Oklahoma City, Oklahoma

Master FM Broadband System Commissioning Report

Prepared For

KOMA 92.5, KMGL 104.1 & KRXO 107.7
Renda Broadcasting
&
KYIS 98.9 Citidel Broadcasting

Equipment

ERI COG-20P-12-240-2 Panel Antenna
with Dual Inputs and Reverse-fed IBOC
1660′ Dual ERI 6″- 50Ω Maxline & Dual 3″ Heliax Transmission Line
ERI 973-8 Four Channel Constant Impedance Combiner with Circulator
Isolated IBOC

Measurement Data Taken on
3 - 12 August 2007

Submitted By

Todd R Loney
Senior RF Engineer

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Measurement setup

Measurements were taken with an Agilent 8753ES network analyzer, Agilent 4-port dual directional coupler. A three watt amplifier was used to overcome high RF level ingress. Richland Towers broadband, precision test adapters were used to make the measurements.
Data was extracted from the analyzer in complex pair values (real/imaginary) via the GPIB port to laptop computer. Data was then analyzed and presented using SoftPlot™ software and is imported into this document as an Object Linking Embedding (OLE). This data can be manipulated, (scale, format, markers, etc.) follow link to http://softplot.com/ and download demonstration version to utilize this feature.
Markers are placed at fc for each frequency utilized in the system; an additional marker is placed at the peak.

Measurement details

Analogue measurements were taken from the power divider input and on both 6" feeders, at the patch panel, on the output of the power divider. Both VSWR and polar impedance plots are presented. Time domain reflectometry plots are included to show line discontinuities vs. distance.
The IBOC upper and lower 3" Heliax lines were also swept from the 3" IBOC output ports of the patch panel. Polar impedance and VSWR plots are presented.
The antenna RHP (Analogue) – LHP (IBOC) isolation was measured between the upper, lower and combined inputs.
This report only includes data from the patch panel to the antenna. Individual station data is prepared under a separate report for each station

Findings

Overall results are satisfactory for this type of broadband system.
All three 9" inputs, on the analogue patch panel, exhibit a slight input mismatch. I slugged the lower line with a 0.5" slug to bump to locus over centre but it could use a bit more. This location is very difficult to disassemble and reassemble due to the amount of components and weights involved. The antenna inputs were optimized at tower top as well as from the patch panel. Overall, the antenna system readily meets the VSWR specification of <1.15 so additional attempts at optimization were not performed.
Antenna manufacturers favour the analogue match and RHP-LHP isolation over the digital match due to the lower power levels involved (-20dB for IBOC). The circulator provides the additional required isolation to the IBOC transmitters consequently; the match for the IBOC is determined by the circulator isolation. This equates to <≈1.2:1 match for the IBOC irrespective of the match
RHP – LHP antenna isolation is quite acceptable at ≈-25dB (combined resultant).

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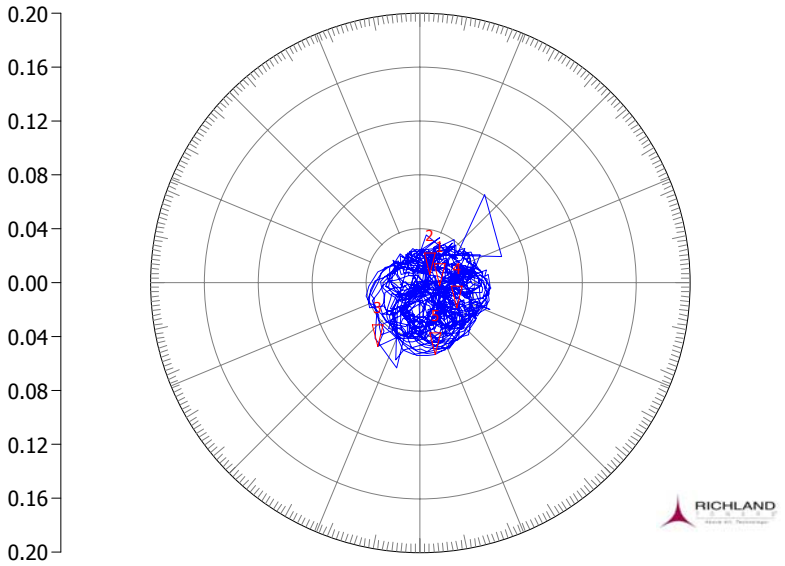
OKC Combined Polar Impedance 200mU

Combined



1 Combined
92.500000 MHz
0.0147, -8.9205°

2 Combined
98.900000 MHz
0.0091, 39.6457°

3 Combined
104.100000 MHz
0.0565, -123.5517°

4 Combined
107.700000 MHz
0.0330, -34.2465°

5 Combined
105.387500 MHz
0.0547, -78.2899°

Centre: 98.000000 MHz
8/10/2007 10:09:51 AM
Final Antenna Match.spt

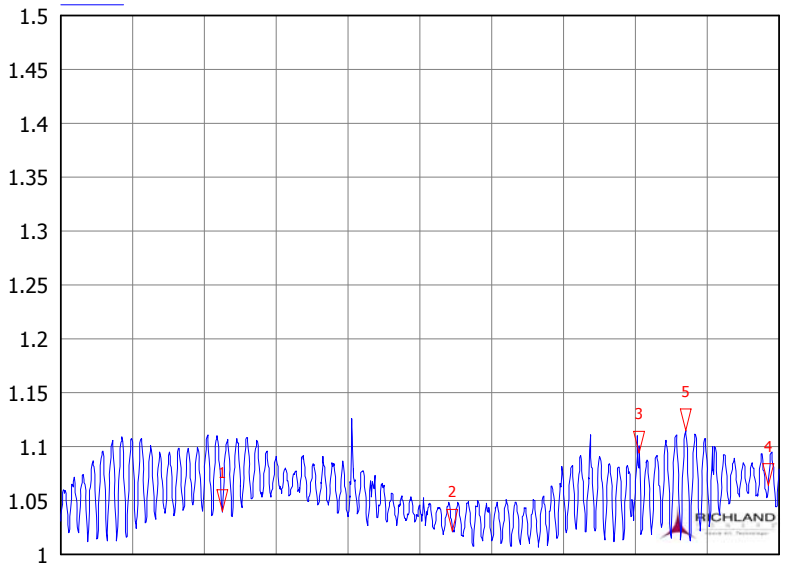
Span: 20.000000 MHz
8753ES

Patch Panel to Antenna

OKC Combined VSWR 1.05/div

VSWR

Combined



1 Combined
92.500000 MHz
1.0399 VSWR

2 Combined
98.900000 MHz
1.0221 VSWR

3 Combined
104.100000 MHz
1.0946 VSWR

4 Combined
107.700000 MHz
1.0639 VSWR

5 Combined
105.400000 MHz
1.1151 VSWR

Centre: 98.000000 MHz
8/10/2007 10:09:51 AM
Final Antenna Match.spt

Span: 20.000000 MHz
8753ES

Patch Panel to Antenna

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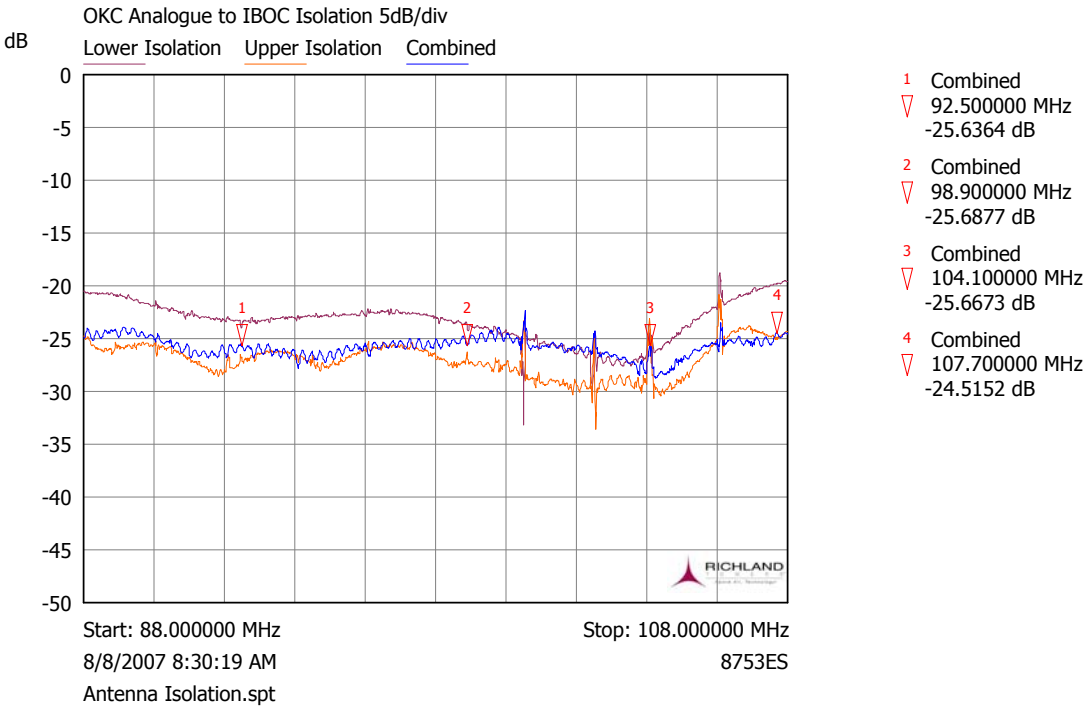

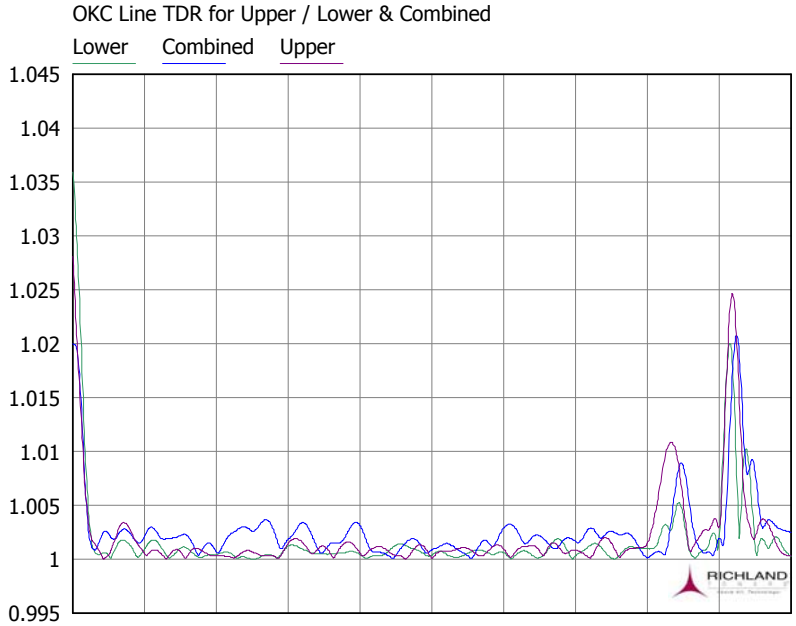

20MHz TDR @ 1601 points

400 North Ashley Dr., Suite 3010
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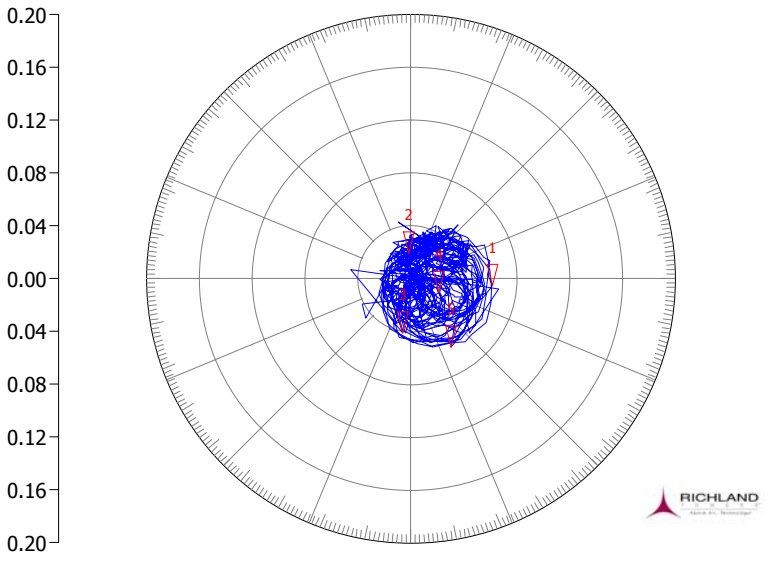
OKC FM Lower Line & Antenna Polar Impedance 200mU

Lower



1 Lower
92.500000 MHz
0.0620, -5.1577°

2 Lower
98.900000 MHz
0.0196, 94.2825°

3 Lower
104.100000 MHz
0.0421, -98.5995°

4 Lower
107.700000 MHz
0.0238, -27.2942°

5 Lower
106.150000 MHz
0.0603, -59.1499°

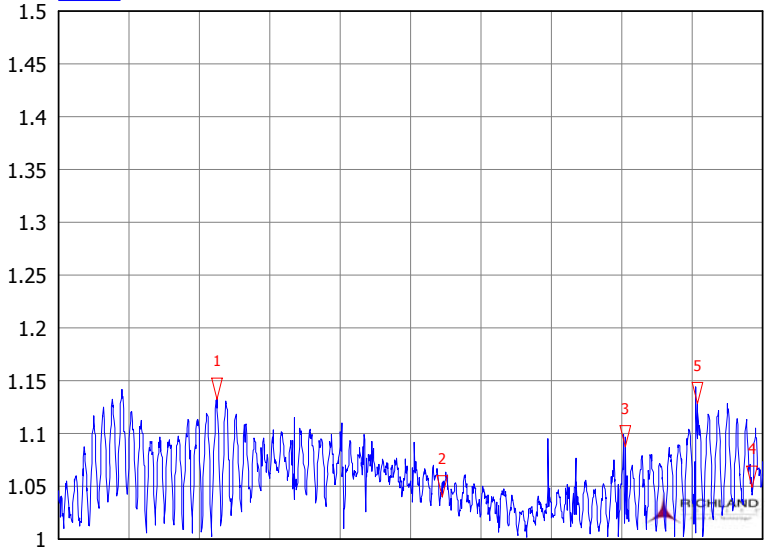
Start: 88.000000 MHz
Stop: 108.000000 MHz
8/10/2007 10:09:51 AM
8753ES
Final Antenna Match.spt

Patch Panel to Antenna (0.5" slug located 31.5" from top of vertical riser on patch panel)

OKC FM Lower Line & Antenna VSWR 1.05/div

VSWR

Lower



1 Lower
92.500000 MHz
1.1323 VSWR

2 Lower
98.900000 MHz
1.0399 VSWR

3 Lower
104.100000 MHz
1.0879 VSWR

4 Lower
107.700000 MHz
1.0488 VSWR

5 Lower
106.150000 MHz
1.1284 VSWR

Start: 88.000000 MHz
Stop: 108.000000 MHz
8/10/2007 10:09:51 AM
8753ES
Final Antenna Match.spt

Patch Panel to Antenna (0.5" slug located 31.5" from top of vertical riser on patch panel)

400 North Ashley Dr., Suite 3010
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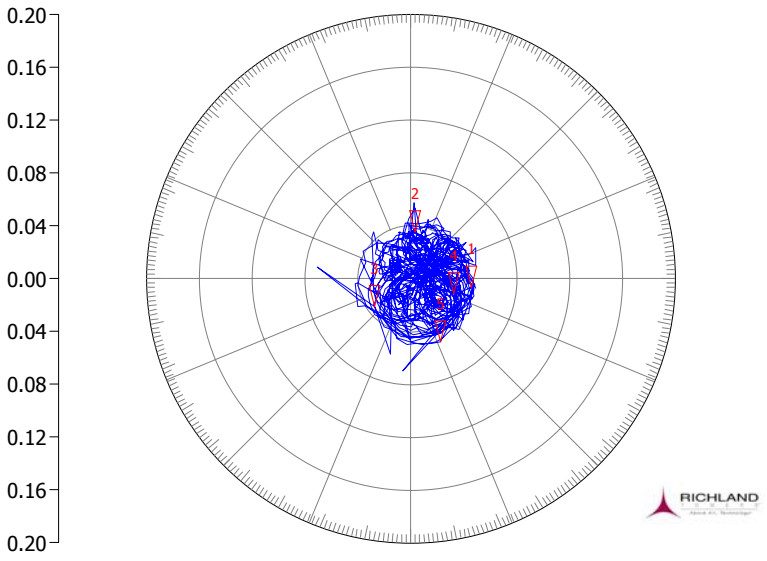
OKC FM Upper Line & Antenna Polar Impedance 200mU

Upper



1 Upper
92.500000 MHz
0.0463, -8.1748°

2 Upper
98.900000 MHz
0.0356, 84.3404°

3 Upper
104.100000 MHz
0.0349, -141.7032°

4 Upper
107.700000 MHz
0.0344, -19.2637°

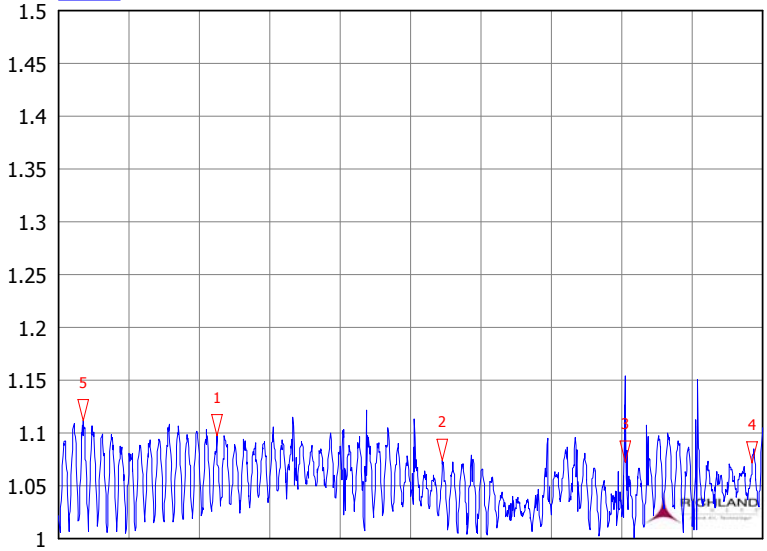
5 Upper
88.700000 MHz
0.0529, -64.7454°

Start: 88.000000 MHz
Stop: 108.000000 MHz
8/10/2007 10:09:51 AM
8753ES
Final Antenna Match.spt

OKC FM Upper Line & Antenna VSWR 1.05/div

VSWR

Upper



1 Upper
92.500000 MHz
1.0971 VSWR

2 Upper
98.900000 MHz
1.0738 VSWR

3 Upper
104.100000 MHz
1.0723 VSWR

4 Upper
107.700000 MHz
1.0713 VSWR

5 Upper
88.700000 MHz
1.1117 VSWR

Start: 88.000000 MHz
Stop: 108.000000 MHz
8/10/2007 10:09:51 AM
8753ES
Final Antenna Match.spt

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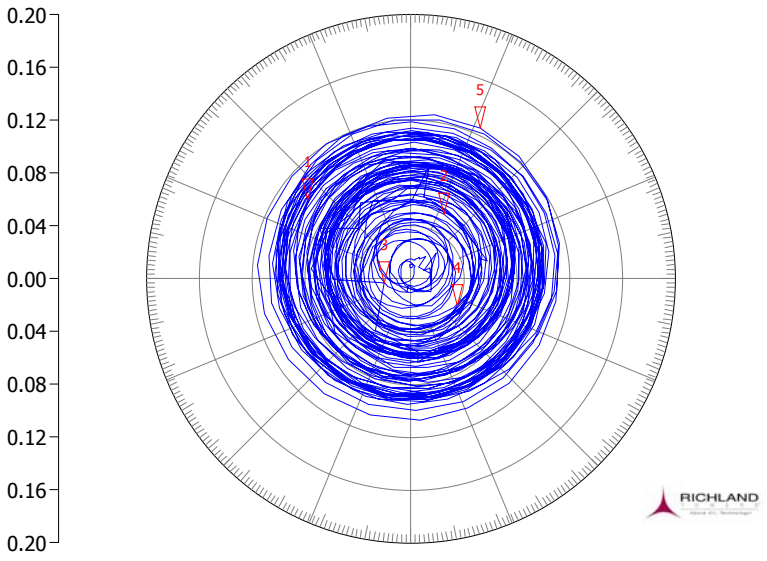
OKC FM IBOC Lower Line & Antenna Polar Impedance 200mU

IBOC Lower



1 IBOC Lower
92.500000 MHz
0.0979, 142.5380°

2 IBOC Lower
98.900000 MHz
1.1153 VSWR, 62.476

3 IBOC Lower
104.100000 MHz
0.0202, -170.1240°

4 IBOC Lower
107.700000 MHz
0.0409, -30.6881°

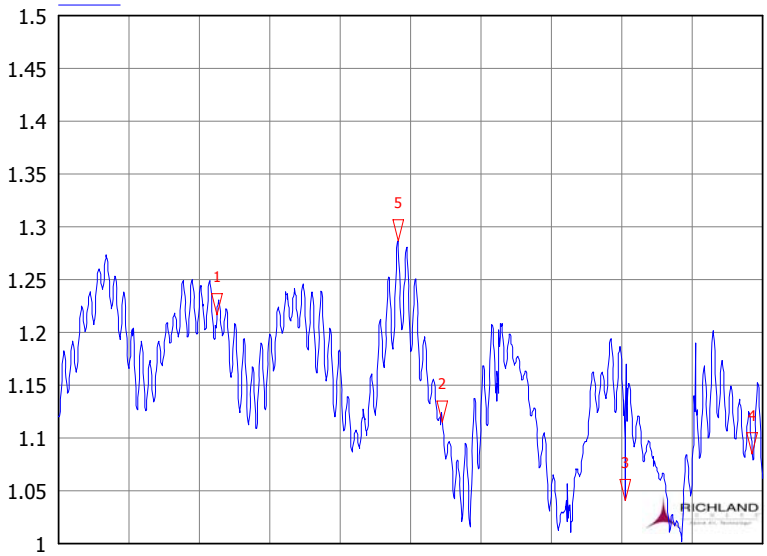
5 IBOC Lower
97.637500 MHz
0.1255, 65.1012°

Centre: 98.000000 MHz
Span: 20.000000 MHz
8/2/2007 3:33:06 PM
8753ES
IBOC S11.spt

OKC FM IBOC Lower Line & Antenna VSWR 1.05/div

VSWR

IBOC Lower



1 IBOC Lower
92.500000 MHz
1.2170 VSWR

2 IBOC Lower
98.900000 MHz
1.1153 VSWR, 62.476

3 IBOC Lower
104.100000 MHz
1.0412 VSWR

4 IBOC Lower
107.700000 MHz
1.0854 VSWR

5 IBOC Lower
97.637500 MHz
1.2870 VSWR

Centre: 98.000000 MHz
Span: 20.000000 MHz
8/2/2007 3:33:06 PM
8753ES
IBOC S11.spt

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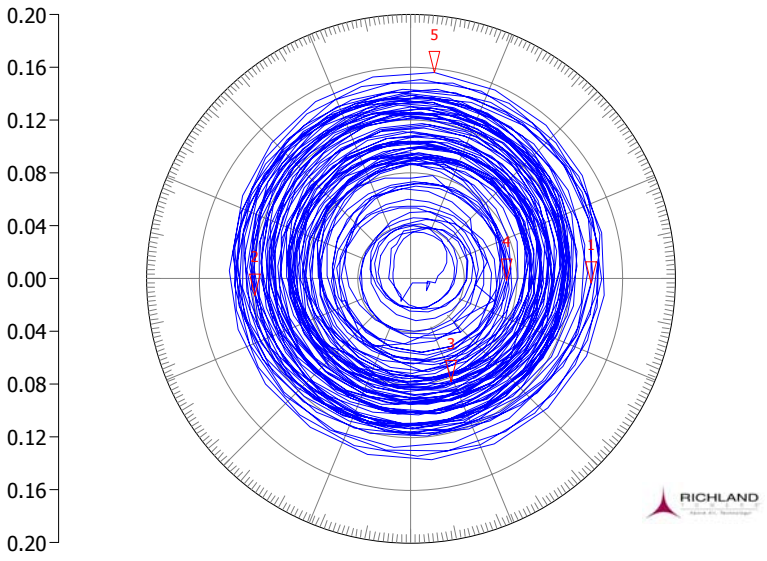
OKC FM Upper Line & Antenna Polar Impedance 200mU

IBOC Upper



1 IBOC Upper
92.500000 MHz
0.1369, -1.3089°

2 IBOC Upper
98.900000 MHz
0.1189, -173.8273°

3 IBOC Upper
104.100000 MHz
0.0837, -68.4502°

4 IBOC Upper
107.700000 MHz
0.0725, -1.0790°

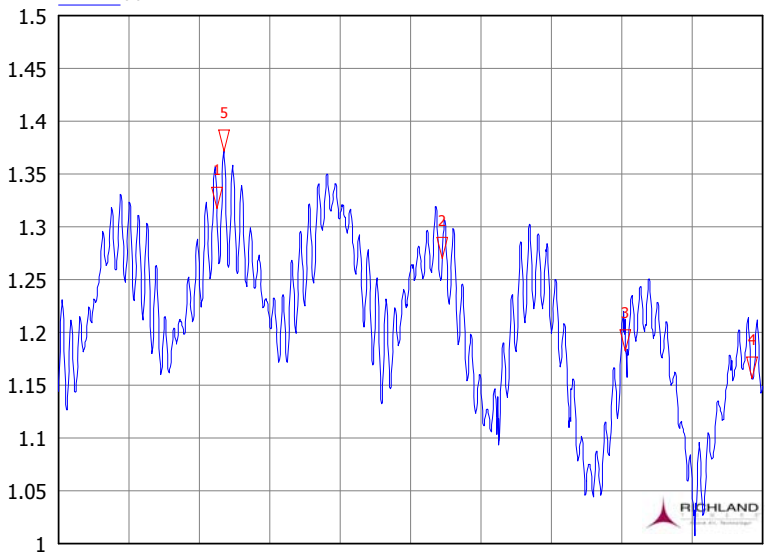
5 IBOC Upper
92.687500 MHz
0.1568, 83.3094°

Centre: 98.000000 MHz
Span: 20.000000 MHz
8/2/2007 3:33:06 PM
8753ES
IBOC S11.spt

OKC FM Upper Line & Antenna VSWR 1.05/div

VSWR

IBOC Upper



1 IBOC Upper
92.500000 MHz
1.3173 VSWR

2 IBOC Upper
98.900000 MHz
1.2699 VSWR

3 IBOC Upper
104.100000 MHz
1.1827 VSWR

4 IBOC Upper
107.700000 MHz
1.1564 VSWR

5 IBOC Upper
92.687500 MHz
1.3718 VSWR

Centre: 98.000000 MHz
Span: 20.000000 MHz
8/2/2007 3:33:06 PM
8753ES
IBOC S11.spt

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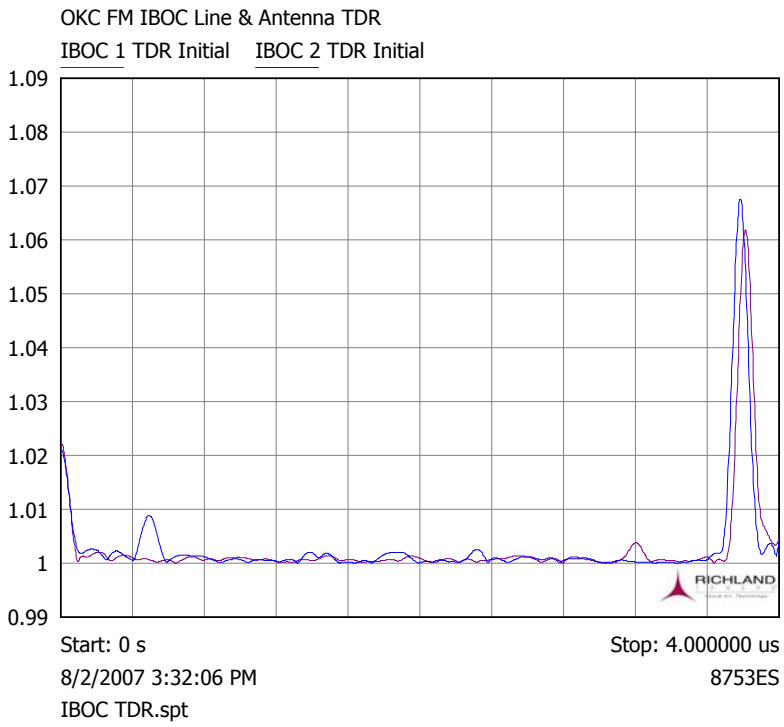
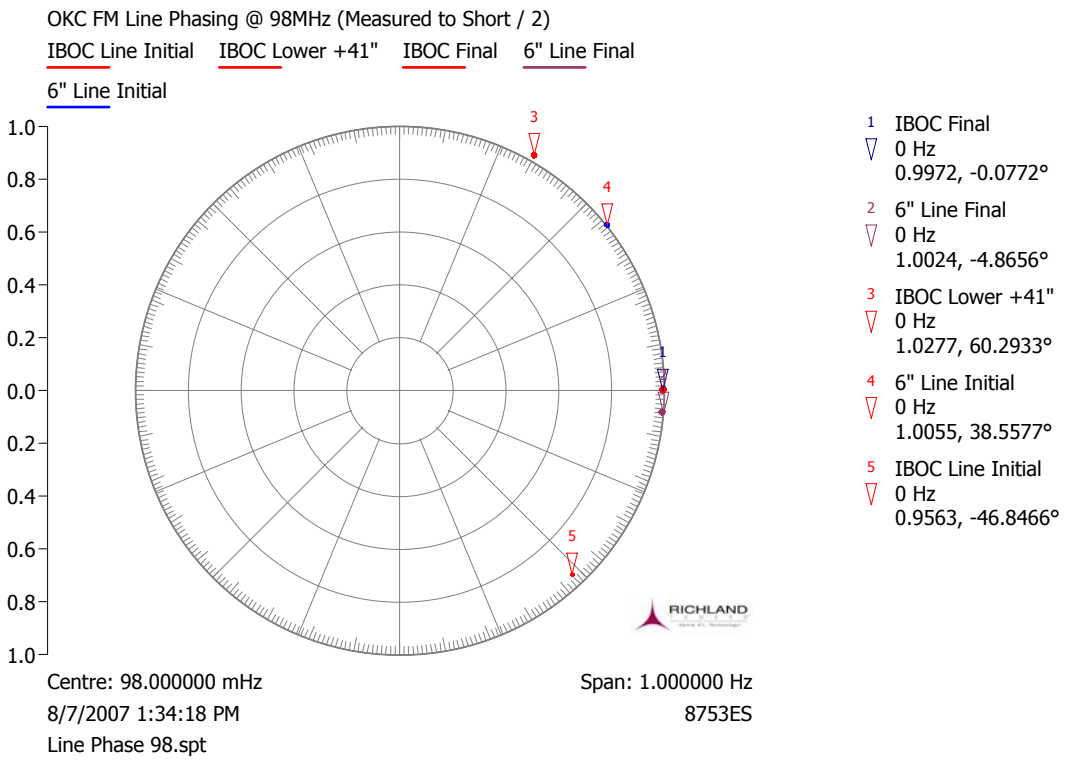


20MHz TDR @ 1601 points



Analogue Line is +6.5" added to Upper & IBOC Line is +51.625" added to Lower)

6" Line Initial 6" Upper (Lower Ref)

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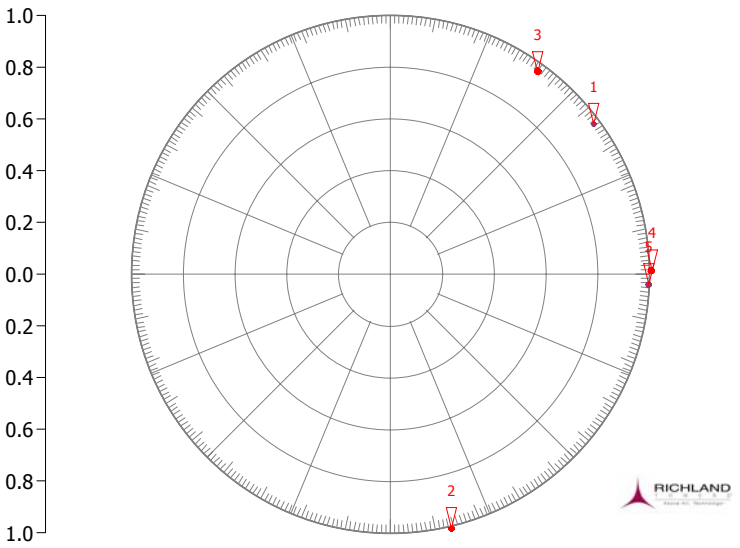
OKC FM Line Phasing @ 88MHz (Measured to Short / 2)

