


	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 1



DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 2

INTRODUCCIÓN

En éste documento se describe la memoria de la evaluación estructural para una torre cuadrada de sección variable auto-soportada 100 m.

La evaluación se realiza según el levantamiento realizado en obra, corresponde a dimensiones de la torre, elementos estructurales y tornillería instalada.

Coordenadas 5° 53' 29" N 73° 4' 56" W

*Para el análisis estructural se utilizó para el diseño de la estructura, **la velocidad de viento de diseño de 125 Km/h. y velocidad de servicio de 80 Km/h, que corresponde a la región 3 del mapa eólico según NSR 10***

NORMAS

AISC Método LRFD

ASCE, report 52

EIA/TIA Standard, EIA/TIA-222-G

ANSI/ASCE 10-90

ACI 318 Método LRFD

NSR-10 (2010)

CARACTERISTICAS GEOMETRICAS

Altura: 166.46 metros

Ancho en la base: 13050 mm

Ancho en el tope: 820 mm

Altura Truncocónica: 104.56 metros

Altura sección recta: 61.90 metros

CALIDAD DE LOS MATERIALES



Platinas Acero ASTM A-36

Tornillos ASTM A 394 T-0 Para la torre en estado actual carga actual

Tornillos ASTM A 325 T-1 Para montantes y diagonales en reforzado y carga



futura Pernos de Anclaje SAE 1020 Calibrado

DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 3

ESTADO ACTUAL

ESTADO ACTUAL DE LA TORRE			
ANTENAS			
CANTIDAD		DESCRIPCION ANTENA	ALTURA EN TORRE
3		Antena Panel UHF 0.48 x 0.983	166
3		Antena Panel UHF 0.48 x 0.983	65
3		Antena Panel UHF 0.48 x 0.983	164
3		Antena Panel UHF 0.48 x 0.983	163
3		Antena Panel UHF 0.48 x 0.983	162
3		Antena Panel UHF 0.48 x 0.983	161
3		Antena Panel VHF Banda III 4 dipolos	152
3		Antena Panel VHF Banda III 4 dipolos	150.3
3		Antena Panel VHF Banda III 4 dipolos	148.6
3		Antena Panel VHF Banda III 4 dipolos	146.9
3		Antena Panel VHF Banda III 4 dipolos	145.2
3		Antena Panel VHF Banda III 4 dipolos	143.5
3		Antena Panel VHF Banda III 4 dipolos	140.0
3		Antena Panel VHF Banda III 4 dipolos	138.3
3		Antena Panel VHF Banda III 4 dipolos	136.6
3		Antena Panel VHF Banda III 4 dipolos	134.9
3		Antena Panel VHF Banda III 4 dipolos	133.2
3		Antena Panel VHF Banda III 4 dipolos	131.5
3		Antena Panel TV 4 Dipoles	96.0
3		Antena Panel TV 4 Dipoles	93.2

	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
Pág. 4			

ANTENAS MW

CANTIDAD	DIAMETRO	ALTURA EN TORRE	CANTIDAD
1	3.70	13	1
1	2.40	10	1

CARGA FUTURA

CARGA FUTURA ANTENAS RF		
CANTIDAD	DESCRIPCION ANTENA	ALTURA EN TORRE
3	Directional antenna470-860 MHz	160
3	Directional antenna470-860 MHz	159
3	Directional antenna470-860 MHz	158
3	Directional antenna470-860 MHz	157
3	Directional antenna470-860 MHz	156
3	Directional antenna470-860 MHz	154

NOTA:

A CONTINUACION SE MUESTRAN LOS AZIMUT DE LAS CARAS DE LA TORRE:

AZIMUT DE LA CARA A: 93°

AZIMUT DE LA CARA B: 183°

AZIMUT DE LA CARA C: 273°

AZIMUT DE LA CARA D: 3°

Estado Actual de la estructura

Tornilleria: Instalada calidad A-394 – en regular estado, se recomienda realizar mantenimiento

Pintura: En mal estado, se recomienda realizar mantenimiento

Luces de obstrucción y Fotocelda: En regular estado, no funciona bien



Pararrayos: En buen estado

Sistema puesta a tierra torre: En buen estado

Escalera de acceso: En regular

Línea de Vida: No Se encuentra línea de vida

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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 5



Evaluación Estructural Actual



El análisis estructural se realiza con las cargas actuales y una velocidad de viento de 125 kph y una velocidad de viento de servicio de 80 kph para verificar deflexiones.

El elemento con mayor sobre esfuerzo de 224.7 % se ubica en la diagonal a 128 m

Capacidad de los elementos estructurales



Section Capacity Table



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T1	166.46 - 162.46	Leg	L89x89x6	1	4546.72	29078.14	15.6	Pass
		Diagonal	L38x38x5	13	-1235.45	4968.65	24.9	Pass
		Top Girt	L64x64x6.4	7	74.01	16625.93	0.4	Pass
							0.5 (b)	
		Inner Bracing	L38x38x5	6	-80.51	3473.75	2.3	Pass
T2	162.46 - 159.46	Leg	L89x89x6	43	13088.64	29078.14	45.0	Pass
		Diagonal	L38x38x5	49	-2074.85	4968.65	41.8	Pass
T3	159.46 - 153.96	Leg	L89x89x6	71	37309.62	29078.14	128.3	Fail 
		Diagonal	L38x38x5	75	-2835.86	4968.65	57.1	Pass
T4	153.96 - 152.86	Leg	L89x89x8	119	40073.17	34122.54	117.4	Fail 
		Diagonal	L64x64x6	140	5709.23	16114.19	35.4	Pass
		Top Girt	L76x76x6	123	7672.74	20260.30	37.9	Pass
							44.1 (b)	

	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 6



T5	152.86 - 146.86	Leg	4L102x102x10	149	-46252.37	198905.30	23.3	Pass	
		Diagonal	L64x64x6	155	-3566.53	6025.07	59.2	Pass	
		Top Girt	L102x102x6	136	-4793.61	23716.17	20.2	Pass	
24.3 (b)									
T6	146.86 - 140.86	Leg	4L102x102x10	177	-83121.28	198905.30	41.8	Pass	
		Diagonal	L64x64x6	183	-4901.57	6025.07	81.4	Pass	
T7	140.86 - 134.86	Leg	4L102x102x10	205	-127516.64	198905.30	64.1	Pass	
		Diagonal	L76x76x6	211	-6309.65	9312.98	67.8	Pass	
T8	134.86 - 128.86	Leg	4L102x102x10	233	-177490.29	198905.30	89.2	Pass	
		Diagonal	L89x89x6	239	-7679.41	13033.25	58.9	Pass	
T9	128.86 - 122.86	Leg	4L102x102x10	259	230109.74	194922.76	118.1	Fail❌	
		Diagonal	L152x152x10	272	-12906.48	45267.58	28.5	Pass	
		37.5 (b)							
T10	122.86 - 119.56	Leg	4L152x152x16	287	201152.85	517458.32	38.9	Pass	
		41.4 (b)							
		Diagonal	L152x152x10	303	-40262.10	44326.42	90.8	Fail❌	
		224.7 (b)							
		Top Girt	L102x102x6	292	-18329.76	22012.25	83.3	Pass	
		94.0 (b)							
T11	119.56 - 112.06	Leg	4L127x127x13	311	150838.10	331706.75	45.5	Pass	
		Diagonal	L102x102x6	328	-8374.50	18044.54	46.4	Pass	
		46.8 (b)							
		Horizontal	L64x64x6	380	-2526.32	12772.80	19.8	Pass	
		Top Girt	L102x102x6	320	-11645.22	13890.73	83.8	Pass	
		Inner Bracing	L76x76x6	315	-247.03	2507.65	9.9	Pass	
T12	112.06 - 104.56	Leg	4L127x127x13	396	198561.48	331706.75	59.9	Pass	

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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 7



T13	104.56 - 99.76	Diagonal	L102x102x6	405	-10411.99	18044.54	57.7	Pass
		58.7 (b)						
		Horizontal	L64x64x6	423	-3159.21	10437.16	30.3	Pass
		Leg	4L152x152x10	462	-214673.08	292212.00	73.5	Pass
		Diagonal	L102x102x10	481	-10204.33	30551.32	33.4	Pass
		51.4 (b)						
		Horizontal	L64x64x6	477	-3224.04	11463.42	28.1	Pass
		Top Girt	L76x76x6	467	-3226.45	11906.89	27.1	Pass
		Redund Horz 1 Bracing	L51x51x3	498	-3693.28	4911.95	75.2	Pass
		Redund Diag 1 Bracing	L51x51x3	488	-3885.63	3383.01	114.9	Fail 
		Redund Hip 1 Bracing	L64x64x5	534	-113.32	8714.37	1.3	Pass
		Inner Bracing	L64x64x5	464	-389.37	1083.06	36.0	Pass
		Leg	4L152x152x10	537	-224031.60	290193.51	77.2	Pass
		Diagonal	L102x102x10	550	-6990.40	28249.29	24.7	Pass
		35.2 (b)						
T14	99.76 - 94.26	Horizontal	L64x64x6	546	-3364.59	8177.64	41.1	Pass
		Redund Horz 1 Bracing	L51x51x5	595	-4313.11	7117.46	60.6	Pass
		Redund Diag 1 Bracing	L51x51x5	582	-4739.27	3230.06	146.7	Fail 
		Redund Hip 1 Bracing	L64x64x5	597	-31.54	7808.55	0.4	Pass
		Leg	4L152x152x10	601	-228977.12	286864.60	79.8	Pass
		Diagonal	L102x102x10	614	-9546.04	25247.00	37.8	Pass
		48.1 (b)						
		Horizontal	L64x64x6	610	-3438.86	6231.00	55.2	Pass
		Redund Horz 1	L51x51x5	631	-3766.49	6365.35	59.2	Pass
T15	94.26 - 87.76							





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---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 8



Bracing								
T16	87.76 - 81.26	Redund Diag 1 Bracing	L51x51x5	646	-3944.33	2254.96	174.9	Fail X
		Redund Hip 1 Bracing	L64x64x5	647	-39.19	6791.41	0.6	Pass
		Leg	4L152x152x10	665	-244008.72	286864.60	85.1	Pass
		Diagonal	L102x102x10	678	-7095.55	24326.76	29.2	Pass
		35.9 (b)						
		Horizontal	L64x64x6	674	-3664.61	4656.17	78.7	Pass
		Redund Horz 1 Bracing	L51x51x5	700	-3871.64	5581.14	69.4	Pass
		Redund Diag 1 Bracing	L51x51x5	710	-3801.60	2002.06	189.9	Fail X
		Redund Hip 1 Bracing	L64x64x5	711	-34.06	5350.12	0.6	Pass
		Leg	4L152x152x10	729	-253392.19	286864.60	88.3	Pass
		Diagonal	L102x102x10	742	-8628.15	23345.09	37.0	Pass
		43.5 (b)						
		Horizontal	L76x76x6	738	-3805.53	6181.38	61.6	Pass
		Redund Horz 1 Bracing	L64x64x5	764	-3911.28	7618.68	51.3	Pass
		Redund Diag 1 Bracing	L64x64x5	774	-3423.09	3552.09	96.4	Pass
T17	81.26 - 74.76	Redund Hip 1 Bracing	L64x64x5	775	-32.66	4132.55	0.8	Pass
		Leg	4L152x152x13	793	-268849.72	447618.68	60.1	Pass
		61.9 (b)						
		Diagonal	L102x102x10	803	-7387.80	22285.09	33.2	Pass
		37.2 (b)						
T18	74.76 - 68.26	Horizontal	L76x76x6	802	-4037.68	4957.63	81.4	Pass
		Redund Horz 1 Bracing	L64x64x5	807	-4037.68	6839.59	59.0	Pass




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---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 9



T19	68.26 - 61.76	Redund Diag 1 Bracing	L64x64x5	838	-3063.23	3173.79	96.5	Pass
		Redund Hip 1 Bracing	L64x64x5	839	-22.77	3287.82	0.7	Pass
		Leg	4L152x152x13	857	-280245.32	447618.68	62.6	Pass
							64.8 (b)	
		Diagonal	L102x102x10	870	-8473.43	21211.85	39.9	Pass
							43.5 (b)	
		Horizontal	L76x76x6	866	-4208.82	4106.70	102.5	Fail 
		Redund Horz 1 Bracing	L64x64x5	871	-4208.82	5886.45	71.5	Pass
		Redund Diag 1 Bracing	L64x64x5	902	-3027.86	2843.21	106.5	Fail 
		Redund Hip 1 Bracing	L64x64x5	903	-19.32	2677.92	0.7	Pass
T20	61.76 - 57.265	Leg	4L152x152x19	921	-299558.84	663115.94	45.2	Pass
							52.1 (b)	
		Diagonal	L102x102x10	940	-8068.50	25883.08	31.2	Pass
							40.7 (b)	
		Redund Horz 1 Bracing	L64x64x6	941	-4498.88	10645.05	42.3	Pass
		Redund Horz 2 Bracing	L64x64x6	942	-4498.88	3342.90	134.6	Fail 
		Redund Diag 1 Bracing	L64x64x6	943	-3637.07	5416.53	67.1	Pass
		Redund Diag 2 Bracing	L64x64x6	944	-2704.58	2327.11	116.2	Fail 
		Redund Hip 1 Bracing	L64x64x6	973	-29.31	6277.72	0.5	Pass
		Redund Hip 2 Bracing	L64x64x5	972	-10.07	1209.06	0.8	Pass
T21	57.265 - 52.77	Leg	4L152x152x19	977	-300791.25	663115.94	45.4	Pass
							53.3 (b)	

DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 10



T22	52.77 - 48.275	Diagonal	L152x152x13	997	-12159.00	63265.27	19.2	Pass
		61.3 (b)						
		Horizontal	L102x102x6	934	-4517.39	20678.06	21.8	Pass
		28.2 (b)						
		Redund Horz 1 Bracing	L64x64x6	1006	-4517.39	10645.05	42.4	Pass
		Redund Horz 2 Bracing	L64x64x6	999	-4517.39	3342.90	135.1	Fail 
		Redund Diag 1 Bracing	L64x64x6	1008	-3776.82	6064.12	62.3	Pass
		Redund Diag 2 Bracing	L64x64x6	1001	-2983.12	3469.07	86.0	Pass
		Redund Hip 1 Bracing	L64x64x6	1033	-124.83	6277.72	2.0	Pass
		Redund Hip 2 Bracing	L64x64x5	1018	-53.61	1209.06	4.4	Pass
		Inner Bracing	L64x64x6	1035	-786.31	697.53	112.7	Fail 
		Leg	4L152x152x19	1046	-321578.03	663115.94	48.5	Pass
		55.9 (b)						
		Diagonal	L152x152x13	1060	-9382.97	63265.27	14.8	Pass
		47.3 (b)						
		Redund Horz 1 Bracing	L76x76x6	1076	-4829.58	13476.32	35.8	Pass
		Redund Horz 2 Bracing	L76x76x6	1067	-4829.58	4648.96	103.9	Fail 
		Redund Diag 1 Bracing	L76x76x6	1078	-4070.21	8525.72	47.7	Pass
		Redund Diag 2 Bracing	L76x76x6	1069	-2819.69	3435.66	82.1	Pass
		Redund Hip 1 Bracing	L64x64x6	1104	-113.30	4997.23	2.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1086	-58.03	962.44	6.0	Pass
		Redund Hip Diagonal	L76x76x6	1107	-48.03	1248.59	3.8	Pass


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---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 11



Bracing								
T23	48.275 - 43.78	Leg	4L152x152x19	1110	-323045.40	663115.94	48.7	Pass
57.2 (b)								
		Diagonal	L152x152x13	1130	-13793.43	61843.71	22.3	Pass
69.5 (b)								
		Horizontal	L76x76x6	1074	-4851.63	9472.28	51.2	Pass
		Redund Horz 1 Bracing	L76x76x6	1131	-4851.63	13476.32	36.0	Pass
		Redund Horz 2 Bracing	L76x76x6	1132	-4851.63	4648.96	104.4	Fail X
		Redund Diag 1 Bracing	L76x76x6	1143	-3499.41	9528.30	36.7	Pass
		Redund Diag 2 Bracing	L76x76x6	1144	-3068.65	5249.92	58.5	Pass
		Redund Hip 1 Bracing	L64x64x6	1172	-200.65	4997.23	4.0	Pass
		Redund Hip 2 Bracing	L64x64x5	1137	-27.75	962.44	2.9	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1154	-150.77	2792.19	5.4	Pass
		Inner Bracing	L64x64x6	1176	-242.35	555.25	43.6	Pass
T24	43.78 - 39.59	Leg	4L152x152x19	1187	-349135.14	666567.78	52.4	Pass
61.0 (b)								
		Diagonal	L152x152x13	1201	-9964.25	62861.12	15.9	Pass
50.2 (b)								
		Redund Horz 1 Bracing	L76x76x6	1207	-5243.44	12518.74	41.9	Pass
		Redund Horz 2 Bracing	L76x76x6	1208	-5243.44	3792.94	138.2	Fail X
		Redund Diag 1 Bracing	L76x76x6	1209	-3650.04	8207.08	44.5	Pass
		Redund Diag 2	L76x76x6	1210	-2950.28	3013.17	97.9	Pass

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---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 12



Bracing								
T25	39.59 - 34.79	Redund Hip 1 Bracing	L64x64x6	1245	-93.88	4098.98	2.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1227	-66.62	789.45	8.4	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1248	-47.98	1048.33	4.6	Pass
		Leg	4L152x152x19	1251	-350386.60	659437.31	53.1	Pass
		62.1 (b)						
		Diagonal	L152x152x13	1271	-13931.64	59360.29	23.5	Pass
		70.2 (b)						
		Horizontal	L76x76x6	1200	-5262.22	7844.84	67.1	Pass
		Redund Horz 1 Bracing	L76x76x6	1272	-5262.22	12518.74	42.0	Pass
		Redund Horz 2 Bracing	L76x76x6	1273	-5262.22	3792.94	138.7	Fail 
		Redund Diag 1 Bracing	L76x76x6	1274	-3728.13	8005.54	46.6	Pass
		Redund Diag 2 Bracing	L76x76x6	1275	-3290.16	4376.69	75.2	Pass
		Redund Hip 1 Bracing	L64x64x6	1313	-178.08	4098.98	4.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1278	-32.39	789.45	4.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1279	-137.70	2319.94	5.9	Pass
T26	34.79 - 30.29	Inner Bracing	L64x64x6	1317	-121.27	455.44	26.6	Pass
		Leg	4L152x152x19	1328	-375248.91	663056.98	56.6	Pass
		80.7 (b)						
		Diagonal	L152x152x13	1342	-11715.75	60336.87	19.4	Pass
		59.1 (b)						
		Redund Horz 1 Bracing	L76x76x6	1348	-5635.61	11526.10	48.9	Pass

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---------------------------------	-----------------------	--------------

	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 13



T27	30.29 - 25.8	Redund Horz 2 Bracing	L76x76x6	1349	-5635.61	3114.30	181.0	Fail X
		Redund Diag 1 Bracing	L76x76x6	1360	-3878.98	6862.40	56.5	Pass
		Redund Diag 2 Bracing	L76x76x6	1361	-3157.43	2497.00	126.4	Fail X
		Redund Hip 1 Bracing	L64x64x6	1386	-81.40	3381.46	2.4	Pass
		Redund Hip 2 Bracing	L64x64x5	1368	-56.38	651.25	8.7	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1389	-44.87	867.28	5.2	Pass
		Leg	4L203x203x19	1392	-376696.78	914120.43	41.2	Pass
							66.8 (b)	
		Diagonal	L152x152x16	1412	-14980.66	72732.65	20.6	Pass
							75.5 (b)	
		Horizontal	L76x76x6	1341	-5657.39	6538.26	86.5	Pass
		Redund Horz 1 Bracing	L76x76x6	1413	-5657.39	11687.72	48.4	Pass
		Redund Horz 2 Bracing	L76x76x6	1424	-5657.39	3163.20	178.8	Fail X
		Redund Diag 1 Bracing	L76x76x6	1415	-3703.40	7912.29	46.8	Pass
		Redund Diag 2 Bracing	L76x76x6	1426	-3365.76	4046.21	83.2	Pass
		Redund Hip 1 Bracing	L64x64x6	1454	-139.87	3381.46	4.1	Pass
		Redund Hip 2 Bracing	L64x64x5	1419	-25.76	651.25	4.0	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1420	-113.91	2019.41	5.6	Pass
		Inner Bracing	L64x64x6	1458	-106.86	375.72	28.4	Pass
T28	25.8 - 21.1	Leg	4L203x203x19	1469	-407945.22	912160.91	44.7	Pass
							71.4 (b)	





DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 14



T29	21.1 - 14.7	Diagonal	L152x152x16	1483	-12580.48	72428.74	17.4	Pass
		42.8 (b)						
		Redund Horz 1 Bracing	L76x76x6	1489	-6126.67	10714.35	57.2	Pass
		Redund Horz 2 Bracing	L76x76x6	1490	-6126.67	2645.43	231.6	Fail ✖
		Redund Diag 1 Bracing	L76x76x6	1501	-4137.65	6116.83	67.6	Pass
		Redund Diag 2 Bracing	L76x76x6	1502	-3404.91	2152.80	158.2	Fail ✖
		Redund Hip 1 Bracing	L64x64x6	1508	-57.22	2842.69	2.0	Pass
		Redund Hip 2 Bracing	L64x64x5	1509	-56.27	547.49	10.3	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1530	-47.65	732.46	6.5	Pass
		Leg	4L203x203x19	1533	-409289.21	911199.29	44.9	Pass
		72.5 (b)						
		Diagonal	L152x152x19	1559	-20012.23	104905.97	19.1	Pass
		74.1 (b)						
		Horizontal	L102x102x10	1482	-6146.86	18626.46	33.0	Pass
		Redund Horz 1 Bracing	L76x76x6	1560	-6146.86	13701.12	44.9	Pass
		Redund Horz 2 Bracing	L76x76x6	1571	-6146.86	4793.97	128.2	Fail ✖
		Redund Horz 3 Bracing	L76x76x6	1563	-6146.86	2076.99	296.0	Fail ✖
		Redund Diag 1 Bracing	L76x76x6	1572	-5115.30	9286.08	55.1	Pass
		Redund Diag 2 Bracing	L76x76x6	1574	-3483.78	3739.59	93.2	Pass
		Redund Diag 3 Bracing	L76x76x6	1565	-3637.33	3415.26	106.5	Fail ✖

DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 15




T30	14.7 - 9.6	Redund Hip 1 Bracing	L64x64x6	1605	-54.54	5053.66	1.1	Pass
		Redund Hip 2 Bracing	L64x64x5	1586	-36.29	973.31	3.7	Pass
		Inner Bracing	L64x64x6	1607	-133.68	315.85	42.3	Pass
		Leg	4L203x203x19	1618	-442592.43	919763.12	48.1	Pass
		76.8 (b)						
		Diagonal	L152x152x19	1636	-15477.26	108209.03	14.3	Pass
		43.9 (b)						
		Redund Horz 1 Bracing	L76x76x6	1644	-6646.99	12743.95	52.2	Pass
		Redund Horz 2 Bracing	L76x76x6	1645	-6646.99	3904.94	170.2	Fail 
		Redund Horz 3 Bracing	L76x76x6	1647	-6646.99	1696.00	391.9	Fail 
		Redund Diag 1 Bracing	L76x76x6	1646	-5041.77	9270.48	54.4	Pass
		Redund Diag 2 Bracing	L76x76x6	1662	-3671.45	3195.28	114.9	Fail 
		Redund Diag 3 Bracing	L76x76x6	1649	-3532.22	1530.80	230.7	Fail 
		Redund Hip 1 Bracing	L64x64x6	1671	-44.25	4146.39	1.1	Pass
		Redund Hip 2 Bracing	L64x64x5	1672	-60.65	798.58	7.6	Pass
		Redund Hip 3 Bracing	L64x64x5	1653	-31.73	354.92	8.9	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1702	-73.18	1070.23	6.8	Pass
T31	9.6 - 0	Leg	4L203x203x19	1706	-447032.19	900979.85	49.6	Pass
		78.7 (b)						
		Diagonal	L127x127x16	1738	-24028.16	67151.65	35.8	Pass
		68.1 (b)						
		Horizontal	L102x102x10	1635	-6713.67	15455.57	43.4	Pass



DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 16

Redund Horz 1 Bracing	L76x76x6	1757	-6713.67	14803.99	45.4	Pass
Redund Horz 2 Bracing	L76x76x6	1758	-6713.67	6208.91	108.1	Fail 
Redund Horz 3 Bracing	L76x76x6	1760	-6713.67	2680.61	250.5	Fail 
Redund Horz 4 Bracing	L76x76x6	1744	-6713.67	1486.36	451.7	Fail 
Redund Diag 1 Bracing	L76x76x6	1741	-6165.59	8173.78	75.4	Pass
Redund Diag 2 Bracing	L76x76x6	1743	-4184.72	4009.33	104.4	Fail 
Redund Diag 3 Bracing	L76x76x6	1745	-3721.07	2184.87	170.3	Fail 
Redund Diag 4 Bracing	L76x76x6	1746	-4066.99	2654.59	153.2	Fail 
Redund Hip 1 Bracing	L64x64x6	1812	-196.91	6478.75	3.0	Pass
Redund Hip 2 Bracing	L64x64x6	1813	-93.86	1619.68	5.8	Pass
Redund Hip 3 Bracing	L64x64x6	1815	-125.22	719.86	17.4	Pass
Redund Hip 4 Bracing	L64x64x6	1817	-39.09	404.92	9.7	Pass
Redund Hip Diagonal Bracing	L76x76x6	1782	-104.42	823.23	12.7	Pass
Inner Bracing	L64x64x6	1822	-107.40	259.15	41.4	Pass



Summary

Leg (T3)	128.3	Fail 
Diagonal (T10)	224.7	Fail 
Horizontal (T19)	102.5	Fail 
Top Girt (T10)	94.0	Pass
Redund Horz 1	75.2	Pass

	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	









	Bracing (T13)	
X	Redund Horz 2 Bracing (T28)	231
X	Redund Horz 3 Bracing (T30)	391
X	Redund Horz 4 Bracing (T31)	451
X	Redund Diag 1 Bracing (T16)	189
X	Redund Diag 2 Bracing (T28)	158
X	Redund Diag 3 Bracing (T30)	230
X	Redund Diag 4 Bracing (T31)	153
	Redund Hip 1 Bracing (T25)	4.
	Redund Hip 2 Bracing (T28)	10
	Redund Hip 3 Bracing (T31)	17
	Redund Hip 4 Bracing (T31)	9.

