



ELECTRONICS RESEARCH, INC.

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Report Of Intermodulation Product Findings

*WNOU, WFMS BROADCAST FACILITY
INDIANAPOLIS, INDIANA*

December 2002

**Electronics Research Inc.
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TABLE OF CONTENTS

Indianapolis, Indiana

Report of Findings for Intermodulation Product Measurements

Page 1	Introduction
Page 3	Carrier Reference Levels
Page 3	Table of Second order Products Expected
Page 4	Intermodulation Product Measurements
Page 5	Conclusion
Page 6	Affidavit

Exhibits Accompanying This Report

EXHIBIT A	Antenna and Combiner Specification Sheet and Drawing
A-1	Drawing Depicting Antenna
A-2	ERI Antenna Specification Sheet
A-3	Drawing Depicting Combiner Module
A-4	ERI Combiner Specification Sheet
A-5	Theoretical Vertical Plane Relative Field Antenna Plots
EXHIBIT B-1	Intermodulation Product Measurement Equipment Layout
B-2	Broadcasting Scheme of the Multiplexed System

REPORT OF FINDINGS
BURK ROAD BROADCAST FACILITY
INDIANAPOLIS, INDIANA
December 15, 2002

Introduction : This report of findings is based on data collected at the Burk Road FM broadcast facility located in Indianapolis, IN. The report includes measurements offered as proof that the combined operations of WNOU (93.1 MHz.) and WFMS (95.5 MHz.) 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 second 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). WZPL (99.5 MHz.) operate into separate tower located within 1/4 mile from the WNOU and WFMS combined antenna. Their effects on the stations operating from the multiplexed system has been considered in this report. Mark Steapleton of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on December 15, 2002.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 1083-3CP 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 Second 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 second 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 second 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 : At the time of my measurements two FM stations were operating from the combined antenna system. The WNOU, and WFMS multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The 1083-3CP antenna and 960-6 constant impedance 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 two transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of combiner modules was installed. Specifically, two ERI 960-6 constant impedance combiner modules and four ERI 945 notch filters were installed into the broad port of the combiner to be used as an auxiliary transmitter site for WENS (97.1 MHz.) and WYXB (105.7 MHz.) The complete combiner is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -50 dB. 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 32 dB directivity and a forward signal sample of -41 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 (dB:)	Scale Reading (dB)	Adjusted Level (dB:)	Notes
WNOU (93.1)	10	---	140	-16.8	133.2	
WFMS (95.5)	10	---	140	-14.8	135.2	

Predictable second-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 - Second order Products.

Carrier Frequency (MHz)		
Interfering Frequency (MHz)	WNOU 93.1	WFMS 95.5
WNOU 93.1	---	97.9
WFMS 95.5	90.7	---

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*
86.7	93.1	99.5	10	7.1	20	<-20.0	< 17.1	133.2	< -116.1	
90.7	93.1	95.5	10	6.9	20	-11.9	25.0	133.2	108.2	
91.5	95.5	99.5	10	6.6	20	-16.9	19.7	135.2	115.5	
97.9	95.5	93.1	10	6.2	40	-4.2	52.0	135.2	83.2	1

NOTES

1) Measured signal is a local carrier WGNR transmitting at 97.9 MHz: No discernable signal was measured.

The Spectrum Analyzer was used to check the close- in spectral attenuation of each transmitter operating into the combined antenna system, for 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 analyzer and resulted in no additional investigations.

Conclusion : Based upon my observations and measurements taken December 15th., 2002 as summarized in this document, I, Mark Steapleton, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the WNOU, and WFMS into the 1083-3CP 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 WNOU, and WFMS 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 
Mark Steapleton Field Technician

State of Indiana)
) SS:
County of Warrick)

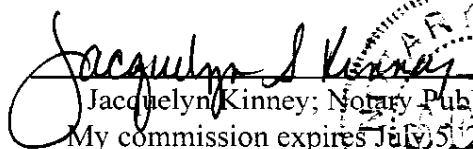
AFFIDAVIT

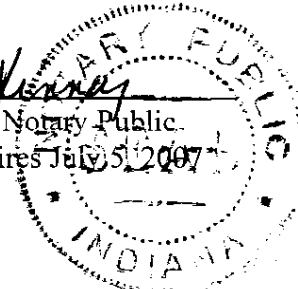
I, Mark Steapleton, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