6" Line Initial IBOC Line Initial IBOC Lower +41" IBOC Final

6" Line Final



1 6" Line Initial
0 Hz
0.9769, 36.4174°

2 IBOC Line Initial
0 Hz
1.0118, -76.4068°

3 IBOC Lower +41"
0 Hz
0.9669, 53.9208°

4 IBOC Final
0 Hz
1.0133, 0.8041°

5 6" Line Final
0 Hz
0.9995, -2.3239°

Centre: 88.000000 mHz Span: 1.000000 Hz

8/7/2007 1:34:50 PM 8753ES

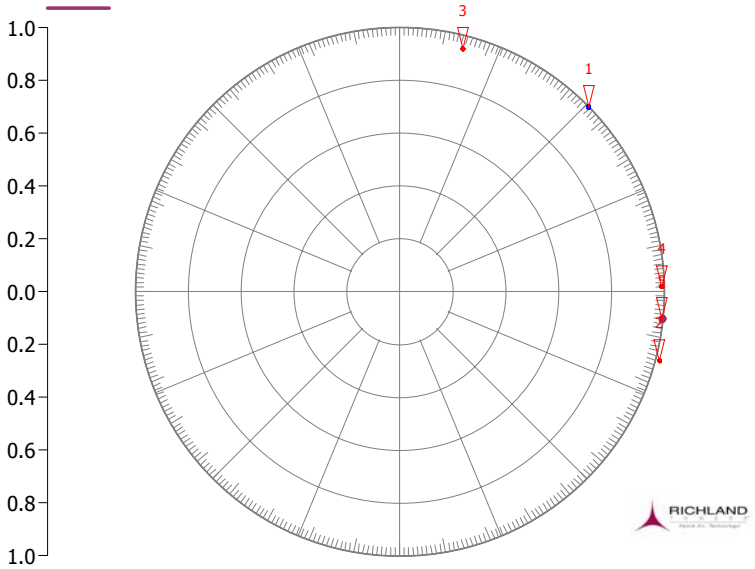
Line Phase 88.spt

Analogue Line is +6.5" added to Upper & IBOC Line is +51.625" added to Lower)

OKC FM Line Phasing @ 108MHz (Measured to Short / 2)

6" Line Initial IBOC Initial IBOC Lower +41" Upper Final

6" Line Final



1 6" Line Initial
0 Hz
1.0027, 44.3662°

2 IBOC Initial
0 Hz
1.0187, -14.9405°

3 IBOC Lower +41"
0 Hz
0.9514, 75.3932°

4 Upper Final
0 Hz
0.9942, 1.0482°

5 6" Line Final
0 Hz
0.9987, -5.8615°

Centre: 108.000000 mHz Span: 1.000000 Hz

8/7/2007 1:36:01 PM 8753ES

Line Phase 108.spt

Analogue Line is +6.5" added to Upper & IBOC Line is +51.625" added to Lower)

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OK City Renda IM Testing
3rd order IM products
Todd Loney 30 August 2007

	F2			
F1	92.5	98.9	104.1	107.7
92.5	-	86.1	80.9	77.3
98.9	105.3	-	93.7	90.1
104.1	115.7	109.3	-	100.5
107.7	122.9	116.5	111.3	-

= IM product in FM band

Fo	IM	fo Ref Le	fo Fltr Loss	Offset Ref	Measured	IM Fltr Loss	Measured Offs	Calculated	
92.5	**77.3**	-1.00	4.5	3.50	-85.00	5.15	-79.85	**83.35**	level indicated is KOCO-5 vision carrier (77.25) located <1 mi
92.5	**80.9**	-1.00	4.5	3.50	-101.00	5.40	-95.60	**99.10**	
92.5	**86.1**	-1.00	4.5	3.50	-102.00	6.68	-95.32	**98.82**	
98.9	**90.1**	-0.07	4.3	4.23	-89.00	5.70	-83.30	**87.53**	level indicated is from nearby FM station <1 mi.
98.9	**93.7**	-0.07	4.3	4.23	-101.00	4.36	-96.64	**100.87**	
104.1	**100.5**	0.08	4.8	4.88	-72.00	5.20	-66.80	**71.68**	level indicated is from nearby FM station <1 mi.
98.9	**105.3**	-0.07	4.3	4.23	-104.00	4.16	-99.84	**104.07**	
104.1	**109.3**	0.08	4.8	4.88	-104.00	4.66	-99.34	**104.22**	
107.7	**111.3**	0.52	4.5	5.02	-103.00	4.30	-98.70	**103.72**	
104.1	**115.7**	0.08	4.8	4.88	-103.00	1.50	-101.50	**106.38**	
107.7	**116.5**	0.52	4.5	5.02	-103.00	2.00	-101.00	**106.02**	
107.7	**122.9**	0.52	4.5	5.02	-103.00	4.00	-99.00	**104.02**	

FM Band Stop Filter used for these frequencies as Tunable Bandpass filter would not tune to these frequencies

Preliminary FM Antenna System Calculations

Model COG20P-12-240-2 Master FM Antenna
System Losses without Group Delay Compensation

	ANALOG				*DIGITAL*			
Call Letters:	KYIS-FM							
Frequency:	98.9	MHz						
ERP:	100.000	kW	20.000	dBk	1.000	kW	0.000	dBk
Polarization:	Circular				Circular			
Antenna Gain:	6.127		7.872	dB	6.127		7.872	dB
Element Input Power:	16.321	kW	12.128	dBk	0.163	kW	-7.872	dBk
Element Hybrid Losses:	-0.165	kW	20.000	dB	-0.002	kW	20.000	dB
Antenna Input Power:	16.486	kW	12.171	dBk	0.165	kW	12.171	dBk
Transmission Line Type - Vertical Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Vertical Run Length:	1627.000	feet			1627.000	feet		
Vertical Run Attenuation:	0.048	dB/100-feet			0.140	dB/100-feet		
Transmission Line Type - Horizontal: Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Horizontal: Run Length:	100.000	feet			100.000	feet		
Horizontal: Run Attenuation:	0.048	dB/100-feet			0.140	dB/100-feet		
Line Loss:	3.467	kW	0.829	dB	0.123	kW	2.418	dB
Line Efficiency:	82.624%				57.309%			
Power Output from Hybrid Splitter:	19.953	kW	13.000	dBk	0.288	kW	-5.411	dBk
Combiner System Losses:	-1.925	kW	0.400	dB	-0.054	kW	0.750	dB
Transmitter Power Output:	21.878	kW	13.400	dBk	0.342	kW	-4.661	dBk

Additional loss from optional group delay compensation module, increases combiner loss by 0.25 dB.

RICHLAND
TOWERS
Above All, Technology

February 9, 2007

Mike Fields
Citadel Broadcasting WKY-AM
Oklahoma City, OK

Mike,

This letter is to notify you that Richland Towers is proposing construction of a broadcast tower located approximately 2.04km from the WKY-AM tower, at a bearing of 95.41 degrees. The Richland Towers proposed site coordinates (NAD27) and overall height are:

Latitude	35-33-36.76 N
Longitude	97-29-06.47 W
Overall height	2749ft AMSL
	1605ft AGL

Richland Towers has conducted a pre-construction partial proof of performance for the WKY-AM directional array, pursuant to FCC Title 47 Section 73.1692(d). Pre-construction measurements were taken along the four radials that include the reference monitoring points, per FCC Title 47 Section 73.154. Preliminary results are attached. The engineering consultant contracted by Richland who performed the measurements is Munn-Reese.

Upon completion of the tower construction, Richland Towers will perform the post-construction partial proof of performance. This is anticipated in Spring 2007. At that time, a complete report will be provided.

Sincererly,

John Figura
RF Engineering Manager
Richland Towers

Cc: Niel Atkinson, Richland Towers
Dave Denton, Richland Towers

Enclosure

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www.richlandtowers.com

RICHLAND TOWERS℠
Above All, Technology℠

WKY AM Proof-of-Performance (Pre-construction)				
Directional (night pattern)				
Radial (deg)	Level (mV/m)	Distance (km)	Distance (mi)	
44	150.00	2.79	1.73	
44	76.00	3.91	2.43	Monitoring Point
44	76.00	5.02	3.12	
44	53.00	6.17	3.83	
44	47.50	7.33	4.55	
44	22.50	8.44	5.24	
44	19.50	9.53	5.92	
44	17.50	10.80	6.71	
44	15.20	11.80	7.33	
44	15.00	14.00	8.70	
44	12.80	15.40	9.57	
44	10.80	16.30	10.13	
106	120.00	2.81	1.75	Monitoring Point
106	26.5	4.41	2.74	
106	52	6.20	3.85	
106	20.2	7.40	4.60	
106	12.1	8.67	5.39	
106	16.5	9.53	5.92	
106	6.7	10.20	6.34	
106	13.2	11.20	6.96	
106	10.6	12.90	8.02	
106	11.9	14.50	9.01	
106	7.9	15.90	9.88	
106	7.7	16.20	10.07	
271	23.90	18.20	11.31	
271	27.50	16.60	10.31	
271	41.50	15.00	9.32	
271	44.00	13.40	8.33	
271	53.00	11.80	7.33	
271	45.00	10.10	6.28	
271	100.00	5.33	3.31	
271	92.00	6.00	3.73	
271	138.00	3.72	2.31	
271	148.00	3.23	2.01	
271	210.00	2.52	1.57	Monitoring Point
307	148.00	2.65	1.65	Monitoring Point
307	150.00	3.47	2.16	
307	132.00	5.02	3.12	
307	111.00	6.09	3.78	
307	91.00	7.02	4.36	
307	74.00	8.11	5.04	
307	47.50	10.30	6.40	
307	31.50	11.40	7.08	
307	33.50	12.80	7.95	
307	28.50	14.20	8.82	
307	27.00	16.80	10.44	
307	29.50	14.80	9.20	

400 N. Ashley Drive, Suite 3010, Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

DAY

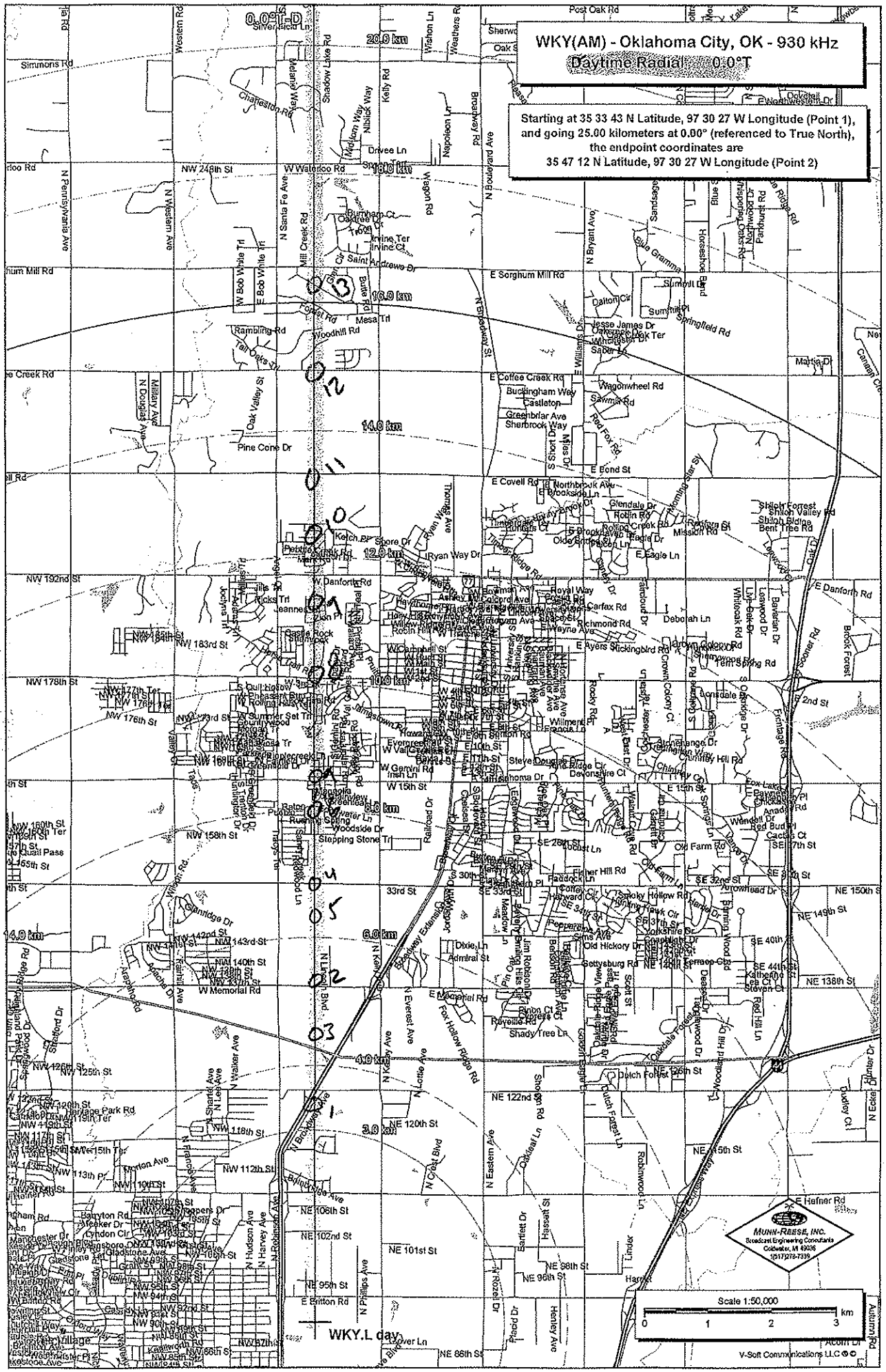
Station WKY Frequency 930 kHz Radial Bearing 0 °T

Center of Array Coordinates
_____NL;_____WL

Endpoint Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Point Number	Revised	Non-Directional Power _____ mV/m	Time	Date	Directional Power _____ mV/m	Time	Date	Distance km	Remarks
1		270	930	10.26				2.25	S of R Sign
2		190	1001					5.26	Nagy Lot
3		185	1032					4.41	By white Tank
4		133	1038					6.88	west of Bright Park Sign
5		145	1042					6.49	Fence to Back lot
6		110	1050					8.06	E of 1813
7		110	1056					8.94	Batting Cage
8		95	1108					10.2	Dumpster @ Spencer Grill
9		84	1115					11.7	W of 1801
10		74	1122					12.5	Box 1801
11		69.0	1127					13.3	opp orange phone Box
12		62.0	1133					15.0	where Tree line starts
13		42.5	1138					16.3	Box 176


WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 0.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 0.00° (referenced to True North), the endpoint coordinates are 35 47 12 N Latitude, 97 30 27 W Longitude (Point 2)
0.0°T-D
20.0 km
16.0 km
14.0 km
12.0 km
10.0 km
8.0 km
6.0 km
4.0 km
2.0 km
WKY.L day
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:50,000
0 1 2 3 km
V-Soft Communications LLC

Station CKKY Frequency 970 kHz Radial Bearing 60 °T Night DAY Center of Array Coordinates

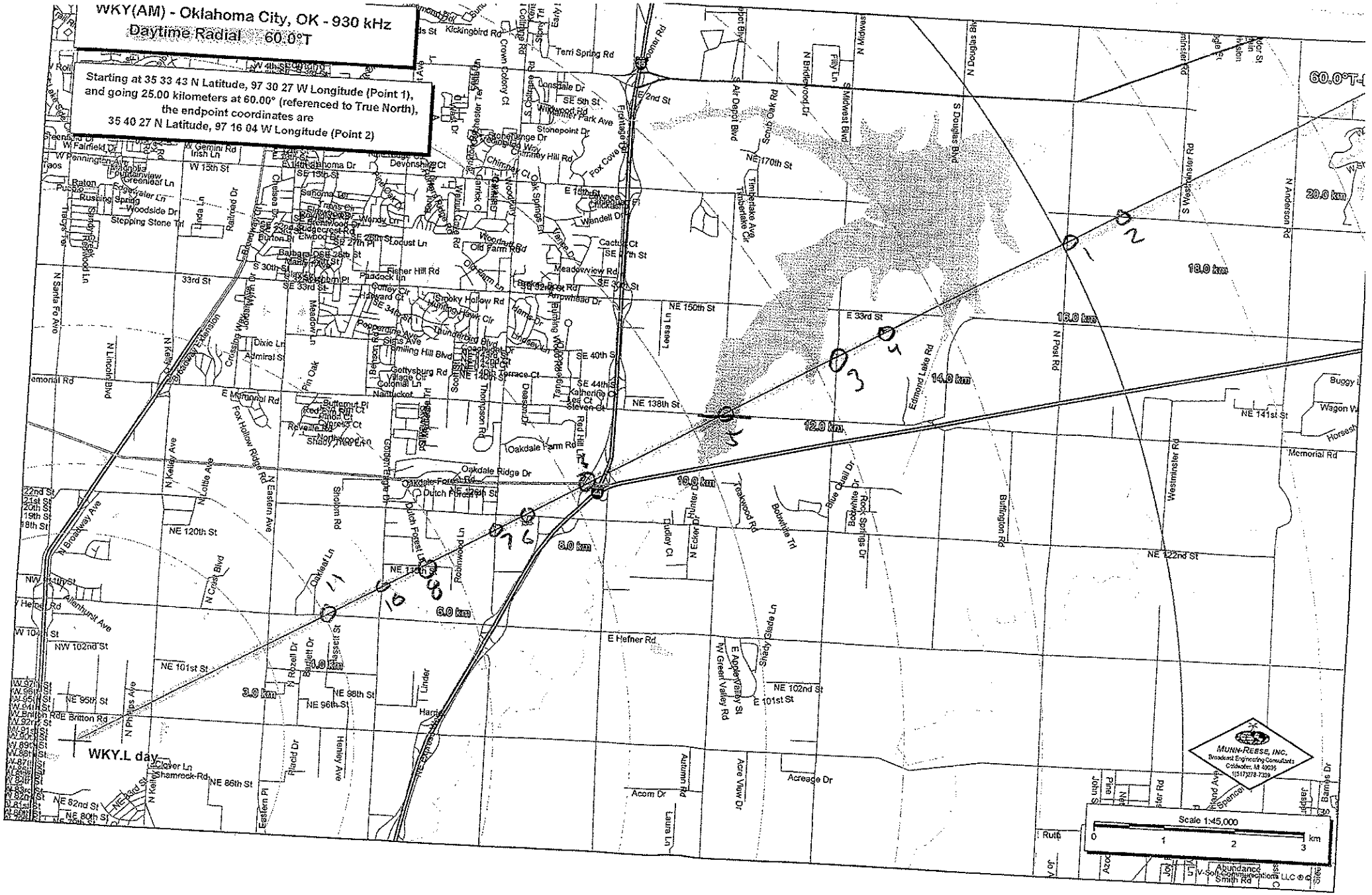
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____ Endpoint Coordinates

Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		22.9	1223	10-25				16.1	N of Housing Development
2		19.5	1226					17.0	Stone J drive S side
3		39.5	1236					12.4	N of Stone wall Entrance
4		33.5	1239					13.2	South of Fountain
5		47.0	1247					10.5	on Land Bridge
6		61.0	1254					7.23	W of F Hatland
7		63	1302					6.78	Dielc
8		94.0	1307					5.65	E side of Hill
9		80.0	1310					4.96	Box 11403
10		63.0	1315					4.02	Speller oil sign
11		150.0	1317					2.11	Drain on curb
12									


WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 60.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 60.00° (referenced to True North), the endpoint coordinates are 35 40 27 N Latitude, 97 16 04 W Longitude (Point 2)
60.0°T
20.0 km
18.0 km
16.0 km
14.0 km
12.0 km
10.0 km
8.0 km
6.0 km
3.0 km
WKY.L day
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:45,000
0 1 2 3 km
Abundance
V-Soft Communications LLC

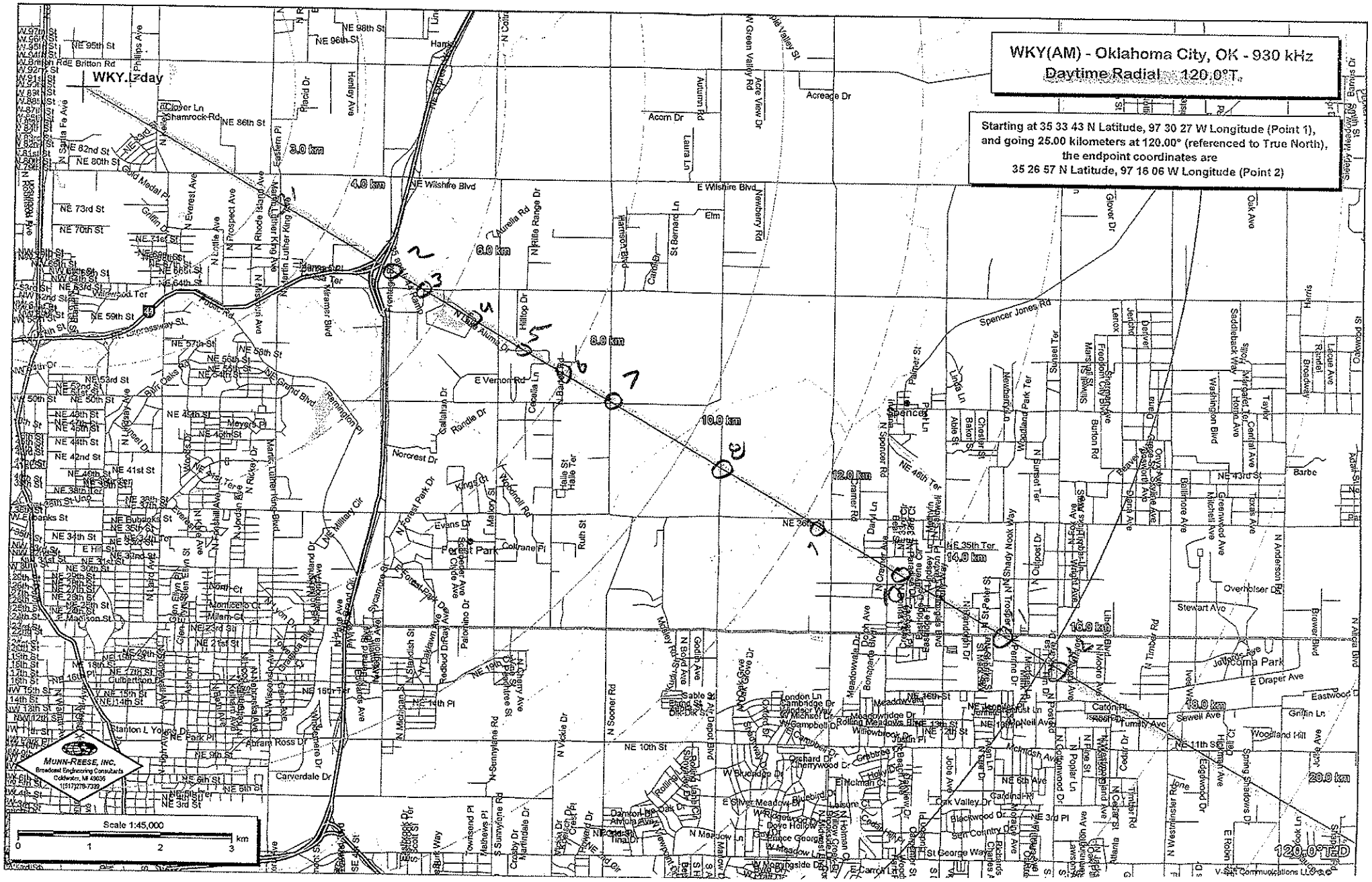
Station WAY Frequency 970 kHz Radial Bearing 120 °T DAY

Center of Array Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Endpoint Coordinates
_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		225	1036	10-25				3.27	Mtk Dr Field
2		125	1043					5.10	◇ church sign
3		115.0	1047					5.60	63th & Aluma Valley
4		121.0	1051					6.48	N of white oasis
5		91.0	1106					7.42	white Mail Box
6		89.0	1110					7.94	Tan / Blue house
7		93.0	1114					8.74	in Triangle of Land
8		69.0	1119					16.6	Sheriff training facil.
9		60.0	1125					12.2	N of Flag pole
10		52.0	1131					17.5	Back lot of Football field
11		28.3	1135					15.3	Box 9512
12		36.5	1138					16.2	Box 1916
13									


WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 120.0°T.
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1),
and going 25.00 kilometers at 120.00° (referenced to True North),
the endpoint coordinates are
35 26 57 N Latitude, 97 16 06 W Longitude (Point 2)
WKY Friday
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:45,000
0 1 2 3 km
120.0° TD
V-Soft Communications LLC

DAY

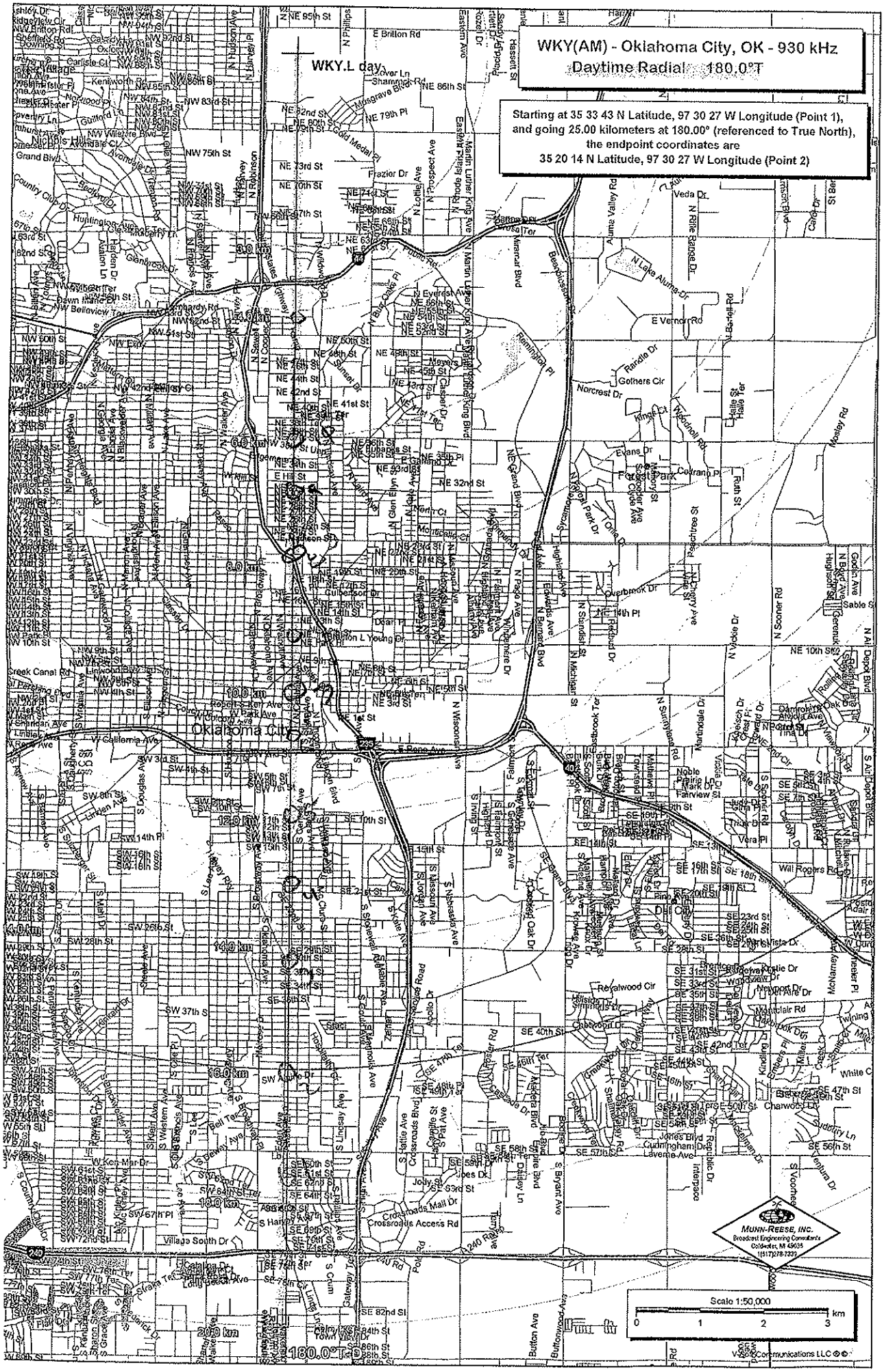
Station WKY Frequency 930 kHz Radial Bearing 180 °T

Center of Array Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Endpoint Coordinates
_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		39.0	952	10-25				17.6	Universal Homes Sign
2		46.0	900					15.8	Greenhouse Market
3		51.0	907					14.4	opp Braum's
4		55.0	925					13.4	E of Andrews Pawn Shop
5		63.0	921					12.5	Hippliner Cir
6		78.0	942					10.7	Alley between Park & Dall
7		72.0	949					10.1	Park is Dirt Property
8		80.0	955					9.23	Back lot of light Tan B
9		115.0	959					7.91	Empty lot across from
10		82.0	1005					7.06	Dent of Trans. Dr
11		115.0	1010					6.00	Baker Dist Lot
12		143.0	1014					5.02	Plumber Bar Lot
13		203.0	1018					4.21	Walnut + 44th St
14		285.0	1023					2.77	Family Question Dr
									Bank 2400


WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 180.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1),
and going 25.00 kilometers at 180.00° (referenced to True North),
the endpoint coordinates are
35 20 14 N Latitude, 97 30 27 W Longitude (Point 2)
WKY Day
Oklahoma City
180.0°T
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:50,000
0 1 2 3 km
Vista Communications LLC

DAY

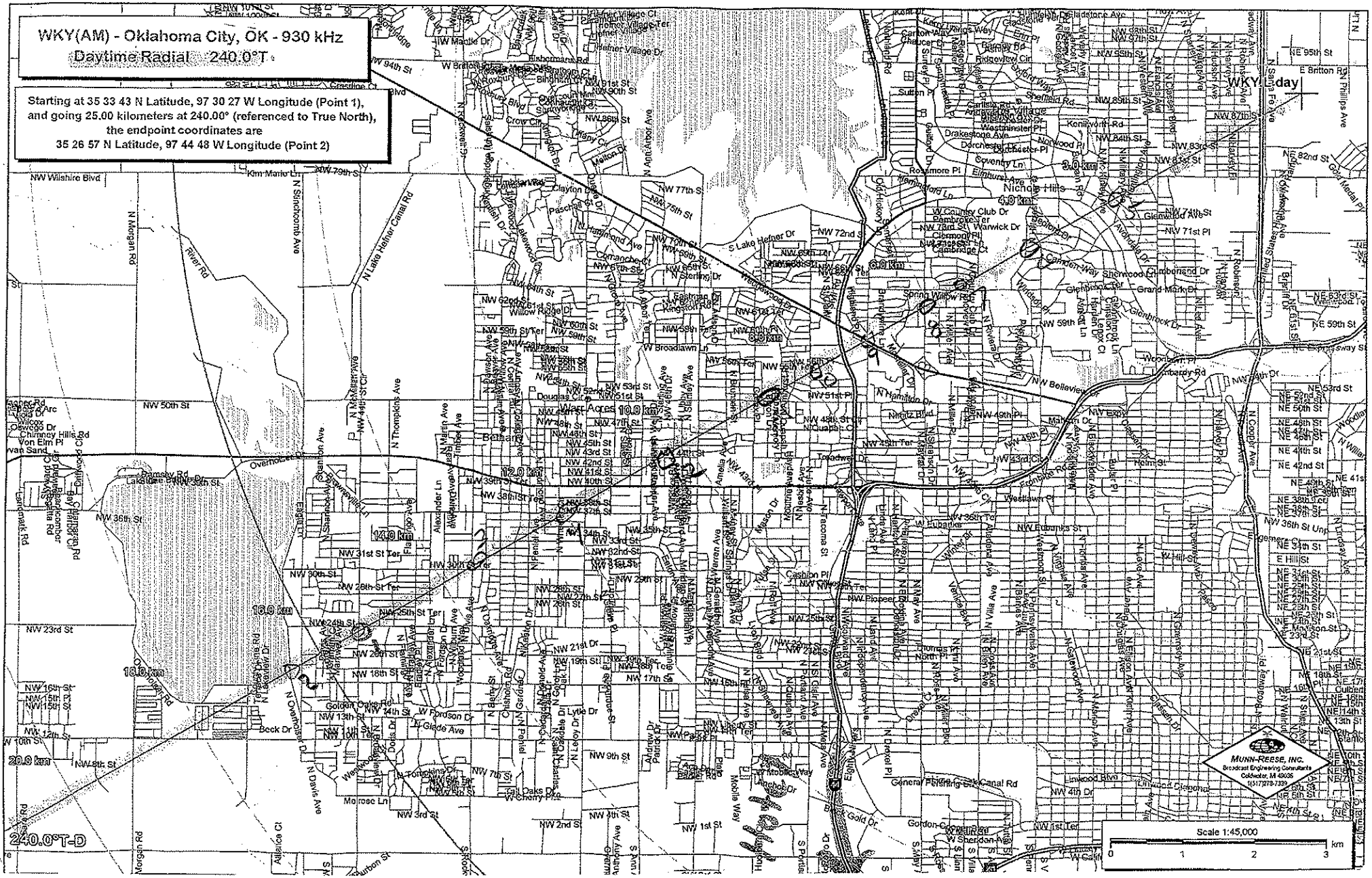
Station WKY Frequency 930 kHz Radial Bearing 240 °T