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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	

	Redund Hip	
	Diagonal	
	Bracing	
	(T31)	
X	Inner	1
	Bracing	
	(T21)	
X	Bolt Checks	2
X	RATING =	4



Bolt Design Data

Section	Elevation	Component	Bolt	Bolt Size	Number	Maximum	Allowable	Ratio	Allowable	Criteria
No.		Type	Grade		Of	Load per	Load	Load	Ratio	
	m			mm	Bolts	kg	kg	Allowable		
T1	166.46	Leg	A325X	16	8	31.49	8444.17	0.004 	1	Bearing
		Diagonal	A325X	16	2	536.30	5431.09	0.099 	1	Member Bearing
		Top Girt	A325X	16	2	37.01	6888.44	0.005 	1	Bolt Shear
T2	162.46	Leg	A325X	16	8	1419.04	8444.17	0.168 	1	Bearing
		Diagonal	A325X	16	2	1002.92	5431.09	0.185 	1	Member Bearing
T3	159.46	Leg	A325X	16	8	3717.83	8444.17	0.440 	1	Bearing
		Diagonal	A325X	16	2	1537.21	5431.09	0.283 	1	Member Bearing
T4	153.96	Leg	A325X	19	20	4007.32	13029.81	0.308 	1	Bearing
		Diagonal	A325X	19	2	2854.62	8702.13	0.328 	1	Member Bearing

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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
FECHA: Mayo de 2016	Revisión: 0	Pág. 19	



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
		Top Girt	A325X	19	2	3836.37	8702.13	0.441 ✓	1	Member Bearing
T5	152.86	Leg	A325X	19	28	1995.43	19838.73	0.101 ✓	1	Bolt DS
		Diagonal	A325X	19	2	1767.76	8702.13	0.203 ✓	1	Member Bearing
		Top Girt	A325X	19	2	2396.81	9877.75	0.243 ✓	1	Bolt Shear
T6	146.86	Leg	A325X	19	28	4112.34	19838.73	0.207 ✓	1	Bolt DS
		Diagonal	A325X	19	2	2390.73	8702.13	0.275 ✓	1	Member Bearing
T7	140.86	Leg	A325X	19	28	6944.50	19838.73	0.350 ✓	1	Bolt DS
		Diagonal	A325X	19	2	3008.41	8702.13	0.346 ✓	1	Member Bearing
T8	134.86	Leg	A325X	19	28	10258.67	19838.73	0.517 ✓	1	Bolt DS
		Diagonal	A325X	19	2	3546.59	8702.13	0.408 ✓	1	Member Bearing
T9	128.86	Leg	A325X	19	36	10416.34	19838.73	0.525 ✓	1	Bolt DS
		Diagonal	A325X	19	4	3706.14	9877.75	0.375 ✓	1	Bolt Shear
T10	122.86	Leg	A325X	22	36	11175.16	26990.52	0.414 ✓	1	Bolt DS
		Diagonal	A325X	19	2	22192.24	9877.75	2.247 ✗	1	Bolt Shear
		Top Girt	A325X	19	2	8181.99	8702.13	0.940 ✓	1	Member Bearing
T11	119.56	Leg	A325X	22	24	10632.12	26990.52	0.394 ✓	1	Bolt DS
		Diagonal	A325X	19	2	4074.50	8702.13	0.468 ✓	1	Member Bearing
		Horizontal	A325X	16	2	1315.05	6888.44	0.191 ✓	1	Bolt Shear
		Top Girt	A325X	19	2	6466.37	8702.13	0.743 ✓	1	Member Bearing









DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T12	112.06	Leg	A325X	22	28	12554.58	26990.52	0.465 	1	Bolt DS
		Diagonal	A325X	19	2	5108.81	8702.13	0.587 	1	Member Bearing
		Horizontal	A325X	16	2	1579.60	6888.44	0.229 	1	Bolt Shear
T13	104.56	Leg	A325X	22	28	15333.78	26990.52	0.568 	1	Bolt DS
		Diagonal	A325X	19	2	5102.14	9919.34	0.514 	1	Bolt Shear
		Horizontal	A325X	16	2	1612.02	6888.44	0.234 	1	Bolt Shear
		Top Girt	A325X	19	2	1613.22	9877.75	0.163 	1	Bolt Shear
T14	99.76	Leg	A325X	22	28	15923.50	26990.52	0.590 	1	Bolt DS
		Diagonal	A325X	19	2	3495.21	9919.34	0.352 	1	Bolt Shear
		Horizontal	A325X	16	2	1682.29	6888.44	0.244 	1	Bolt Shear
T15	94.26	Leg	A325X	22	28	16342.85	26990.52	0.606 	1	Bolt DS
		Diagonal	A325X	19	2	4773.02	9919.34	0.481 	1	Bolt Shear
		Horizontal	A325X	16	2	1719.43	6888.44	0.250 	1	Bolt Shear
T16	87.76	Leg	A325X	22	28	17351.95	26990.52	0.643 	1	Bolt DS
		Diagonal	A325X	19	2	3557.63	9919.34	0.359 	1	Bolt Shear
		Horizontal	A325X	16	2	1832.31	6888.44	0.266 	1	Bolt Shear
T17	81.26	Leg	A325X	22	32	15787.56	26990.52	0.585 	1	Bolt DS
		Diagonal	A325X	19	2	4314.06	9919.34	0.435 	1	Bolt Shear
		Horizontal	A325X	16	2	1902.77	6888.44	0.276 	1	Bolt Shear
























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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 21



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T18	74.76	Leg	A325X	22	32	16716.02	26990.52	0.619 	1	Bolt DS
		Diagonal	A325X	19	2	3693.90	9919.34	0.372 	1	Bolt Shear
		Horizontal	A325X	16	2	2018.84	6888.44	0.293 	1	Bolt Shear
T19	68.26	Leg	A325X	22	32	17483.63	26990.52	0.648 	1	Bolt DS
		Diagonal	A325X	19	2	4312.74	9919.34	0.435 	1	Bolt Shear
		Horizontal	A325X	16	2	2104.41	6888.44	0.305 	1	Bolt Shear
T20	61.76	Leg	A325X	25	32	18367.05	35268.81	0.521 	1	Bolt DS
		Diagonal	A325X	19	2	4034.26	9919.34	0.407 	1	Bolt Shear
T21	57.265	Leg	A325X	25	32	18799.46	35268.81	0.533 	1	Bolt DS
		Diagonal	A325X	19	2	6079.50	9919.34	0.613 	1	Bolt Shear
		Horizontal	A325X	19	2	2258.70	8005.64	0.282 	1	Member Bearing
T22	52.77	Leg	A325X	25	32	19705.51	35268.81	0.559 	1	Bolt DS
		Diagonal	A325X	19	2	4691.46	9919.34	0.473 	1	Bolt Shear
T23	48.275	Leg	A325X	25	32	20190.31	35268.81	0.572 	1	Bolt DS
		Diagonal	A325X	19	2	6896.74	9919.34	0.695 	1	Bolt Shear
		Horizontal	A325X	19	2	2425.80	8005.64	0.303 	1	Member Bearing
T24	43.78	Leg	A325X	25	32	21505.41	35268.81	0.610 	1	Bolt DS
		Diagonal	A325X	19	2	4982.12	9919.34	0.502 	1	Bolt Shear
T25	39.59	Leg	A325X	25	32	21899.13	35268.81	0.621 	1	Bolt DS

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	EVALUACION ESTRUCTURAL ACTUAL		
	TORRE CUADRADA SECC VARIABLE 166 m		
	ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	
			Pág. 22

Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T26	34.79	Diagonal	A325X	19	2	6965.82	9919.34	0.702 	1	Bolt Shear
		Horizontal	A325X	19	2	2631.11	8005.64	0.329 	1	Member Bearing
		Leg	A325X	25	26	28457.80	35268.81	0.807 	1	Bolt DS
		Diagonal	A325X	19	2	5857.88	9919.34	0.591 	1	Bolt Shear
T27	30.29	Leg	A325X	25	32	23543.54	35268.81	0.668 	1	Bolt DS
		Diagonal	A325X	19	2	7490.35	9919.34	0.755 	1	Bolt Shear
		Horizontal	A325X	19	2	2828.68	8005.64	0.353 	1	Member Bearing
		Leg	A325X	25	32	25199.01	35268.81	0.714 	1	Bolt DS
T28	25.8	Diagonal	A325X	19	3	4244.24	9919.34	0.428 	1	Bolt Shear
		Leg	A325X	25	32	25580.58	35268.81	0.725 	1	Bolt DS
		Diagonal	A325X	22	2	10006.11	13495.28	0.741 	1	Bolt Shear
		Horizontal	A325X	19	2	3073.42	9877.75	0.311 	1	Bolt Shear
T29	21.1	Leg	A325X	25	32	27104.01	35268.81	0.768 	1	Bolt DS
		Diagonal	A325X	25	2	7738.61	17634.41	0.439 	1	Bolt Shear
		Leg	A325X	25	32	27749.02	35268.81	0.787 	1	Bolt DS
		Diagonal	A325X	25	2	12014.08	17634.41	0.681 	1	Bolt Shear
T30	14.7	Horizontal	A325X	19	2	3356.84	9877.75	0.340 	1	Bolt Shear
		Leg	A325X	25	32	27104.01	35268.81	0.768 	1	Bolt DS
		Diagonal	A325X	25	2	7738.61	17634.41	0.439 	1	Bolt Shear
		Horizontal	A325X	19	2	3073.42	9877.75	0.311 	1	Bolt Shear
T31	9.6	Leg	A325X	25	32	27749.02	35268.81	0.787 	1	Bolt DS
		Diagonal	A325X	25	2	12014.08	17634.41	0.681 	1	Bolt Shear
		Horizontal	A325X	19	2	3356.84	9877.75	0.340 	1	Bolt Shear
		Leg	A325X	25	32	27749.02	35268.81	0.787	1	Bolt DS

DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. L. F. M.	APROBÓ: RTVC
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	EVALUACION ESTRUCTURAL ACTUAL TORRE CUADRADA SECC VARIABLE 166 m ESTACION: LA RUSIA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 23

