONGITUDINAL 90°	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
5. NESC EXTREME ICE WITH CONCURRENT WIND	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
6. EVERYDAY	60	0.00	0.00	1.00	1.00	1.00	3913	13758	11710
7. NESC HEAVY DE	0	0.50	4.00	2.50	1.65	1.50	8536	22985	20211
8. NESC EXTREME WIND DE	60	0.00	20.74	1.00	1.00	1.00	6525	19491	17202
9. NESC EXTREME ICE W/CONCURRENT WIND DE	15	1.00	4.10	1.00	1.00	1.00	11329	28306	25086
10. TORNADO WIND - STRUCTURE ONLY	60	0.00	63.10	-	-	-	-	-	-
11.NESC MEDIUM (SEE NOTE 9)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142
12.NESC MEDIUM DE (SEE NOTE 9)	15	0.25	4.00	2.50	1.65	1.50	6401	18608	16142

DEADEND 90°

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
1. NESC HEAVY	4.10	22.00	0.00	58.70	171.30	0.00	12.00	50.50	0.00	10.0
2. NESC EXTREME WIND	1.20	10.80	0.00	29.70	96.40	0.00	5.10	28.50	0.00	23
3. NESC EXTREME WIND- YAW 45°	1.20	7.50	-0.60	29.70	70.90	-4.90	5.10	20.60	-1.50	16.3
4. NESC EXTREME WIND- LONGITUDINAL 90°	1.20	5.60	-0.60	29.70	58.40	-4.90	5.10	16.60	-1.50	23
5. NESC EXTREME ICE WITH CONCURRENT WIND	5.70	17.40	0.00	52.80	125.90	0.00	12.40	37.40	0.00	4.1
6. EVERYDAY	1.20	5.60	0.00	29.70	58.40	0.00	5.10	16.60	0.00	0.0
7. NESC HEAVY DE	2.10	11.00	10.00	38.90	85.70	80.50	6.30	25.30	23.60	10.0
8. NESC EXTREME WIND DE	0.70	5.40	4.70	21.20	48.20	41.40	2.80	14.30	12.20	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	2.90	8.70	8.10	32.80	63.00	60.10	6.40	18.70	17.80	4.1
10. TORNADO WIND - STRUCTURE ONLY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.1
11.NESC MEDIUM (SEE NOTE 9)	2.70	16.40	0.00	50.80	138.80	0.00	9.60	40.30	0.00	10
12.NESC MEDIUM DE (SEE NOTE 9)	1.40	8.20	7.50	34.90	69.40	65.20	5.10	20.20	18.90	10

DEADEND 45°

LOAD SCHEDULE (KIPS): ALL LOADS INCLUDE OVERLOAD CAPACITY FACTORS										
DESCRIPTION	V_A	T_A	L_A	V_B	T_B	L_B	V_C	T_C	L_C	WIND ON STRUCTURE (psf)
7. NESC HEAVY DE	2.10	6.40	13.10	38.90	48.80	105.20	6.30	14.40	30.90	10.0
8. NESC EXTREME WIND DE	0.70	3.30	6.10	21.20	29.30	54.10	2.80	8.70	15.90	23.0
9. NESC EXTREME ICE W/CONCURRENT WIND DE	2.90	5.00	10.50	32.80	35.40	78.50	6.40	10.60	23.20	4.1
12.NESC MEDIUM DE (SEE NOTE 9)	1.40	4.80	9.80	34.90	39.50	85.10	5.10	11.60	24.70	10.0



SIGN CONVENTION FOR LOADS

NOTES

1. WIRE TENSIONS PROVIDED PER SUBCONDUCTOR. VECTOR LOADS PROVIDED PER PHASE.
2. CASE 6 SHALL INCLUDE AN ADDITIONAL 800LB LOAD (W_{EM}) AT THE TIP OF EACH ARM TO ACCOUNT FOR MAINTENANCE WITH TWO MEN AND EQUIPMENT. APPROPRIATE OLF SHALL BE APPLIED.
3. APPLY AN OLF OF 1.5 ON STRUCTURE WEIGHT FOR LOAD CASES 1,7,11 & 12.
4. APPLY AN OLF OF 1 ON STRUCTURE WEIGHT FOR LOAD CASES 2,3,4,5,6,7,8,9, & 10.
5. THE VALUES SHOWN FOR WIND PRESSURE ON STRUCTURE ARE FOR ROUND OR 12 SIDED MEMBERS. FOR 8 SIDED MEMBERS, MULTIPLY BY 1.4. FOR FLAT SURFACES, MULTIPLY BY 1.6.
6. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (2) TO 9% OF THE TOTAL STRUCTURE HEIGHT, WHICH INCLUDES 1.72 DEG (3%) FOUNDATION ROTATION.
7. LIMIT THE POLE TOP DEFLECTION UNDER LOAD CASE (6) TO $1\frac{1}{2}$% OF THE TOTAL STRUCTURE HEIGHT. POLES SHALL BE CAMBERED WHEN THIS LIMIT IS EXCEEDED.
8. LOAD CASES 1–5 AND 10 SHALL BE ANALYZED ASSUMING A FOUNDATION ROTATION OF 1.72 DEG (3%).
9. FOR STRUCTURES IN OKLAHOMA STATE, IT WILL BE USED LOADING CASE 1 "NESC HEAVY" AND LOADING CASE 7 "NESC HEAVY DE". FOR ARKANSAS AND TENNESSEE STATES, THE LOADING CASE 1 "NESC HEAVY" WILL BE REPLACED BY LOADING CASE 11 "NESC MEDIUM" AND LOADING CASE 7 "NESC HEAVY DE" WILL BE REPLACED BY LOADING CASE 12 "NESC HEAVY DE".
10. LOADING CASE 10 WILL BE APPLIED ON STRUCTURE ONLY, IN TRANVERSE, 45°, LONGITUDINAL DIRECTIONS.

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	CONCEPTUAL DESIGN	6/23/14	DVW	CIM	CIM	CIM

REFERENCE DRAWINGS

DSGN	CIM	6/9/14
DRN	DVW	6/9/14
CKD	CIM	6/9/14
SCALE:	NTS	

FOR 22x34 DWG ONLY

POWER ENGINEERS

CLEAN LINE ENERGY

PLAINS AND EASTERN ± 600kV HVDC LINE
DEADEND STEEL POLE

SELF SUPPORTING DEADEND TOWER 45°-90°
MRC ABOVE-LOAD DRAWING

JOB NUMBER 132836

REV A

DRAWING NUMBER SSP-16-3

SSP-16-3_DEADEND_LOADS_45-90.DWG