Center of Array Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Endpoint Coordinates
_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		39.0	1618	10-25				16.3	Produce Stand
2		39.0	1623	"				16.4	Cedar Tree by Lake
3		47.5	1630	"				13.4	Stone Dr at church
4		64.0	1636	"				12.1	Hummond Manor
5		250	1212	10-26				2.99	W of Iron rails
6		165	1222	"				4.39	E of 6602
7		135	1226					5.29	Brick see through Garage
8		169	1230					6.17	Back Lot of Golden Corral
9		99	1236					7.01	Starbucks lot
10		120	1243					7.84	By Blue Dumpster in Alley
11		101	1247					8.81	Brick Corner House
~~12~~			~~1253~~					~~9.94~~	~~Off~~
12		59	1253					10.4	Red rd. white house


WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 240.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1),
and going 25.00 kilometers at 240.00° (referenced to True North),
the endpoint coordinates are
35 26 57 N Latitude, 97 44 48 W Longitude (Point 2)
240.0°T-D
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:45,000
0 1 2 3 km

DAY

Station WKY Frequency 930 kHz Radial Bearing 300°T

Center of Array Coordinates
______NL; ______WL

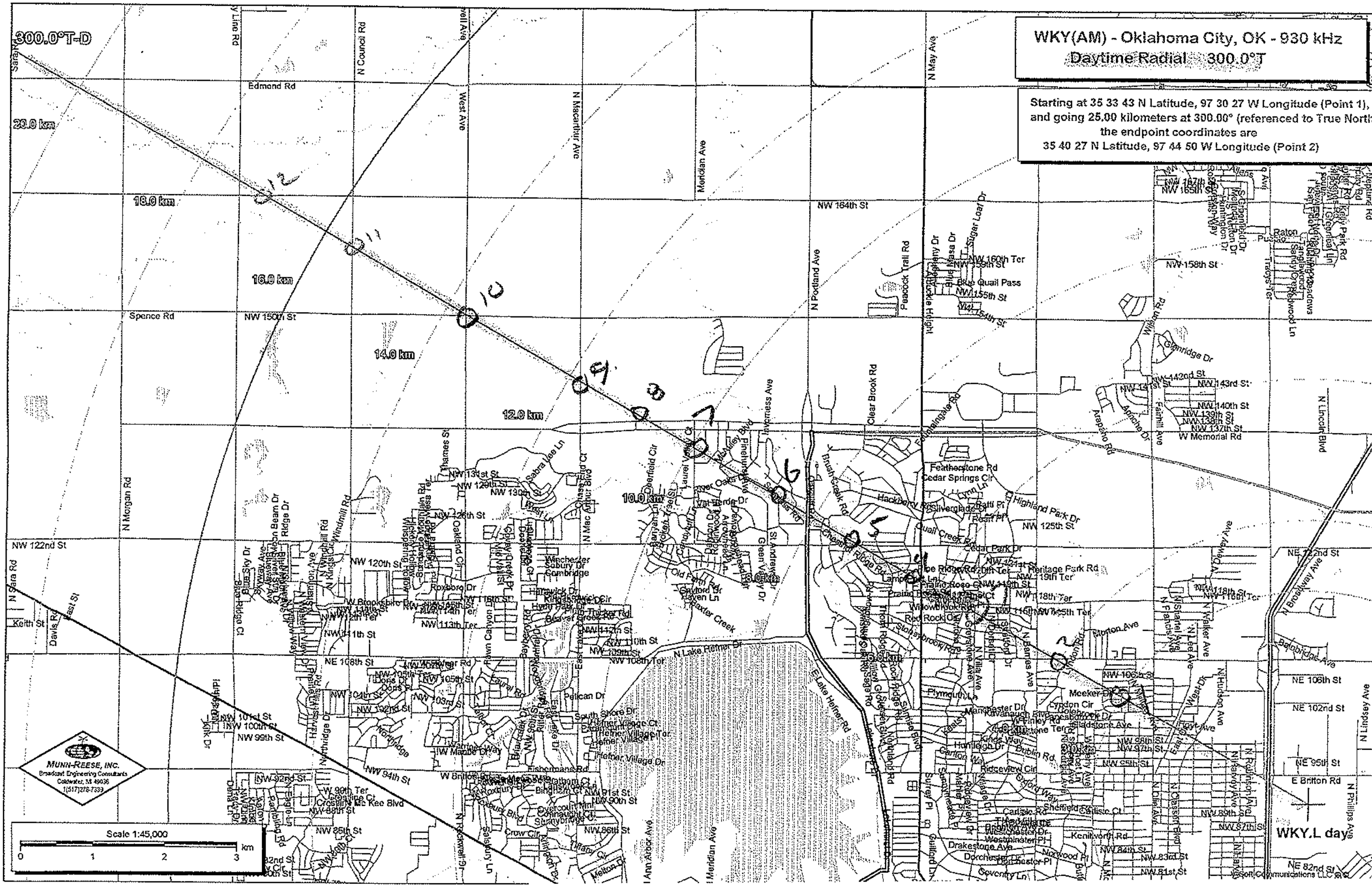
Meter NDA Type ______ S/N ______ Cal Date ______ Engineer ______
Meter DA Type ______ S/N ______ Cal Date ______ Engineer ______

Endpoint Coordinates
______NL; ______WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		242	1509	10-25				3.03	Blue - Gray House
2		175	1514					4.01	Dr to oil well
3		150	1518					5.32	Box 11417
4		134	1524					6.45	Box 11909
5		106	1529					7.32	Box 3400
6		119	1534					8.46	Triangle island
7		90.0	1543					9.94	Lot opp hospital .03 [illegible]
8		105.0	1547					10.9	Back "Drive" to office
9		90.0	1550					11.8	Gaillardia Dr
10		72.0	1553					13.7	30 MPH Sign
11		71.0	1556					15.5	Fenced Drive
12		42.5	1559					17.0	25 ft E of Bridge

WKY(AM) - Oklahoma City, OK - 930 kHz
Daytime Radial 300.0°T

Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 300.00° (referenced to True North), the endpoint coordinates are 35 40 27 N Latitude, 97 44 50 W Longitude (Point 2)



NITE

Station WKY Frequency 930 kHz Radial Bearing 44 °T

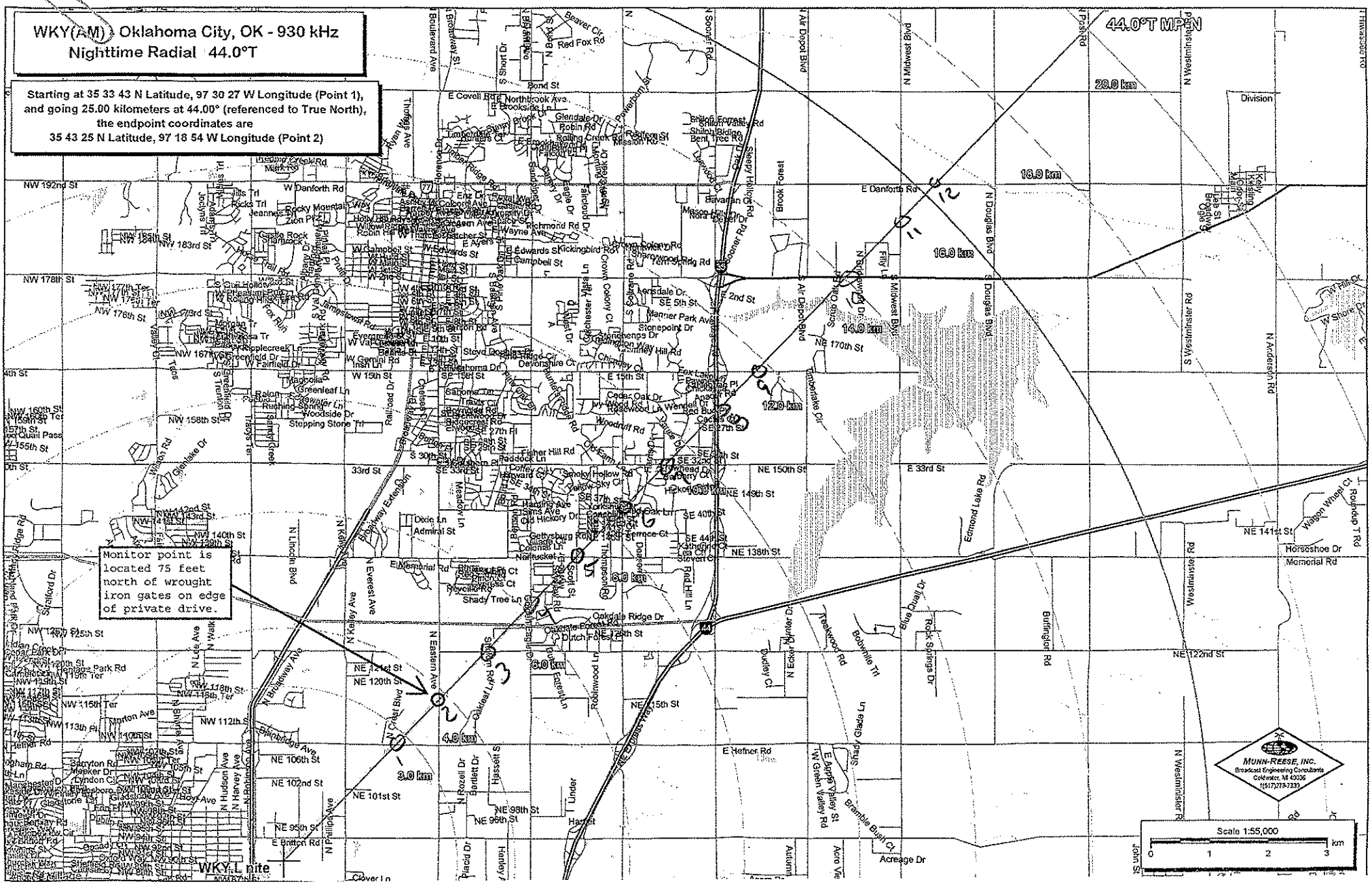
Center of Array Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____

Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Endpoint Coordinates
_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		150	1339	10-24				2.79	West of wire generator
2		76	1343					3.91	Box 2021 MP
3		76	1347					5.02	Duel Black mail Barrel
4		57.0	RTD					6.17	North of Bridge
5		47.5	1354					7.33	7th Ave Adv. Lot
6		22.5	1402					8.44	N of 40th + railroad
7		19.5	1406					9.53	W of Fenced Generator
8		17.5	1409					10.6	S of SE 15th St
9		15.2	1413					11.8	1/8 mi W of fenced DP
10		15.0	1427					14.0	Even w/ Silver propane tank
11		12.8	1432					15.4	White Meters Fence
12		10.8	1434					16.3	W of Private DP


WKY(AM) Oklahoma City, OK - 930 kHz
Nighttime Radial 44.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 44.00° (referenced to True North), the endpoint coordinates are 35 43 25 N Latitude, 97 18 54 W Longitude (Point 2)
44.0°T MPRN
Monitor point is located 75 feet north of wrought iron gates on edge of private drive.
WKY L nite
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:55,000
0 1 2 3 km

Nike

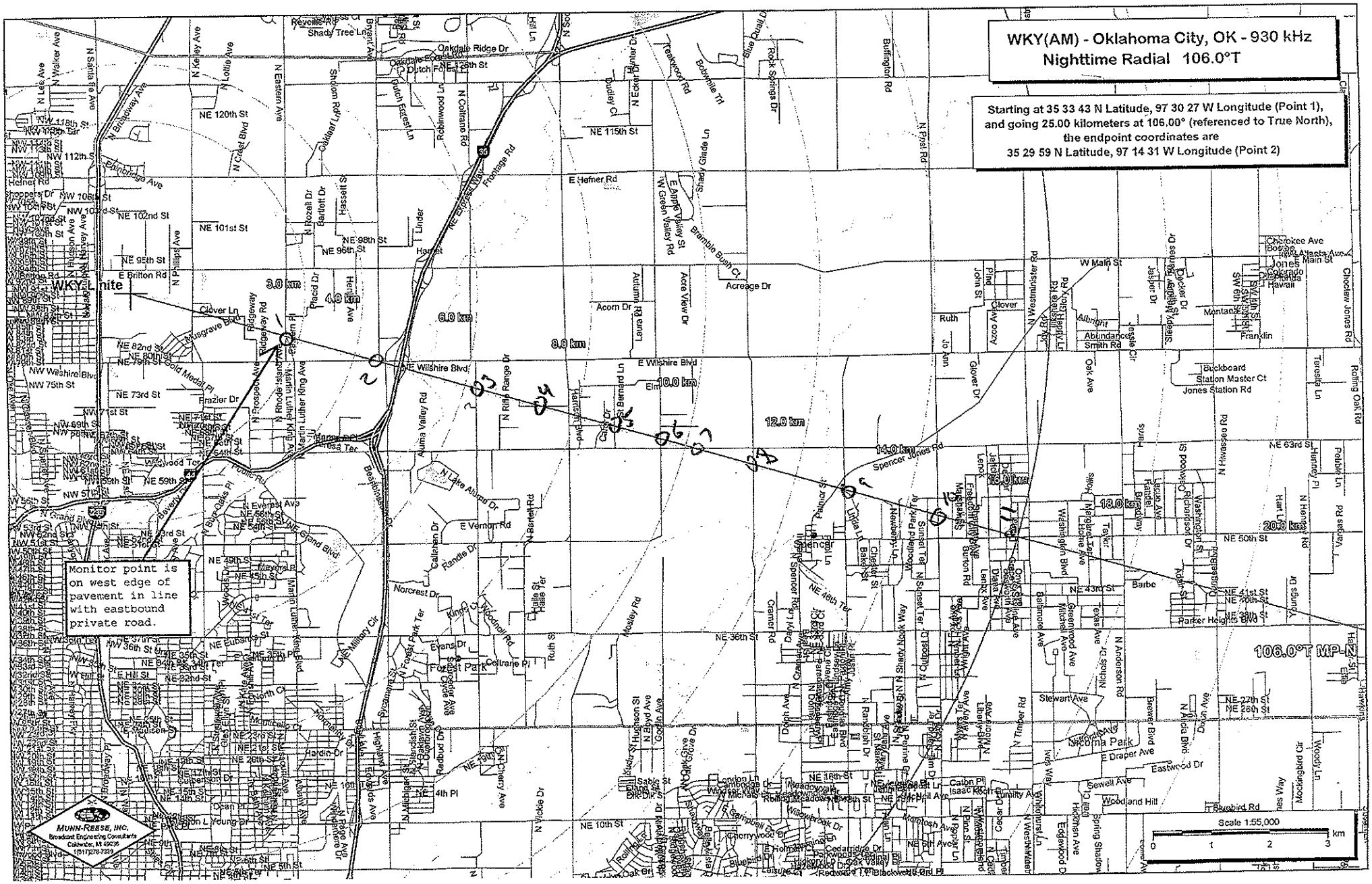
Station LHY Frequency 930 kHz Radial Bearing 166 °T

Center of Array Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Endpoint Coordinates
_____NL;_____WL

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		120	1551	10-24				2.81	on Curve ~~Tee~~ MT
2		26.5	1557					4.41	Stop sheet Sign
3		52.0	1601					6.20	N of stand of oak trees
4		20.2	1606					7.40	open mowed field
5		12.1	1611					8.67	opp white house black trim
6		16.5	1615					9.53	N of New house
7		6.7	1618					10.2	Top of hill wires
8		13.2	1620					11.2	10 ft N of yellow Gas sign
9		10.6	1627					12.9	N of "The Bradfords"
10		11.9	1632					14.5	opp Pearlcourt Church
11		2.9	1636					15.9	cement Drive to Church
12		7.7	1638					16.2	S of BBQ Shack


WKY(AM) - Oklahoma City, OK - 930 kHz
Nighttime Radial 106.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 106.00° (referenced to True North), the endpoint coordinates are 35 29 59 N Latitude, 97 14 31 W Longitude (Point 2)
WKY-Licensed Site
Monitor point is on west edge of pavement in line with eastbound private road.
106.0°T MP-L
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339
Scale 1:55,000
km
0
1
2
3

N.L.R

Ken Boyd (405) 694-3860

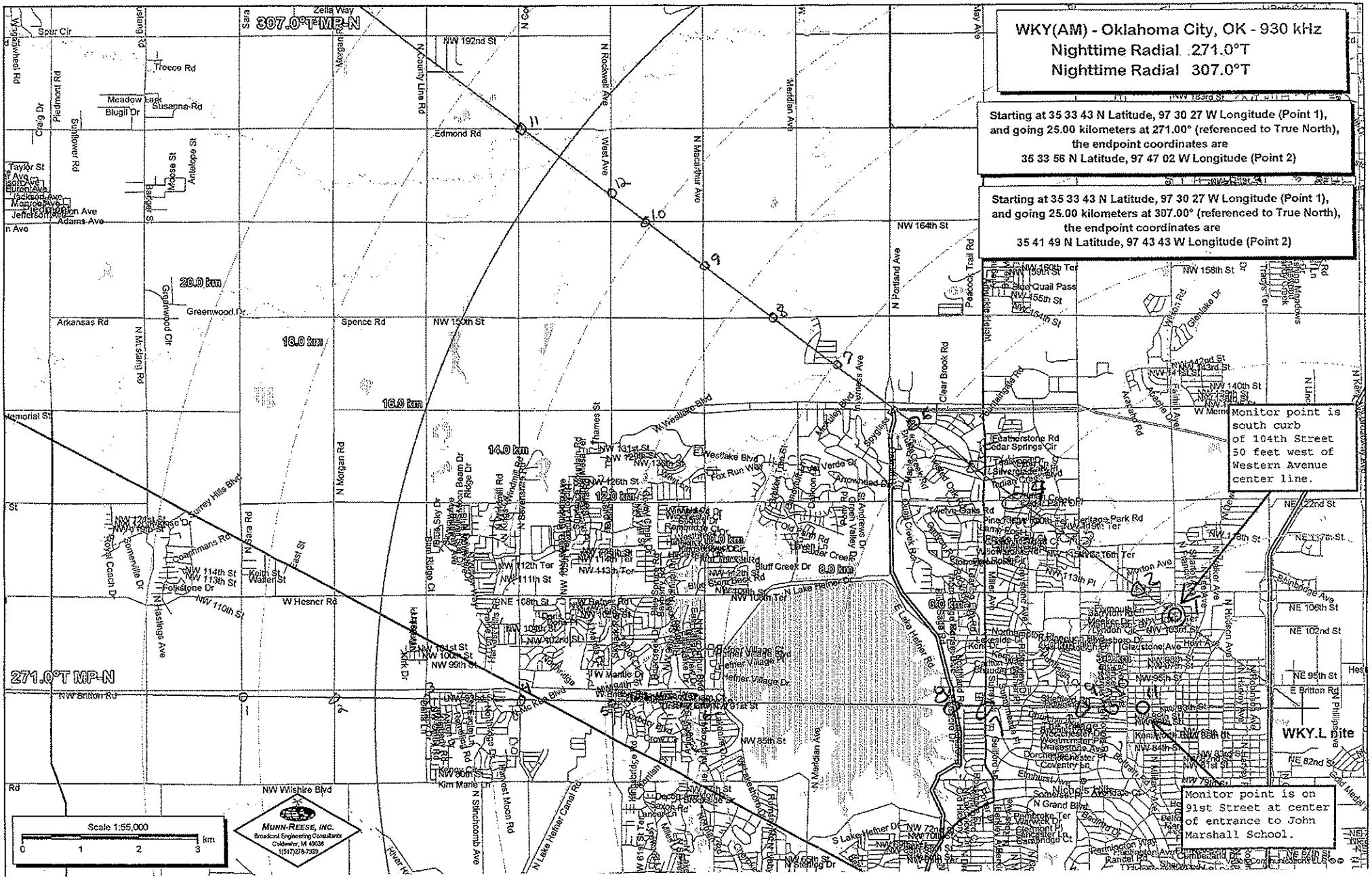
Station WKY Frequency 930 kHz Radial Bearing 271 °T

Center of Array Coordinates
_____NL;_____WL

Endpoint Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		23.9	1118	10-24				18.2	S of Britton 30ft
2		27.5	1123					16.6	End of tree line
3		41.5	1127					15.0	Trees N of 92nd St
4		44.0	1132					13.4	N corner of car wash
5		53	1144					11.8	Childrens World
6		45	1150					10.1	S of Lola's
7		100	1231					5.37	St. Martins lot white sign
8		92	1239					6.06	S of Eastwest sign
9		135	1323					3.72	Dox 1633
10		146	1325					3.23	Box 1414
11		210	1329					2.52	Middle school Flg pole


WKY(AM) - Oklahoma City, OK - 930 kHz
Nighttime Radial 271.0°T
Nighttime Radial 307.0°T
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 271.00° (referenced to True North), the endpoint coordinates are 35 33 56 N Latitude, 97 47 02 W Longitude (Point 2)
Starting at 35 33 43 N Latitude, 97 30 27 W Longitude (Point 1), and going 25.00 kilometers at 307.00° (referenced to True North), the endpoint coordinates are 35 41 49 N Latitude, 97 43 43 W Longitude (Point 2)
307.0°T MP-N
271.0°T MP-N
Monitor point is south curb of 104th Street 50 feet west of Western Avenue center line.
Monitor point is on 91st Street at center of entrance to John Marshall School.
WKY-L site
20.0 km
18.0 km
16.0 km
14.0 km
12.0 km
10.0 km
8.0 km
6.0 km
Scale 1:55,000
0 1 2 3 km
MUNN-REESE, INC.
Broadcast Engineering Consultants
Coldwater, MI 49036
(517)278-7339

Station WKY Frequency 930 kHz Radial Bearing 307 °T

Nike

Center of Array Coordinates
_____NL;_____WL

Endpoint Coordinates
_____NL;_____WL

Meter NDA Type _____ S/N _____ Cal Date _____ Engineer _____
Meter DA Type _____ S/N _____ Cal Date _____ Engineer _____

Point Number	Revised	Non-Directional Power mV/m	Time	Date	Directional Power mV/m	Time	Date	Distance km	Remarks
1		148.0	1001	10-24				2.65	Box 1011 (MP)
2		150	1006					3.47	Box 10912
3		132	1012					5.02	Box 2219
4		111	1018					6.09	20 ft S of Cedar Park Dr
5		91	1022					7.02	Box 2909
6		74	1030					8.11	25 E of 3409
7		47.5	1040					10.3	Box 14417
8		31.5	1044					11.4	3 Pine Trees, middle of field
9		33.5	1048					12.8	South edge of yard
10		28.5	1052					14.2	100 N of Driveway
11		27.0	1057					16.8	S of intersection
12		29.5	1102					17.8	Box 16825

Oklahoma City, Oklahoma

Analogue/IBOC FM Broadband System Commissioning Report

Prepared For

KYIS 98.9
Citidel Broadcasting

Equipment

ERI COG-20P-12-240-2 Panel Antenna
with Dual Inputs and Reverse-fed IBOC
1660' Dual ERI 6"- 50Ω Maxline & Dual 3" Heliax Transmission Line
ERI 973-8 Four Channel Constant Impedance Combiner with Circulator
Isolated IBOC

Measurement Data Taken on
3 – 12 August 2007

Submitted By

Todd R Loney
Senior RF Engineer

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Measurement setup

Measurements were taken with an Agilent 8753ES network analyzer, Agilent 4-port dual directional coupler. A three watt amplifier was used to overcome high RF level ingress. For combiner measurements, an HP S-Parameter test was used.
Richland Towers broadband, precision test adapters were used to make the measurements.
Data was extracted from the analyzer in complex pair values (real/imaginary) via the GPIB port to laptop computer. Data was then analyzed and presented using SoftPlot™ software and is imported into this document as an Object Linking Embedding (OLE). This data can be manipulated, (scale, format, markers, etc.) follow link to http://softplot.com/ and download demonstration version to utilize this feature.
Markers are placed at fc as well as +/- 150kHz.

Measurement details

Measurements were taken from the input to the combiner as well as from the transmitter output.
Antenna system data is included under a separate antenna system report.

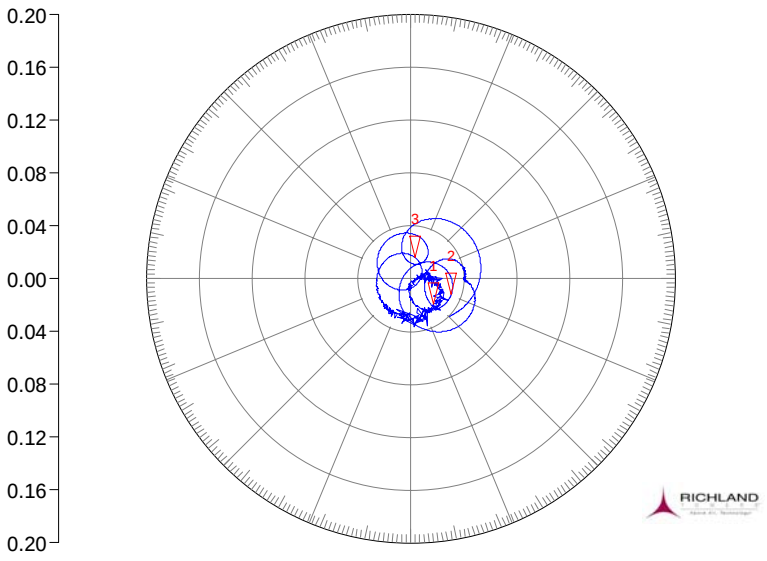
Findings

- Performance of the system, from transmitter outputs, through the combiner to the antenna is satisfactory
- Station to station isolations measured >-80dB except 98.9 into 104.1 which measured -75dB. Specification is -55dB

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

KYIS 98.9 Transmitter to Antenna Polar Impedance 200mU

TX to ANT



1 TX to ANT
98.900000 MHz
0.0260, -48.0351°

2 TX to ANT
98.750000 MHz
0.0331, -20.8204°

3 TX to ANT
99.050000 MHz
0.0161, 77.6244°

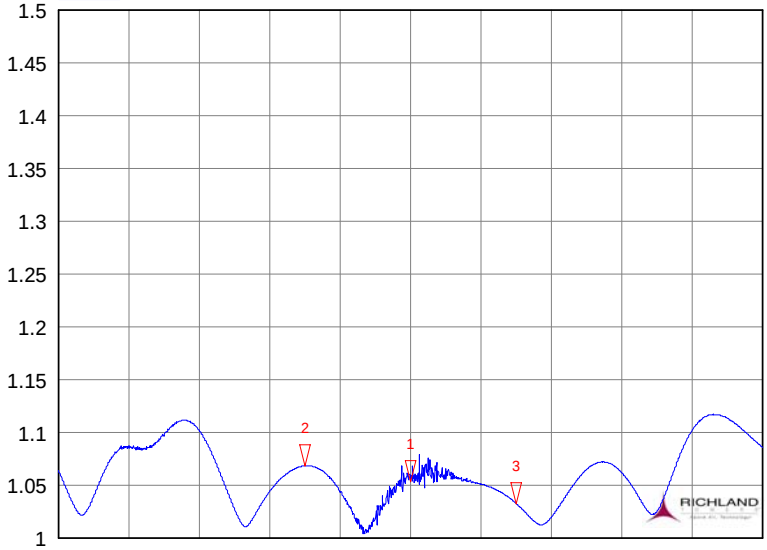
Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

98.9 Module

KYIS 98.9 Transmitter to Antenna VSWR 1.05/div

VSWR

TX to ANT



1 TX to ANT
98.900000 MHz
1.0535 VSWR

2 TX to ANT
98.750000 MHz
1.0684 VSWR

3 TX to ANT
99.050000 MHz
1.0328 VSWR

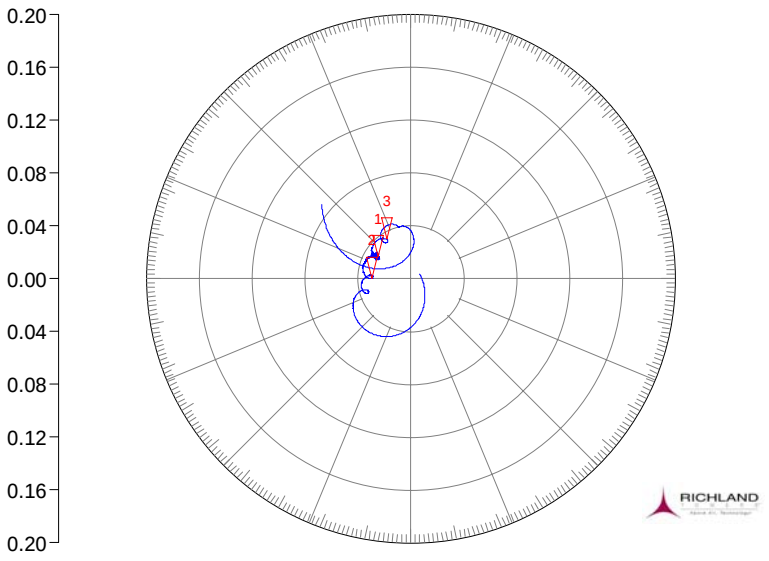
Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

98.9 Module

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

KYIS 98.9 IBOC Transmitter to Antenna Polar Impedance 200mU

IBOC TX to ANT



1 IBOC TX to ANT
98.900000 MHz
0.0295, 146.3068°

2 IBOC TX to ANT
98.750000 MHz
0.0291, -179.9681°

3 IBOC TX to ANT
99.050000 MHz
0.0350, 121.4650°

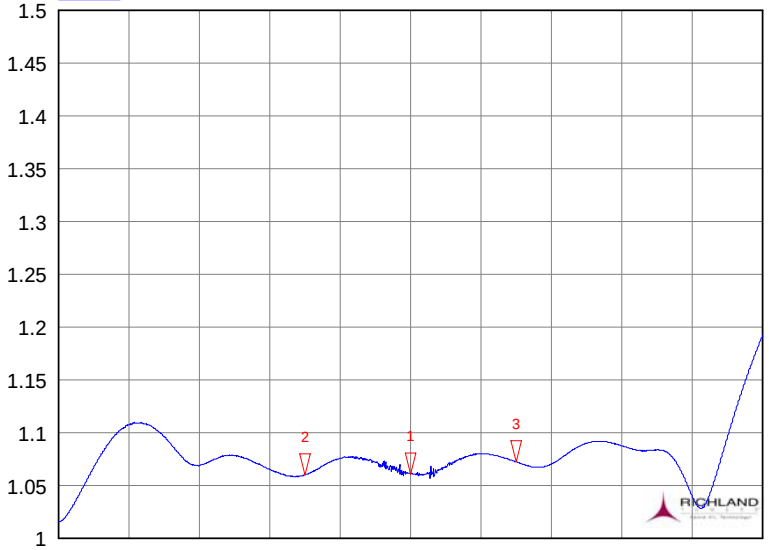
Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