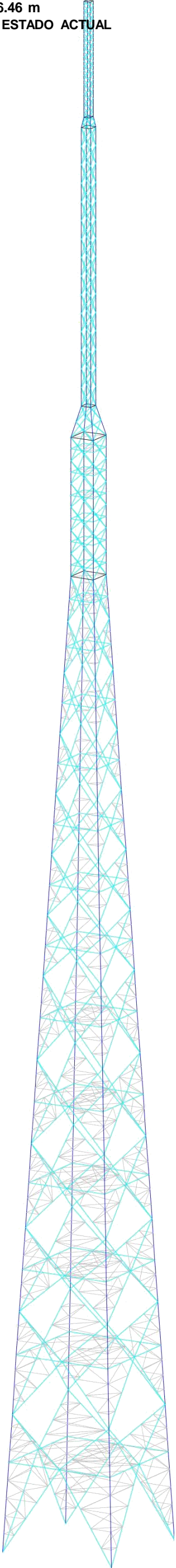
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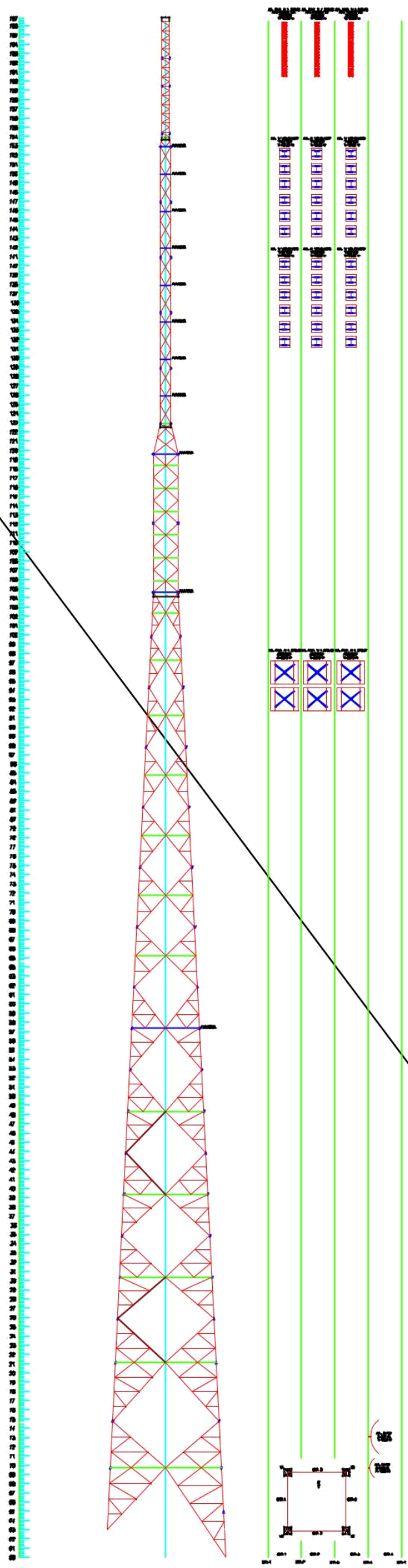
Luego de análisis de la torre en el estado reforzado con las cargas actuales más cargas futuras y teniendo en cuenta la velocidad de viento de operación de 80 kph La estructura está trabajando dentro de los parámetros de desplazamiento.

OK

CIMENTACION

Según lo explorado en campo la cimentación es una pila cuadrada de 1.60 m de lado, no se pudo determinar la profundidad.





	ESTACION BASE: LA RUSIA TORRE CUADRADA SECCION VARIABLE 166.46 m	REALIZO:	FECHA: Mayo /16
CONTRATISTA: 	CONTIENE: ESTADO ACTUAL – UBICACION ANTENAS	DIBUJO: M.C. Betancourt.	ESCALA:

DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	145.2
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	145.2
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	138.3
ANTENA PANEL UHF 0.48x0.983	163	ANTENA VHF BAND III 2 DIPOLOS	138.3
ANTENA PANEL UHF 0.48x0.983	163	ANTENA VHF BAND III 2 DIPOLOS	136.6
ANTENA PANEL UHF 0.48x0.983	162	ANTENA VHF BAND III 2 DIPOLOS	136.6
ANTENA PANEL UHF 0.48x0.983	162	ANTENA VHF BAND III 2 DIPOLOS	134.9
ANTENA PANEL UHF 0.48x0.983	161	ANTENA VHF BAND III 2 DIPOLOS	134.9
ANTENA PANEL UHF 0.48x0.983	161	ANTENA VHF BAND III 2 DIPOLOS	134.9
ANTENA VHF BAND III 2 DIPOLOS	152	ANTENA VHF BAND III 2 DIPOLOS	133.2
ANTENA VHF BAND III 2 DIPOLOS	152	ANTENA VHF BAND III 2 DIPOLOS	133.2
ANTENA VHF BAND III 2 DIPOLOS	152	ANTENA VHF BAND III 2 DIPOLOS	131.5
ANTENA VHF BAND III 2 DIPOLOS	150.3	ANTENA VHF BAND III 2 DIPOLOS	131.5
ANTENA VHF BAND III 2 DIPOLOS	150.3	ANTENA VHF BAND III 2 DIPOLOS	131.5
ANTENA VHF BAND III 2 DIPOLOS	150.3	ANTENA PANEL TV 4 DIPOLES	96
ANTENA VHF BAND III 2 DIPOLOS	148.6	ANTENA PANEL TV 4 DIPOLES	96
ANTENA VHF BAND III 2 DIPOLOS	148.6	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	146.9	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	146.9	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	146.9	HP12-59E	13
ANTENA VHF BAND III 2 DIPOLOS	145.2	HP8-122D	10

SYMBOL LIST

MARK	SIZE	MARK	SIZE
A	L89x89x8	I	L38x38x5
B	4L152x152x16	J	L64x64x5
C	L76x76x6	K	L64x64x6
D	L89x89x6	L	2 @ 0.55
E	L64x64x6.4	M	2 @ 1.65
F	L102x102x6	N	1 @ 4.19
G	L102x102x10	O	1 @ 4.49
H	L51x51x3		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	345 MPa	448 MPa			

TOWER DESIGN NOTES

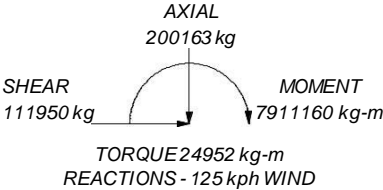
- Tower designed for Exposure C to the TIA-222-G Standard.
- Tower designed for a 125 kph basic wind in accordance with the TIA-222-G Standard.
- Deflections are based upon a 80 kph wind.
- Tower Structure Class II.
- Topographic Category 1 with Crest Height of 0.000 m 6.
- Weld together tower section have flange connections.
- Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153
- Tower members are fabricated with AWS E60XX/E70XX electrodes.
- All welded joints and connection flanges certified for integrity at a quality per AWS D1:1
- RF antennas feeders shall be 1-5/8" and installed 48 feeders per side
- MW dishes feeders shall be 1/2" and installed 8 feeders per side
- TOWER RATING: 451.7%

ALL REACTIONS

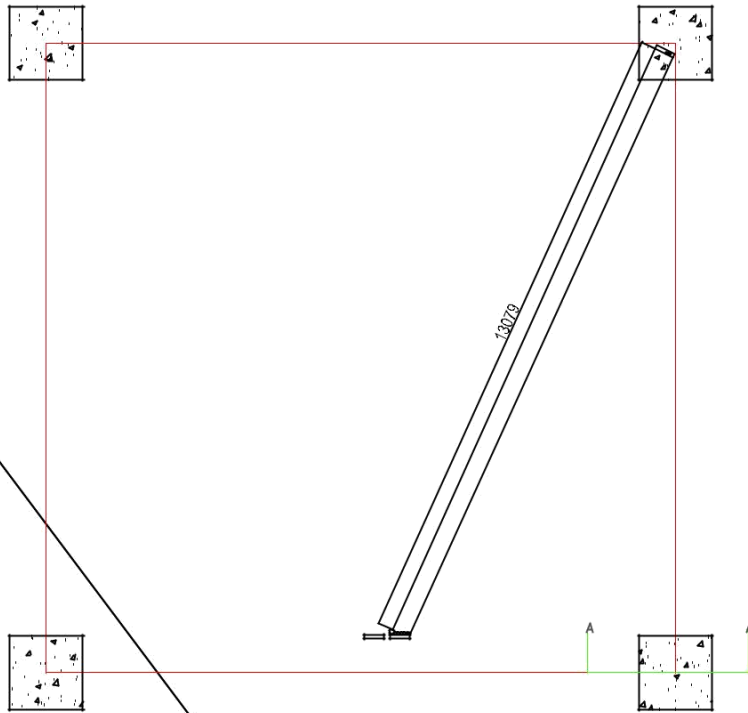
ARE FACTORED TIA/EIA-222 and AISC Specifications.

MAX. CORNER REACTIONS AT BASE:

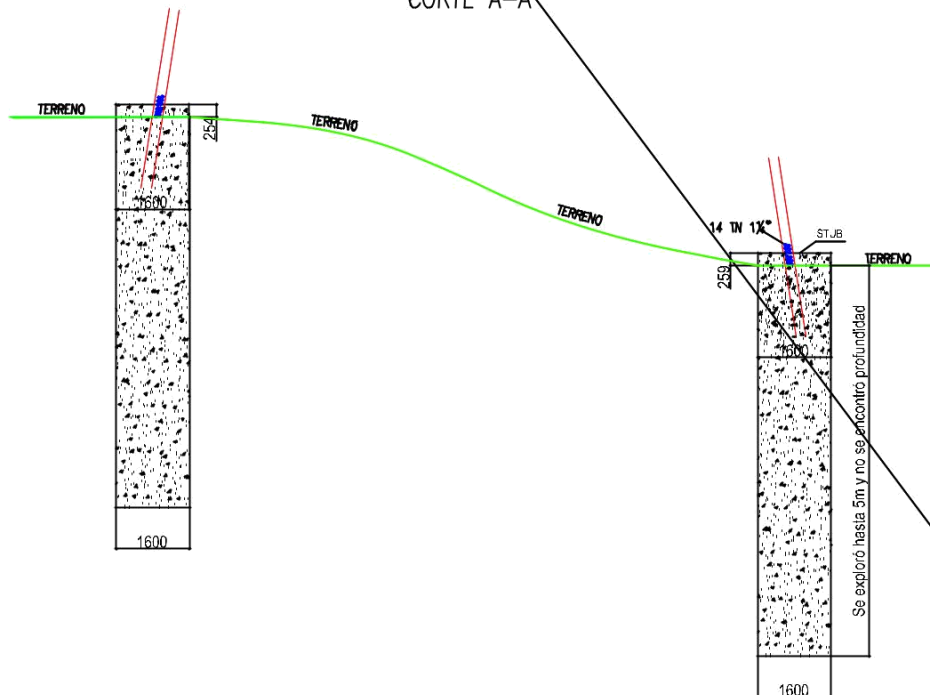
DOWN: 478394 kg
UP/LIFT: -390344 kg
SHEAR: 48227 kg



BTESA Calle 129 No. 8 - 08 Bogotá - Colombia Phone: (57-1) 274 0536 FAX: (57-1) 274 0536	Job: ESTUDIO ESTRUCTURAL - ESTACION LA RUSIA ESTADO ACTUA Project: TORRE CUADRADA SECCION VARIABLE DE 166.46 m Client: RTVC Code: TIA-222-G Path: Drawn by: Ing. Jaime Gutierrez C. Date: 05/20/16 Scale: NTS Dwg No. E-1
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CIMENTACION CORTE A-A'



ESTACION BASE: LA RUSIA
TORRE CUADRADA SECCION VARIABLE 166.46 m

REALIZO:

FECHA:

Mayo X16

CONTRATISTA:





CONTIENE:
CIMENTACION TORRE

DIBUJO:

M.C. Betancourt.

ESCALA:

	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 1

EVALUACION TORRE A 125 KPH

Solicitan adicionar las siguientes cargas:

Estación	Sistema de antenas				
	Configuración Antenas Panel	Acimut Antenas Panel	Altura centro de radiación (m)	No de Distribuidores	Líneas de Transmisión
LA RUSIA	(6:6:6:)	(120:210:300:)	161	2	2 x 1 5/8"

Con esta solicitud la estructura de la torre no cumple con la carga actual más la carga futura y es necesario reforzar el cual se informa adelante.

EVALUACION ESTRUCTURAL TORRE CON CARGA FUTURA

Se realizó el análisis estructural de la torre con la carga actual + carga futura obteniendo el siguiente resultado:

Tornillería

*La tornillería instalada es de calidad A 394 T-0, **NO CUMPLE** la unión entre montantes con los esfuerzos, se solicita se reemplace toda la tornillería de unión de montantes por **tornillos A 325 T-1***

Torqueo



Como se realiza refuerzo de la torre y cambio de tornillería es recomendable se realice protocolo de torque después de terminado el refuerzo

Placa Base y Pernos de Anclaje

Placa base: Cumple con los esfuerzos requerido

Pernos de anclaje: Cumple con los esfuerzos requeridos

DISEÑO: Ing. Jaime Gutiérrez C.	REVISÓ: Ing. J. G. C.	APROBÓ: RTVC
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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 2

Escalera de Acceso

Se encuentra escalera de acceso con Línea de vida y no cumple con la norma

Se recomienda por seguridad, la instalación de línea de vida que cumpla con la norma y en la parte superior con absorbedor de energía y su anclaje inferior con indicador de tensión del cable

PORCENTAJES DE ESFUERZO

En el análisis realizado a la estructura de la torre, se realizó con las normas vigentes de la EIA/TIA Standard, EIA/TIA-222-G, ANSI/ASCE 10-90 (1991), NSR-10 (2010).



