ELECTRONICS RESEARCH, INC.
7777 Gardner Road, Chandler, Indiana 47610, (812) 925-6000, Fax (812) 925-4030

Report Of Intermodulation Product Findings

WHRM, WIFC, WDEZ BROADCAST FACILITY
RIB MOUNTAIN: WAUSAU, WISCONSIN

October 2003

Electronics Research Inc.
7777 Gardner Road
Chandler, Indiana 47610
Phone (812) 925-6000 Fax (812) 925- 4030

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REPORT OF FINDINGS
WHRM, WIFC, WDEZ COMBINED BROADCAST FACILITY
WAUSAU, WISCONSIN

Introduction: This report of findings is based on data collected at the WHRM, WIFC and WDEZ combined FM broadcast facility located in Wausau, WI. The report includes measurements offered as proof that the combined operations of WHRM (90.9 MHz.), WIFC (95.5 MHz.) and WDEZ (101.9 MHz.) transmitters are in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 section 73.317 paragraph (b) through (d). In brief, the collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by this multiplex system are less than the maximum allowable level as required by section 73.317 (b) through (d). WLBL (91.9 Mhz.) operates into a separate side mount antenna located lower on the same tower. Their effects on the stations operating from the multiplexed system has been considered in this report. I, Jeff Taylor of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on October 8, 2003.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 1083-10CP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 Multiplexer Specification Sheet.
- A-5 Theoretical Vertical Plane Relative Field Antenna Plots

Exhibit B:
- B-1 Equipment Employed In Intermodulation Product Measurement.
- B-2 Broadcasting Scheme of the Multiplexed Systems.

Table 1. Carrier Reference Levels.
Table 2. Calculated Third Order Products.
Table 3. Intermodulation Analysis Measurements.

Exhibits Accompanying Report: Exhibit A, provides comprehensive information on both antenna and filters used by these radio stations. Exhibit B, illustrates the broadcasting scheme of each station, the layout of the equipment used to isolate and measure potential intermodulation products and forward carrier reference levels. Found within Table 1 are the narrow band carrier frequency measurements that provide relative output signal levels for the IM analysis. Table 2 lists the calculated third order products that can be generated from FM transmitters broadcasting from the multiplexed system. The IM Analysis Measurements, in Table 3, provides detailed information obtained from the product frequency investigation.

The Nature Of Intermodulation Products (IM) : Intermodulation products result from inadequate transmitter-to-transmitter isolation. Intermodulation products are commonly generated from radio stations operating into multiplexed facilities and congested antenna broadcast sites. The mechanics associated with the phenomenon have been well documented. When two or more transmitters are coupled to each other, new spectral components are produced by the mixing of the station frequencies in the active circuits of each transmitter. The common term used to describe this phenomenon is third order product denoted by the mathematical expression $[\ 2(F_1)-(F_2)\ ]$, where F_1 signifies the frequency of the transmitter that is generating the intermodulation product, and F_2 signifies the frequency causing the interference.

The Multiplexed System : These measurements were taken with three FM stations operating from the combined antenna system. The WHRM, WIFC, and WDEZ multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The 1083-10CP antenna and 963-6 multiplexer units are products of Electronics Research, Inc, whereas the feed line is manufactured by Andrew and Myat, Refer to Exhibit B-2, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of three transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a Combiner modules was installed. Specifically, the Multiplexer utilizes three ERI Model 963-6 Constant impedance combiner modules. All combiner components are natural convection cooled. The combiner is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -90dB. Other performance measurements, such as match, loss, group delay, etc, revealed that the multiplexer unit was in proper working condition. Refer to Exhibit A-4 for the Combiner Specification Sheet.

The IM Investigation : Directional Couplers were placed at key locations throughout the combiner to monitor and maintain the multiplexers performance. All couplers furnished with the system are factory calibrated and capable of delivering accurate and repeatable RF measurements. To facilitate the taking of the measurements, the coupler located at the antenna output of the multiplexed system was used. Care was taken in the selection of the measurement location to insure that the measurements would be made far removed from transmitters and any filtering used to reduce broadcast emissions. The coupler selected would normally be used for antenna reflection measurements and thus would provide greater than 33 dB directivity and a forward signal sample of -46 dB.

The forward port of the coupler was used for sampling the outgoing carrier levels and IM products. The IM sampled signal was fed by shielded cable into a Band Pass Filter where all extraneous energy was steeply attenuated. Various attenuation pads were used, when needed, on the band pass filter and/or the FIM71 to ensure an adequate signal level for measurements without overloading the measurement equipment. A Potomac Instruments FIM-71 Field Strength Receiver was employed to record the level of all signals investigated. To facilitate the selective tuning of the Receiver and Band Pass Filter a Wavetek Model 3000 signal generator was used. An Anritsu Model S114B Spectrum Analyzer was used to measure the close in spectral attenuation of each carrier and wide band search for any anomalies that may need further investigation. See attached Exhibit B-1 for an illustration of the measurement equipment.

Prior to recording measurements, all pertinent broadcasting equipment including Transmitters, Multiplexer, Feed Line and Antenna were adjusted to optimal performance. Also, it was confirmed before taking any measurements that all stations of concern were operating at their full licensed power level. From the equipment setup described above, the relative output signal level of each stations forward carrier was made. The resulting signal levels of these measurements are listed in Table 1, column labeled "Adjusted Level". This level will be used as the reference level for possible IM products of each carrier and was necessary to confirm that no significant levels of spurious energy, referenced to each carrier, were present from any transmitter operating from the multiplexed system.

Table 1 - Carrier Reference Levels.

Carrier Frequency (MHz)	Pad One (dB)	Bandpass Filter Loss (dB)	Full Scale Range (dBµ)	Scale Reading (dB)	**Adjusted Level (dBµ)**	Notes
WHRM (90.9)	3	-	140	-9.5	**133.5**	
WIFC (95.5)	3	-	140	-9.7	**133.3**	
WDEZ (101.9)	3	-	140	-10.3	**132.7**	

Predictable third-order products due to system harmonics mixed with all on-site interfering frequencies that could be generated from the multiplexed system are calculated and listed in Table 2.