Through Circulator

KYIS 98.9 IBOC Transmitter to Antenna VSWR 1.05/div

VSWR

IBOC TX to ANT



1 IBOC TX to ANT
98.900000 MHz
1.0607 VSWR

2 IBOC TX to ANT
98.750000 MHz
1.0600 VSWR

3 IBOC TX to ANT
99.050000 MHz
1.0725 VSWR

Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

98.9 Module

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
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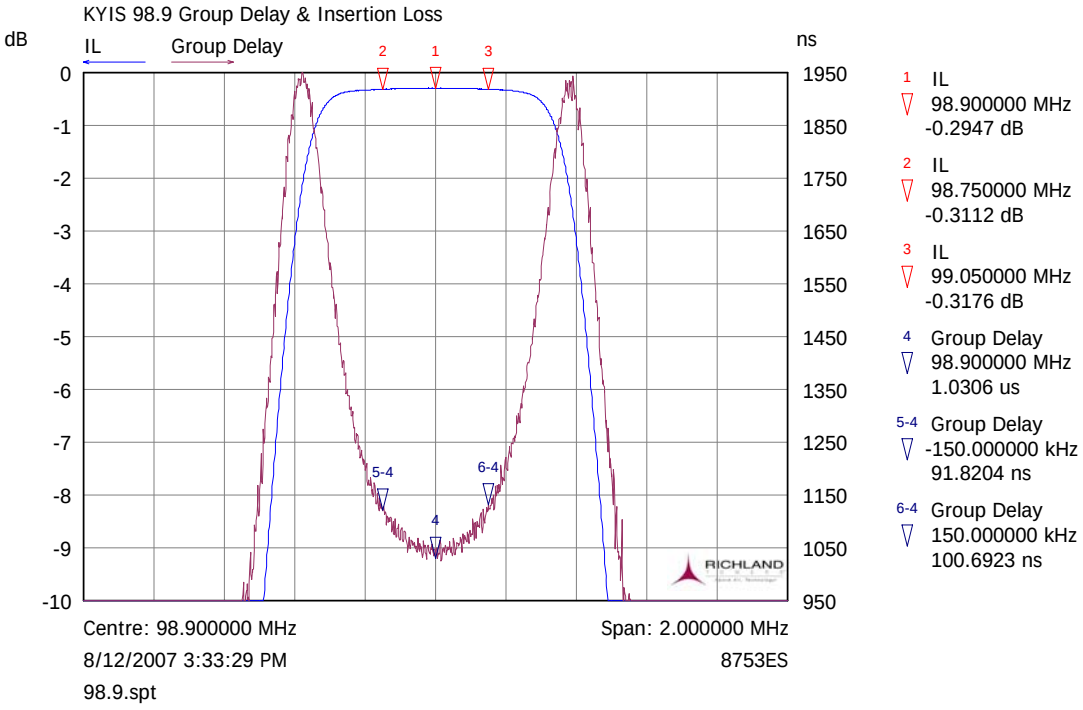

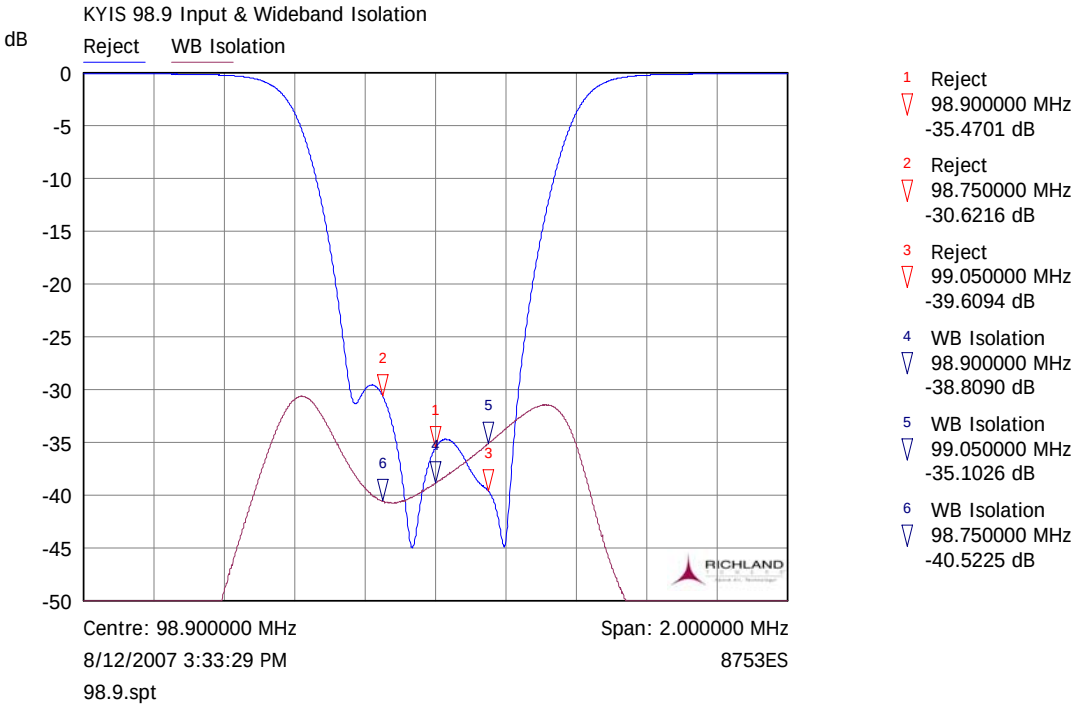

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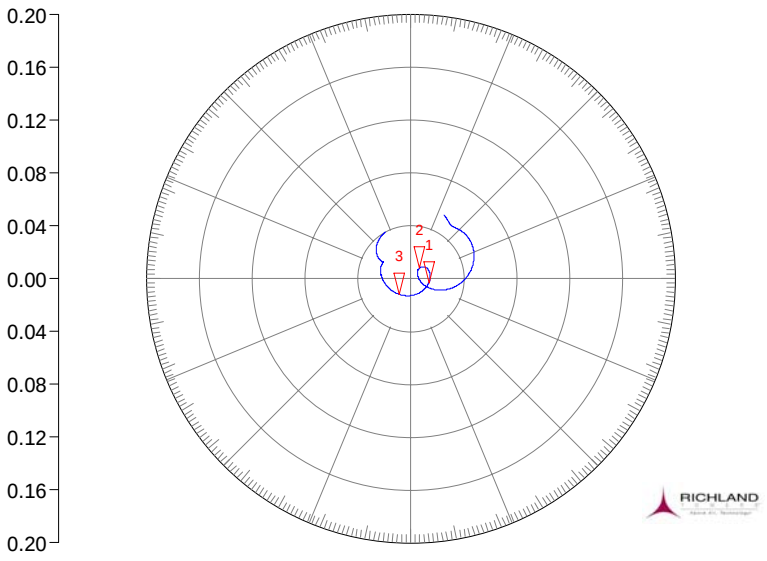
KYIS 98.9 Combiner System Polar Impedance 200mU

S11



1 S11
98.900000 MHz
0.0142, -12.9652°

2 S11
98.750000 MHz
0.0104, 49.7270°

3 S11
99.050000 MHz
0.0147, -124.8285°

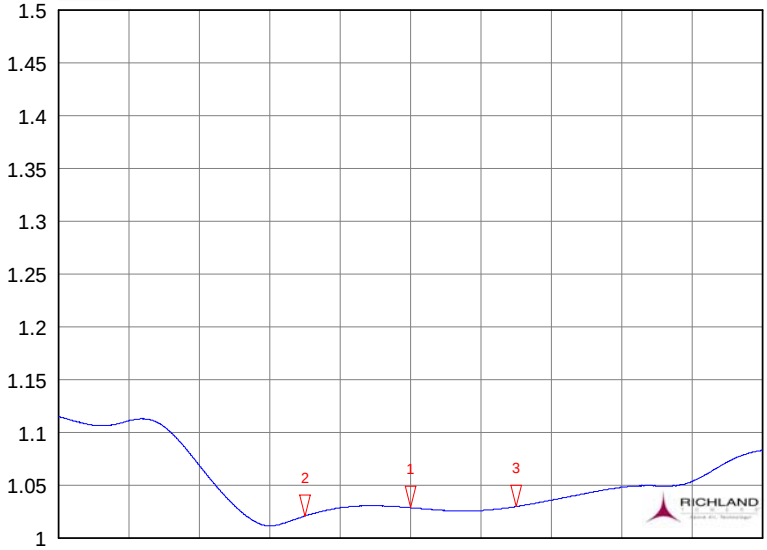
Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

98.9 Module

KYIS 98.9 Combiner System VSWR 1.05/div

VSWR

S11



1 S11
98.900000 MHz
1.0288 VSWR

2 S11
98.750000 MHz
1.0210 VSWR

3 S11
99.050000 MHz
1.0299 VSWR

Centre: 98.900000 MHz
Span: 1.000000 MHz
8/12/2007 3:33:29 PM
8753ES
98.9.spt

98.9 Module

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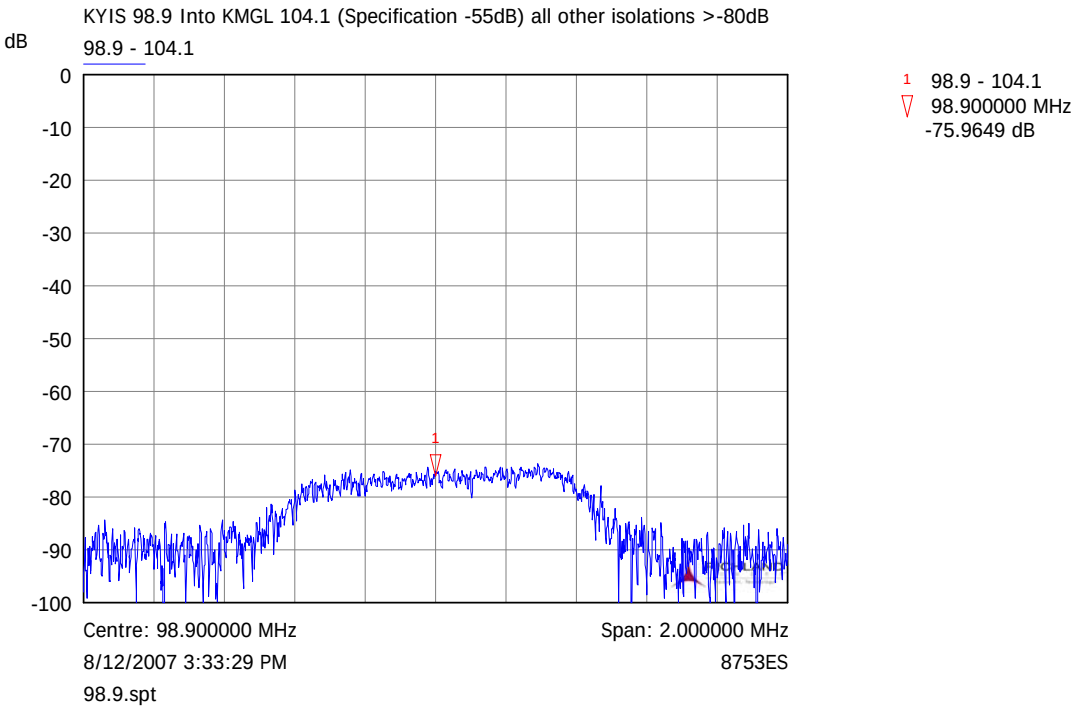

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Oklahoma City, Oklahoma

Analogue/IBOC FM Broadband System Commissioning Report

Prepared For

KRXO 107.7
Renda Broadcasting

Equipment

ERI COG-20P-12-240-2 Panel Antenna
with Dual Inputs and Reverse-fed IBOC
1660′ Dual ERI 6″- 50Ω Maxline & Dual 3″ Heliax Transmission Line
ERI 973-8 Four Channel Constant Impedance Combiner with Circulator
Isolated IBOC

Measurement Data Taken on
3 – 12 August 2007

Submitted By

Todd R Loney
Senior RF Engineer

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Measurement setup

Measurements were taken with an Agilent 8753ES network analyzer, Agilent 4-port dual directional coupler. A three watt amplifier was used to overcome high RF level ingress. For combiner measurements, an HP S-Parameter test was used.
Richland Towers broadband, precision test adapters were used to make the measurements.
Data was extracted from the analyzer in complex pair values (real/imaginary) via the GPIB port to laptop computer. Data was then analyzed and presented using SoftPlot™ software and is imported into this document as an Object Linking Embedding (OLE). This data can be manipulated, (scale, format, markers, etc.) follow link to http://softplot.com/ and download demonstration version to utilize this feature. Markers are placed at fc as well as +/- 150kHz.

Measurement details

Measurements were taken from the inputs to the combiner as well as from the transmitter output.
Antenna system data is included under a separate antenna system report.

Findings

- Performance of the system, from transmitter outputs, through the combiner to the antenna is satisfactory
- Station to station isolations measured >-80dB except 98.9 into 104.1 which measured -75dB. Specification is -55dB

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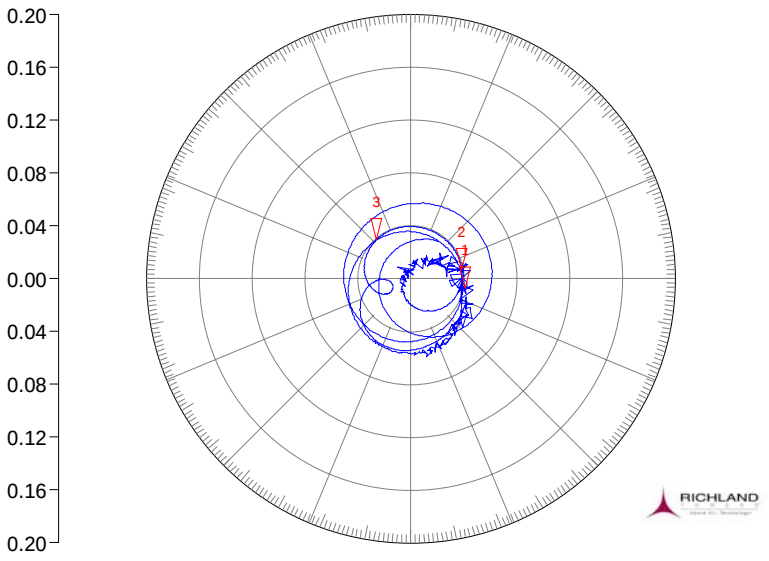
KRXO 107.7 Transmitter to Antenna Polar Impedance 200mU

TX to ANT



1 TX to ANT
107.700000 MHz
0.0421, -10.0456°

2 TX to ANT
107.550000 MHz
0.0395, 9.4660°

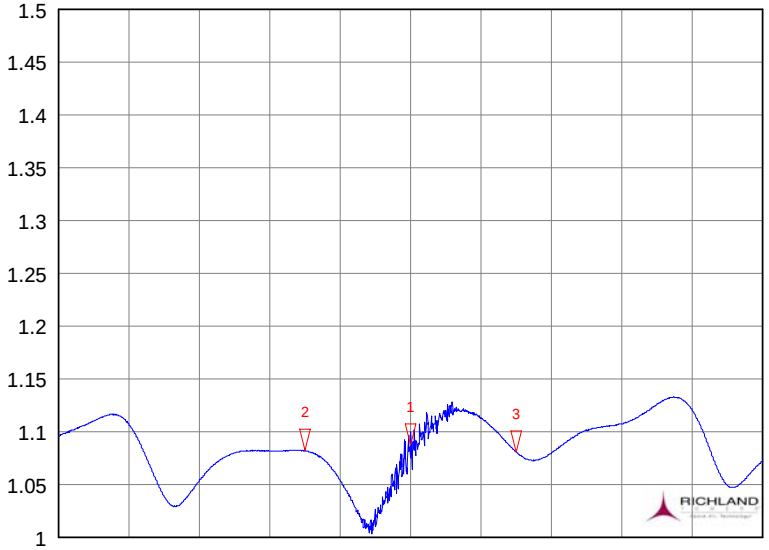
3 TX to ANT
107.850000 MHz
0.0389, 131.5496°

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

KRXO 107.7 Transmitter to Antenna VSWR 1.05/div

VSWR

TX to ANT



1 TX to ANT
107.700000 MHz
1.0878 VSWR

2 TX to ANT
107.550000 MHz
1.0823 VSWR

3 TX to ANT
107.850000 MHz
1.0810 VSWR

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

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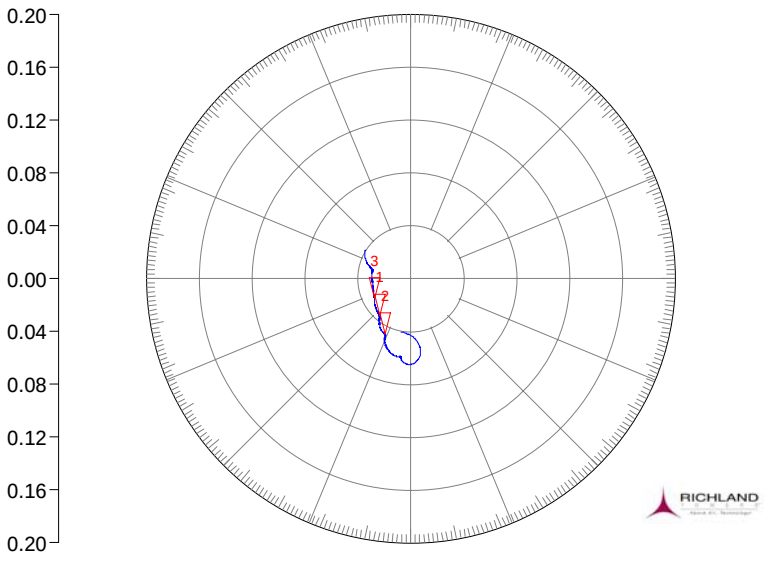
www.richlandtowers.com

KRXO 107.7 IBOC Transmitter to Antenna Polar Impedance 200mU

IBOC TX to ANT



1 IBOC TX to ANT
107.700000 MHz
0.0369, -129.7955°

2 IBOC TX to ANT
107.550000 MHz
0.0463, -114.7526°

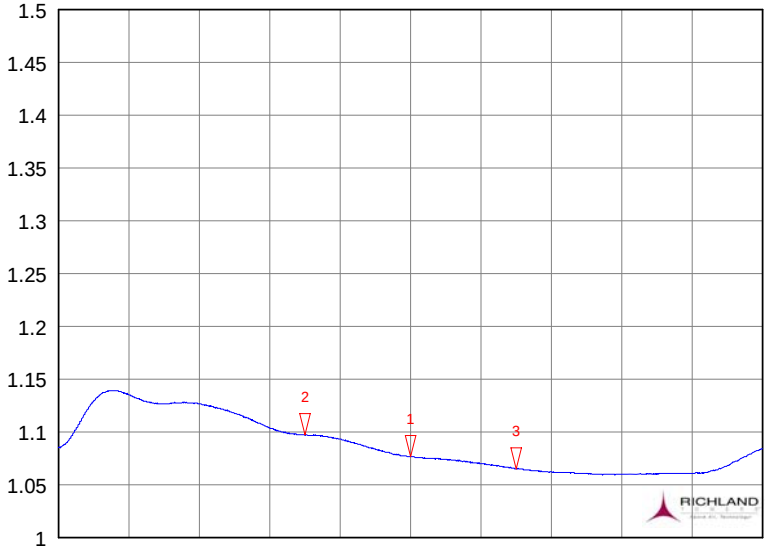
3 IBOC TX to ANT
107.850000 MHz
0.0316, -150.5100°

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

KRXO 107.7 IBOC Transmitter to Antenna VSWR 1.05/div

VSWR

IBOC TX to ANT



1 IBOC TX to ANT
107.700000 MHz
1.0765 VSWR

2 IBOC TX to ANT
107.550000 MHz
1.0971 VSWR

3 IBOC TX to ANT
107.850000 MHz
1.0653 VSWR

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

Through Circulator

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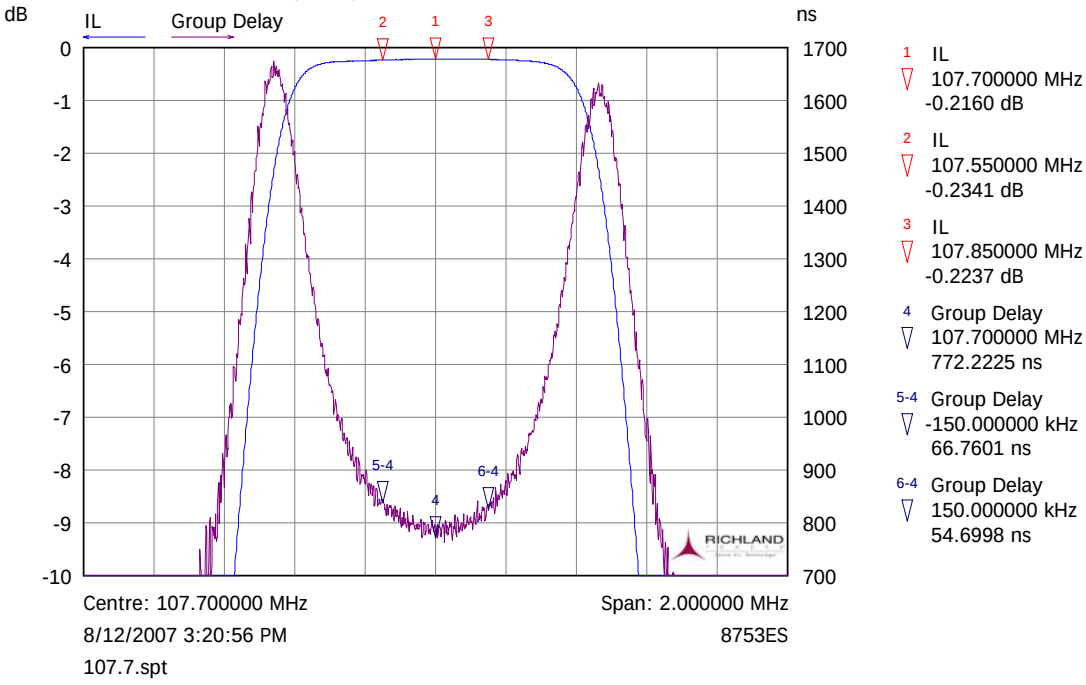
KRXO 107.7 IBOC Group Delay & Insertion Loss



1 IL
107.700000 MHz
-0.2160 dB

2 IL
107.550000 MHz
-0.2341 dB

3 IL
107.850000 MHz
-0.2237 dB

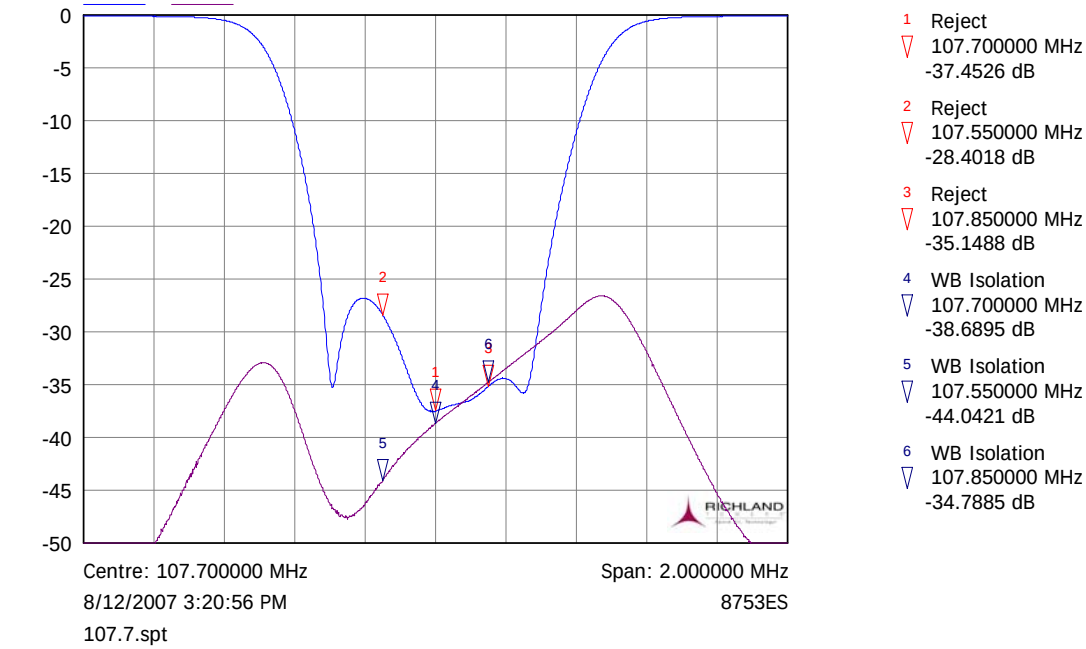
4 Group Delay
107.700000 MHz
772.2225 ns

5-4 Group Delay
-150.000000 kHz
66.7601 ns

6-4 Group Delay
150.000000 kHz
54.6998 ns

Centre: 107.700000 MHz
Span: 2.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

KRXO 107.7 Input & Wideband Isolation



1 Reject
107.700000 MHz
-37.4526 dB

2 Reject
107.550000 MHz
-28.4018 dB

3 Reject
107.850000 MHz
-35.1488 dB

4 WB Isolation
107.700000 MHz
-38.6895 dB

5 WB Isolation
107.550000 MHz
-44.0421 dB

6 WB Isolation
107.850000 MHz
-34.7885 dB

Centre: 107.700000 MHz
Span: 2.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

Reject Analogue to IBOC

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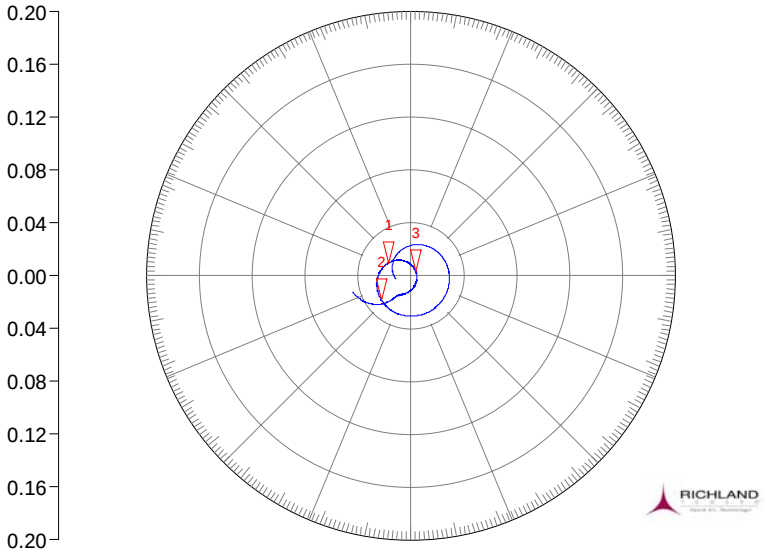
KRXO 107.7 Combiner System Polar Impedance 200mU

S11



1 S11
107.700000 MHz
0.0193, 151.0055°

2 S11
107.550000 MHz
0.0291, -139.3488°

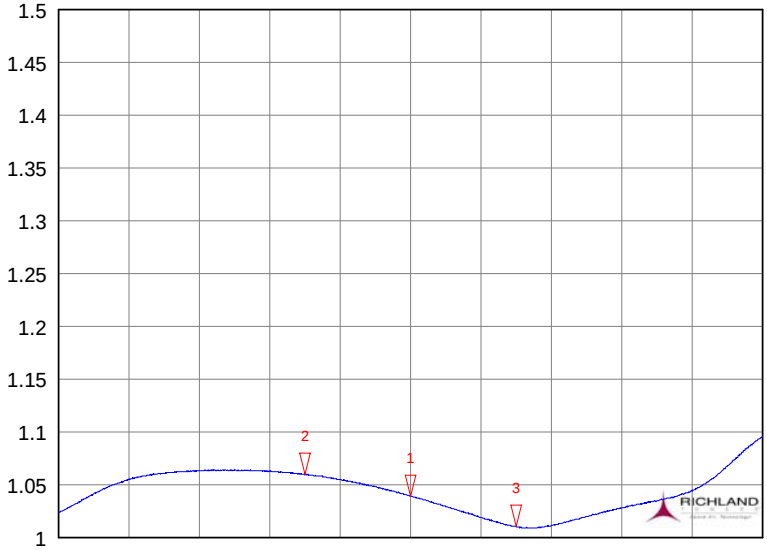
3 S11
107.850000 MHz
0.0052, 43.2076°

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

KRXO 107.7 Combiner System VSWR 1.05/div

VSWR

S11



1 S11
107.700000 MHz
1.0394 VSWR

2 S11
107.550000 MHz
1.0599 VSWR

3 S11
107.850000 MHz
1.0105 VSWR

Centre: 107.700000 MHz
Span: 1.000000 MHz
8/12/2007 3:20:56 PM
8753ES
107.7.spt

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www.richlandtowers.com

Oklahoma City, Oklahoma

Analogue/IBOC FM Broadband System Commissioning Report

Prepared For

KOMA 92.5
Renda Broadcasting

Equipment

ERI COG-20P-12-240-2 Panel Antenna
with Dual Inputs and Reverse-fed IBOC
1660′ Dual ERI 6″- 50Ω Maxline & Dual 3″ Heliax Transmission Line
ERI 973-8 Four Channel Constant Impedance Combiner with Circulator
Isolated IBOC

Measurement Data Taken on
3 – 12 August 2007

Submitted By

Todd R Loney
Senior RF Engineer

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Measurement setup

Measurements were taken with an Agilent 8753ES network analyzer, Agilent 4-port dual directional coupler. A three watt amplifier was used to overcome high RF level ingress. For combiner measurements, an HP S-Parameter test was used.
Richland Towers broadband, precision test adapters were used to make the measurements. Data was extracted from the analyzer in complex pair values (real/imaginary) via the GPIB port to laptop computer. Data was then analyzed and presented using SoftPlot™ software and is imported into this document as an Object Linking Embedding (OLE). This data can be manipulated, (scale, format, markers, etc.) follow link to http://softplot.com/ and download demonstration version to utilize this feature. Markers are placed at fc as well as +/- 150kHz.

Measurement details

Measurements were taken from the input to the combiner as well as from the transmitter output.
Antenna system data is included under a separate antenna system report.