ITEM	TORRE (Velocidad viento 125 KPH)	MONTANTE	DIAGONAL	HORIZONTAL	TORNILLERIA
1	Antes de Reforzarse Con Cargas de Antenas Actuales	128.3%	224.7%	451.7%	224.7%
2	Estado Actual + Carga de Antenas Nuevas, Recomendadas	95.7%	97.8%	96.7%	97.7%

Luego del análisis de la torre con la carga futura, el resultado de la estructura quedo así:

Montantes, Diagonales, Horizontales



Section Capacity Table

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 3



<i>Section</i>	<i>Elevation</i>	<i>Component</i>	<i>Size</i>	<i>Critical</i>	<i>P</i>	<i>ØP_{allow}</i>	<i>%</i>	<i>Pass</i>
<i>No.</i>	<i>m</i>	<i>Type</i>		<i>Element</i>	<i>kg</i>	<i>kg</i>	<i>Capacity</i>	<i>Fail</i>
T1	166.46 - 162.46	Leg	L89x89x6	1	4607.46	29078.14	15.8	Pass
		Diagonal	L38x38x5	13	-1213.04	4968.65	24.4	Pass
		Top Girt	L64x64x6.4	7	80.25	16625.93	0.5	Pass
							0.6 (b)	
		Inner Bracing	L38x38x5	6	-90.14	3473.75	2.6	Pass
T2	162.46 - 159.46	Leg	L89x89x6	43	13125.11	29078.14	45.1	Pass
		Diagonal	L38x38x5	49	-2191.01	4968.65	44.1	Pass
T3	159.46 - 153.96	Leg	L89x6+L76x6	71	40825.73	60920.19	67.0	Pass
		Diagonal	L38x38x5	81	-3676.31	4968.65	74.0	Pass
T4	153.96 - 152.86	Leg	L89x6+L76x6	119	43821.03	59538.10	73.6	Pass
		Diagonal	L64x64x6	139	-5480.62	15095.56	36.3	Pass
		Top Girt	L76x76x6	123	7996.43	20260.30	39.5	Pass
							45.9 (b)	
T5	152.86 - 146.86	Leg	4L102x102x10	149	-54480.54	198905.30	27.4	Pass
		Diagonal	L64x64x6	155	-4372.33	6025.07	72.6	Pass
		Top Girt	L102x102x6	136	-5146.78	23716.17	21.7	Pass
							26.1 (b)	
T6	146.86 - 140.86	Leg	4L102x102x10	177	-96226.02	198905.30	48.4	Pass
		Diagonal	L64x64x6	183	-5661.70	6025.07	94.0	Pass
T7	140.86 - 134.86	Leg	4L102x102x10	205	-143797.89	198905.30	72.3	Pass
		Diagonal	L76x76x6	211	-6955.84	9312.98	74.7	Pass
T8	134.86 - 128.86	Leg	4L127x127x10	233	-195256.15	265231.86	73.6	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 4



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ØPallow kg	% Capacity	Pass Fail
T9	128.86 - 122.86	Diagonal	L89x89x6	239	-8221.91	13343.42	61.6	Pass
		Leg	4L127x127x10	259	250056.47	261260.66	95.7	Pass
		Diagonal	L152x152x10	272	-13213.19	44747.40	29.5	Pass
T10	122.86 - 119.56						81.1 (b)	
		Leg	4L152x152x16	287	218773.10	517458.32	42.3	Pass
							45.0 (b)	
T11	119.56 - 112.06	Diagonal	L152x152x10	303	-44736.69	45749.79	97.8	Pass
		Top Girt	L102x102x6	292	-18895.67	22463.62	84.1	Pass
		Leg	4L127x127x13	311	162909.11	331706.75	49.1	Pass
		Diagonal	L102x102x6	328	-8832.90	18044.54	49.0	Pass
							49.4 (b)	
		Horizontal	L64x64x6	380	-2761.43	12772.80	21.6	Pass
T12	112.06 - 104.56	Top Girt	L102x102x6	320	-13434.37	13890.73	96.7	Pass
		Inner Bracing	L76x76x6	315	-284.99	2507.65	11.4	Pass
		Leg	4L127x127x13	396	211997.79	331706.75	63.9	Pass
		Diagonal	L102x102x6	405	-10832.97	18044.54	60.0	Pass
							61.7 (b)	
		Horizontal	L64x64x6	426	-3366.22	10437.16	32.3	Pass
T13	104.56 - 99.76	Leg	4L152x152x10	462	-225519.39	292212.00	77.2	Pass
		Diagonal	L102x102x10	481	-13008.49	30551.32	42.6	Pass
							65.6 (b)	
		Horizontal	L64x64x6	477	-3386.93	11463.42	29.5	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 5



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T14	99.76 - 94.26	Top Girt	L76x76x6	467	-3518.76	11906.89	29.6	Pass
		Redund Horz 1 Bracing	L64x64x6	498	-6648.89	14097.56	47.2	Pass
		Redund Diag 1 Bracing	L64x64x6	483	-6819.04	10197.39	66.9	Pass
		Redund Hip 1 Bracing	L64x64x5	534	-135.66	8714.37	1.6	Pass
		Inner Bracing	L64x64x5	464	-424.26	1083.06	39.2	Pass
		Leg	4L152x152x10	537	-234219.74	290193.51	80.7	Pass
		Diagonal	L102x102x10	550	-8283.10	28249.29	29.3	Pass
							41.8 (b)	
		Horizontal	L64x64x6	554	-3517.60	8177.64	43.0	Pass
		Redund Horz 1 Bracing	L64x64x6	595	-6102.45	13191.29	46.3	Pass
		Redund Diag 1 Bracing	L64x64x6	582	-6600.77	8348.78	79.1	Pass
		Redund Hip 1 Bracing	L64x64x5	597	-33.96	7808.55	0.4	Pass
		Leg	4L152x152x10	601	-238535.22	286864.60	83.2	Pass
		Diagonal	L102x102x10	614	-10556.41	25247.00	41.8	Pass
T15	94.26 - 87.76						53.2 (b)	
		Horizontal	L64x64x6	610	-3582.41	6231.00	57.5	Pass
		Redund Horz 1 Bracing	L64x64x6	631	-5063.86	12149.79	41.7	Pass
		Redund Diag 1 Bracing	L64x64x6	646	-5242.35	5828.39	89.9	Pass
		Redund Hip 1 Bracing	L64x64x5	647	-41.59	6791.41	0.6	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 6



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T16	87.76 - 81.26	Leg	4L152x152x10	665	-252981.24	286864.60	88.2	Pass
		Diagonal	L102x102x10	678	-7819.48	24326.76	32.1	Pass
							39.4 (b)	
		Horizontal	L64x64x6	674	-3799.36	4656.17	81.6	Pass
		Redund Horz 1 Bracing	L64x64x6	723	-5138.84	11049.10	46.5	Pass
		Redund Diag 1 Bracing	L64x64x6	710	-4964.48	5174.72	95.9	Pass
T17	81.26 - 74.76	Redund Hip 1 Bracing	L64x64x5	725	-36.42	5350.12	0.7	Pass
		Leg	4L152x152x10	729	-261914.74	286864.60	91.3	Pass
		Diagonal	L102x102x10	742	-9201.12	23345.09	39.4	Pass
							46.4 (b)	
		Horizontal	L76x76x6	738	-3933.53	6181.38	63.6	Pass
		Redund Horz 1 Bracing	L76x76x6	787	-4972.96	13802.32	36.0	Pass
T18	74.76 - 68.26	Redund Diag 1 Bracing	L76x76x6	774	-4310.47	8111.00	53.1	Pass
		Redund Hip 1 Bracing	L64x64x5	775	-34.40	4132.55	0.8	Pass
		Leg	4L152x152x13	793	-276791.67	447618.68	61.8	Pass
							63.7 (b)	
		Diagonal	L102x102x10	803	-7493.62	22285.09	33.6	Pass
							38.8 (b)	
		Horizontal	L76x76x6	802	-4156.96	4957.63	83.8	Pass
		Redund Horz 1 Bracing	L76x76x6	828	-4399.13	12719.23	34.6	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 7



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T19	68.26 - 61.76	Redund Diag 1 Bracing	L76x76x6	838	-3695.58	7247.14	51.0	Pass
		Redund Hip 1 Bracing	L64x64x5	839	-23.93	3287.82	0.7	Pass
		Leg	4L152x152x13	857	-287738.22	447618.68	64.3	Pass
							66.5 (b)	
		Diagonal	L102x102x10	870	-8915.00	21211.85	42.0	Pass
							45.6 (b)	
		Horizontal	2L76x76x6	866	-4321.36	13253.47	32.6	Pass
		Redund Horz 1 Bracing	L76x76x6	871	-4321.36	11672.07	37.0	Pass
		Redund Diag 1 Bracing	L76x76x6	902	-3108.82	6492.31	47.9	Pass
		Redund Hip 1 Bracing	L64x64x5	917	-20.14	2677.92	0.8	Pass
T20	61.76 - 57.265	Leg	4L152x152x19	921	-307019.07	663115.94	46.3	Pass
							53.3 (b)	
		Diagonal	L102x102x10	940	-7759.70	25883.08	30.0	Pass
							39.1 (b)	
		Redund Horz 1 Bracing	L76x76x6	941	-4610.90	14493.87	31.8	Pass
		Redund Horz 2 Bracing	L76x76x6	942	-4610.90	5880.55	78.4	Pass
		Redund Diag 1 Bracing	L76x76x6	943	-3926.46	9528.30	41.2	Pass
		Redund Diag 2 Bracing	L76x76x6	944	-2772.43	4093.67	67.7	Pass
		Redund Hip 1 Bracing	L64x64x6	973	-31.52	6277.72	0.5	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 8



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T21	57.265 - 52.77	Redund Hip 2 Bracing	L64x64x5	946	-10.57	1209.06	0.9	Pass
		Leg	4L152x152x19	977	-308337.21	663115.94	46.5	Pass
							54.6 (b)	
		Diagonal	L152x152x13	997	-12550.68	63265.27	19.8	Pass
							63.3 (b)	
		Horizontal	L102x102x6	934	-4630.73	20678.06	22.4	Pass
							28.9 (b)	
		Redund Horz 1 Bracing	L64x64x6	1006	-4630.73	10645.05	43.5	Pass
		Redund Horz 2 Bracing	L76x76x6	999	-4630.73	5880.55	78.7	Pass
		Redund Diag 1 Bracing	L76x76x6	1008	-4123.69	10454.22	39.4	Pass
		Redund Diag 2 Bracing	L76x76x6	1009	-3057.96	6102.50	50.1	Pass
		Redund Hip 1 Bracing	L64x64x6	1033	-137.45	6277.72	2.2	Pass
		Redund Hip 2 Bracing	L64x64x5	1018	-66.56	1209.06	5.5	Pass
		Inner Bracing	L76x76x6	1035	-882.81	1227.03	71.9	Pass
T22	52.77 - 48.275	Leg	4L152x152x19	1046	-328854.11	663115.94	49.6	Pass
							57.0 (b)	
		Diagonal	L152x152x13	1060	-9269.03	63265.27	14.7	Pass
							46.7 (b)	
		Redund Horz 1 Bracing	L102x102x6	1096	-5224.12	19720.25	26.5	Pass
		Redund Horz 2	L102x102x6	1067	-4938.85	11295.00	43.7	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 9



Section	Elevation	Component	Size	Critical Element	P	ØPallow	% Capacity	Pass Fail
No.	m	Type			kg	kg		
Bracing								
		Redund Diag 1 Bracing	L102x102x6	1078	-4664.93	16034.13	29.1	Pass
		Redund Diag 2 Bracing	L102x102x6	1069	-2883.77	8347.19	34.5	Pass
		Redund Hip 1 Bracing	L64x64x6	1104	-134.40	4997.23	2.7	Pass
		Redund Hip 2 Bracing	L64x64x5	1086	-66.45	962.44	6.9	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1107	-46.64	1248.59	3.7	Pass
T23	48.275 - 43.78	Leg	4L152x152x19	1110	-330387.25	663115.94	49.8	Pass
							58.5 (b)	
		Diagonal	L152x152x13	1130	-14427.92	61843.71	23.3	Pass
							72.7 (b)	
		Horizontal	L76x76x6	1059	-4961.89	9472.28	52.4	Pass
		Redund Horz 1 Bracing	L102x102x6	1141	-4961.89	19720.25	25.2	Pass
		Redund Horz 2 Bracing	L102x102x6	1132	-4961.89	11295.00	43.9	Pass
		Redund Diag 1 Bracing	L102x102x6	1143	-3908.82	16605.16	23.5	Pass
		Redund Diag 2 Bracing	L102x102x6	1134	-3138.39	12755.02	24.6	Pass
		Redund Hip 1 Bracing	L64x64x6	1172	-214.32	4997.23	4.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1153	-29.47	962.44	3.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1154	-159.93	2792.19	5.7	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T24	43.78 - 39.59	Inner Bracing	L64x64x6	1176	-221.97	555.25	40.0	Pass
		Leg	4L152x152x19	1187	-356276.04	666567.78	53.4	Pass
							62.1 (b)	
		Diagonal	L152x152x13	1201	-9790.07	62861.12	15.6	Pass
							49.3 (b)	
		Redund Horz 1 Bracing	L102x102x6	1207	-5350.67	18928.41	28.3	Pass
		Redund Horz 2 Bracing	L102x102x6	1208	-5350.67	9215.23	58.1	Pass
		Redund Diag 1 Bracing	L102x102x6	1209	-4104.50	15832.51	25.9	Pass
		Redund Diag 2 Bracing	L102x102x6	1210	-3011.17	7320.76	41.1	Pass
		Redund Hip 1 Bracing	L64x64x6	1245	-109.76	4098.98	2.7	Pass
		Redund Hip 2 Bracing	L64x64x5	1227	-72.92	789.45	9.2	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1248	-46.39	1048.33	4.4	Pass
T25	39.59 - 34.79	Leg	4L152x152x19	1251	-357618.22	659437.31	54.2	Pass
							63.4 (b)	
		Diagonal	L152x152x13	1271	-14375.80	59360.29	24.2	Pass
							72.5 (b)	
		Horizontal	L76x76x6	1200	-5370.85	7844.84	68.5	Pass
		Redund Horz 1 Bracing	L102x102x6	1272	-5370.85	18928.41	28.4	Pass
		Redund Horz 2 Bracing	L102x102x6	1273	-5370.85	9215.23	58.3	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 11