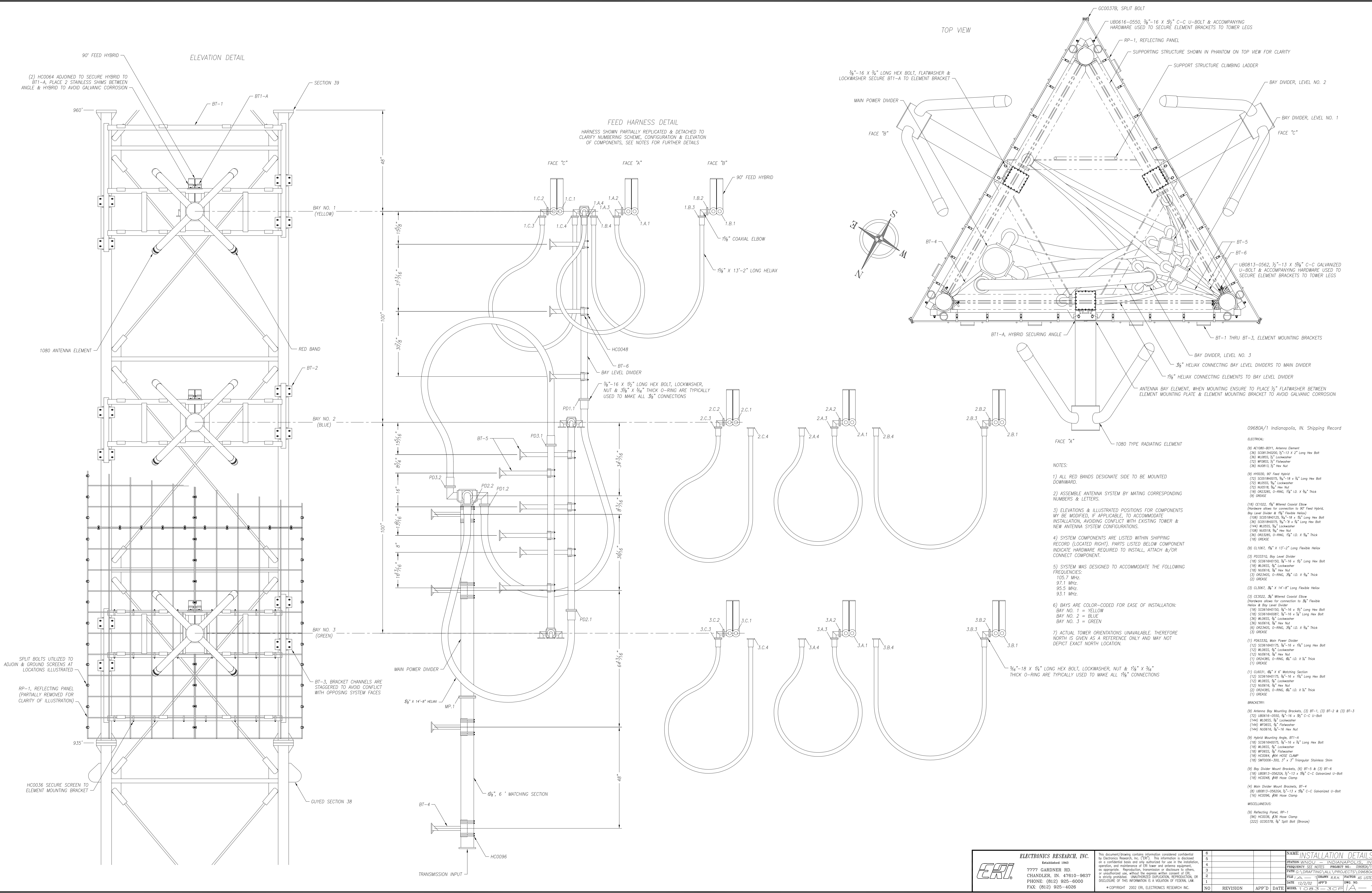
- 1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 22 years. I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Multiplexers in my long tenure with ERI.
- 2.) I have either prepared and/or directly 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 Emmis Communications on behalf of radio Stations WNOU and WFMS in Indianapolis, IN. to prepare this Report Of Findings.


Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 20th. day of December 2002.


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





A-2 ERI Antenna Specification Sheet

INDIANAPOLIS, INDIANA

General Specifications

Antenna Type High Power FM-Broadcast, Suitable For Diplexing
 Model Number 1083-3CP
 Number Of Bay Levels Three
 Polarization Right Hand Circular

Electrical Specifications

Antenna Input Power Capability 90 KW. Maximum ⁽¹⁾
 Operating Frequency Band 93.1 And 95.5 Megahertz.
 VSWR 1.15 : 1 @ Operating Frequencies. ⁽²⁾
 Azimuthal Pattern Circularity +/- 2dB From RMS (Free Space)
 Power Split 50/50 (Horizontal & Vertical)
 Quarter Wave Shorting Stub NA
 Frequency Specific Information:

<u>Frequency</u>	<u>Station ERP</u>	<u>Beam Tilt</u>	<u>First Null Fill</u>	<u>Second Null Fill</u>	<u>Power Gain</u>	<u>Line Loss</u> ⁽³⁾	<u>Filter Loss</u> ⁽⁴⁾	<u>Computed TPO</u>
93.1	13.0 (KW)	0.0°	0.0 %	0.0%	1.380	1.236 dB	.271 dB	13.32 (KW)
95.5	13.0 (KW)	0.0°	0.0 %	0.0%	1.406	1.225 dB	.309 dB	13.16 (KW)