Findings

- Performance of the system, from transmitter outputs, through the combiner to the antenna is satisfactory
- Station to station isolations measured >-80dB except 98.9 into 104.1 which measured -75dB. Specification is -55dB

400 North Ashley Dr., Suite 3010
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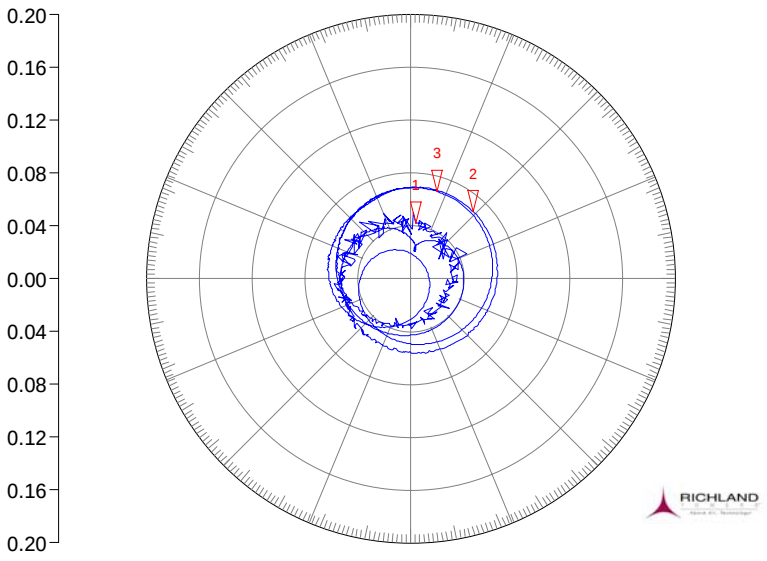
KOMA 92.5 Transmitter to Antenna Polar Impedance 200mU

TX to ANT



1 TX to ANT
92.500000 MHz
0.0422, 84.5245°

2 TX to ANT
92.350000 MHz
0.0694, 46.8610°

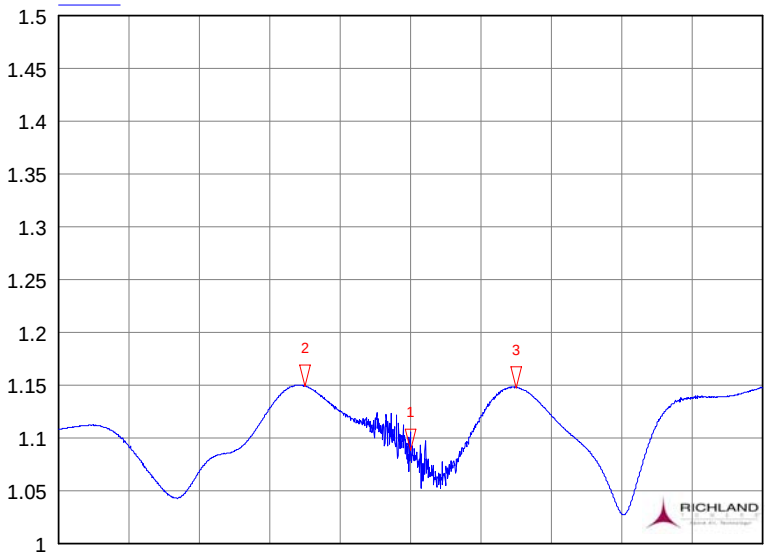
3 TX to ANT
92.650000 MHz
0.0688, 73.0173°

Centre: 92.500000 MHz
Span: 1.000000 MHz
8/12/2007 3:25:26 PM
8753ES
92.5.spt

KOMA 92.5 Transmitter to Antenna VSWR 1.05/div

VSWR

TX to ANT



1 TX to ANT
92.500000 MHz
1.0882 VSWR

2 TX to ANT
92.350000 MHz
1.1492 VSWR

3 TX to ANT
92.650000 MHz
1.1478 VSWR

Centre: 92.500000 MHz
Span: 1.000000 MHz
8/12/2007 3:25:26 PM
8753ES
92.5.spt

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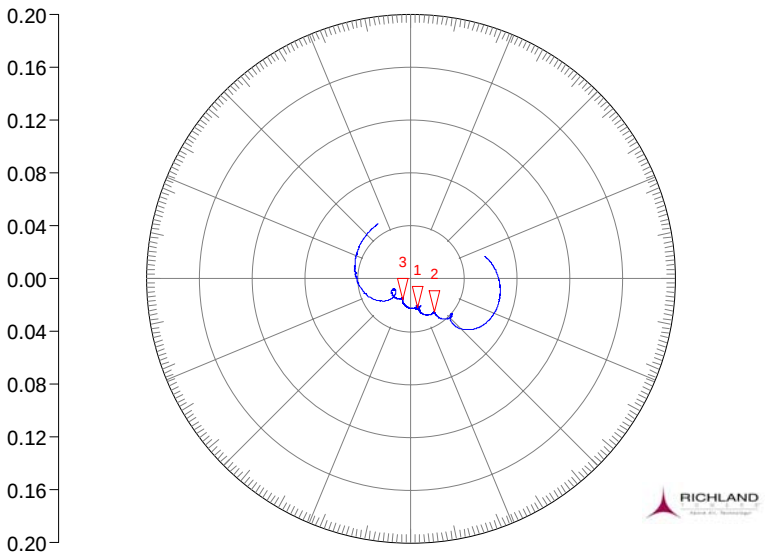
KOMA 92.5 IBOC Transmitter to Antenna Polar Impedance 200mU

IBOC TX to ANT



1 IBOC TX to ANT
92.500000 MHz
0.0226, -75.6112°

2 IBOC TX to ANT
92.350000 MHz
0.0310, -54.8298°

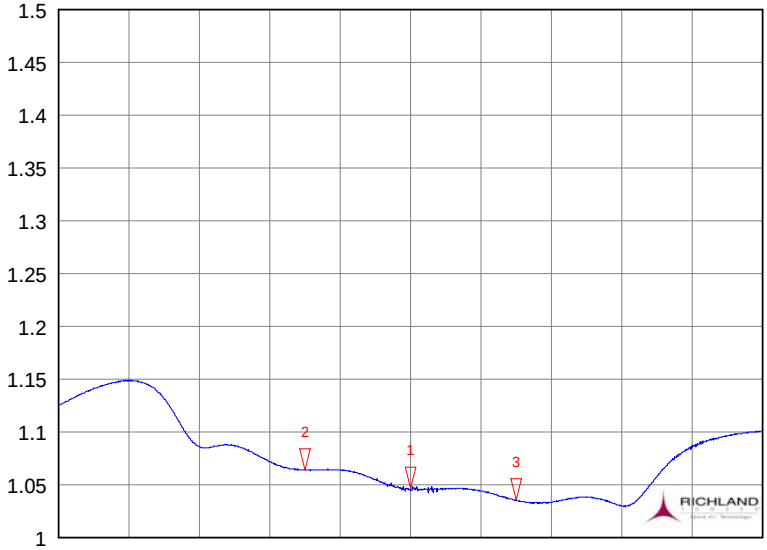
3 IBOC TX to ANT
92.650000 MHz
0.0174, -110.8140°

Centre: 92.500000 MHz
Span: 1.000000 MHz
8/12/2007 3:25:26 PM
8753ES
92.5.spt

KOMA 92.5 IBOC Transmitter to Antenna VSWR 1.05/div

VSWR

IBOC TX to ANT



1 IBOC TX to ANT
92.500000 MHz
1.0463 VSWR

2 IBOC TX to ANT
92.350000 MHz
1.0641 VSWR

3 IBOC TX to ANT
92.650000 MHz
1.0355 VSWR

Centre: 92.500000 MHz
Span: 1.000000 MHz
8/12/2007 3:25:26 PM
8753ES
92.5.spt

IBOC TX to ANT Through circulator

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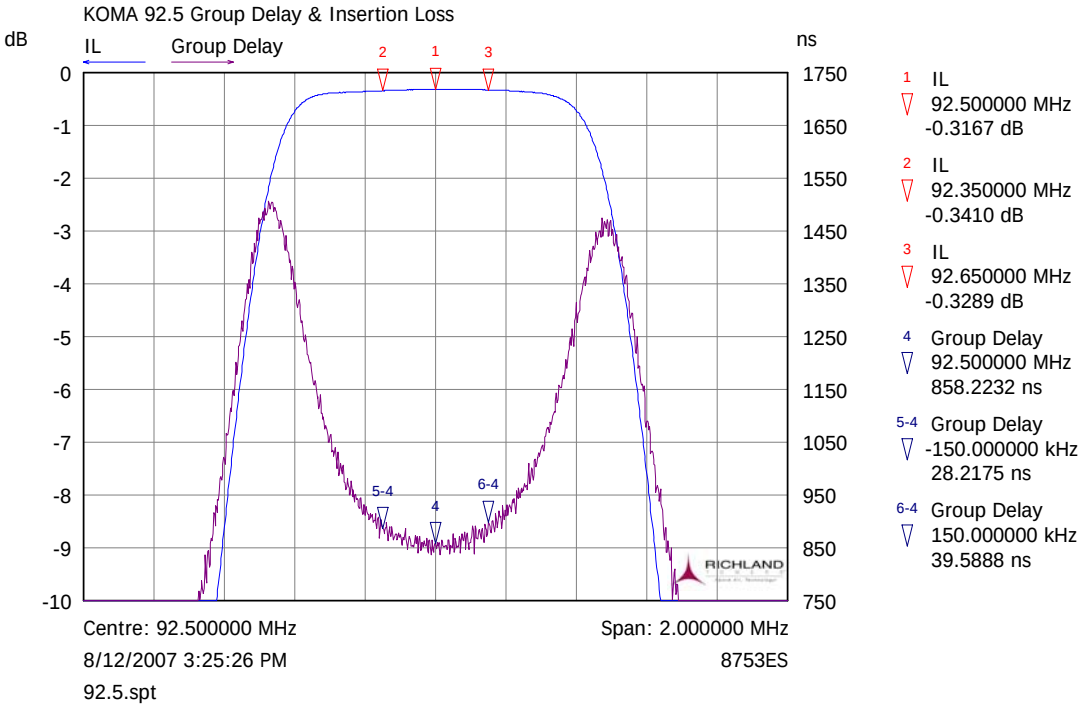

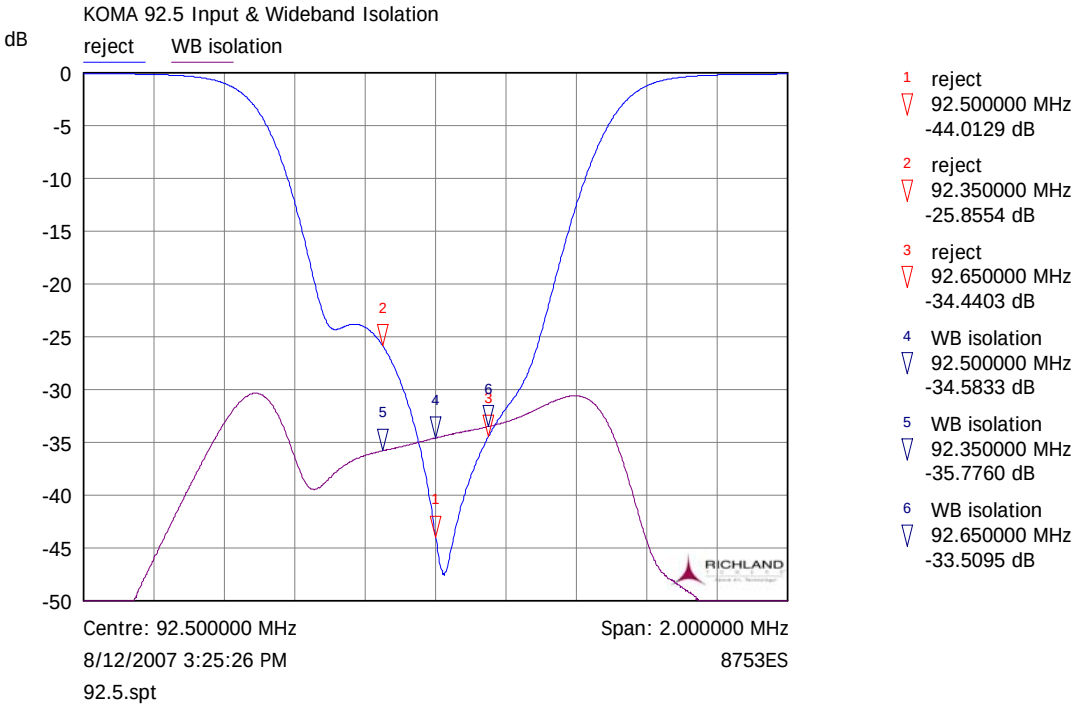

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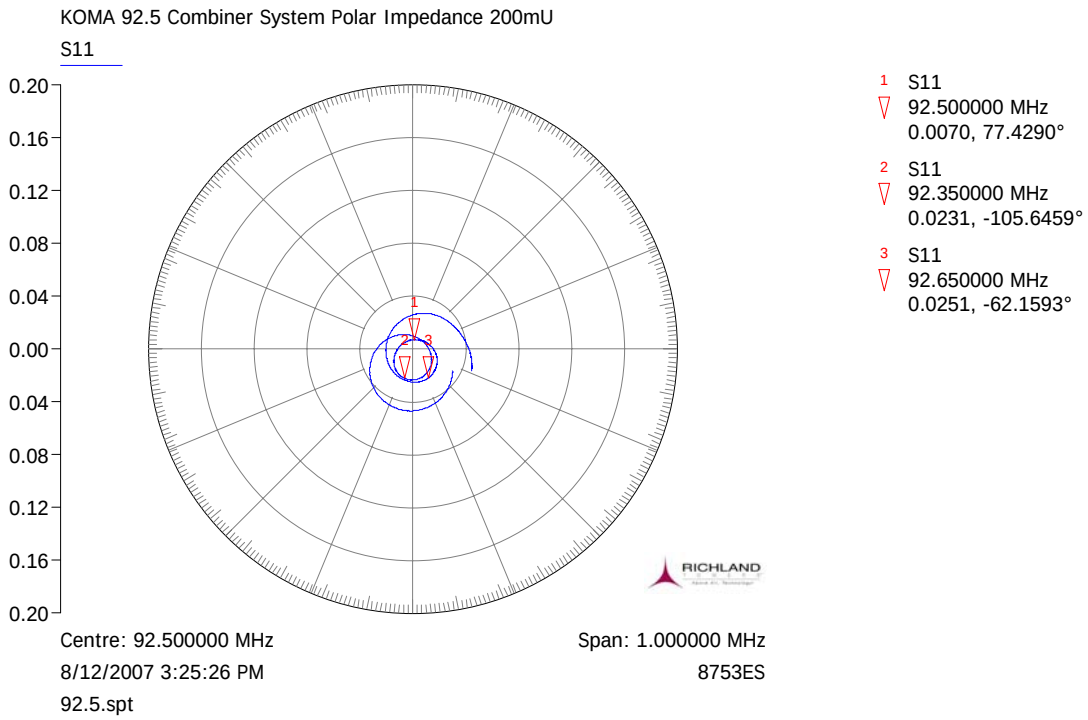

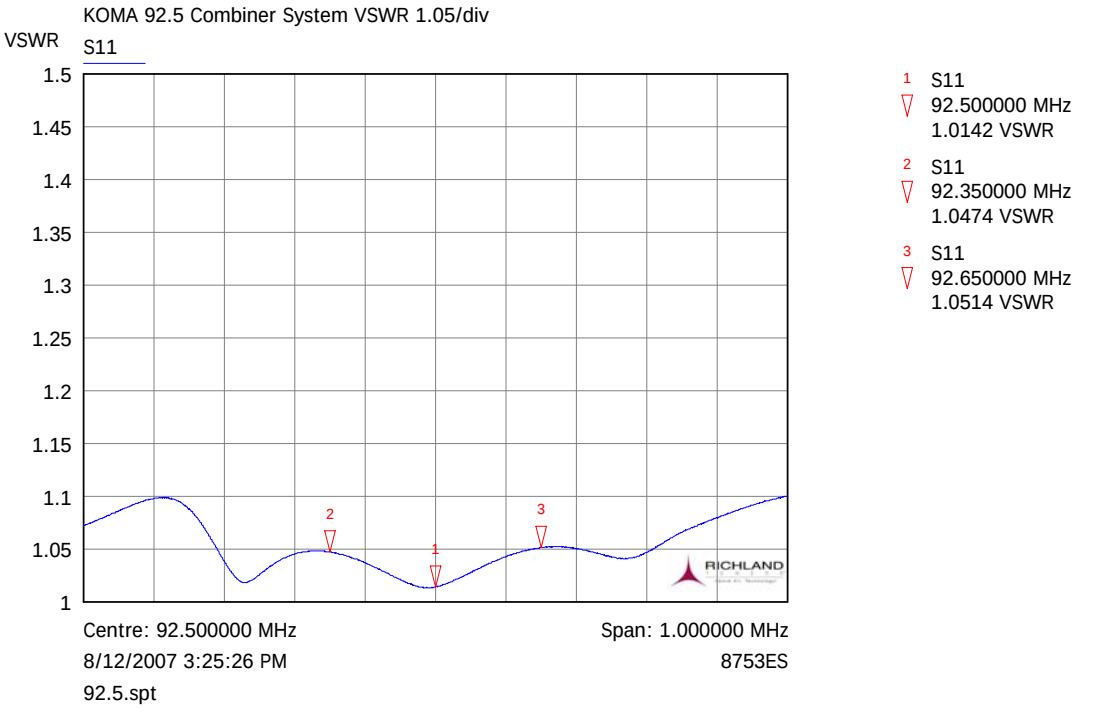

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Oklahoma City, Oklahoma

Analogue/IBOC FM Broadband System Commissioning Report

Prepared For

KMGL 104.1
Renda Broadcasting

Equipment

ERI COG-20P-12-240-2 Panel Antenna
with Dual Inputs and Reverse-fed IBOC
1660′ Dual ERI 6″- 50Ω Maxline & Dual 3″ Heliax Transmission Line
ERI 973-8 Four Channel Constant Impedance Combiner with Circulator
Isolated IBOC

Measurement Data Taken on
3 – 12 August 2007

Submitted By

Todd R Loney
Senior RF Engineer

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Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
www.richlandtowers.com

Measurement setup

Measurements were taken with an Agilent 8753ES network analyzer, Agilent 4-port dual directional coupler. A three watt amplifier was used to overcome high RF level ingress. For combiner measurements, an HP S-Parameter test was used.
Richland Towers broadband, precision test adapters were used to make the measurements.
Data was extracted from the analyzer in complex pair values (real/imaginary) via the GPIB port to laptop computer. Data was then analyzed and presented using SoftPlot™ software and is imported into this document as an Object Linking Embedding (OLE). This data can be manipulated, (scale, format, markers, etc.) follow link to http://softplot.com/ and download demonstration version to utilize this feature.
Markers are placed at fc as well as +/- 150kHz.

Measurement details

Measurements were taken from the input to the combiner as well as from the transmitter output.
Antenna system data is included under a separate antenna system report.

Findings

- Performance of the system, from transmitter outputs, through the combiner to the antenna is satisfactory
- Station to station isolations measured >-80dB except 98.9 into 104.1 which measured -75dB. Specification is -55dB
- When taking the KMGL data, the operating site was being received very well as can be seen by the “noise” on the analogue polar and VSWR plots. This was by far the hottest ingress of any station. For all “system” measurements, the amplifier was not used due the need to be calibrated for VSWR, isolation and loss measurements.

400 North Ashley Dr., Suite 3010
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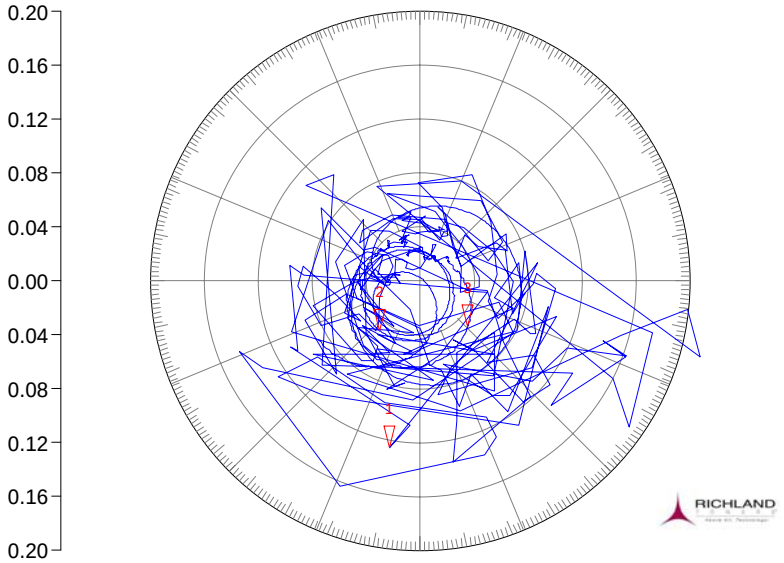
KMGL 104.1 Transmitter to Antenna Polar Impedance 200mU

TX to ANT



1 TX to ANT
104.100000 MHz
0.1262, -100.3408°

2 TX to ANT
103.950000 MHz
0.0478, -128.9700°

3 TX to ANT
104.250000 MHz
0.0493, -43.6480°

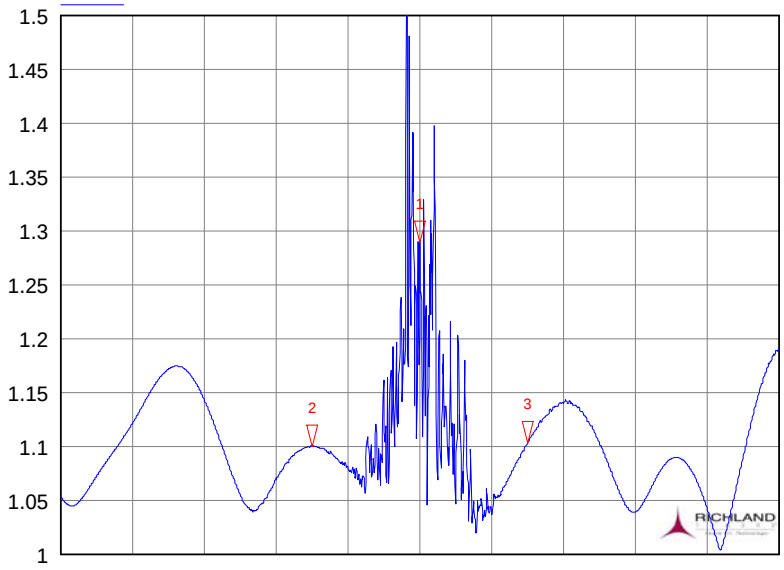
Centre: 104.100000 MHz
Span: 1.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

High Level Ingress from Operating Station

KMGL 104.1 Transmitter to Antenna VSWR 1.05/div

VSWR

TX to ANT



1 TX to ANT
104.100000 MHz
1.2888 VSWR

2 TX to ANT
103.950000 MHz
1.1003 VSWR

3 TX to ANT
104.250000 MHz
1.1037 VSWR

Centre: 104.100000 MHz
Span: 1.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

High Level Ingress from Operating Station

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
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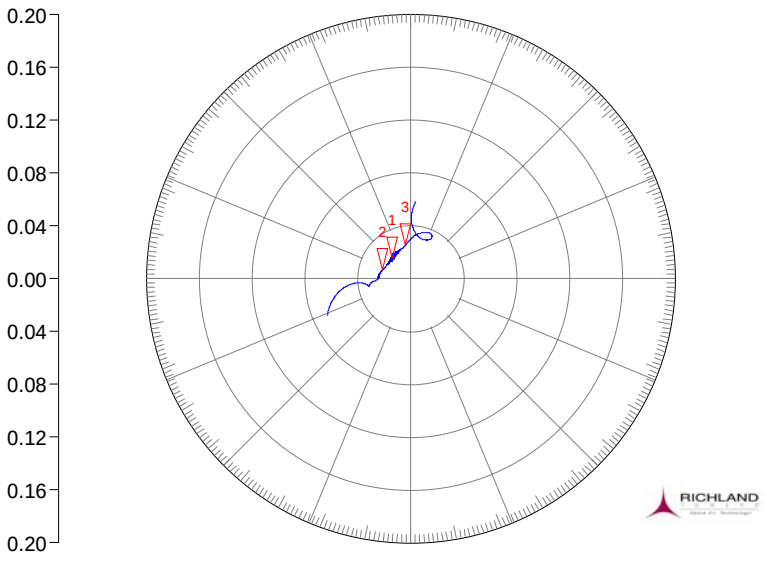
www.richlandtowers.com

KMGL 104.1 IBOC Transmitter to Antenna Polar Impedance 200mU

IBOC TX to ANT



1 IBOC TX to ANT
104.100000 MHz
0.0210, 133.0018°

2 IBOC TX to ANT
103.950000 MHz
0.0221, 162.3533°

3 IBOC TX to ANT
104.250000 MHz
0.0255, 98.8290°

Start: 103.600000 MHz

Stop: 104.600000 MHz

8/12/2007 3:22:45 PM

8753ES

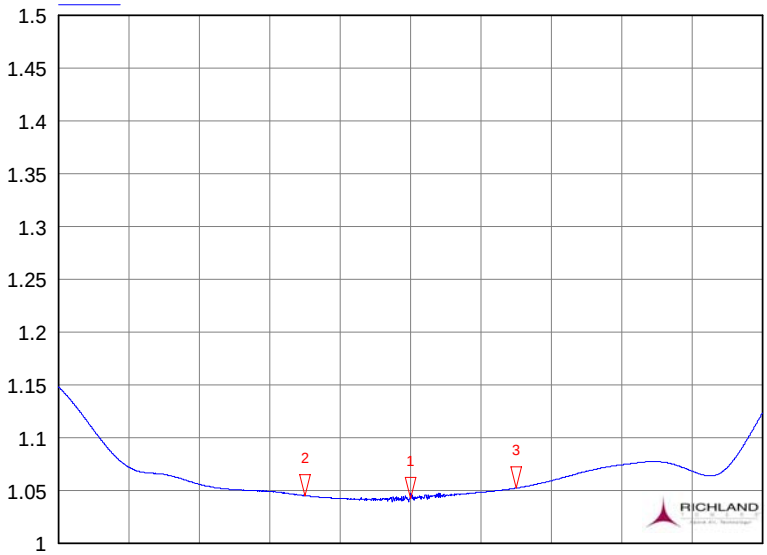
104.1.spt

Through Circulator

KMGL 104.1 IBOC Transmitter to Antenna VSWR 1.05/div

VSWR

IBOC TX to ANT



1 IBOC TX to ANT
104.100000 MHz
1.0429 VSWR

2 IBOC TX to ANT
103.950000 MHz
1.0451 VSWR

3 IBOC TX to ANT
104.250000 MHz
1.0523 VSWR

Start: 103.600000 MHz

Stop: 104.600000 MHz

8/12/2007 3:22:45 PM

8753ES

104.1.spt

Through Circulator

400 North Ashley Dr., Suite 3010
Tampa, FL 33602
813.286.4140 ● Fax 813.286.4130
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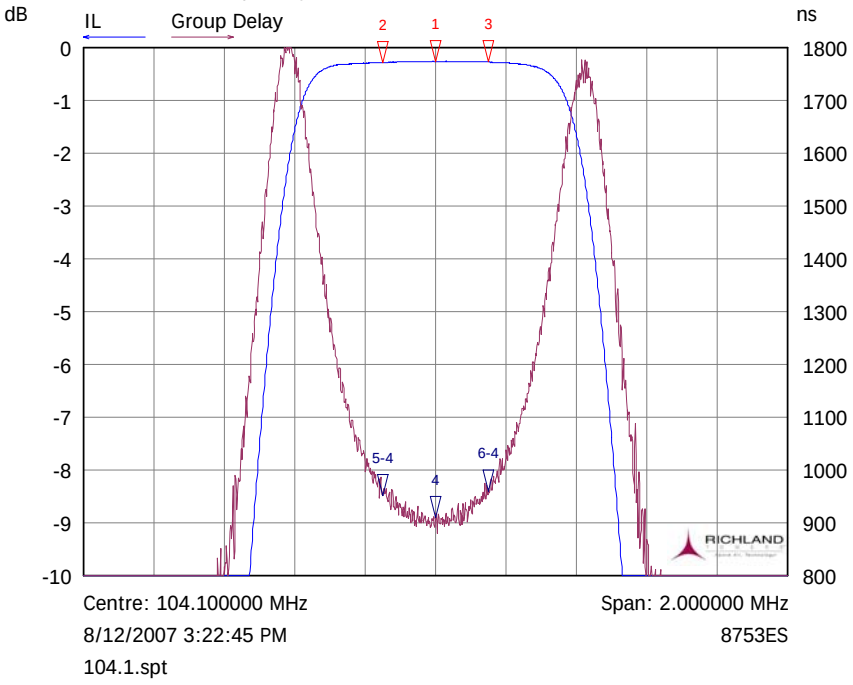
KMGL 104.1 Group Delay & Insertion Loss



1 IL
104.100000 MHz
-0.2634 dB

2 IL
103.950000 MHz
-0.2794 dB

3 IL
104.250000 MHz
-0.2732 dB

4 Group Delay
104.100000 MHz
909.5519 ns

5-4 Group Delay
-150.000000 kHz
41.4007 ns

6-4 Group Delay
150.000000 kHz
49.6777 ns

Centre: 104.100000 MHz
Span: 2.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

KMGL 104.1 Input & Wideband Isolation

1 Reject
104.100000 MHz
-38.4104 dB

2 Reject
103.950000 MHz
-28.3767 dB

3 Reject
104.250000 MHz
-31.5615 dB

4 WB Isolation
104.100000 MHz
-34.5399 dB

5 WB Isolation
103.950000 MHz
-39.7522 dB

6 WB Isolation
104.250000 MHz
-30.7392 dB

Centre: 104.100000 MHz
Span: 2.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

Reject Analogue to IBOC Isolation

WB Isolation Isolation to IBOC Patch

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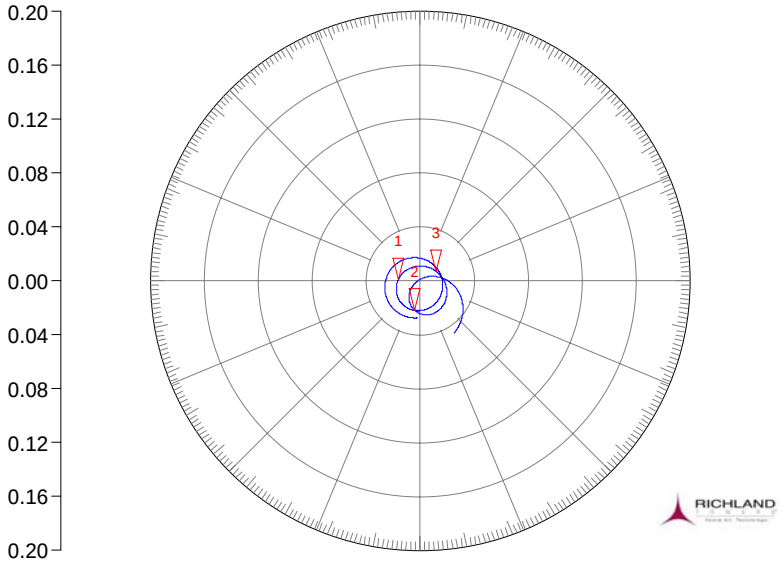
KMGL 104.1 Combiner System Polar Impedance 200mU

S11



1 S11
104.100000 MHz
0.0162, 178.1618°

2 S11
103.950000 MHz
0.0225, -99.5314°

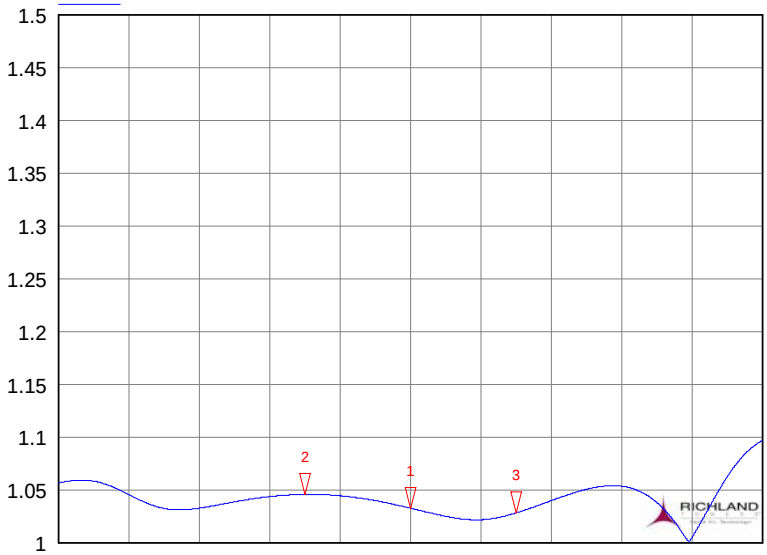
3 S11
104.250000 MHz
0.0140, 28.5498°

Centre: 104.100000 MHz
Span: 1.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

S11 Analogue Match

KMGL 104.1 Combiner System VSWR 1.05/div

VSWR S11



1 S11
104.100000 MHz
1.0329 VSWR

2 S11
103.950000 MHz
1.0460 VSWR

3 S11
104.250000 MHz
1.0284 VSWR

Centre: 104.100000 MHz
Span: 1.000000 MHz
8/12/2007 3:22:45 PM
8753ES
104.1.spt

S11 Analogue Match

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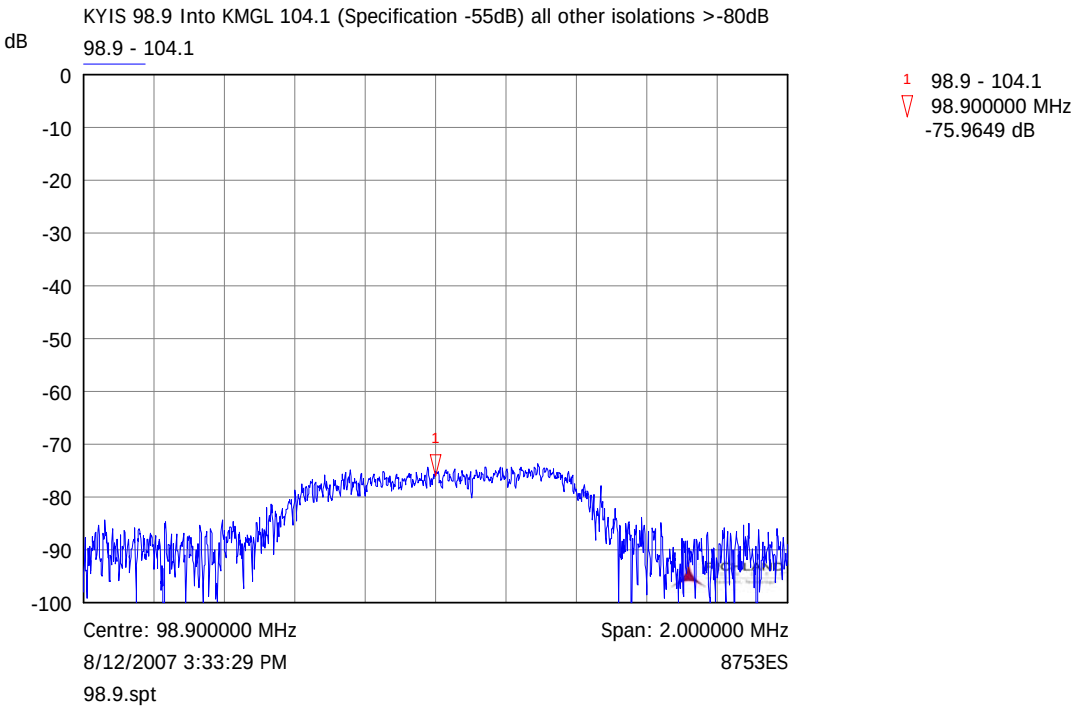

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ERI Model COG3-20P-12-240-2 Master FM Antenna

Richland Towers COGWHEEL Atlanta Master FM Antenna.

The Oklahoma City, Richland Towers Master FM Antenna and Combiner system description, a simplified schematic diagram, titled Combiner Plan, and a detailed sketch titled COGWHEEL™ Antenna showing the modular arrangement of the COGWHEEL antenna are provided.