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T26	34.79 - 30.29	Redund Diag 1 Bracing	L102x102x6	1284	-4118.54	15699.34	26.2	Pass
		Redund Diag 2 Bracing	L102x102x6	1285	-3358.07	10633.48	31.6	Pass
		Redund Hip 1 Bracing	L64x64x6	1313	-190.76	4098.98	4.7	Pass
		Redund Hip 2 Bracing	L64x64x5	1294	-33.23	789.45	4.2	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1295	-142.15	2319.94	6.1	Pass
		Inner Bracing	L64x64x6	1317	-113.72	455.44	25.0	Pass
		Leg	4L152x152x19	1328	-382512.29	663056.98	57.7	Pass
							82.1 (b)	
		Diagonal	L152x152x13	1342	-11619.77	60336.87	19.3	Pass
							58.6 (b)	
		Redund Horz 1 Bracing	L102x102x6	1348	-5744.70	18084.69	31.8	Pass
		Redund Horz 2 Bracing	L102x102x6	1349	-5744.70	7566.42	75.9	Pass
		Redund Diag 1 Bracing	L102x102x6	1350	-4316.14	14845.36	29.1	Pass
		Redund Diag 2 Bracing	L102x102x6	1351	-3219.29	6066.62	53.1	Pass
		Redund Hip 1 Bracing	L64x64x6	1386	-95.35	3381.46	2.8	Pass
T27	30.29 - 25.8	Redund Hip 2 Bracing	L64x64x5	1368	-62.56	651.25	9.6	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1389	-43.79	867.28	5.0	Pass
		Leg	4L203x203x19	1392	-384076.73	914120.43	42.0	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 12



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ØP _{allow} kg	% Capacity	Pass Fail
							68.1 (b)	
		Diagonal	L152x152x16	1412	-15931.58	72732.65	21.9	Pass
							80.3 (b)	
		Horizontal	L76x76x6	1341	-5768.20	6538.26	88.2	Pass
		Redund Horz 1 Bracing	L102x102x6	1413	-5768.20	18223.81	31.7	Pass
		Redund Horz 2 Bracing	L102x102x6	1424	-5768.20	7685.22	75.1	Pass
		Redund Diag 1 Bracing	L102x102x6	1415	-3775.95	15636.10	24.1	Pass
		Redund Diag 2 Bracing	L102x102x6	1416	-3431.70	9830.57	34.9	Pass
		Redund Hip 1 Bracing	L64x64x6	1454	-145.77	3381.46	4.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1419	-26.52	651.25	4.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1437	-51.23	856.43	6.0	Pass
		Inner Bracing	L64x64x6	1458	-105.37	375.72	28.0	Pass
T28	25.8 - 21.1	Leg	4L203x203x19	1469	-415372.79	912160.91	45.5	Pass
							72.5 (b)	
		Diagonal	L152x152x16	1483	-12522.96	72428.74	17.3	Pass
							42.4 (b)	
		Redund Horz 1 Bracing	L102x102x10	1489	-6238.21	26839.84	23.2	Pass
		Redund Horz 2 Bracing	L102x102x10	1490	-6238.21	9309.12	67.0	Pass
		Redund Diag 1	L102x102x6	1491	-4212.99	14176.63	29.7	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 13



Section	Elevation	Component	Size	Critical Element	P	ϕP_{allow}	% Capacity	Pass Fail
No.	m	Type			kg	kg		
T29	21.1 - 14.7	Bracing						
		Redund Diag 2 Bracing	L102x102x6	1492	-3468.45	5230.38	66.3	Pass
		Redund Hip 1 Bracing	L64x64x6	1527	-64.76	2842.69	2.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1509	-61.03	547.49	11.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1530	-46.00	732.46	6.3	Pass
		Leg	4L203x203x19	1533	-416926.80	911199.29	45.8	Pass
							73.9 (b)	
		Diagonal	L152x152x19	1559	-22808.08	104905.97	21.7	Pass
							84.5 (b)	
		Horizontal	L102x102x10	1482	-6261.57	18626.46	33.6	Pass
		Redund Horz 1 Bracing	L102x102x10	1596	-7364.48	31573.94	23.3	Pass
		Redund Horz 2 Bracing	L102x102x10	1561	-6261.57	16869.79	37.1	Pass
		Redund Horz 3 Bracing	L102x102x10	1563	-6261.57	7308.83	85.7	Pass
		Redund Diag 1 Bracing	L102x102x6	1572	-6993.40	16475.21	42.4	Pass
		Redund Diag 2 Bracing	L102x102x6	1564	-3548.79	9085.59	39.1	Pass
		Redund Diag 3 Bracing	L102x102x6	1575	-3705.21	8297.61	44.7	Pass
		Redund Hip 1 Bracing	L64x64x6	1605	-63.20	5053.66	1.3	Pass
		Redund Hip 2 Bracing	L64x64x5	1586	-44.63	973.31	4.6	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 14



Section No.	Elevation m	Component Type	Size	Critical Element	P kg	ϕP_{allow} kg	% Capacity	Pass Fail
T30	14.7 - 9.6	Inner Bracing	L64x64x6	1607	-137.94	315.85	43.7	Pass
		Leg	4L203x203x19	1618	-450389.23	919763.12	49.0	Pass
							77.7 (b)	
		Diagonal	L152x152x19	1636	-16639.77	108209.03	15.4	Pass
							47.2 (b)	
		Redund Horz 1 Bracing	L102x102x10	1686	-8124.07	30074.95	27.0	Pass
		Redund Horz 2 Bracing	L102x102x13	1645	-6764.11	17744.04	38.1	Pass
		Redund Horz 3 Bracing	L102x102x13	1647	-6764.11	7706.63	87.8	Pass
		Redund Diag 1 Bracing	L102x102x6	1646	-7142.99	16466.68	43.4	Pass
		Redund Diag 2 Bracing	L102x102x6	1662	-3736.12	7763.15	48.1	Pass
		Redund Diag 3 Bracing	L102x102x6	1649	-3599.83	3719.20	96.8	Pass
		Redund Hip 1 Bracing	L64x64x6	1692	-58.65	4146.39	1.4	Pass
		Redund Hip 2 Bracing	L64x64x5	1672	-56.86	798.58	7.1	Pass
		Redund Hip 3 Bracing	L64x64x5	1674	-57.09	354.92	16.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1702	-80.35	1070.23	7.5	Pass
T31	9.6 - 0	Leg	4L203x203x19	1706	-455588.30	900979.85	50.6	Pass
							80.1 (b)	
		Diagonal	L127x127x16	1738	-24403.82	67151.65	36.3	Pass
							69.2 (b)	

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 15



<i>Section</i>	<i>Elevation</i>	<i>Component</i>	<i>Size</i>	<i>Critical</i>	<i>P</i>	<i>ØPallow</i>	<i>%</i>	<i>Pass</i>
<i>No.</i>	<i>m</i>	<i>Type</i>		<i>Element</i>	<i>kg</i>	<i>kg</i>	<i>Capacity</i>	<i>Fail</i>
		Horizontal	L102x102x10	1635	-6842.22	15455.57	44.3	Pass
		Redund Horz 1 Bracing	L102x102x6	1739	-6842.22	20787.74	32.9	Pass
		Redund Horz 2 Bracing	L127x127x13	1758	-6842.22	42358.37	16.2	Pass
		Redund Horz 3 Bracing	L127x127x13	1760	-6842.22	24379.74	28.1	Pass
		Redund Horz 4 Bracing	L127x127x13	1744	-6842.22	13518.24	50.6	Pass
		Redund Diag 1 Bracing	L102x102x6	1759	-6283.62	15810.83	39.7	Pass
		Redund Diag 2 Bracing	L102x102x6	1743	-4264.82	9740.94	43.8	Pass
		Redund Diag 3 Bracing	L102x102x6	1745	-3792.30	5308.30	71.4	Pass
		Redund Diag 4 Bracing	L102x102x6	1746	-4144.83	6449.54	64.3	Pass
		Redund Hip 1 Bracing	L64x64x6	1812	-210.80	6478.75	3.3	Pass
		Redund Hip 2 Bracing	L64x64x6	1813	-97.30	1619.68	6.0	Pass
		Redund Hip 3 Bracing	L64x64x6	1815	-125.07	719.86	17.4	Pass
		Redund Hip 4 Bracing	L64x64x6	1817	-45.13	404.92	11.1	Pass
		Redund Hip Diagonal Bracing	L76x76x6	1782	-104.43	823.23	12.7	Pass
		Inner Bracing	L64x64x6	1822	-112.74	259.15	43.5	Pass
Summary								
						Leg (T9)	95.7	Pass
						Diagonal	97.8	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 16

<i>Section</i>	<i>Elevation</i>	<i>Component</i>	<i>Size</i>	<i>Critical Element</i>	<i>P</i>	<i>ØP_{allow}</i>	<i>% Capacity</i>	<i>Pass Fail</i>
<i>No.</i>	<i>m</i>	<i>Type</i>			<i>kg</i>	<i>kg</i>		
						(T10)		
						Horizontal (T27)	88.2	Pass
						Top Girt (T11)	96.7	Pass
						Redund Horz 1 Bracing (T13)	47.2	Pass
						Redund Horz 2 Bracing (T21)	78.7	Pass
						Redund Horz 3 Bracing (T30)	87.8	Pass
						Redund Horz 4 Bracing (T31)	50.6	Pass
						Redund Diag 1 Bracing (T16)	95.9	Pass
						Redund Diag 2 Bracing (T20)	67.7	Pass
						Redund Diag 3 Bracing (T30)	96.8	Pass
						Redund Diag 4 Bracing (T31)	64.3	Pass

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 17



















<i>Section</i>	<i>Elevation</i>	<i>Component</i>	<i>Size</i>	<i>Critical Element</i>	<i>P</i>	<i>øP_{allow}</i>	<i>% Capacity</i>	<i>Pass Fail</i>
<i>No.</i>	<i>m</i>	<i>Type</i>			<i>kg</i>	<i>kg</i>		
						Redund Hip 1 Bracing (T25)	4.7	Pass
						Redund Hip 2 Bracing (T28)	11.1	Pass
						Redund Hip 3 Bracing (T31)	17.4	Pass
						Redund Hip 4 Bracing (T31)	11.1	Pass
						Redund Hip Diagonal Bracing (T31)	12.7	Pass
						Inner Bracing (T21)	71.9	Pass
						Bolt Checks	97.7	Pass
						RATING =	97.8	Pass

Tornilleria:



Bolt Design Data



















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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 18