Table 2 - Third order Products.

	Carrier Frequency MHz.		
Interfering Frequency MHz	WHRM 90.9	WIFC 95.5	WDEZ 101.9
WHRM 90.9	--	100.1	112.9
WIFC 95.5	86.3	--	108.3
WDEZ 101.9	79.9	89.1	--
WLBL 91.9	89.1	99.1	111.9

Using the equipment previously described the IM product measurements were recorded and are listed in Table 3. The signal levels referenced to the carriers are calculated and listed in the column labeled "Level Referenced to Carrier". Refer to Exhibit B for a layout of the measurement equipment.

Table 3 Intermodulation Measurements

Product Frequency (MHz)	Carrier Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Full Scale Range (dBµ)	Scale reading (dB)	Adjusted Level (dBµ)	Carrier Reference Level (dBµ) (See Table 1)	**Level Referenced to Carrier (dB)**	Notes*
79.9	90.9	101.9	3	11.5	20	-14.3	20.2	133.5	**113.3**	
86.3	90.9	95.5	3	10.2	20	-8.2	25.0	133.5	**108.5**	
89.1	95.5	101.9	3	10.7	20	<-20	13.7	133.3	**119.6**	
89.9	90.0	91.9	3	10.2	20	-3.0	30.2	133.5	**103.3**	
99.1	95.5	91.9	3	10.0	20	-8.1	24.9	133.3	**108.4**	
100.1	95.5	90.9	3	9.1	20	-1.7	30.4	133.3	**102.9**	
108.3	101.9	95.5	3	9.8	20	-14.8	18.0	132.7	**114.7**	
111.9	101.9	91.9	3	9.6	20	<-20	12.6	132.7	**120.1**	
112.9	101.9	90.9	3	9.8	20	-8.5	24.3	132.7	**108.4**	

*** NOTES**

The Spectrum Analyzer was used to check the close in spectral attenuation of each carrier to confirm the operation of these transmitters are in compliance with Sections (b) and (c) of the FCC Rules and Regulations.

As a final proof of the systems IM Product performance, a wide band search was undertaken using the Spectrum Analyzer. The purpose for this measurement was to look for suspicious anomalies that may warrant further investigation. My search ranged the complete frequency span of the receiver and resulted in no additional investigations.

Conclusion : Based upon my observations and measurements taken October 8th, 2003 as summarized in this document, I, Jeff Taylor, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the WHRM, WIFC and WDEZ into the 1083 10-CP antenna to be in proper working order. Furthermore, based on the measured data, it is my opinion that there are no inter-modulation products in excess of 80 dB below carrier levels generated from or within the stations operating on the installed system. Also, based on this recorded data. I conclude that WHRM, WIFC and WDEZ are in compliance with the requirements of Section 73.317 paragraph (b) through (d) of the FCC Rules and Regulations.

Respectfully submitted,
Electronics Research, Inc.

By 
Jeff Taylor Field Technician

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Jeff Taylor, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 7 years. I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Multiplexers in my long tenure with ERI.

2.) I have either prepared and/or directly supervised the preparation of all technical information contained in this Report Of Findings and to my knowledge to be accurate and true.

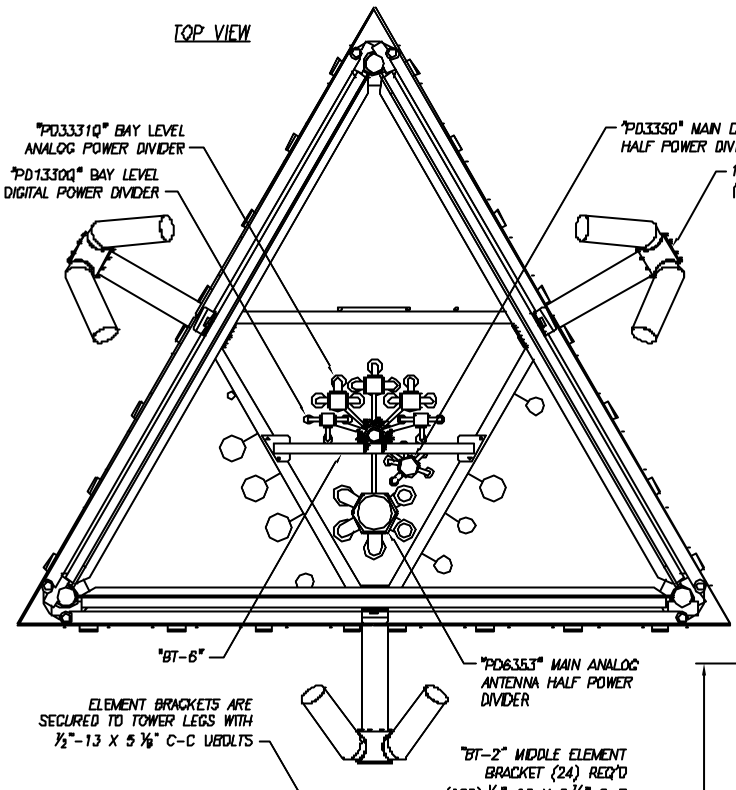
3.) ERI has been requested by Gary Tesch WRIG, Inc. on behalf of radio Stations WHRM , WIFC and WDEZ in Wausau, WI. to prepare this Report Of Findings.