The standard COG-20P-12-240-2 antenna is built on its own supporting spine and only a transition section is all that is required to interface with a triangular support tower; however, due to the tower candelabra mounting requirement of the Richland Towers project, a support tower for this project will be offered and fabricated to a specific height of 25-feet and made up of two bolt-together sections. The support tower will interface to the tower candelabra arm and elevate the antenna, topping out at a height above ground level of 1,605-feet[1]. The support tower would appear conventional in design; however, it would be factory equipped with brackets and the necessary intermediary power dividers and phased rigid line sections in order for the antenna installation to be completed in a minimum amount of time. Once the support tower is placed on top of the broadcast tower, the COGWHEEL can then be installed.

The COG-20P-12-240-2 Master FM Antenna is an eight-section antenna developed specifically for the simultaneous radiation of analog and digital signals. Each COGWHEEL section consists of three radiators, mounted at 120-degree intervals around the cogwheel pole. The COGWHEEL Master FM Antenna features broadband operating characteristics, a simplified feed system and durable modular construction. Each factory assembled module is furnished complete with two levels of elements including integral pole and structural wing sections, plus RF feed harness (bay level power dividers) ready for operation with FM stations with a combined analog power input of 240 kW (with both halves of the array in use). This provides adequate power handling for up to 12 Class C FM radio stations, given the average numeric power gain for the antenna of approximate 5.0. Each module is provided with interconnecting transmission lines contained within each flanged pole section. This feature allows for quick and easy module stacking. For example, ERI testing will consist of setting up half of the antenna (two modules at a time) on a stationary stand. Once proofed and inspected each two-module assembly can be transferred via crane onto a flatbed tractor trailer and shipped as semi-assembled sections. The antenna's two module assemblies

[1] Overall height above top of tower does not include any necessary obstruction lighting and doesn't include the new "Lightning / Beacon Shield" for the protection of the beacon from lightning and RF power.

(4 bays each) can be installed in three lifts and the antenna installation is complete by interconnecting the internal feed lines.

Electrical feed to both the analog and digital components of each antenna module is by means of rigid coaxial transmission lines brought down through the bottom of each module. A single analog and digital line is required for each module; therefore, four 4-1/16-inch analog and four 3-1/8-inch digital feeds are used to feed the individual modules. Two intermediate analog and two intermediate digital power dividers placed below the COGWHEEL in the COGWHEEL support structure permit the feeding of the upper and lower sections of the antenna system. The power dividers are fed from two 6-1/8-inch and two 3-1/8-inch transmission lines, hence the power handling capacity is correspondingly high due to this power distribution method and the use of appropriately sized material.

To complete the antenna's installation, interconnections to the four transmission line sections are made. Two 6-1/8-inch rigid lines carry analog signals and two 3-inch air HELIAX lines are used for digital IBOC. These feed lines create the dual feed system planned for the project. The dual line concept provides a means of changing the feed arrangement to the antenna (within the combiner room) to permit emergency operation to either half of the antenna, should an unlikely failure ever occur in either half of the system.

Contained within this proposal packet is a set of azimuth patterns to exhibit the Cogwheel's ability to radiate well in all directions. Also included is a set of elevation patterns illustrating the vertical cut pattern of the 12-bay antenna. The 114-inch spacing between element levels provides an average antenna gain value of five. This gain roughly allows twelve stations to achieve 100-kilowatts of Effective Radiated Power (ERP) with 25 kW transmitters. Special vertical pattern shaping is desired for this project: with first and second null fill[2] the antenna provides good uniform close-in coverage and, together with -0.75-degrees of electrical beam tilt[2], the antenna will yield a strong broadcast signal in the desired coverage locations. With the system in operation, the antenna/combiner provides concurrent operation of twelve or more analog channels along with their companion digital IBOC carriers.

The combiner is designed to handle combined RF power up to 290 kW from twelve stations and is designed with the ability to simultaneously operate with Analog and Digital signals, hence two inputs are provided on each combiner module. With non-adjacent filter coupling and Circulators placed on Digital IBOC input ports, the combining is achieved without transmitter interaction. In a system such as this (using individualized combiner modules) it is possible to initially operate with a small group of stations and expand the group up to the full capability of the antenna and combiner system.

[2] Vertical plane pattern shaping provided at the request of the customer.

Senior Road Tower Group COGWHEEL Master FM Antenna installation of two sections in January 2006.

In the arrangement shown in the drawing titled "Combiner Plan" all stations are injected into the 9-3/16-inch main combiner trunk and, due to the combiner's behavior, the Analog and Digital IBOC output signals appear at opposite ends of the combiner string. The two output terminals lead to independent 90-degree hybrid power splitters where the signals are converted into two feeds for the antenna. This scheme provides the ability to use the combined or either the upper or lower halves of the Cogwheel independently in an emergency. Therefore, by either rerouting the combiner with (optional) bypass coax components, patching equipment, or electronic switching, the hybrids can be bypassed. Note: electronic sensing equipment can be provided as an option to provide rapid switching between operating modes if a fault is detected within the system.

The versatility and flexibility of the combining network makes possible a number of desirable features. For instance, if there is additional capacity in the Digital IBOC power distribution system, then (after final review of system ratings) additional Combiner modules can be placed and arranged to inject high power Analog signals into the Digital IBOC branch of the system.

On-site assembly and the erection of the antenna are not included as part of the services supplied by ERI; however, assembly supervision and electrical checkout by a qualified ERI service engineer is provided. This will include comprehensive final tests to insure a correct installation.

1.1. Power Considerations (Overview)

Average Power and Peak Voltage coax ratings must be evaluated when combining stations into a common coax line (or lines). The following provides a critical analysis of the tower transmission feeds, for it is these feeds that predominantly regulate the power supplied to the antenna; therefore, the antenna will be built with ratings equal to or exceeding those of its transmission feeds.

1.2. ERI Recommended Rigid Line Ratings and Specifications

The investigations show that under the operating condition imposed by the Antenna and Combiner in Figures A & B, there are four distinct areas that the transmission lines carry large levels of RF within the system:

3-1/8-inch 50 ohm air HELIAX; Used as dual Digital IBOC antenna feeds.

6-1/8-inch 50 ohm rigid coaxial line; Feed to Digital power divider and this coax is used as the dual Analog antenna feeds and carries the majority of power to the antenna.
9-3/16-inch 50 ohm rigid coaxial line; Main trunk used to interconnect Combiner Modules

Rigid Line Size	Derated Average Power[3,4]	Maximum Peak Voltage[3,4]
3-1/8-inch	39 kW	6.32 kV
6-1/8-inch, 50 ohm	147.5 kW	12.25 kV
9-3/16-inch, 50 ohm	289.7 kW	17.32 kV

It is understood that the antenna and transmission line ratings are recommended by ERI and are low enough to prevent catastrophic failure should a 1.5:1 VSWR be incurred from a failure of an antenna component or if a sudden loss of pressure is experienced from a mechanical breach in the outer conductor of the system.

NOTE: If the 9-3/16-inch rigid line in the interconnecting transmission line for the combiner system or the 6-1/8-inch transmission line used for the analog antenna feeds would be exceeded, there is adequate power handling remaining in the dual 3-inch air HELIAX digital transmission lines to accommodate two additional Class C FM radio stations, including their companion IBOC carriers.

1.3. Theoretical Evaluations

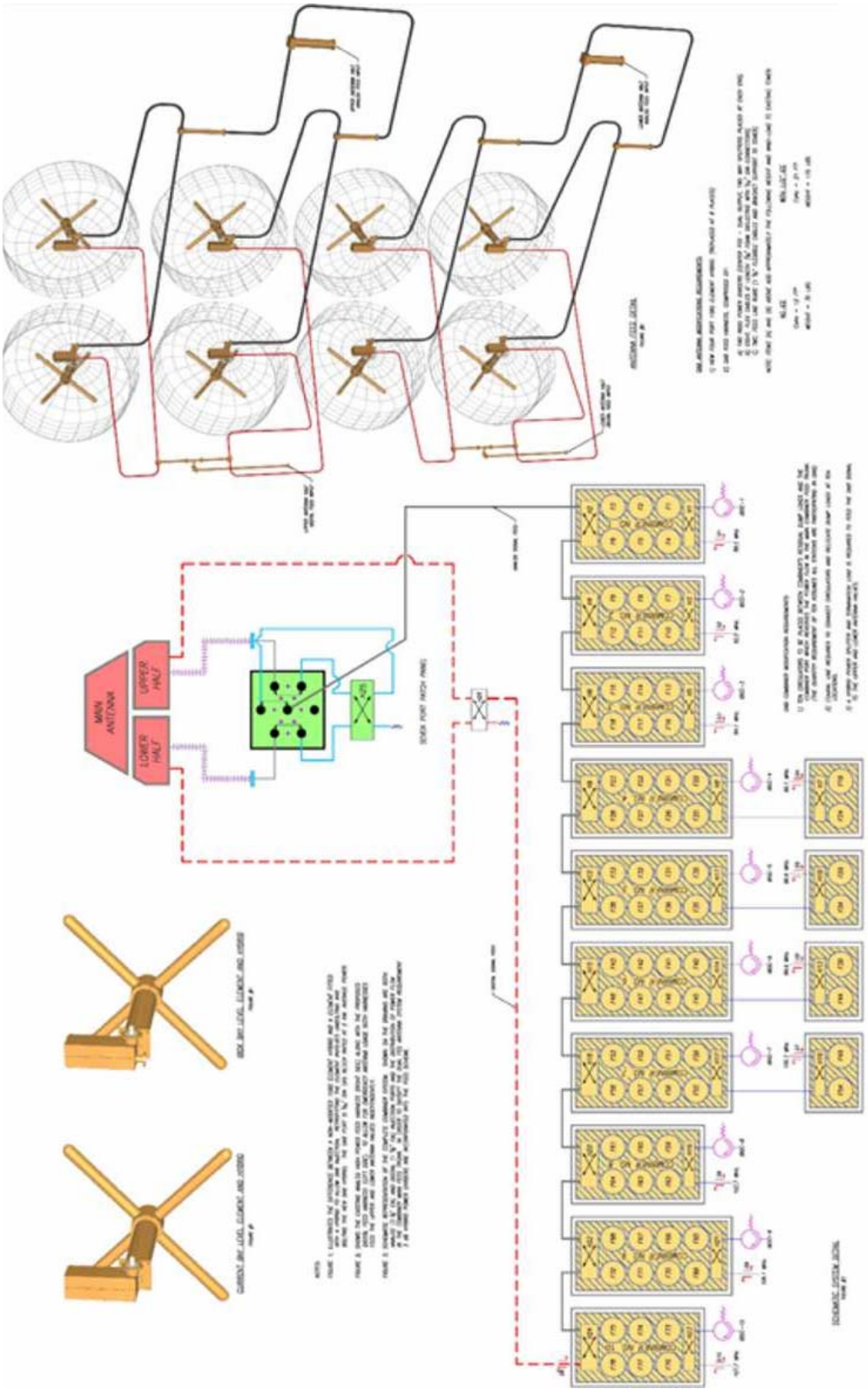
We hope that this summary will clarify the number of stations that may occupy the system, their operating criteria, and offer reviewed definitions to determine and compute the power handling boundaries of a new station to the system. The primary finding in Myron Fanton's worksheet (See Attached Sheet "Power Computations – 10 Stations") is that there does not appear to be any major concerns regarding the selection of Antenna feeds by Richland Tower for the operation of 10 FM stations.

1.4. Power Handling Considerations

Operating with a VSWR less than 1.5 will increase the maximum power of the system. Additionally, pressurizing the transmission lines would allow for a greater Average Power rating.

Note:
1) Average Power and Peak Voltage assume: Operating VSWR of 1.5:1; atmospheric pressure, dry air, no solar loading, and multiple carriers; maximum (non-objectionable) transformer conductor temperature of 100ºC (212ºF).
2) For a margin of safety (Average Power and Peak Voltage), it is suggested that the antenna operate below its rated power. Determination of level is as the consumer's discretion.

[3] The Digital IBOC power rating is derated to 1/6 the normal average peak.
[4] It is assumed the Digital IBOC will operate at 1% (-20dB) of the Analog ERP otherwise the transmission line ratings will be exceeded if Analog stations are added to this supplement.


MAIN ANTENNA
UPPER HALF
LOWER HALF

The antenna system is designed with all elements at DC ground and the screens, transmission lines, and power dividers will be all firmly bonded to the support structure. This eliminates any potential for the static build up and helps protect the system from damage from lightning. ERI has also included full scale range testing on our far field range to optimize the horizontal plane pattern during the design phase and will range test one section of the complete antenna prior to shipment.

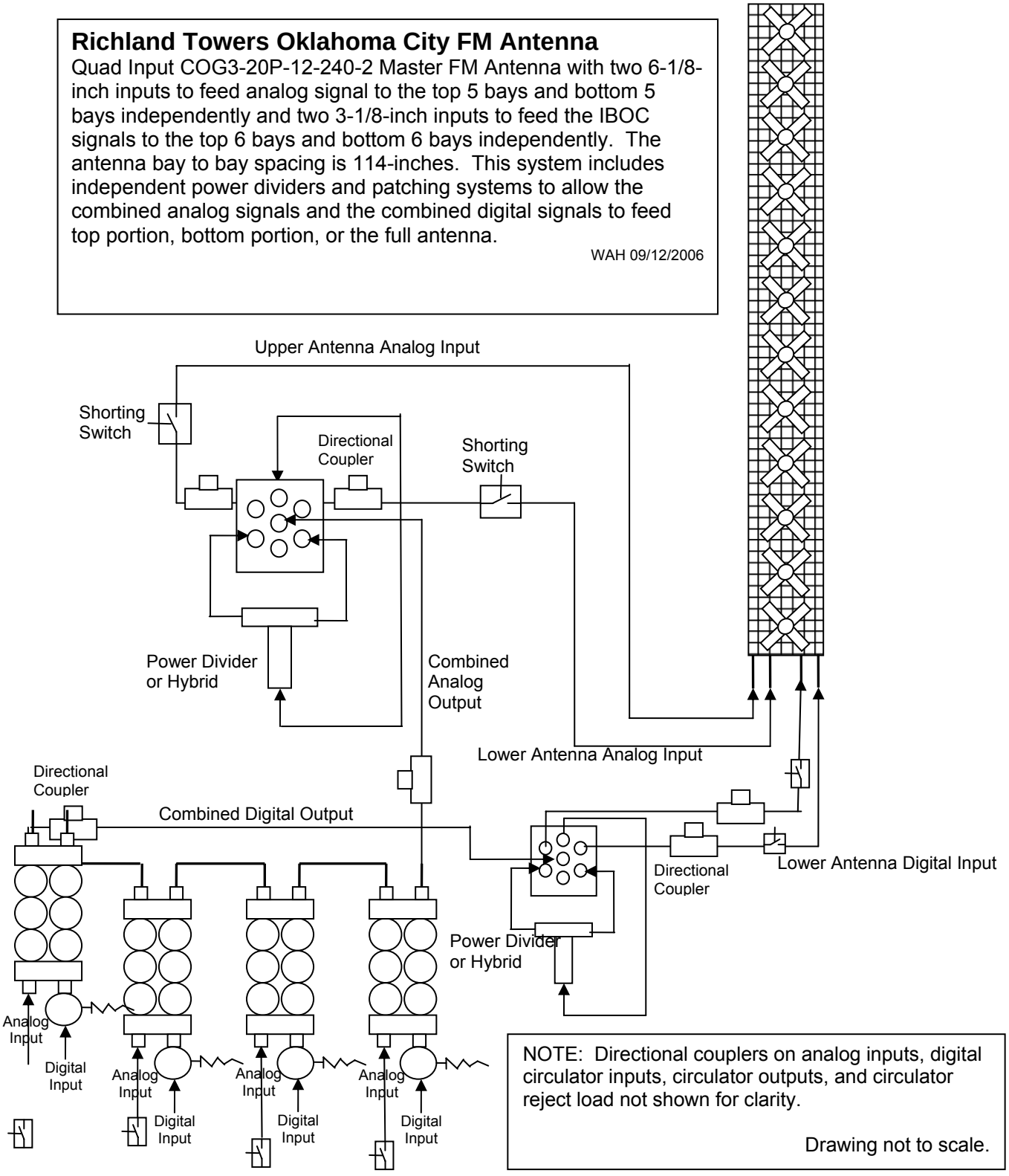
The preliminary electrical and mechanical specifications for this antenna are as follows:

Model:	COG3-20P-12-240-2
Frequency Range:	88 to 108 MHz
Input Power Handling:	240 kW average power, 120 kW, each half
RF Input:	Analog Inputs: Dual 6-1/8-inch EIA female
	Digital Inputs: Dual 3-1/8-inch EIA female
Configuration:	Twelve (12) layers of three elements per layer
VSWR:	1.15:1, maximum 1.25:1, maximum with 1/2-inch of radial ice
Element Type:	1180 Series
Panel Dimensions:	92-inches wide x 114-inches high
Panel to Panel Spacing	114-inches
Antenna Height:	120-feet, including 4-foot A-3 Lightning Spurs
Antenna Aperture:	114-feet
Support Spine:	118-feet high, including lightning rods and transition section x 22-inch pipe
Broadcast Mode:	Analog: Right hand circular polarization Digital: Left hand circular polarization
Isolation between antenna inputs (analog to digital and digital to analog):	23 dB or better at band edges and an average of better than 30 dB over the primary FM pass band.
EPA (No Ice):	665 ft^2
Weight (No Ice):	56,500 lbs.
EPA $^{\text{with 2.1-inches ice}}$:	1,800 ft^2
Weight $^{\text{with 2.1-inches ice}}$:	118,750 lbs.
Notes: (1) All mechanical data per TIA-227-G standard for 90 mph (40 mph with ¾-inch radial ice thickness) (3 second gust). (2) Loading includes “typical” inner transmission feed harness.	

Simplified Block Diagram

Richland Towers Oklahoma City FM Antenna
Quad Input COG3-20P-12-240-2 Master FM Antenna with two 6-1/8-inch inputs to feed analog signal to the top 5 bays and bottom 5 bays independently and two 3-1/8-inch inputs to feed the IBOC signals to the top 6 bays and bottom 6 bays independently. The antenna bay to bay spacing is 114-inches. This system includes independent power dividers and patching systems to allow the combined analog signals and the combined digital signals to feed top portion, bottom portion, or the full antenna.

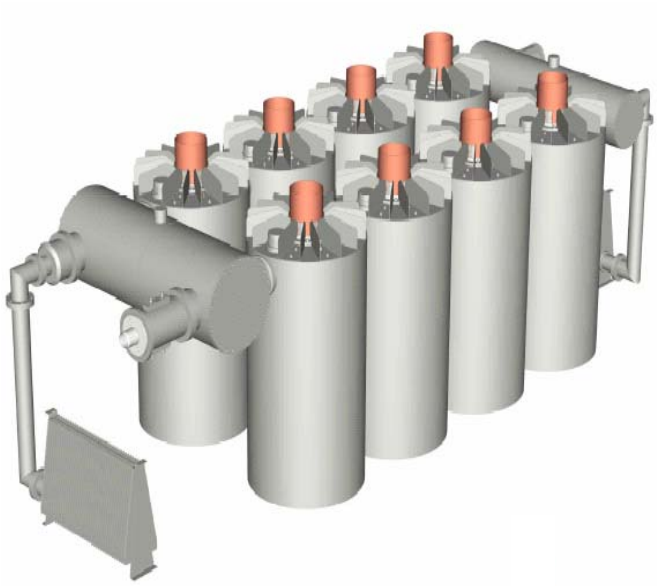
WAH 09/12/2006



NOTE: Directional couplers on analog inputs, digital circulator inputs, circulator outputs, and circulator reject load not shown for clarity.

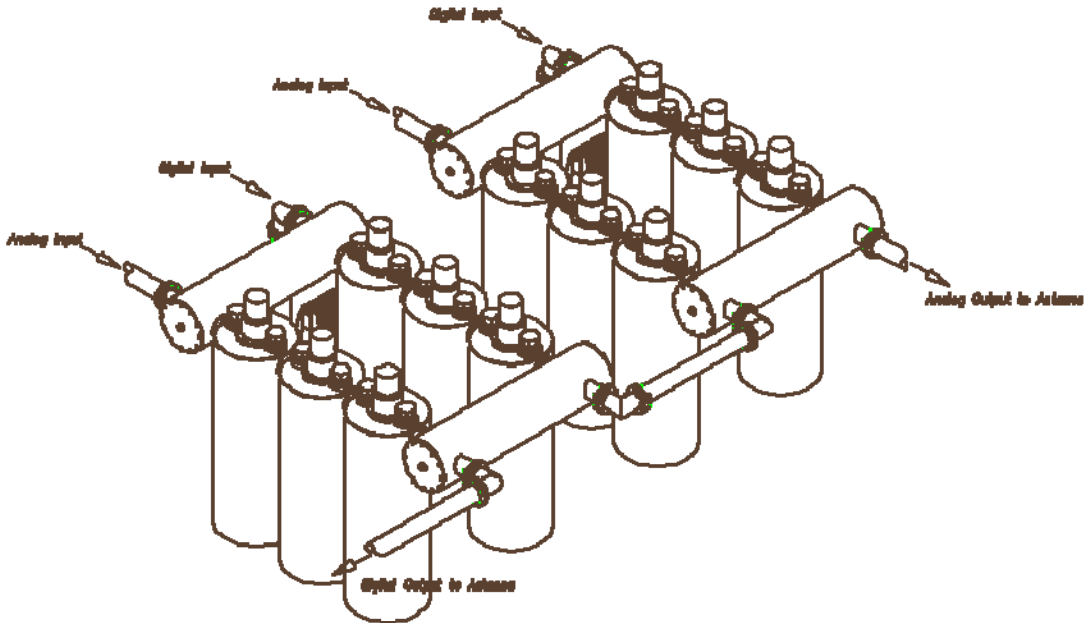
Drawing not to scale.

ERI Model 973-8 Series Constant Impedance Combiner



The system proposed includes a four (4) station constant impedance combiner system, that can be expanded (with a minimum of 0.8 MHz of frequency spacing) until the power limit of the combined transmission line is reached.. Each of the modules includes eight band pass cavities, hybrids on the input and output of each module, and a dump load. Each of the combiner modules is configured for floor mounting allow for easy placement and connection. Each module includes non-adjacent coupling loops to improve pass band performance on modules that are closely spaced in terms of frequency. The combiner system also can be optionally equipped with circulators to allow the digital FM IBOC signals to be "reverse fed" and combined using the same modules.

The ERI Model 973-8 Series Constant Impedance Combiner is an improved design that includes an exclusive bellows temperature compensation system, temperature indicator, and unique cylindrical tank construction. The use of cylindrical tanks provides the benefit of a mechanically rigid tank design. The effect of thermal expansion and contraction on electrical performance is minimized. The use of an Invar/Bellows



temperature compensator eliminates any residual impact of mechanical expansion and contraction on electrical performance. The filters operate and meet specifications at any operating temperature.

The filter system offered is configured in a floor mounted configuration to maximize heat transfer, power handling capability, and simplify system modification in the future. The individual modules are forced air cooled. There are optional configurations that include ceiling hung frames and floor stands to accommodate a wide variety of physical space requirements. The combiner includes circulators for the dump load ports of the system to enable the capability or "reverse feeding" the combiner with the digital FM signals.

973-8 Series Constant Impedance Combiner Specifications:

Model:	973-8
Combiner Type:	Band Pass Constant Impedance
VSWR:	1.1:1 ±200kHz, maximum
Injected Port to Broad Port Isolation:	≥-30 dB
Injected Port to Injected Port Isolation:	≥-55 dB, with two or more modules
Output Connector:	Appropriate for size for power rating
Output Power Capability:	289 kW capability (limited by line size)
Combiner Module Size and Weight:	50-inches H x 53-inches W x 146-inches L, 1900 lbs.
Group Delay Compensation Module Size and Weight:	50-inches H x 53-inches W x 62-inches L, 475 lbs.
Multiple Station Broad Port:	
Frequency[4]:	All FM Broadcast Channels (88 to 108MHz)
Connector:	6-1/8" 50-Ohm EIA (flanged)
VSWR[1]:	<1.06:1
Insertion Loss[2]:	-0.05dB Typical
Group Delay[3]:	<75ns Overall Variation, Carrier ± 150kHz
Injected Station Port Performance:	
Frequency[4]:	All FM Broadcast Channels (88 to 108MHz)
Power Rating:	60 kW
Connector:	6-1/8" 50-Ohm EIA (flanged)
VSWR[1]:	<1.06:1 at ±150 kHz
Isolation Analog Input to Digital Input (no circulator)[1]:	<-25.0 dB or better
Isolation Analog Input to Digital Input (with circulator)[1]:	<-45.0 dB or better
Isolation Digital Input to Analog Input[1]:	<-25.0 dB or better
Insertion Loss[2]:	<0.40 dB without GDC Module <0.65 dB with GDC Module
Group Delay[3]:	<75 nsec overall variation ±150 kHz <25 nsec overall variation ±150 KHz with optional Group Delay Compensation

1) When terminated in 50-Ohm resistive load.

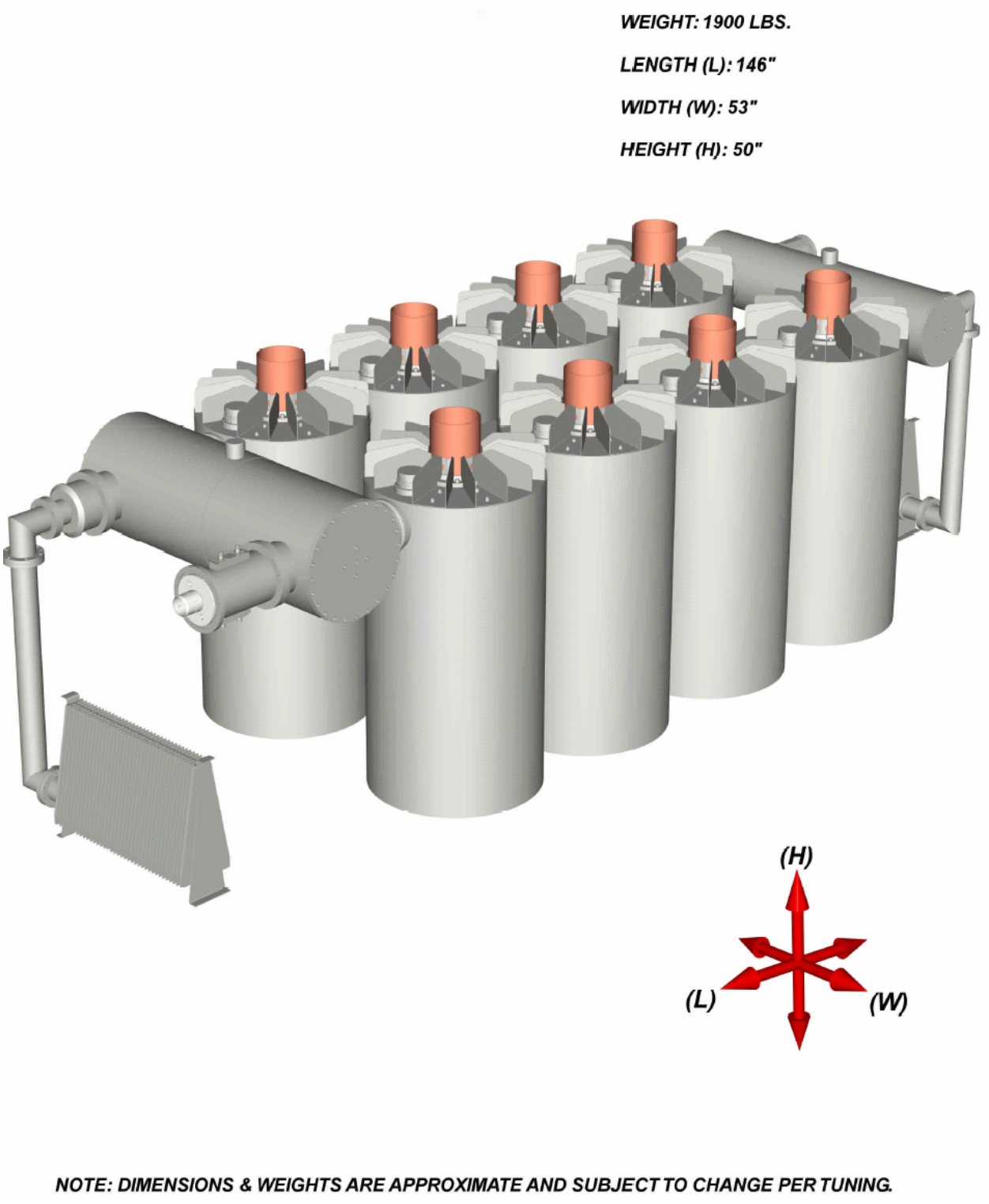
2) Loss values will be somewhat greater for frequency separations 2.0 MHz or less.

3) Group delay correction required for frequency separations 0.8 MHz or less and recommended for frequency separations of 2.0 MHz or less.

4) 800kHz or more removed from any signal appearing at the broad port.

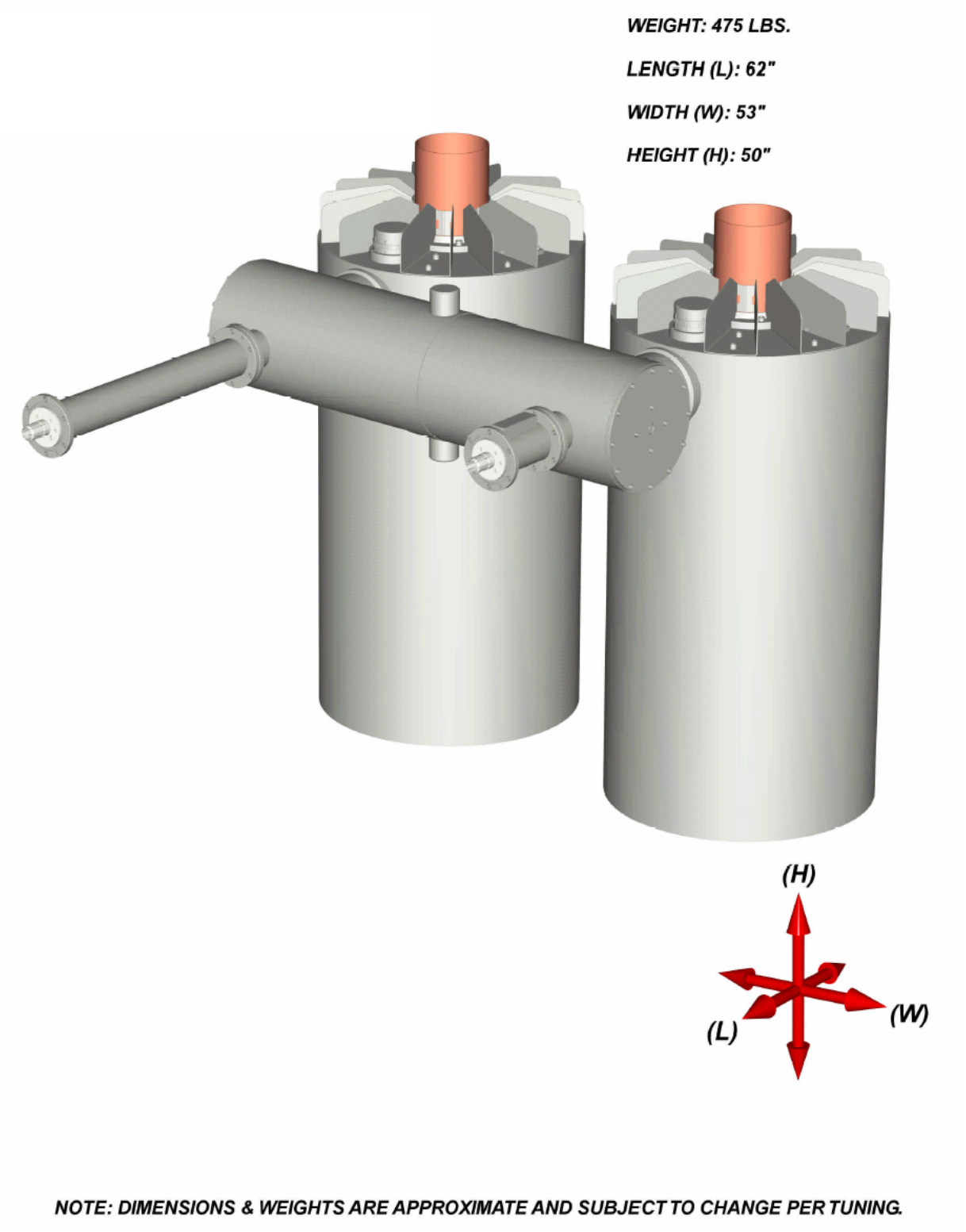
Specifications presented are typical, total system performance may vary. In a continuing effort to improve products, ERI reserves the right to change specifications and features.