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T1	166.46	Leg	A325X	16	8	33.81	8444.17	0.004 	1	Bearing
		Diagonal	A325X	16	2	526.49	5431.09	0.097 	1	Member Bearing
		Top Girt	A325X	16	2	40.13	6888.44	0.006 	1	Bolt Shear
T2	162.46	Leg	A325X	16	8	1432.41	8444.17	0.170 	1	Bearing
		Diagonal	A325X	16	2	1011.01	5431.09	0.186 	1	Member Bearing
T3	159.46	Leg	A325X	16	8	3755.46	8444.17	0.445 	1	Bearing
		Diagonal	A325X	16	2	1790.61	5431.09	0.330 	1	Member Bearing
T4	153.96	Leg	A325X	19	20	4382.10	10423.83	0.420 	1	Bearing
		Diagonal	A325X	19	2	2924.38	8702.13	0.336 	1	Member Bearing
		Top Girt	A325X	19	2	3998.21	8702.13	0.459 	1	Member Bearing
T5	152.86	Leg	A325X	19	28	2277.91	19838.73	0.115 	1	Bolt DS
		Diagonal	A325X	19	2	2161.70	8702.13	0.248 	1	Member Bearing
		Top Girt	A325X	19	2	2573.40	9877.75	0.261 	1	Bolt Shear
T6	146.86	Leg	A325X	19	28	4823.14	19838.73	0.243 	1	Bolt DS
		Diagonal	A325X	19	2	2742.81	8702.13	0.315 	1	Member Bearing
T7	140.86	Leg	A325X	19	28	7968.89	19838.73	0.402 	1	Bolt DS
		Diagonal	A325X	19	2	3270.43	8702.13	0.376 	1	Member Bearing
T8	134.86	Leg	A325X	19	28	11491.86	19838.73	0.579 	1	Bolt DS



















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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 19



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T9	128.86	Diagonal	A325X	19	2	3793.61	8702.13	0.436 	1	Member Bearing
		Leg	A325X	19	36	11551.64	19838.73	0.582 	1	Bolt DS
		Diagonal	A325X	19	2	8011.99	9877.75	0.811 	1	Bolt Shear
T10	122.86	Leg	A325X	22	36	12154.06	26990.52	0.450 	1	Bolt DS
		Diagonal	A325X	19	5	9651.09	9877.75	0.977 	1	Bolt Shear
		Top Girt	A325X	19	3	6298.54	9877.75	0.638 	1	Bolt Shear
T11	119.56	Leg	A325X	22	24	11571.42	26990.52	0.429 	1	Bolt DS
		Diagonal	A325X	19	2	4296.02	8702.13	0.494 	1	Member Bearing
		Horizontal	A325X	16	2	1431.06	6888.44	0.208 	1	Bolt Shear
T12	112.06	Top Girt	A325X	19	2	7416.24	8702.13	0.852 	1	Member Bearing
		Leg	A325X	22	28	13480.09	26990.52	0.499 	1	Bolt DS
		Diagonal	A325X	19	2	5369.54	8702.13	0.617 	1	Member Bearing
T13	104.56	Horizontal	A325X	16	2	1683.11	6888.44	0.244 	1	Bolt Shear
		Leg	A325X	22	28	16108.52	26990.52	0.597 	1	Bolt DS
		Diagonal	A325X	19	2	6504.24	9919.34	0.656 	1	Bolt Shear
T14	99.76	Horizontal	A325X	16	2	1693.46	6888.44	0.246 	1	Bolt Shear
		Top Girt	A325X	19	2	1759.38	9877.75	0.178 	1	Bolt Shear
		Leg	A325X	22	28	16624.66	26990.52	0.616 	1	Bolt DS



















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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 20



Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T15	94.26	Diagonal	A325X	19	2	4141.55	9919.34	0.418 	1	Bolt Shear
		Horizontal	A325X	16	2	1758.80	6888.44	0.255 	1	Bolt Shear
		Leg	A325X	22	28	17024.96	26990.52	0.631 	1	Bolt DS
		Diagonal	A325X	19	2	5278.23	9919.34	0.532 	1	Bolt Shear
		Horizontal	A325X	16	2	1791.20	6888.44	0.260 	1	Bolt Shear
T16	87.76	Leg	A325X	22	28	17981.72	26990.52	0.666 	1	Bolt DS
		Diagonal	A325X	19	2	3909.74	9919.34	0.394 	1	Bolt Shear
		Horizontal	A325X	16	2	1899.68	6888.44	0.276 	1	Bolt Shear
		Leg	A325X	22	32	16314.32	26990.52	0.604 	1	Bolt DS
T17	81.26	Diagonal	A325X	19	2	4600.56	9919.34	0.464 	1	Bolt Shear
		Horizontal	A325X	16	2	1966.77	6888.44	0.286 	1	Bolt Shear
		Leg	A325X	22	32	17204.85	26990.52	0.637 	1	Bolt DS
		Diagonal	A325X	19	2	3853.40	9919.34	0.388 	1	Bolt Shear
T18	74.76	Horizontal	A325X	16	2	2078.48	6888.44	0.302 	1	Bolt Shear
		Leg	A325X	22	32	17948.38	26990.52	0.665 	1	Bolt DS
		Diagonal	A325X	19	2	4521.86	9919.34	0.456 	1	Bolt Shear
		Horizontal	A325X	16	2	2160.68	10331.75	0.209 	1	Gusset Bearing
T20	61.76	Leg	A325X	25	32	18792.20	35268.81	0.533 	1	Bolt DS












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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 21

Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
T21	57.265	Diagonal	A325X	19	2	3879.84	9919.34	0.391 	1	Bolt Shear
		Leg	A325X	25	32	19271.06	35268.81	0.546 	1	Bolt DS
		Diagonal	A325X	19	2	6275.32	9919.34	0.633 	1	Bolt Shear
T22	52.77	Horizontal	A325X	19	2	2315.36	8005.64	0.289 	1	Member Bearing
		Leg	A325X	25	32	20108.66	35268.81	0.570 	1	Bolt DS
		Diagonal	A325X	19	2	4634.54	9919.34	0.467 	1	Bolt Shear
T23	48.275	Leg	A325X	25	32	20649.21	35268.81	0.585 	1	Bolt DS
		Diagonal	A325X	19	2	7213.98	9919.34	0.727 	1	Bolt Shear
		Horizontal	A325X	19	2	2480.94	8005.64	0.310 	1	Member Bearing
T24	43.78	Leg	A325X	25	32	21903.75	35268.81	0.621 	1	Bolt DS
		Diagonal	A325X	19	2	4895.03	9919.34	0.493 	1	Bolt Shear
		Leg	A325X	25	32	22351.13	35268.81	0.634 	1	Bolt DS
T25	39.59	Diagonal	A325X	19	2	7187.90	9919.34	0.725 	1	Bolt Shear
		Horizontal	A325X	19	2	2685.42	8005.64	0.335 	1	Member Bearing
		Leg	A325X	25	26	28959.39	35268.81	0.821 	1	Bolt DS
T26	34.79	Diagonal	A325X	19	2	5809.88	9919.34	0.586 	1	Bolt Shear
		Leg	A325X	25	32	24004.80	35268.81	0.681 	1	Bolt DS
		Diagonal	A325X	19	2	7965.76	9919.34	0.803 	1	Bolt Shear

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	Pág. 22

Section No.	Elevation m	Component Type	Bolt Grade	Bolt Size mm	Number Of Bolts	Maximum Load per Bolt kg	Allowable Load kg	Ratio Load Allowable	Allowable Ratio	Criteria
		Horizontal	A325X	19	2	2884.10	8005.64	0.360 	1	Member Bearing
T28	25.8	Leg	A325X	25	32	25580.26	35268.81	0.725 	1	Bolt DS
		Diagonal	A325X	19	3	4202.90	9919.34	0.424 	1	Bolt Shear
T29	21.1	Leg	A325X	25	32	26057.94	35268.81	0.739 	1	Bolt DS
		Diagonal	A325X	22	2	11404.04	13495.28	0.845 	1	Bolt Shear
		Horizontal	A325X	19	2	3130.78	9877.75	0.317 	1	Bolt Shear
T30	14.7	Leg	A325X	25	32	27386.64	35268.81	0.777 	1	Bolt DS
		Diagonal	A325X	25	2	8319.88	17634.41	0.472 	1	Bolt Shear
T31	9.6	Leg	A325X	25	32	28258.95	35268.81	0.801 	1	Bolt DS
		Diagonal	A325X	25	2	12201.91	17634.41	0.692 	1	Bolt Shear
		Horizontal	A325X	19	2	3421.10	9877.75	0.346 	1	Bolt Shear

REFUERZO DE LA ESTRUCTURA

Para que la estructura cumpla con la carga actual + carga futura solicitada con una velocidad de viento de 125 KPH se debe tener en cuenta reforzar la estructura de la siguiente manera.

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	

MONTANTE

Del nivel +152.86 m al +159.46 m se le adiciona al existente 1 ángulos de 76x76x6 H en forma de cruz con el ángulo existente, y su conexión entre montantes con 12 tornillos de 3/4" a C.D. A 325 T-1

Se conecta con el ángulo existente con silletas en ángulo de 76x76x6 H y su conexión por cara con 2 tornillos de 3/4" A 325 T-1 (distancia máxima entre silletas 1000 mm)

DIAGONAL

Del nivel +122.86 m al +128.86 m se adiciona 1 tornillo a la conexión de los ángulos y quedara la conexión con 5 tornillos A-325 T-1.

HORIZONTAL INTERMEDIA

En el nivel +65.00 m se adiciona al ángulo existente espalda con espalda un ángulo de 76X76X6 H con tornillos A-325 T-1.

REDUNDANTE DIAGONAL

Del nivel 0.00 m a 52.77 m se retira el ángulo existente y se reemplaza por un ángulo de 102x102x6 H con tornillo A-325 T-1.



Del nivel 57.26 m a 81.26 m se retira el ángulo existente y se reemplaza por un ángulo de 76x76x6 H con tornillo A-325 T-1.

Del nivel 81.26 m a 104.56 m se retira el ángulo existente y se reemplaza por un ángulo de 64x64x6 H con tornillo A-325 T-1.

REDUNDANTE HORIZONTAL

Del nivel 0.00 m a 9.60 m se retira el ángulo existente y se reemplaza por un ángulo de 127x127x13 H con tornillo A-325 T-1.

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	

Del nivel 9.60 m a 14.70 m se retira el ángulo existente y se reemplaza por un ángulo de 102x102x13 H con tornillo A-325 T-1.

Del nivel 14.70 m a 25.80 m se retira el ángulo existente y se reemplaza por un ángulo de 102x102x10 H con tornillo A-325 T-1.



Del nivel 25.80 m a 52.77 m se retira el ángulo existente y se reemplaza por un ángulo de 102x102x6 H con tornillo A-325 T-1.

Del nivel 57.77 m a 61.76 m se retira el ángulo existente y se reemplaza por un ángulo de 76x76x6 H con tornillo A-325 T-1.

CUADRO DE REFUERZO

NIVEL	UBICACION	MATERIAL	PESO APROX KG
<i>0 a 14.9</i>	<i>Montante</i>	<i>L 76x6 H + Tornillos</i>	<i>610</i>
<i>61.7 a 68.2</i>	<i>Horizontal intermedia</i>	<i>L 76x6 H + tornillos</i>	<i>215</i>
<i>0 a 9.6</i>	<i>Redundante horizontal</i>	<i>L 127x13 H + tornillos</i>	<i>2560</i>
<i>9.6 a 14.7</i>	<i>Redundante horizontal</i>	<i>L 102x13 H + tornillos</i>	<i>1960</i>
<i>14.7 a 25.8</i>	<i>Redundante horizontal</i>	<i>L 102x10 H + tornillos</i>	<i>1680</i>
<i>25.8 a 52.7</i>	<i>Redundante horizontal</i>	<i>L 102x6 H + tornillos</i>	<i>2170</i>
<i>52.7 a 61.7</i>	<i>Redundante horizontal</i>	<i>L 76x6 H + tornillos</i>	<i>480</i>
<i>0 a 52.7</i>	<i>Redundante diagonal</i>	<i>L 102x6 H + tornillos</i>	<i>3470</i>
<i>57.2 a 81.2</i>	<i>Redundante diagonal</i>	<i>L 76x6 H + tornillos</i>	<i>1350</i>

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	EVALUACION REFUERZO TCSVA 166.46 m		
	ESTACION: LA RUSIA REFORZADO + CARGA FUTURA		
	FECHA: Mayo de 2016	Revisión: 0	

81.2 a 104.5	Redundante diagonal	L 64x6 H + tornillos	870
0 al 166.4	Unión entre montantes y diagonales	Tornillería de reemplazo	9970
PESO REFUERZO TORRE			25335

DEFLEXION

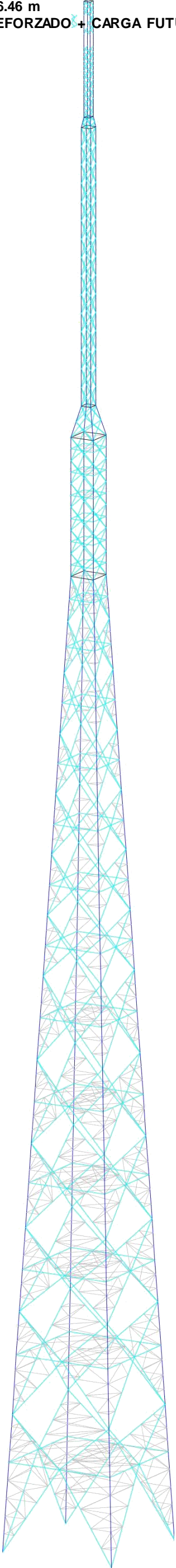
Luego de análisis de la torre en el estado reforzado con las cargas actuales más cargas futuras y teniendo en cuenta la velocidad de viento de operación de 80 kph La estructura está trabajando dentro de los parámetros de desplazamiento.