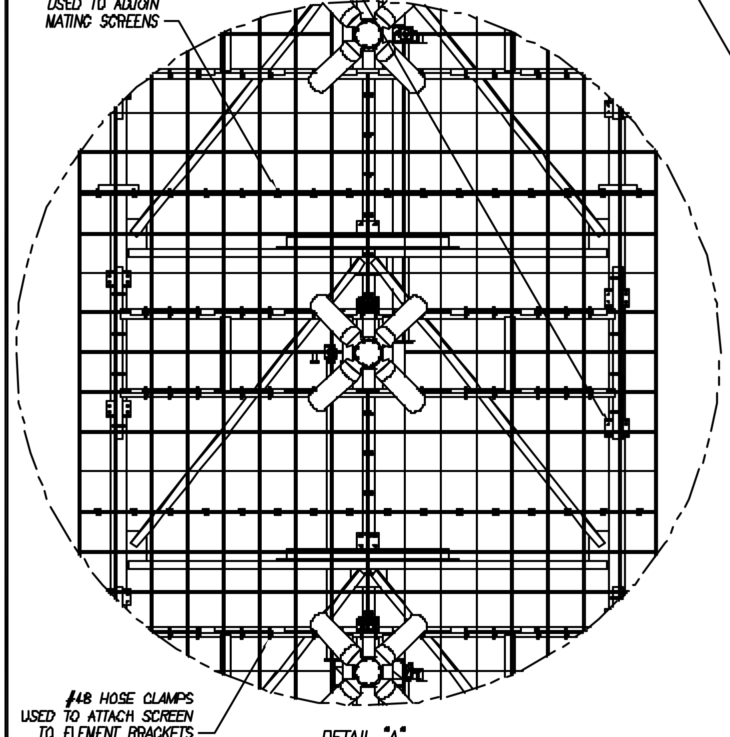
Jeff Taylor; Field Technician

Subscribed and sworn to before me on this 14th, day of October 2003.

Jacquelyn Kinney; Notary Public
My commission expires July 5, 2007

NOTARY PUBLIC SEAL INDIANA





NOTES:

1) ALL 3 ⅛" LINE BRACKETS REQUIRE #48 HOSE CLAMPS TO ATTACH TO 3 ⅛" FEED HARNESS.

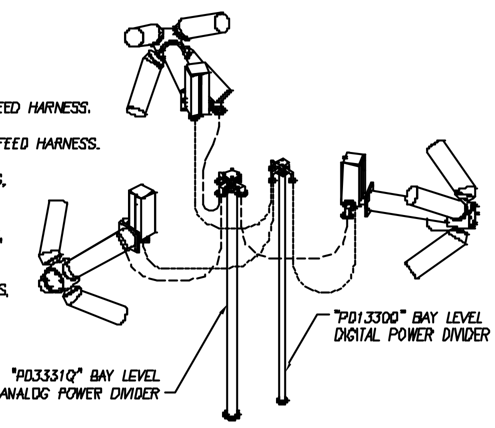
2) ALL 1 ⅝" LINE BRACKETS REQUIRE #28 HOSE CLAMPS TO ATTACH TO 1 ⅝" FEED HARNESS.

3) 6 ⅛" EIA FEED LINE CONNECTIONS REQUIRE ⅜"-16 X 1 ¾" LONG HEX BOLTS, NUTS & LOCKWASHERS (12) EACH CONNECTION.

4) 3 ⅛" EIA FEED LINE CONNECTIONS REQUIRE ⅜"-16 X 1 ½" LONG HEX BOLTS, NUTS & LOCKWASHERS (6) EACH CONNECTION.

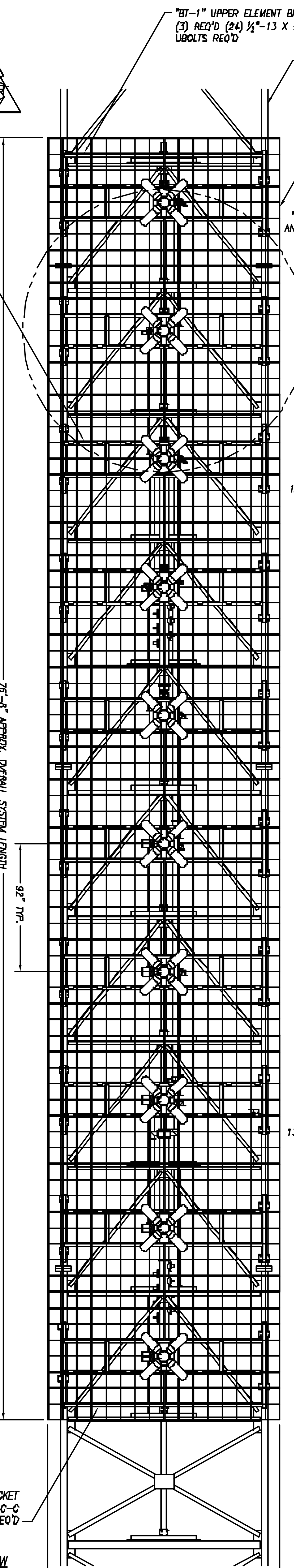
5) 1 ⅝" EIA FEED LINE CONNECTIONS REQUIRE 5/16"-18 X 1 ¼" LONG HEX BOLTS, NUTS & LOCKWASHERS (4) EACH CONNECTION.

6) ⅞" EIA FEED LINE CONNECTIONS REQUIRE ¼"-20 X 1" LONG HEX BOLTS, NUTS & LOCKWASHERS (3) EACH CONNECTION.

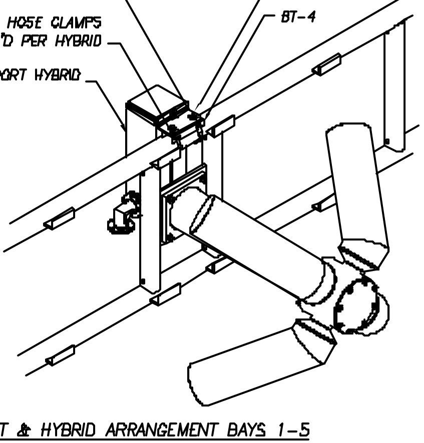


BAY LEVEL HELIAX INSTALLATION DETAIL

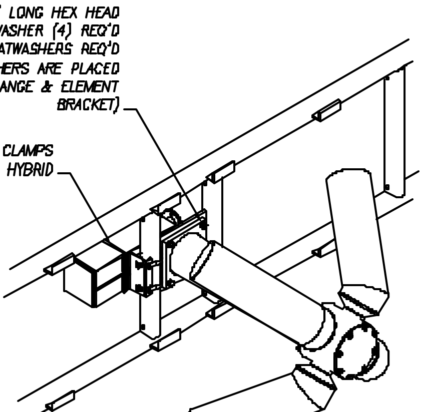
NOTE: HIDDEN LINES ARE SHOWN FOR CONNECTION PURPOSES ONLY AND DO NOT REFLECT ACTUAL LENGTH OF ANALOG & DIGITAL HELIAX JUMPERS.