The system will be completely assembled at ERI's factory in Chandler and the system fully tuned and documented prior to shipment. The individual modules will be shipped as completely assembled as possible to the tower site and then reassembled as designated. The package of services offered includes combiner placement, assembly, set up, and test. When the combiner is totally assembled and the installation complete an ERI technician will take measurements and complete a cross modulation products report for the system.



NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.

ERI Model 973-8 Constant Impedance Combiner Module



NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.

ERI High Level Group Delay Compensation Module

Combiner Summary:

Model 973 Series Constant Impedance Combiner:
Factory tuned to multiplex any or all of the following: 92.5 MHz, 100.5 MHz, 102.7 MHz, and 107.7 MHz. Floor mounted with convection cooling. Includes circulators for reverse fed IBOC combining.
Module types:[5]

92.5 MHz	973-8 Band Pass Filter Module, floor mounted, forced air cooled. Equipped with circulator and optimized for reverse feed IBOC combining.
100.5 MHz	973-8 Band Pass Filter Module, floor mounted, forced air cooled. Equipped with circulator and optimized for reverse feed IBOC combining.
104.1 MHz	973-8 Band Pass Filter Module, floor mounted, forced air cooled. Equipped with circulator and optimized for reverse feed IBOC combining.
107.7 MHz	973-8 Band Pass Filter Module, floor mounted, forced air cooled. Equipped with circulator and optimized for reverse feed IBOC combining.

3-1/8-inch Analog Inputs
1-5/8-inch Digital Inputs
9-3/16-inch Analog Output
6-1/8-inch Digital Output
Typical Input VSWR: Less than 1.06:1[6]

[5] The combiner room ambient temperature should be maintained between 60 and 80 degrees.
[6] With combiner terminated with a 50 ohm RF load.

Patch Panels and Switching System

Patch Panel System

The proposal includes two 7-port patch panels, one for the analog transmission system and one for the digital transmission system. The patch panels are mounted in free standing rack frames which include the typically required interconnecting transmission line, to the combiner outputs, and the power dividers to split the combined output power to feed the top half and bottom half of the antenna system. This portion of the proposal also includes lock out/tag out switches on all four outputs of the splitter system, feeding the Master FM Antenna.

The patch panel/power divider stands include appropriately sized reject loads for hybrid power divider, including a directional coupler at the reject load input. The directional couplers furnished with the combiner for measuring the combined analog and combined digital output provides input power sensing for the hybrid. The system proposed also includes dual port directional couplers for each of the digital transmission lines and each of analog transmission lines. Each patch panel includes one test adapter that provide a Type N female to the patch panel interface ports.

Preliminary FM Antenna System Calculations

Model COG20P-12-240-2 Master FM Antenna
System Losses without Group Delay Compensation

	ANALOG				*DIGITAL*			
Call Letters:	KOMA-FM							
Frequency:	92.5	MHz						
ERP:	100.000	kW	20.000	dBk	1.000	kW	0.000	dBk
Polarization:	Circular				Circular			
Antenna Gain:	5.861		7.680	dB	5.861		7.680	dB
Element Input Power:	17.062	kW	12.320	dBk	0.171	kW	-7.680	dBk
Element Hybrid Losses:	-0.172	kW	20.000	dB	-0.002	kW	20.000	dB
Antenna Input Power:	17.234	kW	12.364	dBk	0.172	kW	12.364	dBk
Transmission Line Type - Vertical Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Vertical Run Length:	1627.000	feet			1627.000	feet		
Vertical Run Attenuation:	0.047	dB/100-feet			0.135	dB/100-feet		
Transmission Line Type - Horizontal: Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Horizontal: Run Length:	100.000	feet			100.000	feet		
Horizontal: Run Attenuation:	0.047	dB/100-feet			0.135	dB/100-feet		
Line Loss:	3.542	kW	0.812	dB	0.122	kW	2.331	dB
Line Efficiency:	82.953%				58.459%			
Power Output from Hybrid Splitter:	20.776	kW	13.176	dBk	0.295	kW	-5.305	dBk
Combiner System Losses:	-2.004	kW	0.400	dB	-0.056	kW	0.750	dB
Transmitter Power Output:	22.780	kW	13.576	dBk	0.350	kW	-4.555	dBk

Preliminary FM Antenna System Calculations

Model COG20P-12-240-2 Master FM Antenna
System Losses without Group Delay Compensation

	ANALOG				*DIGITAL*			
Call Letters:	KATT-FM							
Frequency:	100.5	MHz						
ERP:	100.000	kW	20.000	dBk	1.000	kW	0.000	dBk
Polarization:	Circular				Circular			
Antenna Gain:	6.157		7.894	dB	6.157		7.894	dB
Element Input Power:	16.242	kW	12.106	dBk	0.162	kW	-7.894	dBk
Element Hybrid Losses:	-0.164	kW	20.000	dB	-0.002	kW	20.000	dB
Antenna Input Power:	16.406	kW	12.150	dBk	0.164	kW	12.150	dBk
Transmission Line Type - Vertical Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Vertical Run Length:	1627.000	feet			1627.000	feet		
Vertical Run Attenuation:	0.049	dB/100-feet			0.142	dB/100-feet		
Transmission Line Type - Horizontal: Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Horizontal: Run Length:	100.000	feet			100.000	feet		
Horizontal: Run Attenuation:	0.049	dB/100-feet			0.142	dB/100-feet		
Line Loss:	3.529	kW	0.846	dB	0.124	kW	2.452	dB
Line Efficiency:	82.296%				56.855%			
Power Output from Hybrid Splitter:	19.935	kW	12.996	dBk	0.289	kW	-5.398	dBk
Combiner System Losses:	-1.923	kW	0.400	dB	-0.054	kW	0.750	dB
Transmitter Power Output:	21.858	kW	13.396	dBk	0.343	kW	-4.648	dBk

Preliminary FM Antenna System Calculations

Model COG20P-12-240-2 Master FM Antenna
System Losses without Group Delay Compensation

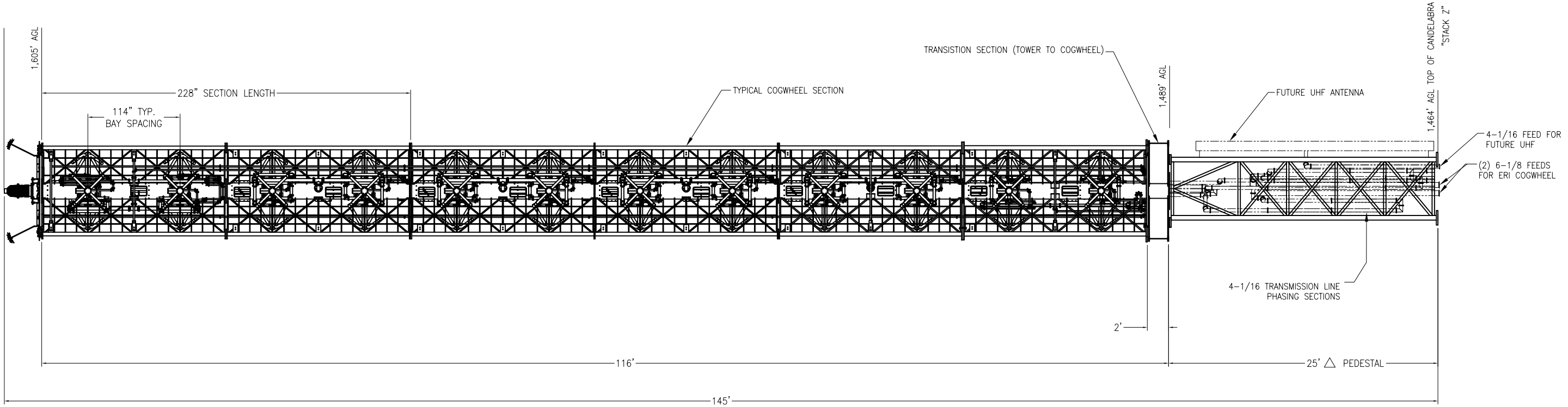
	ANALOG				*DIGITAL*			
Call Letters:	KMGL-FM							
Frequency:	104.1	MHz						
ERP:	100.000	kW	20.000	dBk	1.000	kW	0.000	dBk
Polarization:	Circular				Circular			
Antenna Gain:	6.073		7.834	dB	6.073		7.834	dB
Element Input Power:	16.466	kW	12.166	dBk	0.165	kW	-7.834	dBk
Element Hybrid Losses:	-0.166	kW	20.000	dB	-0.002	kW	20.000	dB
Antenna Input Power:	16.633	kW	12.210	dBk	0.166	kW	12.210	dBk
Transmission Line Type - Vertical Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Vertical Run Length:	1627.000	feet			1627.000	feet		
Vertical Run Attenuation:	0.050	dB/100-feet			0.145	dB/100-feet		
Transmission Line Type - Horizontal: Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Horizontal: Run Length:	100.000	feet			100.000	feet		
Horizontal: Run Attenuation:	0.050	dB/100-feet			0.145	dB/100-feet		
Line Loss:	3.659	kW	0.864	dB	0.130	kW	2.504	dB
Line Efficiency:	81.969%				56.180%			
Power Output from Hybrid Splitter:	20.291	kW	13.073	dBk	0.296	kW	-5.286	dBk
Combiner System Losses:	-1.958	kW	0.400	dB	-0.056	kW	0.750	dB
Transmitter Power Output:	22.249	kW	13.473	dBk	0.352	kW	-4.536	dBk

Preliminary FM Antenna System Calculations

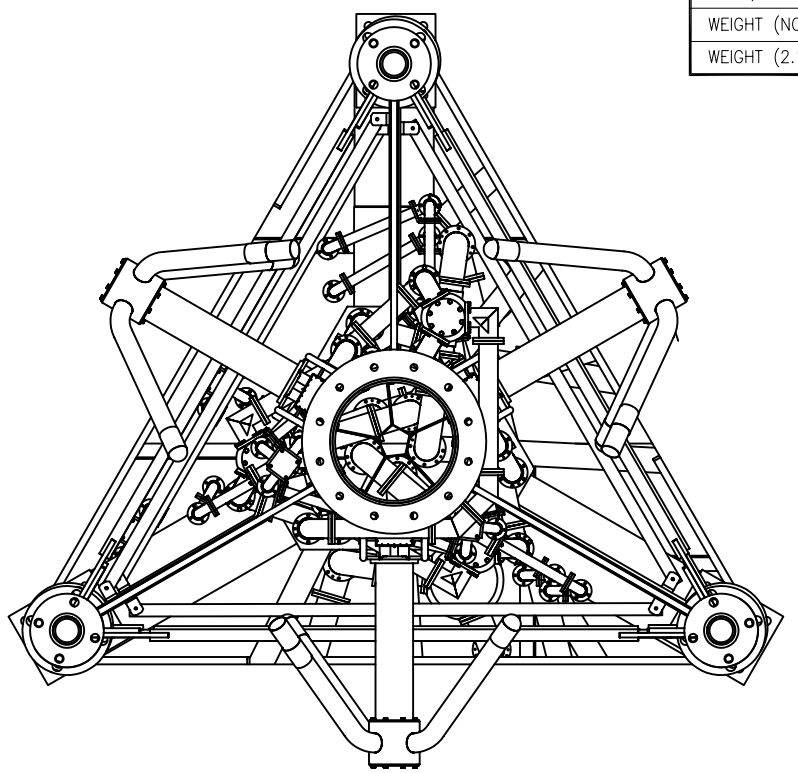
Model COG20P-12-240-2 Master FM Antenna
System Losses without Group Delay Compensation

	ANALOG				*DIGITAL*			
Call Letters:	KRXO-FM							
Frequency:	107.7	MHz						
ERP:	98.500	kW	19.934	dBk	0.985	kW	-0.066	dBk
Polarization:	Circular				Circular			
Antenna Gain:	5.803		7.637	dB	5.803		7.637	dB
Element Input Power:	16.974	kW	12.298	dBk	0.170	kW	-7.702	dBk
Element Hybrid Losses:	-0.171	kW	20.000	dB	-0.002	kW	20.000	dB
Antenna Input Power:	17.145	kW	12.341	dBk	0.171	kW	12.341	dBk
Transmission Line Type - Vertical Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Vertical Run Length:	1627.000	feet			1627.000	feet		
Vertical Run Attenuation:	0.050	dB/100-feet			0.147	dB/100-feet		
Transmission Line Type - Horizontal: Run:	6-1/8-inch rigid line (dual runs)				3-inch air HELIAX (dual runs)			
Horizontal: Run Length:	100.000	feet			100.000	feet		
Horizontal: Run Attenuation:	0.050	dB/100-feet			0.147	dB/100-feet		
Line Loss:	3.772	kW	0.864	dB	0.136	kW	2.539	dB
Line Efficiency:	81.969%				55.735%			
Power Output from Hybrid Splitter:	20.917	kW	13.205	dBk	0.308	kW	-5.120	dBk
Combiner System Losses:	-2.018	kW	0.400	dB	-0.058	kW	0.750	dB
Transmitter Power Output:	22.935	kW	13.605	dBk	0.366	kW	-4.370	dBk

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	CHANGED FROM 8 BAY TO 10 BAY	8/8/06	
	B	ADDED DIMENSIONS TO TOP VIEW	8/18/06	
	C	CHANGED FROM 10 BAY TO 12 BAY	9/12/06	



⚠1 ERI (12) LEVEL MASTER FM COG
EPA (NO ICE) = 665 FT^2
EPA (2.1" ICE) = 1800 FT^2
WEIGHT (NO ICE) = 56,500 LBS
WEIGHT (2.1" ICE) = 118,750 LBS

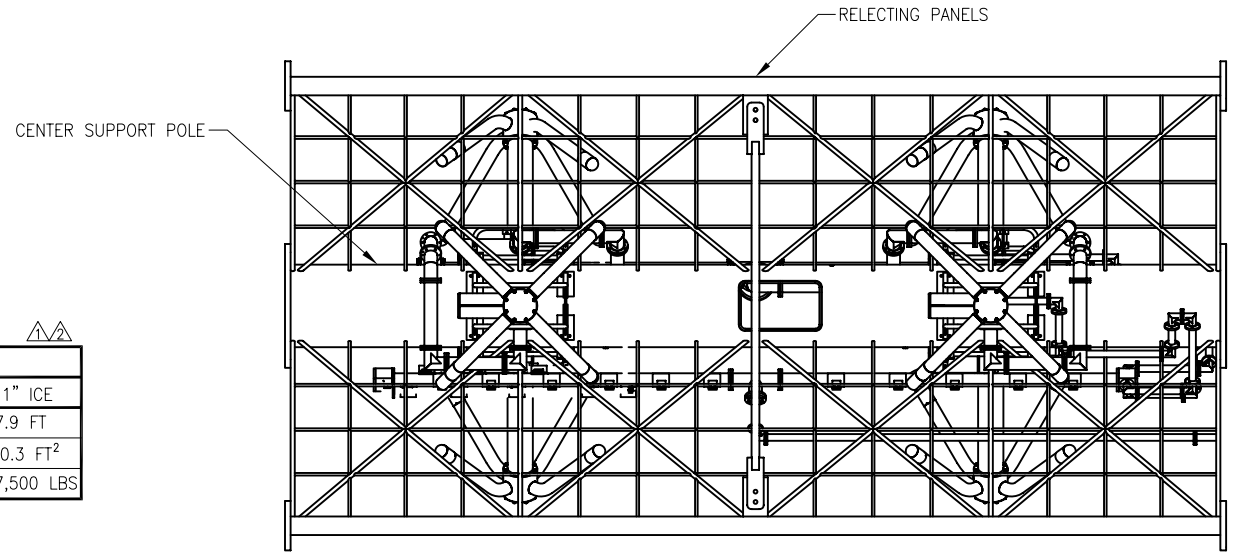


TOP VIEW ANTENNA SYSTEM

⚠1⚠2 STACK MECHANICAL DATA	
90 MPH/0" ICE	40 MPH/2.1" ICE
M_{ARM} = 66.2 FT	M_{ARM} = 67.9 FT
EPA = 884.5 FT^2	EPA = 2240.3 FT^2
WEIGHT = 69,900 LBS	WEIGHT = 147,500 LBS

⚠1 ALL MECHANICAL DATA PER TIA-222-G STANDARD FOR 90 MPH (40 MPH / 3/4" BASE RADIAL ICE THICKNESS) [3 SECOND GUST]

⚠2 STACK MECHANICAL DATA INCLUDES PEDESTAL, FEEDLINES, AND FUTURE UHF SIDE MOUNT TV ANTENNA.



TYPICAL COGWHEEL SECTION

QTY.	UM	PART NO.	DESCRIPTION	ITEM NO.

PARTS LIST

MFG PROCESSES	INSPECTION PROCEDURES	TEST PROCEDURES
—	—	—
—	—	—

THIRD ANGLE PROJECTION

FINISH: — ALL SURFACES

MATERIAL: —

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.
TOLERANCES
1 PLACE DECIMALS ± .030
2 PLACE DECIMALS ± .010
3 PLACE DECIMALS ± .003
ANGLE ± .5°
UNLESS OTHERWISE SPECIFIED

DRAWN BY	BAM	9/12/06
DRAFT.		
DESIGN MGR.		
ENG.	J. ROBINSON	9/12/06
MANUF.		
SUPERSEDES DWG.		

ERI® ELECTRONICS RESEARCH, INC.
Established 1945
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-6026

OKLAHOMA CITY
PROPOSED MASTER ANTENNA SYSTEM "STACK Z"

SIZE	CAGE CODE	DWG NO.	REV
D	0ZNS1	COGOKLA-3	C
SCALE NONE	FILE NO. COGOKLA-3B	SHEET 1 OF 1	

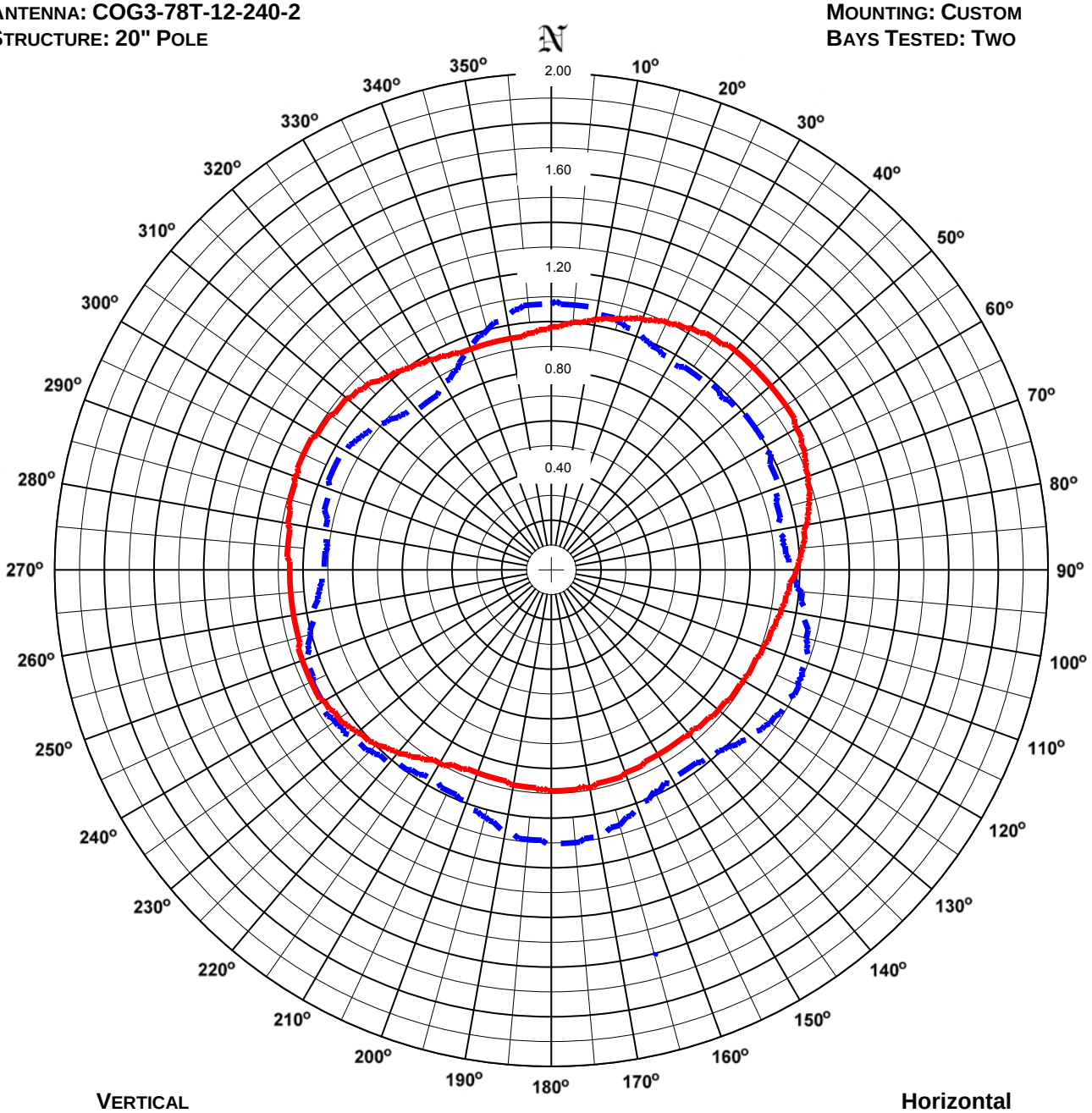
G:\Drafting\ALL\PROJECTS\18120A\COGOKLA-3C.dwg, 9/12/2006 9:12:11 AM, bmeunier

ERI® Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 http://www.eriinc.com/

FIGURE NO: 1B
STATION:
LOCATION: REFERENCE PLOT
ANTENNA: COG3-78T-12-240-2
STRUCTURE: 20" POLE

DATE: 8/3/2005
FREQUENCY: 92.9 MHz
ORIENTATION: 0° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



VERTICAL

RMS: 1.000
MAXIMUM: 1.099 @ 113° TRUE
MINIMUM: 0.843 @ 321° TRUE

Horizontal

RMS: 1.000
Maximum: 1.155 @ 38° True
Minimum: 0.856 @ 138° True

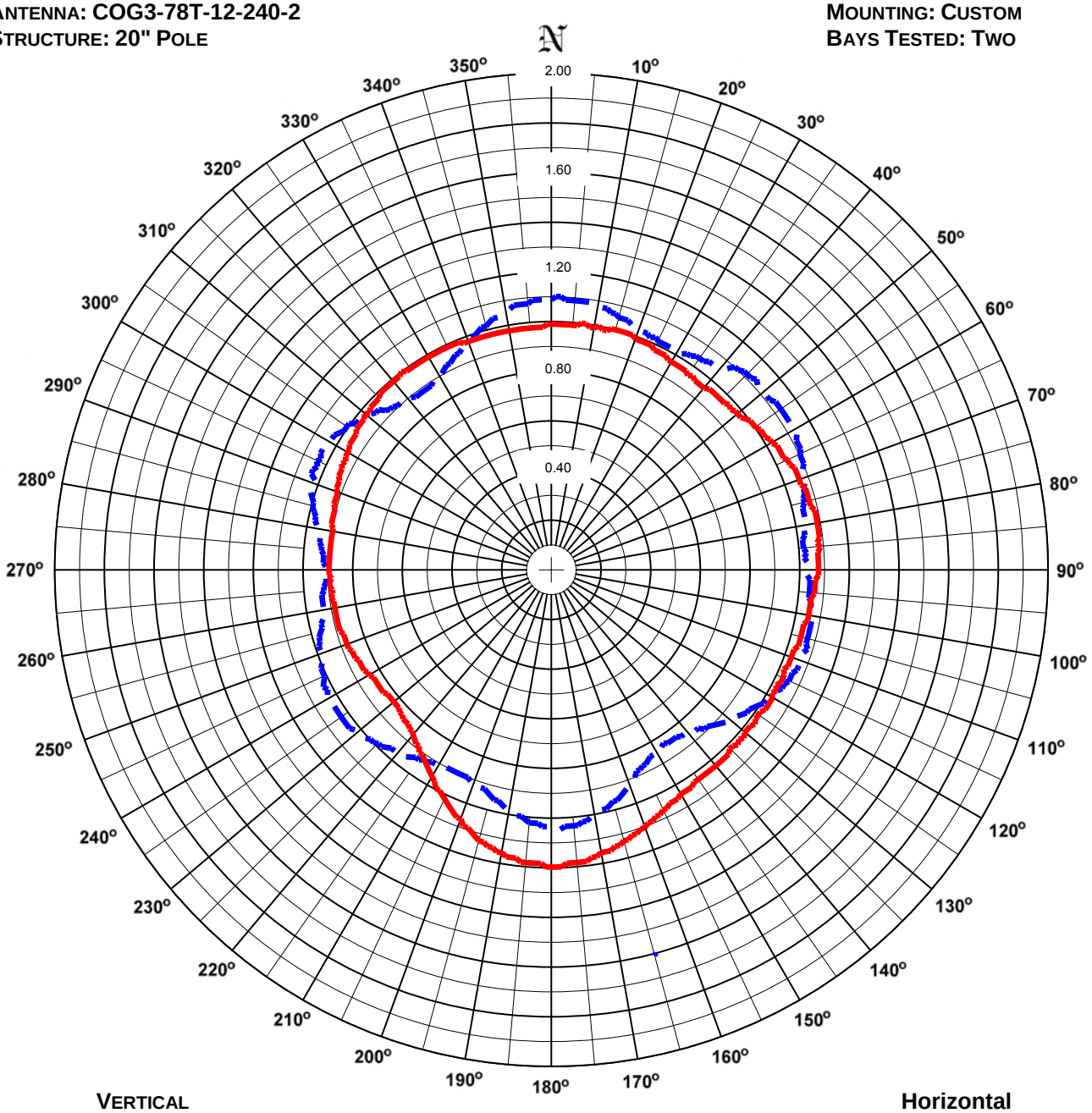
COMMENTS: TWO BAY TEST. ANALOG INPUT. #6 MODULE. "C" LEG DOWN RANGE.

ERI® Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 http://www.eriinc.com/

FIGURE NO: 1B
STATION:
LOCATION: REFERENCE PLOT
ANTENNA: COG3-78T-12-240-2
STRUCTURE: 20" POLE

DATE: 8/3/2005
FREQUENCY: 100.3 MHZ
ORIENTATION: 0° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



VERTICAL

RMS: 1.000
MAXIMUM: 1.130 @ 47° TRUE
MINIMUM: 0.828 @ 147° TRUE

Horizontal

RMS: 1.000
Maximum: 1.193 @ 178° True
Minimum: 0.826 @ 228° True

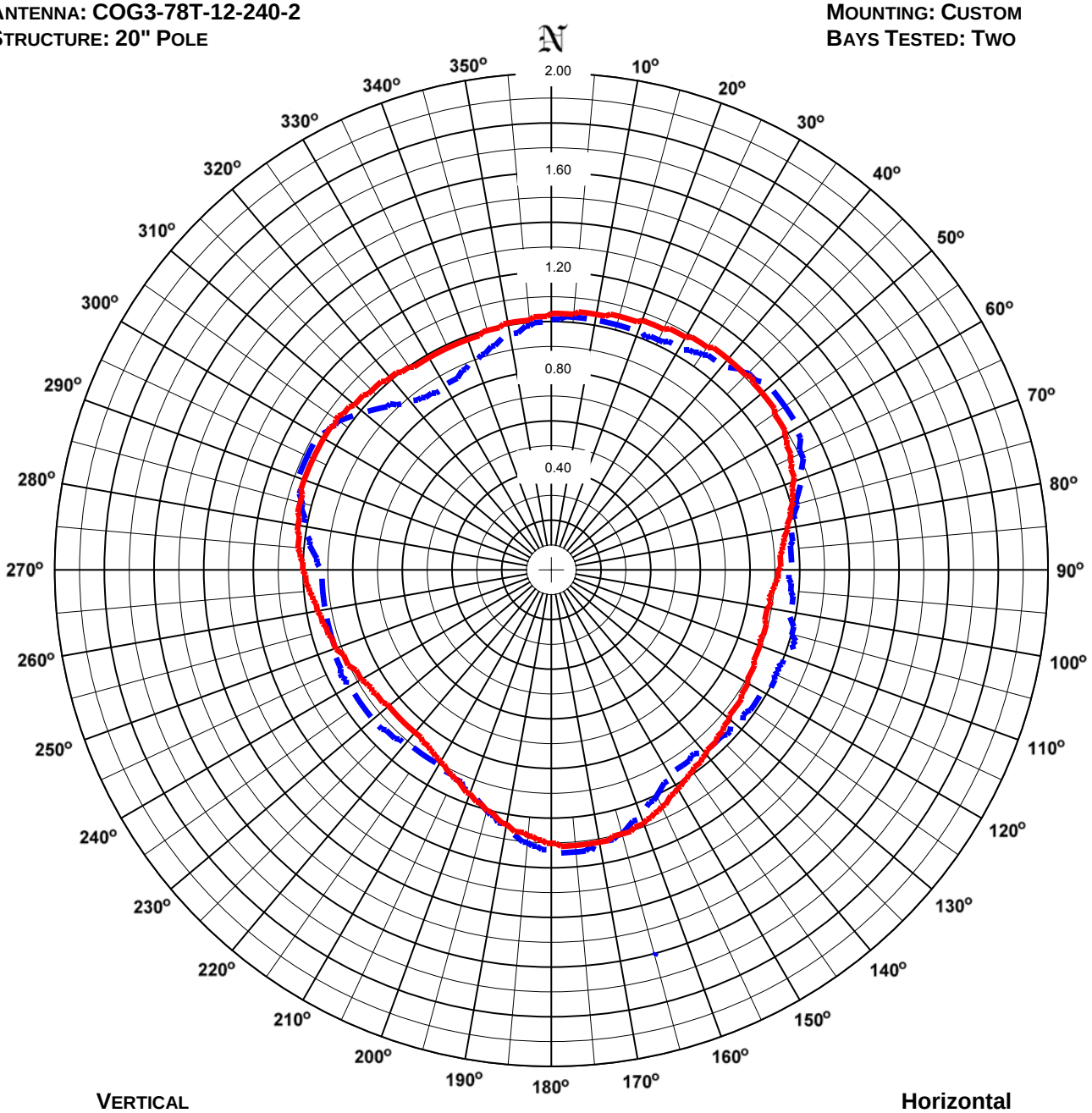
COMMENTS: TWO BAY TEST. ANALOG INPUT. #6 MODULE. "C" LEG DOWN RANGE.

ERI® Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 http://www.eriinc.com/

FIGURE NO: 1B
STATION:
LOCATION: REFERENCE PLOT
ANTENNA: COG3-78T-12-240-2
STRUCTURE: 20" POLE

DATE: 8/3/2005
FREQUENCY: 104.1 MHZ
ORIENTATION: 0° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



VERTICAL

RMS: 1.000
MAXIMUM: 1.150 @ 50° TRUE
MINIMUM: 0.853 @ 327° TRUE

Horizontal

RMS: 1.000
Maximum: 1.123 @ 46° True
Minimum: 0.852 @ 218° True

COMMENTS: TWO BAY TEST. ANALOG INPUT. #6 MODULE. "C" LEG DOWN RANGE.

ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 1

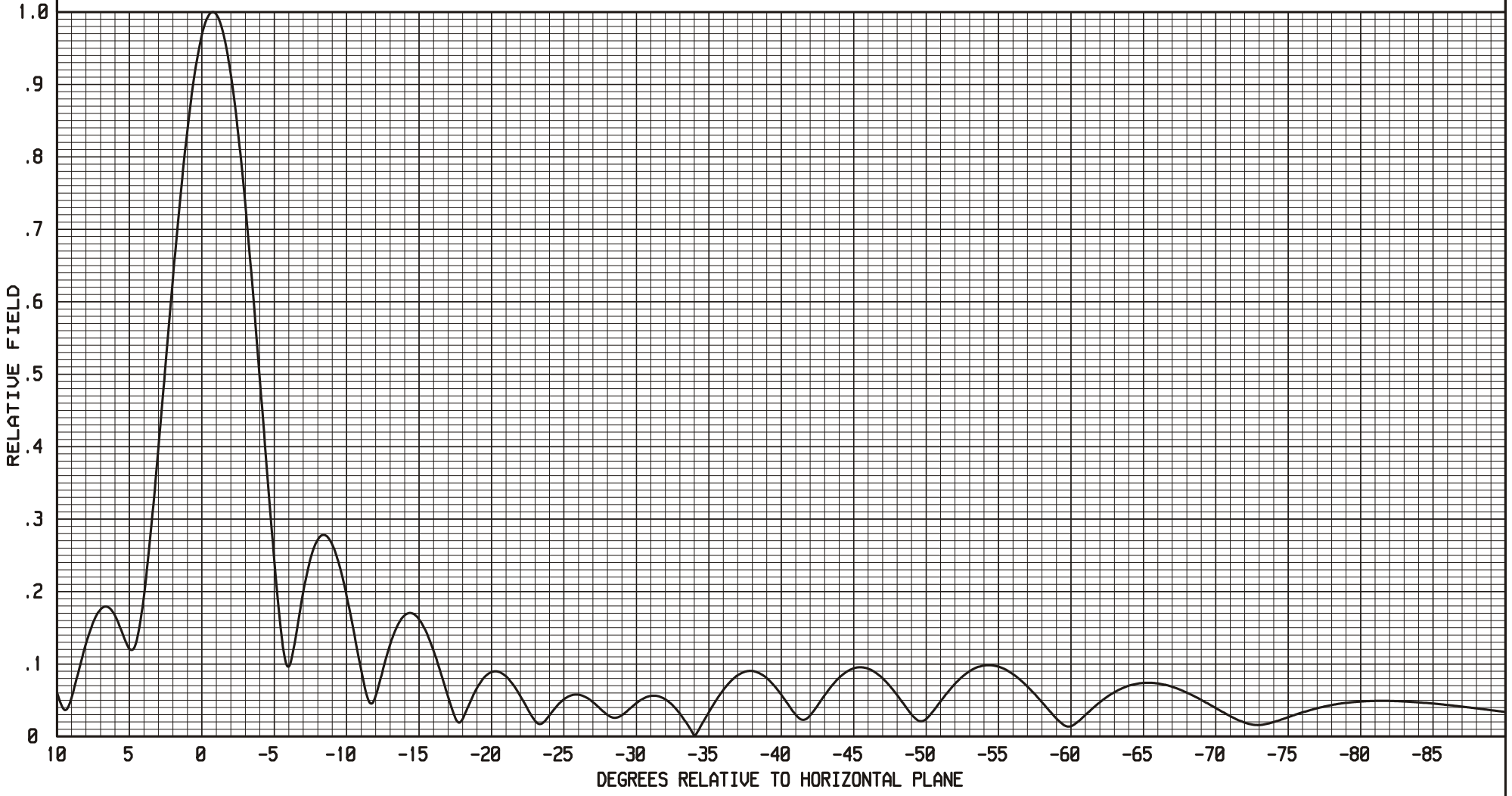
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

ERI 12 LEVEL OMNI-DIRECTIONAL MASTER ANTENNA
-.75 DEGREE(S) BEAM TILT
10 PERCENT FIRST NULL FILL
5 PERCENT SECOND NULL FILL
POWER GAIN IS 5.495 IN THE HORIZONTAL PLANE(5.861 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

AUGUST 16, 2006

92.5 MHz.

BAY SPACING:
114.00 INCHES



ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 2

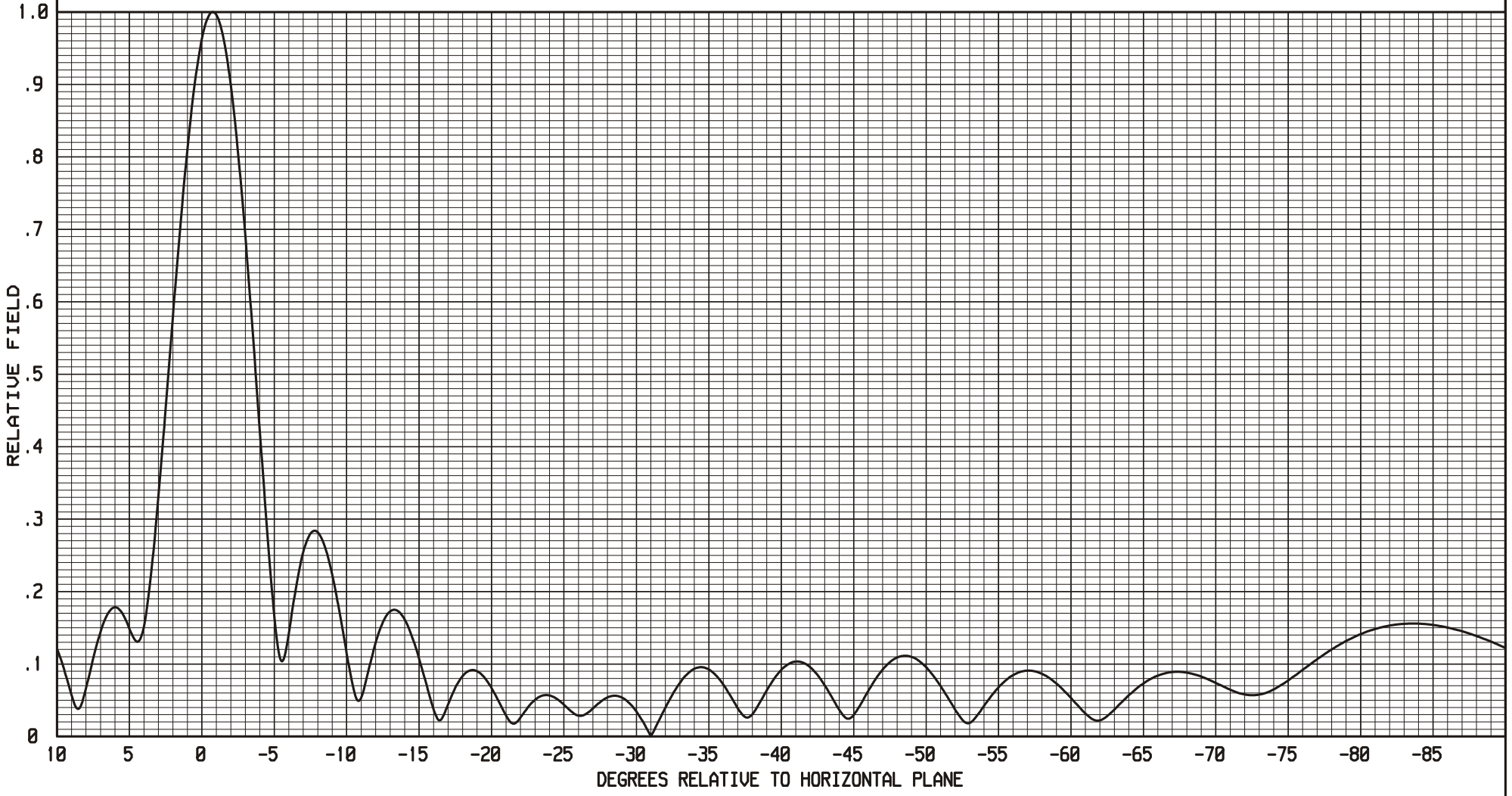
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

ERI 12 LEVEL OMNI-DIRECTIONAL MASTER ANTENNA
-.75 DEGREE(S) BEAM TILT
10 PERCENT FIRST NULL FILL
5 PERCENT SECOND NULL FILL
POWER GAIN IS 5.706 IN THE HORIZONTAL PLANE(6.157 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

AUGUST 16, 2006

100.5 MHz.

BAY SPACING:
114.00 INCHES



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CHANDLER, IN. 47610

FIGURE 3

----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

ERI 12 LEVEL OMNI-DIRECTIONAL MASTER ANTENNA
-.75 DEGREE(S) BEAM TILT
11 PERCENT FIRST NULL FILL
5 PERCENT SECOND NULL FILL
POWER GAIN IS 5.598 IN THE HORIZONTAL PLANE(6.073 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

AUGUST 16, 2006

104.1 MHz.

BAY SPACING:
114.00 INCHES

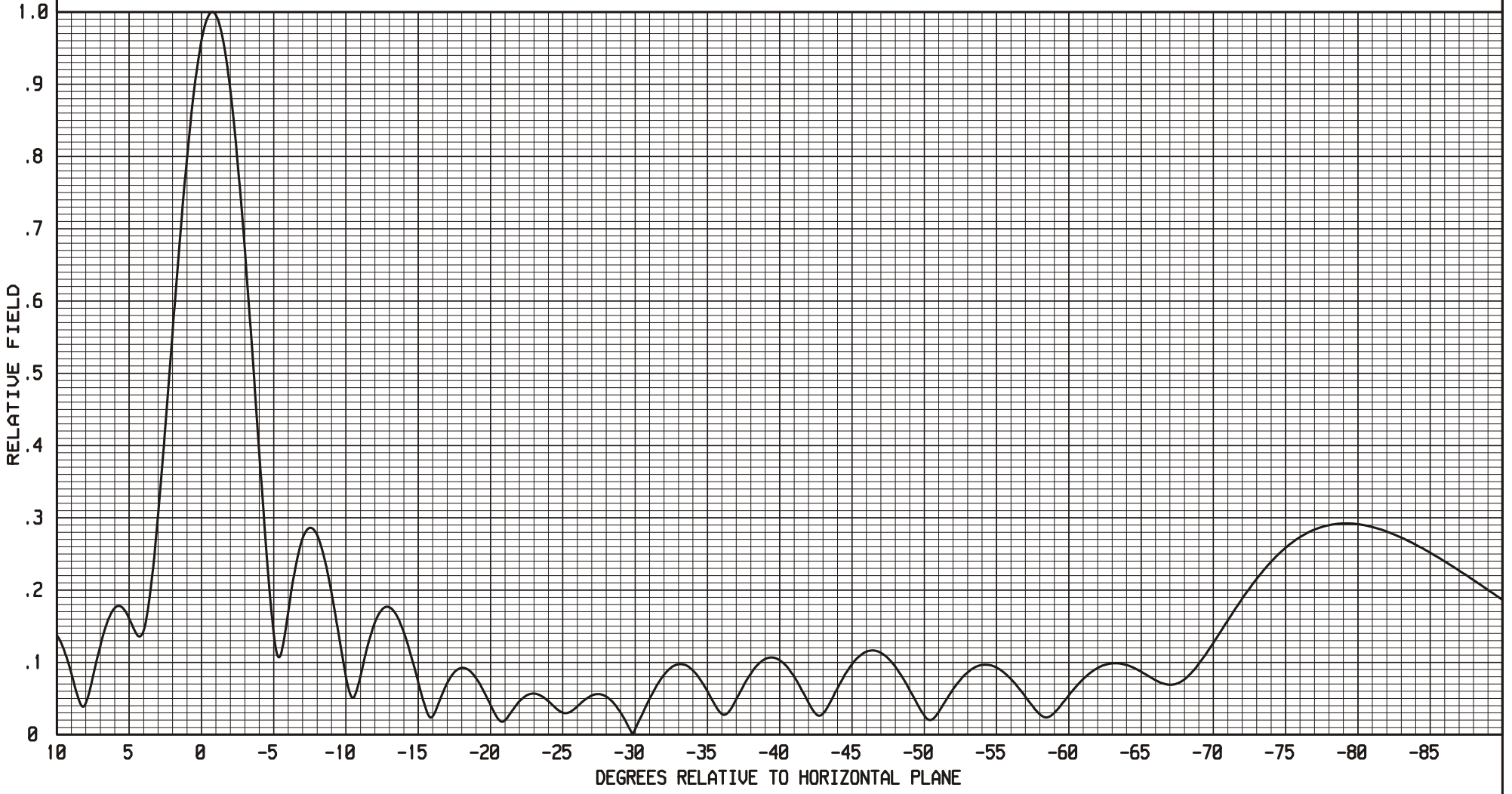

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FIGURE 4

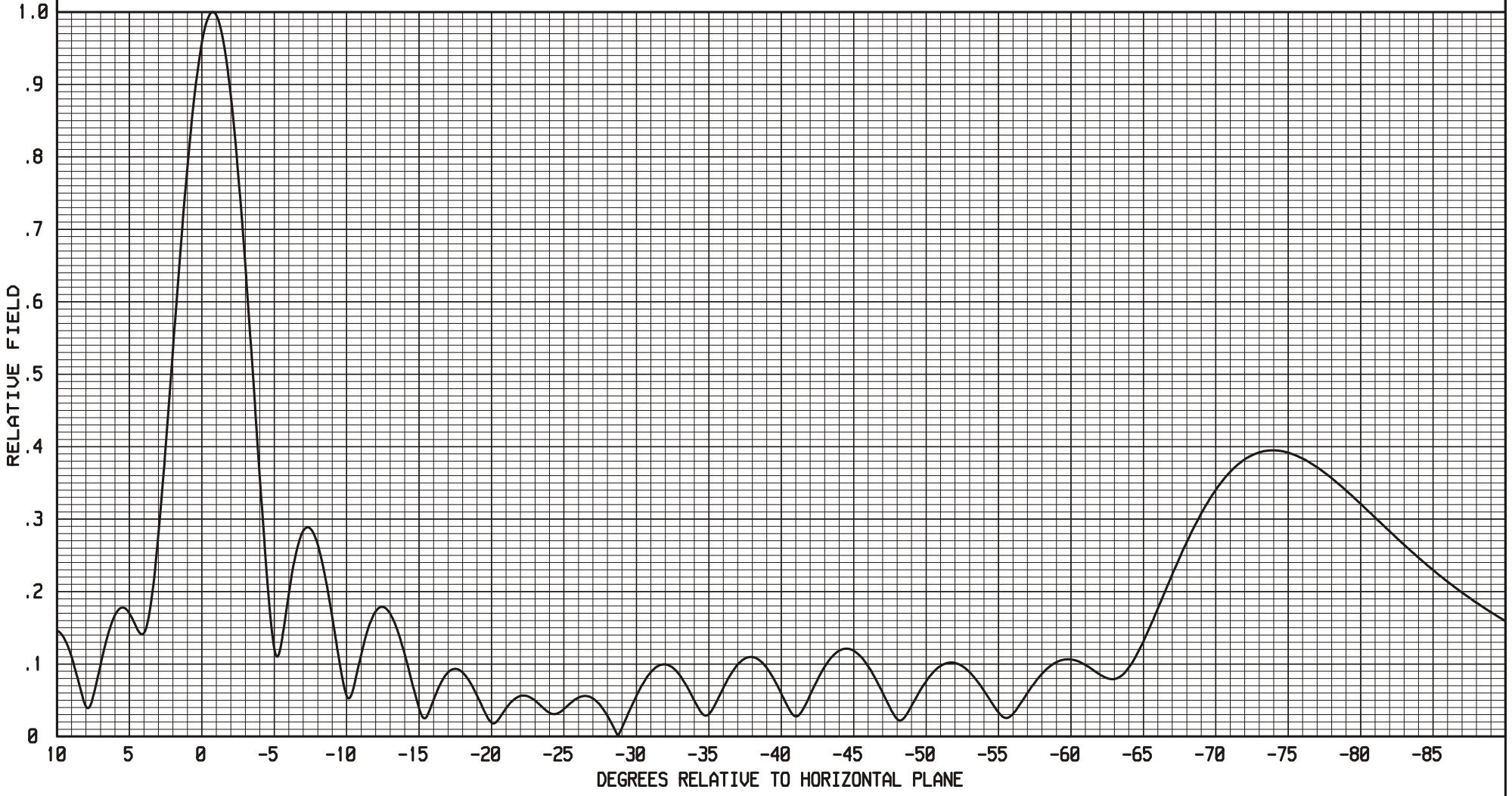
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

ERI 12 LEVEL OMNI-DIRECTIONAL MASTER ANTENNA
-.75 DEGREE(S) BEAM TILT
11 PERCENT FIRST NULL FILL
5 PERCENT SECOND NULL FILL
POWER GAIN IS 5.319 IN THE HORIZONTAL PLANE(5.803 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

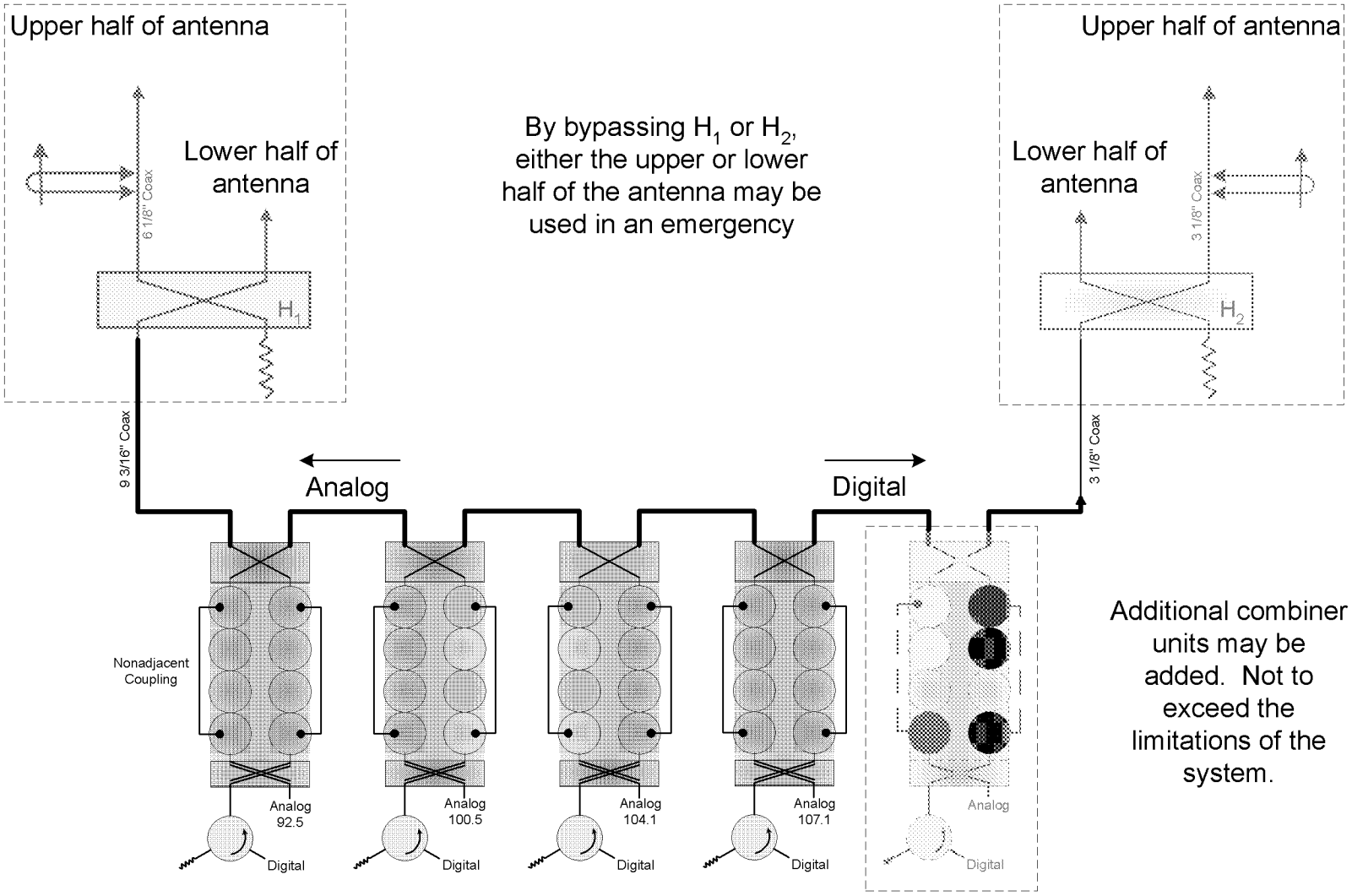
AUGUST 16, 2006

107.7 MHz.

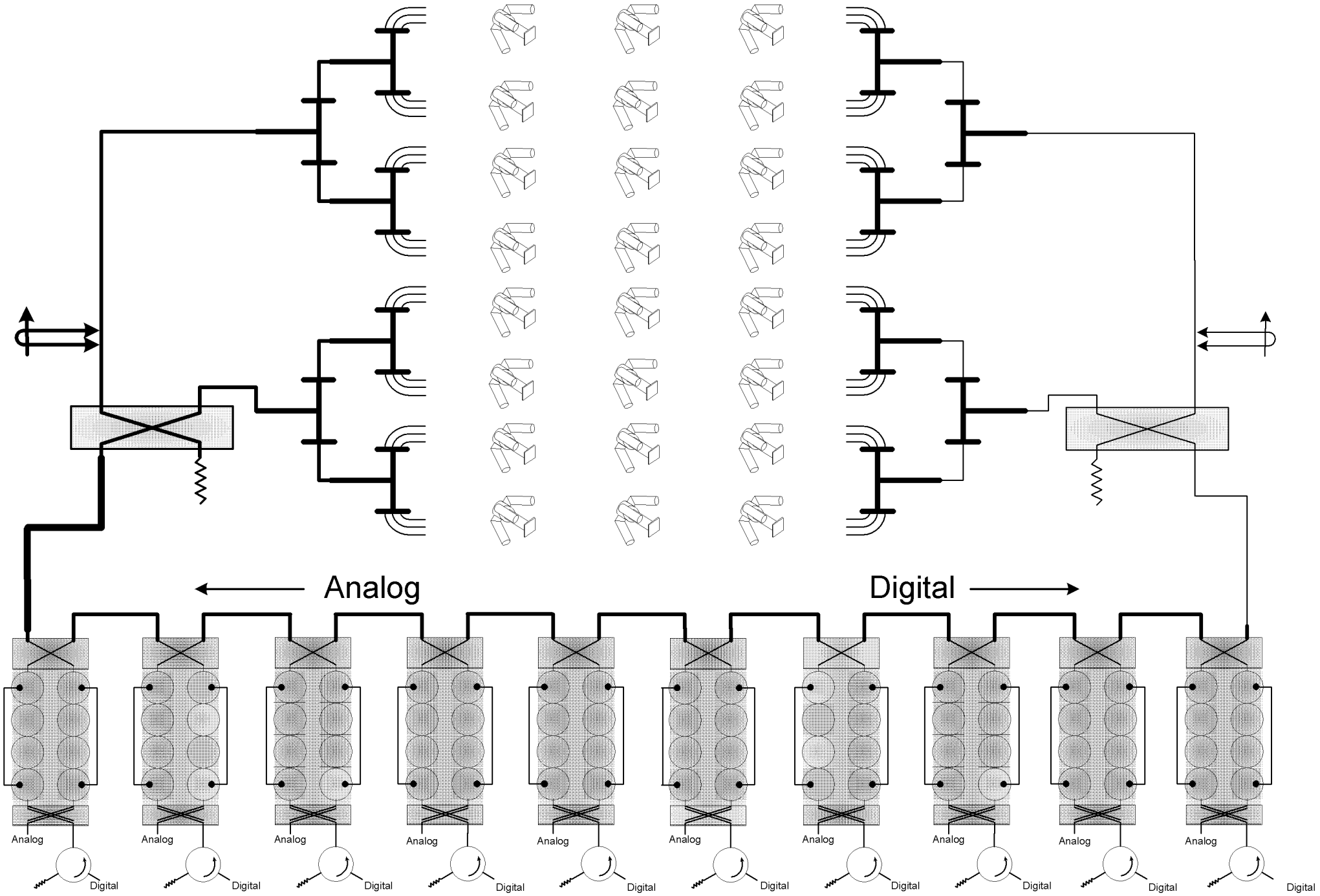
BAY SPACING:
114.00 INCHES



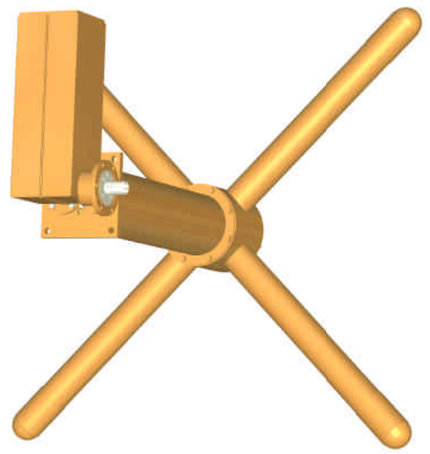
Oklahoma City
Combiner Plan
(Preliminary Drawing)



8-1-2006
Drawn by Aaron Schuetter

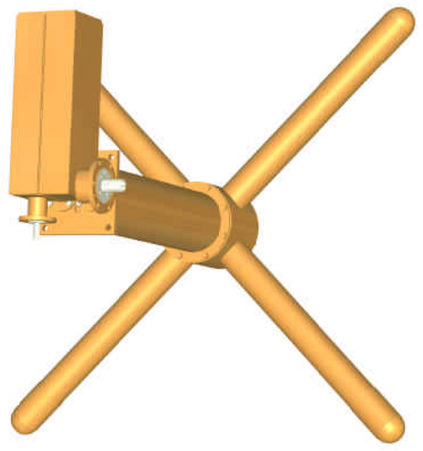


10 Station Analog/Digital



CURRENT BAY LEVEL ELEMENT AND HYBRID

FIGURE #1



IBOX BAY LEVEL ELEMENT AND HYBRID

FIGURE #1

NOTES:

FIGURE 1; ILLUSTRATES THE DIFFERENCE BETWEEN A NON-MODIFIED 1080 ELEMENT HYBRID AND A ELEMENT FITTED WITH A HYBRID TO ALLOW DAB INJECTION. RETROFITTING THE ELEMENT INVOLVES UNBOLTING AND BOLTING THE NEW DAB HYBRID. THE DAB PORT IS 1 5⁄8" EIA GAS PASS RATED AT 2 KW. AVERAGE POWER.

FIGURE 2; SHOWS THE EXISTING ANALOG HIGH POWER FEED HARNESS (RIGHT SIDE) ALONG WITH THE PROPOSED DIGITAL FEED HARNESS (LEFT SIDE). TO ALLOW FOR EMERGENCY ANTENNA USAGE BOTH HARNESSES FEED THE UPPER AND LOWER ANTENNA HALVES INDEPENDENTLY.

FIGURE 3; SCHEMATIC REPRESENTATION OF THE COMPLETE COMBINER SYSTEM. SHOWN ON THE DRAWING ARE BOTH ANALOG (3 1⁄8" EIA) AND DIGITAL (500 WATT CIRCULATOR WITH TYPE "N" FEMALE INPUT CONNECTORS) INJECTION PORTS AND THE DISTRIBUTION OF POWER FLOW IN THE COMBINER MAIN FEED TRUNK. IN ORDER TO SATISFY THE DUAL FED ANTENNA SYSTEM REQUIREMENT 3 dB HYBRID POWER DIVIDERS ARE INCORPORATED INTO THE FEED SCHEME.

LEGEND			
●	DATA COLLECTION SENSOR	⏦	REJECT LOAD
▩	GAS BARRIER	◯⏦	DAB CIRCULATOR
⊥⊥	DIRECTIONAL COUPLER	⌒	CONNECTION ASSEMBLY FOR PATCHING COMPLEX & SWITCHING CONTROLLER

SCHEMATIC SYSTEM DETAIL

FIGURE #3

ANTENNA FEED DETAIL

FIGURE #2

DAB COMBINER MODIFICATION REQUIREMENTS:

1) TEN 500 WATT DIGITAL CIRCULATORS TO BE PLACED BETWEEN COMBINER'S RESIDUAL DUMP LOADS AND THE COMBINER PORT WHICH REVERSES THE POWER FLOW IN THE MAIN COMBINER FEED TRUNK. (THE QUANTITY REQUIREMENT OF TEN ASSUMES ALL STATIONS ARE PARTICIPATING IN DAB)

2) COAXIAL LINE AND COAXIAL ADAPTERS REQUIRED TO CONNECT CIRCULATORS AND RELOCATE DUMP LOADS AT TEN LOCATIONS.

3) ONE RUN OF APPROXIMATELY 40 FEET OF 1 5⁄8" FLEX CABLE TO FEED THE DIGITAL PATCH PANEL FROM THE DIGITAL OUTPUT OF THE COMBINER.

4) A HYBRID POWER SPLITTER AND TERMINATION LOAD IS REQUIRED TO FEED THE DAB SIGNAL TO THE UPPER AND LOWER ANTENNA HALVES, AND A 7 PORT 1 5⁄8" MANUAL PATCH PANEL IS PROVIDED IN ORDER TO FEED EITHER HALF OF THE ANTENNA SYSTEM IN AN EMERGENCY.

DAB ANTENNA MODIFICATIONS REQUIREMENTS:

1) NEW FOUR PORT 1080 ELEMENT HYBRID. (REPLACED AT 8 PLACES)

2) DAB FEED HARNESS, COMPRISED OF:

A) TWO RIGID POWER DIVIDERS (CENTER FED – DUAL OUTPUT, TWO WAY SPLITTERS PLACED AT EACH END)
B) EIGHT, FLEX CABLES 8' LENGTH (7⁄8" AIR DIELECTRIC WITH 1 5⁄8" EIA CONNECTORS)
C) TWO, FEED LINE RUNS (1 5⁄8" FLEXIBLE CABLES AND BRACKET SUPPORT TO TOWER) APPROXIMATELY 200 FEET EACH

NOTE: ITEMS (A) AND (B) ABOVE ADD APPROXIMATELY THE FOLLOWING WEIGHT AND WIND-LOAD TO EXISTING TOWER:

NO ICE	WITH 1/2" ICE
CaAa = 12 FT²	CaAa = 21 FT²
WEIGHT = 75 LBS.	WEIGHT = 175 LBS.

ELECTRONICS RESEARCH, INC.
Established 1943
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4026

NO	REVISION	APP'D	DATE
6			
5			
4			
3			
2	UPDATED TEXT		5/8/02
1	UPDATED TEXT & ADDED DWN. INDX		2/1/02

NAME: IBOC ADDITION PROPOSAL
STATION: WEST TIGER MOUNTAIN
FREQUENCY: N/A QUOTE NO.: WEST TIGER 1
PATH: Q:\DRAFTING\ANTENNA\QUOTES\WEST TIGER 1
FILE: QA_1 DRAWN: BAM FACTOR: NTS
DATE: 12/2/02 APP'D:
MODEL: NON-APPLICABLE DWG. NO.: QA — 1

AM FIELD STRENGTH MEASURMENTS

Station _***WKY***_ Frequency_***930***__ KHz Radial Bearing _____ Deg T.
Center of Array Coordinates: NAD 83 North Lat._***35 33 43***__ West Long _***97 30 28***_
Endpoint Coordinates : NAD 83 North Lat._____ West Long _____
F/S Meter Type_***FM - 41***__ S/N _***2050***__ Cal Date _***2/15/7***_ Cal By_***F Sandel***_
F/S Meter Type _***FM- 41***__ S/N ____***XX***___ Cal Date ___***XX***___ Engineer _____
Pattern Day _____ Ground Condition: Dry___ Damp ___Wet ___ Sky: Clear ___Cloudy __
Pattern Night ___***X***___ Ground Condition: Dry___ Damp _***X***_Wet ___ Sky: Clear _***X***_Cloudy __

Monitoring			By Munn Reese			By Ed Reid			
Point	Max	**Directional power**			Directional Power			Distance	Remarks
Number	mV/m	mV/m	Time	Date	mV/m	Time	Date	Km	GPS Approx. Locations
1	82	76	13:43	10.24.6	81	9:15am	7.26.7	3.91	Lat 35 35.252 Long 97 29.082
2	150	120	15:51	10.24.6	122	9:30am	7.26.7	2.81	Lat 35 32.875 Long 97 29.576
3	211	210	13:29	10.24.6	209	9:45am	7.26.7	2.52	Lat 35 33.741 Long 97 32.151
4	162	148	10:01	10.24.6	148	10:00am	7.26.7	2.65	Lat 35 34.458 Long 97 31.881
5	*				*	11:00am	7.26.7		Lat 35 33.345 Long 97 29.559
6									
7									

Comments:
Pt# 1 Intersection of N. Eastern Ave & NE 115 St 1st drive way on the N. side of 115 St. reading taken near the W. side of the drive way. Coordinates taken in the center of drive way.
Pt# 2 N. Eastern at junction of Eastern Place. Historical readings taken on north side of road st this junction. Munn Reese taken on the south side of the Eastern place road. Coordinates taken near the north side of the road.
Pt# 3 University Ave between NW 90th and NW 89 St.Reading taken in front of the Centenial H.S. school near flag pole (Historical Readings taken in the rear of the school due to traffic and accessibility. This reading was taken in front of the school. Coordinates taken in front of school, but in the street.
Pt#4 N Western Ave & NW 104th St.Readings taken on NW 104th st 2nd home on the right north side of curb. Coordinates taken along the north side of NW 104th St.
* Pt#5 An optional reading taken at the entrance of Richland Tower site at the end of pavement near east side of gate for a future reference (RT info Only) Meter aligned for a Max of 400 mV/m and a Min of 70 mV/m. Coordinates taken on east side of entrance gate of the RT site. New tower still under construction and old tower has not been removed.

Lat long reading taken inside of vehicle and due to MPT's on the side of street, the Lat & long readings is for reference locations only.