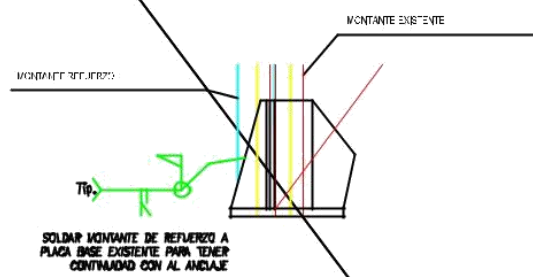
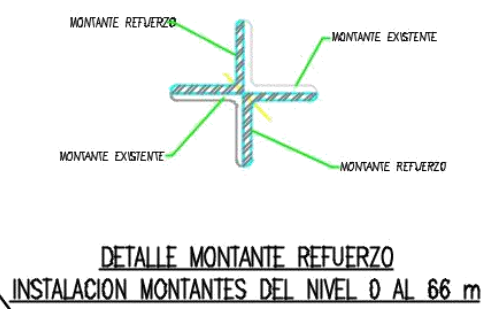
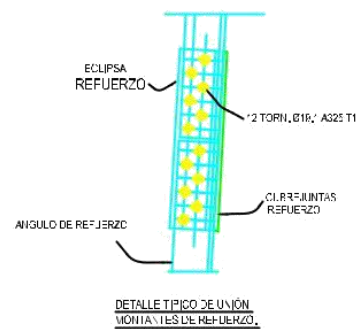
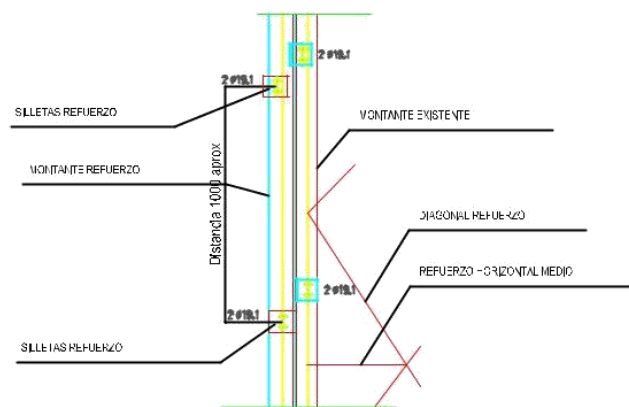
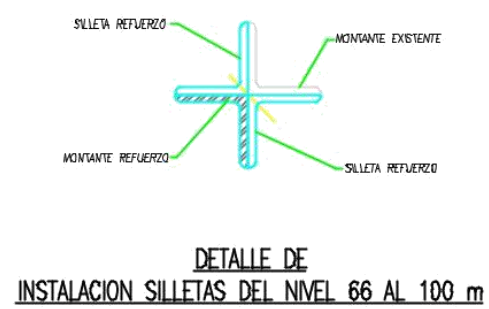
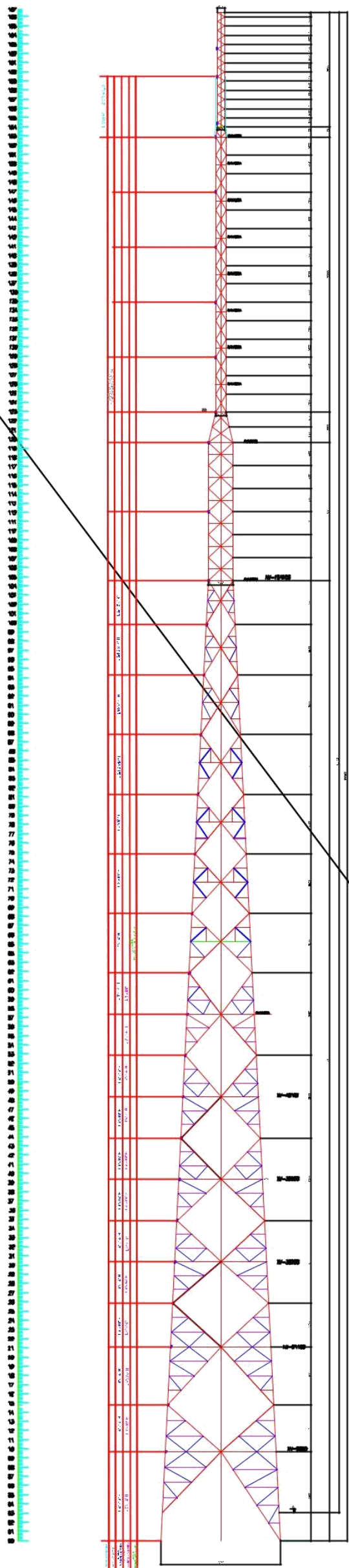
OK

CIMENTACION

Según lo explorado en campo la cimentación es una pila cuadrada de 1.60 m de lado, no se pudo determinar la profundidad.

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NOTA :
TODA LA TORNILLERIA DE UNION ENTRE MONTANTES Y DIAGONALES SERA
REEMPLAZADA POR A325 T-1
MONTANTES: SE ADICIONA AL ANGULO EXISTENTE EN FORMA DE CRUZ
HORIZONTAL INTERMEDIA; SE ADICIONA ESPALDA CON ESPALDA
REDUNDANTE DIAGONAL: RETIRAR ANGULO EXISTENTE Y REEMPLAZAR
REDUNDANTE HORIZONTAL: RETIRAR ANGULO EXISTENTE Y REEMPLAZAR



ESTACION BASE: LA RUSIA
TORRE CUADRADA SECCION VARIABLE 166.46 m

REALIZO:

FECHA:

Mayo /16

CONTRATISTA:

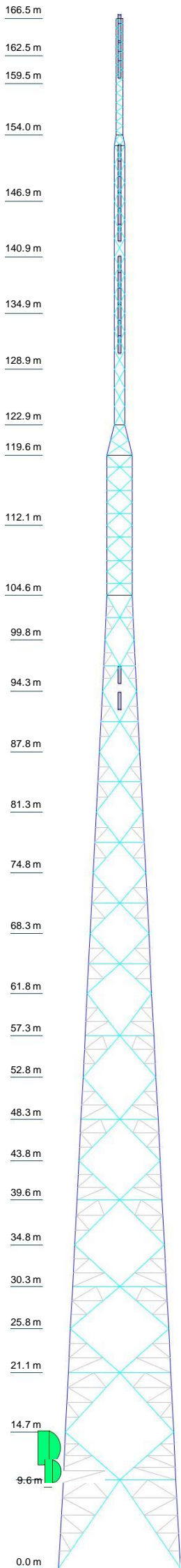


CONTIENE:
TORRE REFORZADA

DIBUJO:

M.C. Betancourt.

ESCALA:

[illegible]

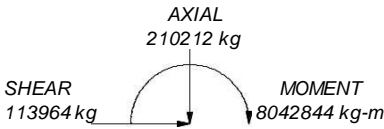
ALL REACTIONS
ARE FACTORED

MAX. CORNER REACTIONS AT BASE:

DOWN: 487995 kg

UPLIFT: -395536 kg
CHURN: 105031 kg

SHEAR: 49507 kg



TORQUE 21675 kg-m
REACTIONS - 125 kph WIND

TYPE	ELEVATION	TYPE	ELEVATION
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	150.3
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	150.3
ANTENA PANEL UHF 0.48x0.983	166	ANTENA VHF BAND III 2 DIPOLOS	148.6
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	148.6
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	148.6
ANTENA PANEL UHF 0.48x0.983	165	ANTENA VHF BAND III 2 DIPOLOS	146.9
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	146.9
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	146.9
ANTENA PANEL UHF 0.48x0.983	164	ANTENA VHF BAND III 2 DIPOLOS	145.2
ANTENA PANEL UHF 0.48x0.983	163	ANTENA VHF BAND III 2 DIPOLOS	145.2
ANTENA PANEL UHF 0.48x0.983	163	ANTENA VHF BAND III 2 DIPOLOS	145.2
ANTENA PANEL UHF 0.48x0.983	163	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	162	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	162	ANTENA VHF BAND III 2 DIPOLOS	143.5
ANTENA PANEL UHF 0.48x0.983	162	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	161	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	161	ANTENA VHF BAND III 2 DIPOLOS	140
ANTENA PANEL UHF 0.48x0.983	161	ANTENA VHF BAND III 2 DIPOLOS	138.3
Directional Antena 470-860 MHz	160	ANTENA VHF BAND III 2 DIPOLOS	138.3
Directional Antena 470-860 MHz	160	ANTENA VHF BAND III 2 DIPOLOS	138.3
Directional Antena 470-860 MHz	160	ANTENA VHF BAND III 2 DIPOLOS	136.6
Directional Antena 470-860 MHz	159	ANTENA VHF BAND III 2 DIPOLOS	136.6
Directional Antena 470-860 MHz	159	ANTENA VHF BAND III 2 DIPOLOS	136.6
Directional Antena 470-860 MHz	159	ANTENA VHF BAND III 2 DIPOLOS	134.9
Directional Antena 470-860 MHz	158	ANTENA VHF BAND III 2 DIPOLOS	134.9
Directional Antena 470-860 MHz	158	ANTENA VHF BAND III 2 DIPOLOS	134.9
Directional Antena 470-860 MHz	158	ANTENA VHF BAND III 2 DIPOLOS	133.2
Directional Antena 470-860 MHz	157	ANTENA VHF BAND III 2 DIPOLOS	133.2
Directional Antena 470-860 MHz	157	ANTENA VHF BAND III 2 DIPOLOS	133.2
Directional Antena 470-860 MHz	157	ANTENA VHF BAND III 2 DIPOLOS	131.5
Directional Antena 470-860 MHz	156	ANTENA VHF BAND III 2 DIPOLOS	131.5
Directional Antena 470-860 MHz	156	ANTENA VHF BAND III 2 DIPOLOS	131.5
Directional Antena 470-860 MHz	156	ANTENA PANEL TV 4 DIPOLES	96
Directional Antena 470-860 MHz	155	ANTENA PANEL TV 4 DIPOLES	96
Directional Antena 470-860 MHz	155	ANTENA PANEL TV 4 DIPOLES	96
Directional Antena 470-860 MHz	155	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	152	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	152	ANTENA PANEL TV 4 DIPOLES	93.2
ANTENA VHF BAND III 2 DIPOLOS	152	HP12-59E	13
ANTENA VHF BAND III 2 DIPOLOS	150.3	HP8-122D	10

SYMBOL LIST

MARK	SIZE	MARK	SIZE
A	L89x6+L76x6	G	L64x64x6
B	4L152x152x16	H	L38x38x5
C	L64x64x6.4	I	L64x64x5
D	L76x76x6	J	2 @ 0.55
E	L102x102x6	K	2 @ 1.65
F	L102x102x10		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	345 MPa	448 MPa			

TOWER DESIGN NOTES

1. Tower designed for Exposure C to the TIA-222-G Standard.
2. Tower designed for a 125 kph basic wind in accordance with the TIA-222-G Standard.
3. Deflections are based upon a 80 kph wind.
4. Tower Structure Class II.
5. Topographic Category 1 with Crest Height of 0.000 m
6. Weld together tower sections have flange connections.
7. Connections use galvanized A394 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
8. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
9. Welds are fabricated with AWS E60XX/E70XX electrodes.
10. All welded joints and connection flanges certified for integrity an quality per AWS D1:1
11. RF antennas feeders shall be 1-5/8" and installed 48 feeders per side
12. MW dishes feeders shall be 1/2" and installed 8 feeders per side
13. TOWER RATING: 97.8%

BTESA	Job: ESTUDIO ESTRUCTURAL - ESTACION LA RUSIA REFORZADO + CARGA FUTURA
Calle 129 No. 8 - 08	Project: TORRE CUADRADA SECCION VARIABLE DE 166.46 m
Bogotá - Colombia	Drawn by: Ing. Jaime Gutierrez C.
Phone: (57-1) 274 0536	Client: RTVC
FAX: (57-1) 274 0536	Code: TIA-222-G
	Date: 05/20/16
	App'd: Scale: NTS
	Path: <small>©Proyectos 2016/05/20/16/05/2016 La Rusia Torre Reforzado en Estacion La Rusia Reforzado 166 m La Rusia Reforzado mac CF at</small>
	Dwg No. E-1