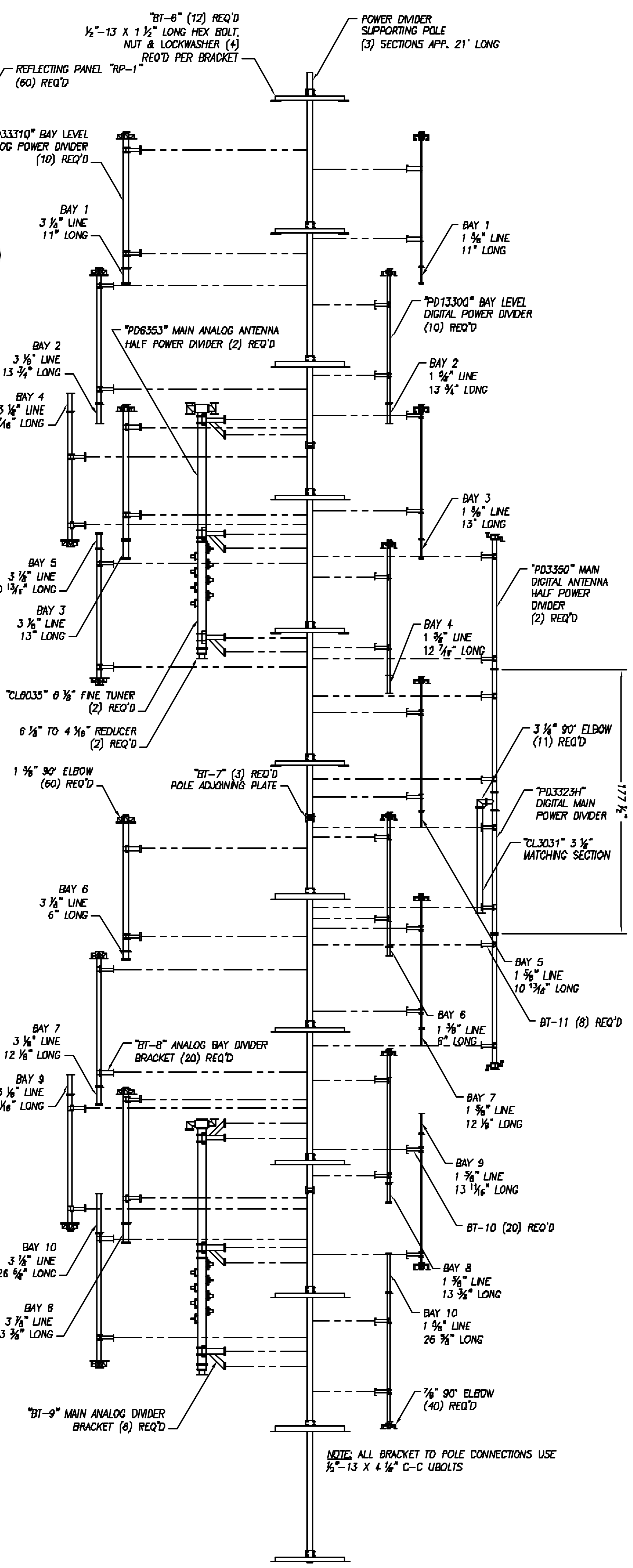
ELEVATION VIEW
ONE FACE SHOWN ONLY



ELEMENT & HYBRID ARRANGEMENT BAYS 1–5
(UPPER HALF)
INSURE TO ORIENTATE HYBRID AS SHOWN



ELEMENT & HYBRID ARRANGEMENT BAYS 6–10
(LOWER HALF)
INSURE TO ORIENTATE HYBRID AS SHOWN



NOTE: ALL BRACKET TO POLE CONNECTIONS USE ½"-13 X 4 ½" C-C UBOLTS

POWER DIVIDER BRACKET & PHASING CONFIGURATION DETAIL

ELECTRONICS RESEARCH, INC.
Established 1943
7777 GARDNER RD.
CHANDLER, IN. 47610-9657
PHONE (812) 925-6000
FAX: (812) 925-4026

NO	REVISION	APP'D	DATE
1	ADDED BAY ... 177 ½"		9/12/03
2	[illegible]		[illegible]
3			
4			
5			
6			

NAME: INSTALLATION DRAWING
MOUNTAIN, WI.
PROJECT NO.: 0860?1
PATH: G:\DRAFTING\ALL PROJECTS\...
DATE: 9/3/03 DRAWN: BAW
SCALE: NON-APPLICABLE
DWG. NO.: 1A — 1

A-2 ERI Antenna Specification Sheet

Rib Mountain: Wausau, Wisconsin

General Specifications

Antenna Type . . . . . .High Power FM-Broadcast, Suitable For Diplexing
Model Number 1083-10CP
Number Of Bay Levels . . . . . Ten
Polarization . . . . . Right Hand Circular

Electrical Specifications

Antenna Input Power Capability (Dual Feed) . . . . . 64 KW Max (1)
Operating Frequency Band . . . . . 90.9,95.5 & 101.9 Megahertz.
VSWR. . . . . 1.1:1 @ Operating Frequencies(2)
Azimuthal Pattern Circularity . . . . . Less Than +/- 1.5 dB From RMS (Free Space)
Power Split . . . . . 50/50 (Horizontal & Vertical)
Quarter Wave Shorting Stub . . . . . None

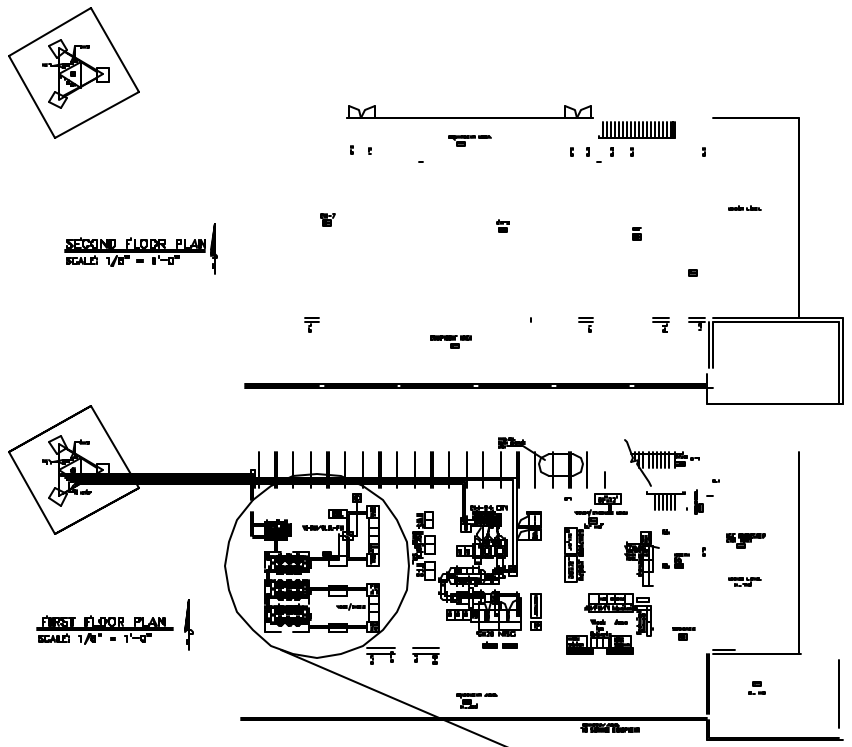
Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
90.9	**82 (KW)**	**.5°**	**9 %**	**1%**	**3.965**	**.372 dB**	**.186 dB**	**23.5 (KW)**
95.5	**100 (KW)**	**.5°**	**10 %**	**1%**	**4.128**	**.380 dB**	**.176 dB**	**27.5 (KW)**
101.9	**100 (KW)**	**.5°**	**10 %**	**2%**	**4.345**	**.393 dB**	**.175 dB**	**26.2 (KW)**

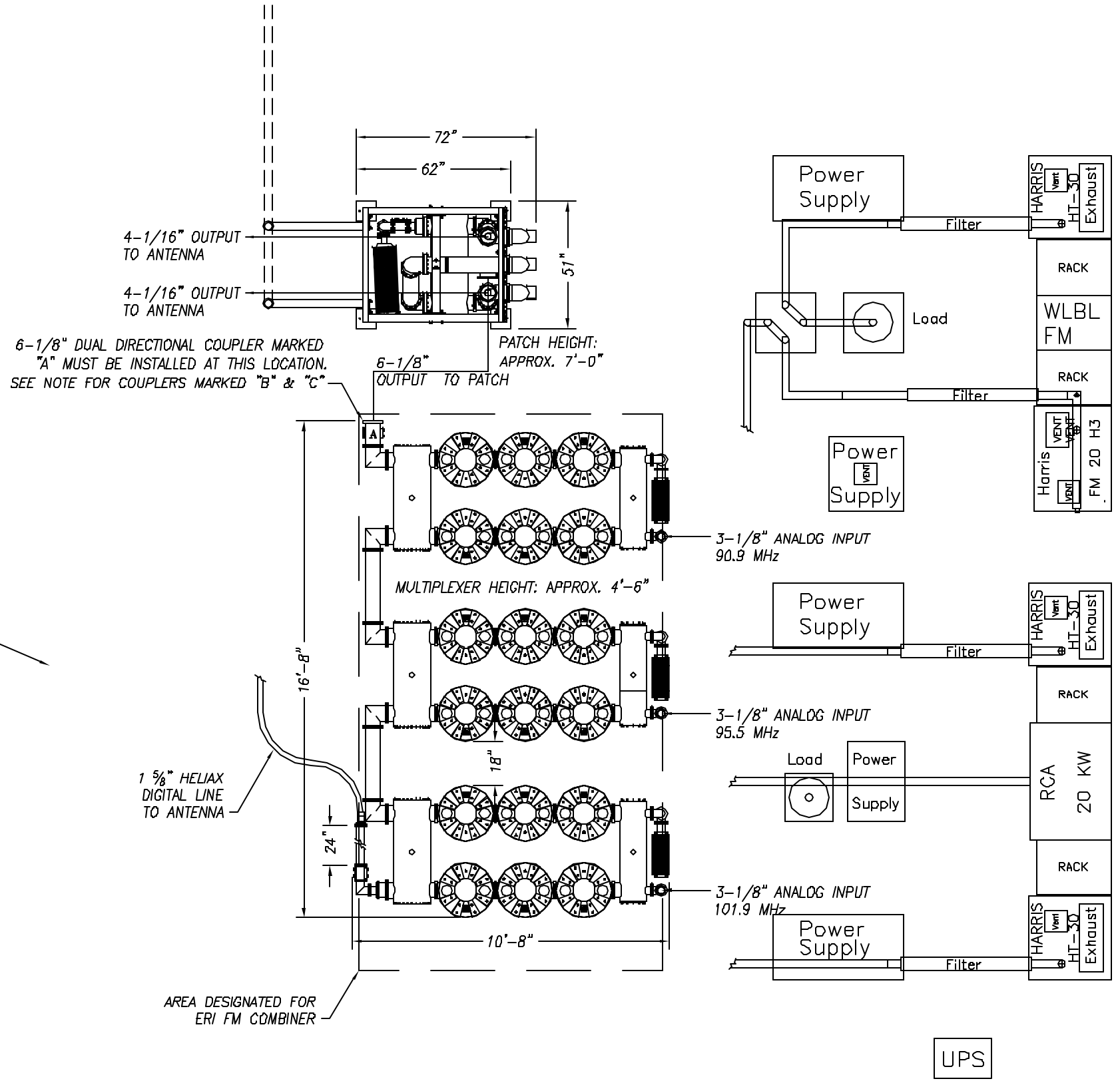
Mechanical Specifications

Antenna Feed System . . . . . Fed with Dual Lines
Input Connector . . . . . . 6 1/8" 50- Ohm EIA Flanged
Element Deicing . . . . . None Ordered (5)
Interbay Spacing . . . . . 92" Center to Center
Array Length . . . . . Approximately 76' 8"
Construction Material (Antenna) . . . . . All Noncorrosive
Construction Material (Mounting) . . . . . Galvanized Plated and Stainless Steel

1) Power Capability Has Been Rated Assuming An Operating Transmission VSWR Of 1.5:1
2) VSWR Specification Achieved After On Site Tuning For User Specific Frequencies.
3) Line Loss Assumes 2 Feed Runs Of 529 Feet, 4 1/6" Myat Rigid Coax.
4) Losses Taken From Actual Multiplexer Measurements.
5) With Low Q Element Design, Moderate Icing Will Not Cause Appreciable VSWR Rise.



NOTE: 6-1/8" DUAL DIRECTIONAL COUPLERS MARKED "B" & "C" ARE ATTACHED TO 90° ELBOWS ON BACK OF PATCH AT THE OUTPUT PORTS. "B" & "C" COUPLERS ARE CALIBRATED THE SAME AND CAN EACH BE INSTALLED ON EITHER UPPER OR LOWER OUTPUTS



ELECTRONICS RESEARCH, INC.
Established 1942
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4026

NO	REVISION	APP'D	DATE
6			
5			
4			
3	UPDATED		9/03 SND
2	REMOVED SYSTEM DUMP		8/03 SND
1	UPDATED		5/03 SND

NAME: COMBINER ROOM LAYOUT
STATION: RIB MOUNTAIN, WI
FREQUENCY: 90.9, 95.5 & 101.9 MHz PROJECT NO.: 08907
PATH: G:\DRAFTING\ALL\PROJECTS\08907\3
FILE: IM-3 DRAWN: S.DEDM FACTOR: NTS
DATE: 4/15/03 APP'D DWG. NO.
MODEL: 963FD6-CDO-036 IM-3

A-4 ERI Combiner Specification Sheet

RIB MOUNTAIN: Wausau, Wisconsin

General Specifications:

Multiplexer Type . . . . . (3) 963-6 Constant Impedance Combiner
Number Of Combining Units . . . . . Three
Injected Port to Injected Port Isolation . . . . . <-90 dB
Output Connector . . . . . 6 1/8 " 50 Ohm EIA (Flanged)
Output Power (Designed) . . . . . 80 KW(1)
Combiner Units, Size and Weight :

Type 963-6 Tuned To 90.9 MHz.	4.5' ht. X 54" wd. X 9.6' lg. & 1250 Lbs.
Type 963-6 Tuned To 95.5 MHz.	4.5' ht. X 54" wd. X 9.6' lg. & 1250 Lbs.
Type 963-6 Tuned To 101.9 MHz.	4.5' ht. X 54" wd. X 9.6' lg. & 1250 Lbs.

Heat Removal (All Multiplexer Components) . . . . . Natural Convection
Physical Arrangement . . . . . All Components Floor Standing

Injected Port Specifications:

Frequency Assignment . . . . . 90.9, 95.5 and 101.9 MHz.
Power Rating, Each Injected Port (Designed) . . . . . 30 KW
Input Connector . . . . . 3-1/8" 50 Ohm EIA (Flanged)
VSWR . . . . . Less than 1.1:1 @ +/-200 KHz(2
Group Delay . . . . . Less than 50 ns Overall Variation, Carrier @ +/- 150 KHz
Insertion Loss (Measured):

90.9 MHz.	- 0.186 dB
95.5 MHz.	- 0.176 dB
101.9 MHz.	- 0.175 dB

1) Power Rating Listed is as Designed Only. Actual Power Capabilities May Vary.
2) When Terminated in 50 Ohm Resistive Load.

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

FIGURE 6.38

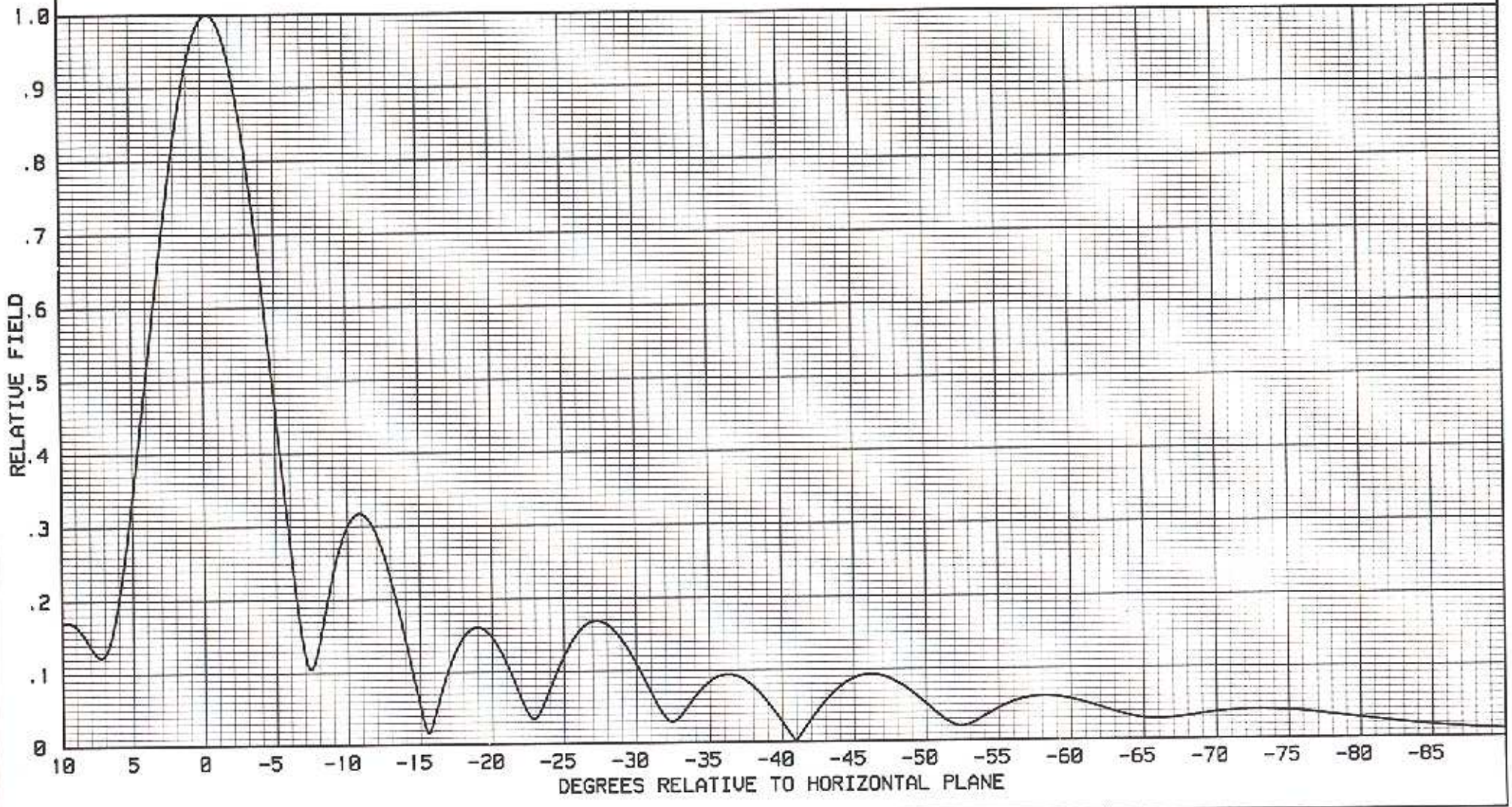
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

10 LEVELS OF TYPE 1080 ELEMENTS
-.50 DEGREE(S) BEAM TILT
11 PERCENT FIRST NULL FILL
2 PERCENT SECOND NULL FILL

JULY 11, 2000

101.9 MHz

BAY SPACING
92.00 INCHES
(.7943 WAVELENGTH)



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

FIGURE 6.2B

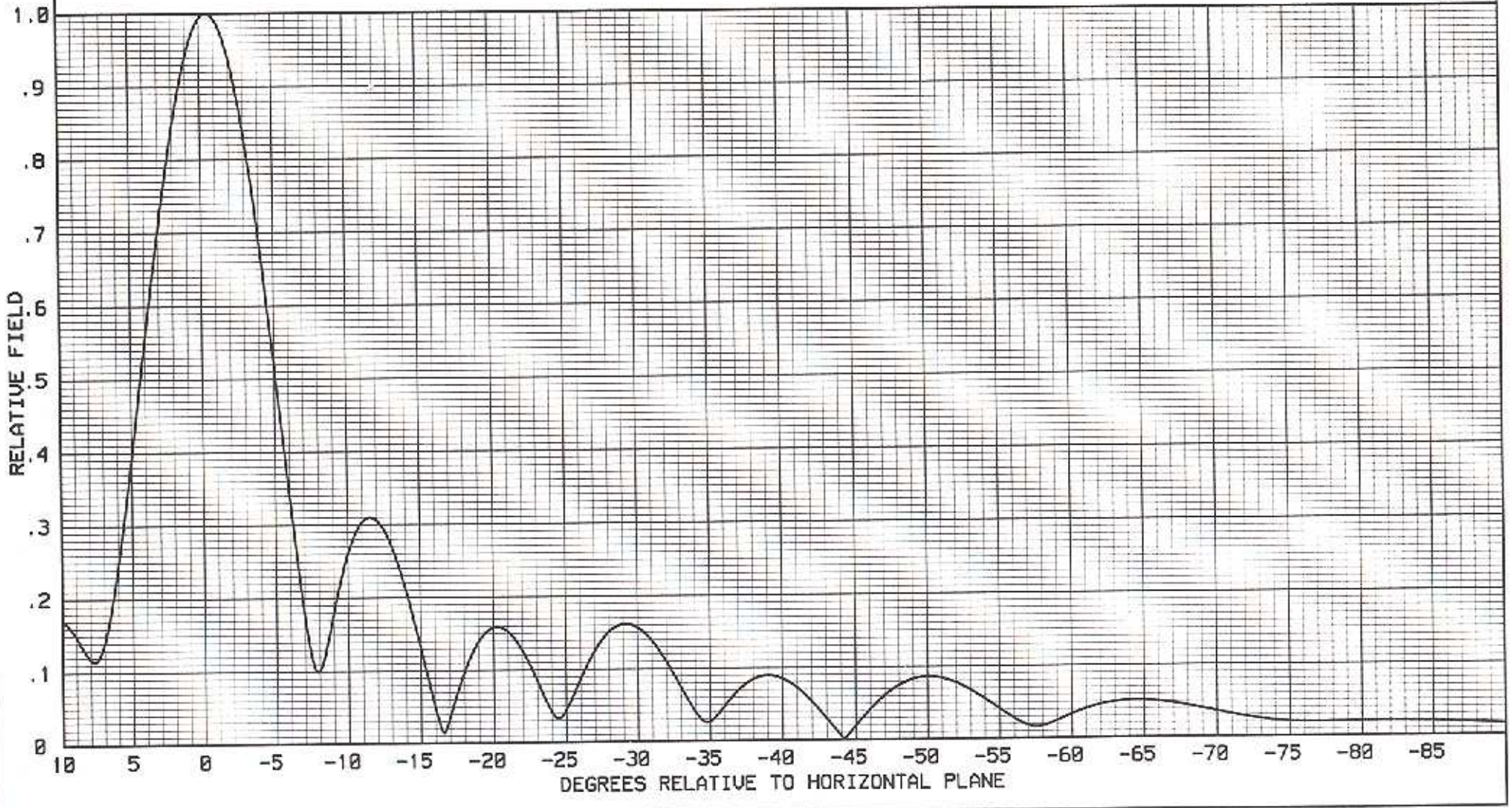
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

10 LEVELS OF TYPE 1080 ELEMENTS
-.50 DEGREE(S) BEAM TILT
10 PERCENT FIRST NULL FILL
1 PERCENT SECOND NULL FILL

JULY 11, 2000

95.5 MHz

BAY SPACING
92.00 INCHES
(.7444 WAVELENGTH)



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

FIGURE 6.18

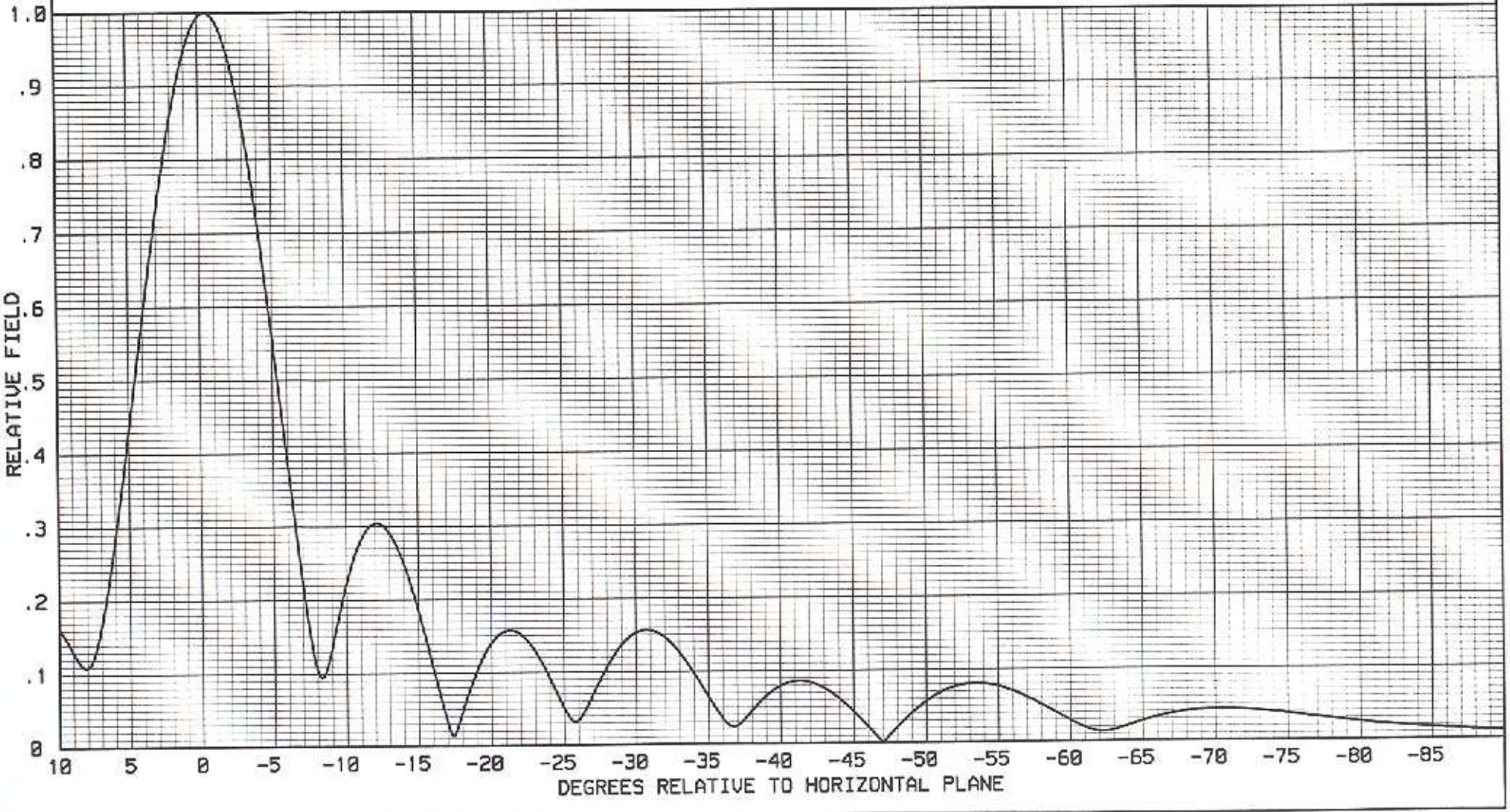
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

10 LEVELS OF TYPE 1080 ELEMENTS
-.50 DEGREE(S) BEAM TILT
9 PERCENT FIRST NULL FILL
1 PERCENT SECOND NULL FILL

JULY 11, 2000

90.9 MHz

BAY SPACING
92.00 INCHES
(.7085 WAVELENGTH)



WHRM ~ WIFC ~ WDEZ Broadcasting Scheme EXHIBIT - B1

FM TRANSMITTERS

WHRM 90.9 MHz.
WIFC 95.5 MHz.
WDEZ 101.1 MHz.

COMBINER
ELECTRONICS RESEARCH

963-6 @ 90.9 MHz
963-6 @ 95.5 MHz
963-6 @ 101.9 MHz
(See Exhibit A - 3)

ERI, 6 1/8"
RF Directional Coupler

46 dB Forward RF
Sample

ANTENNA
ELECTRONICS RESEARCH

MODEL 1083-10CP
(See Exhibit A - 1)

Equipment Employed in Intermodulation Measurements
Exhibit B - 2

CALIBRATION SOURCE
1) Potomac Instruments ; Model FIM-71,Field Strength Meter
2) Wavetek Inc. ; Model 3000, Frequency Generator

SPECTRUM ANALYZER
Anritsu; Sitemater Model S114B
Spectrum Analyzer

BAND PASS FILTER
PHELPS DODGE
ADJUSTABLE RANGE 76~120 MHz.

Attenuator
(-3 dB)

RF VOLT METER
Potomac Instruments ; Model FIM-71
Field Strength Meter

Note *
All RF Connecting Cable Used In
Measurement Setup Is Double Shielded.

Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B