Mechanical Specifications

Antenna Feed System Fed With Single Feed Line
 Input Connector 6 1/8 " 50- Ohm EIA Flanged
 Element Deicing Not Ordered ⁽⁵⁾
 Interbay Spacing 100 Inch Center to Center
 Array Length 26 Feet
 Construction Material (Antenna) All Noncorrosive
 Construction Material (Mounting) Galvanized Plated Steel and Stainless Steel
 Mounting Tower

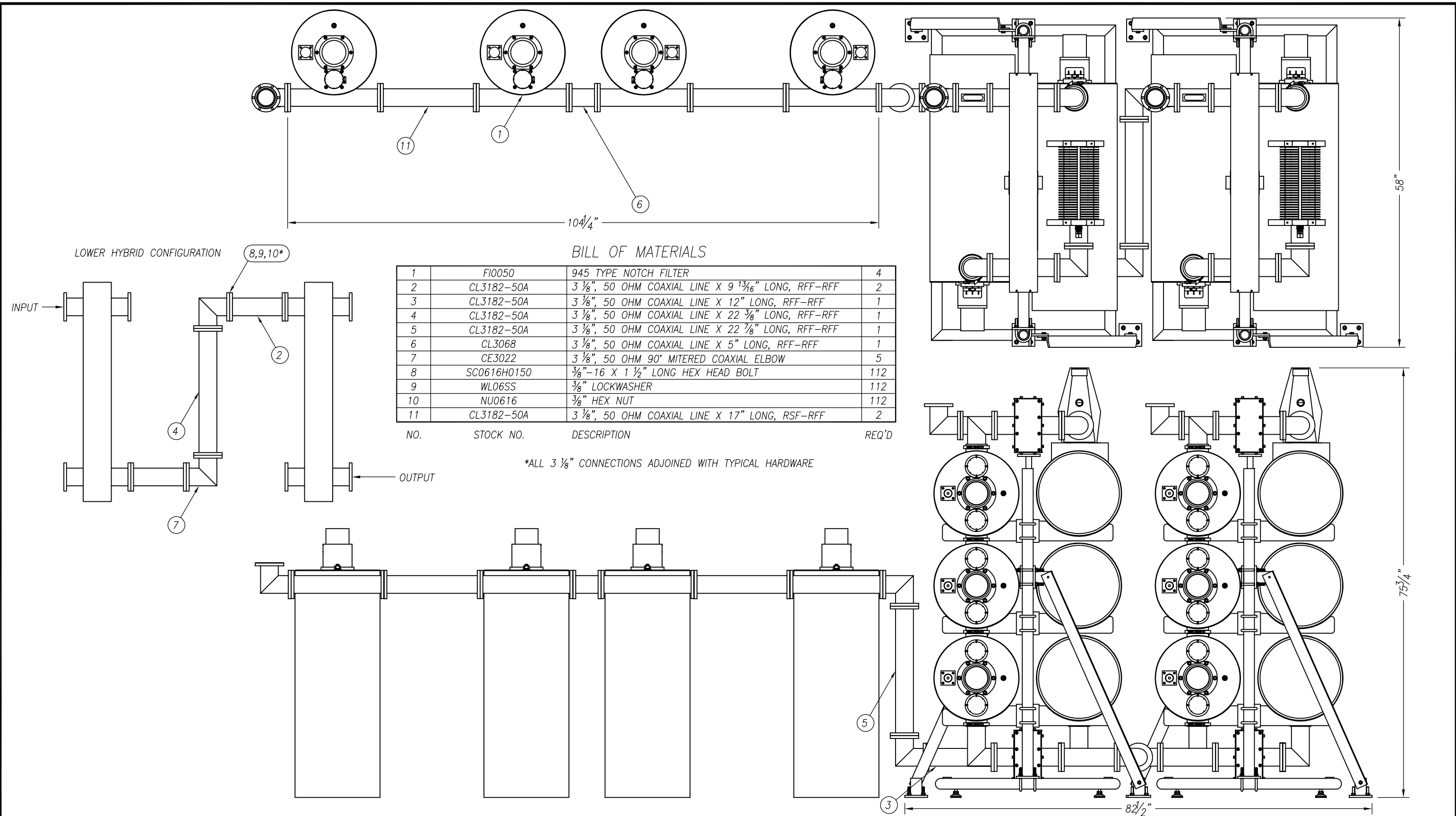
1) Power Capability Has Been Rated Assuming An Operating Transmission VSWR Of 1.5:1

2) VSWR Specification Achieved After On Site Tuning For User Specific Frequencies.

3) Line Loss Assumes A Feed Run Of 965 Feet, 4" Andrew Type HJ11-50 Flex, and 100 Feet, Myat Type 401 Rigid 4 1/16" Coax From The Output Of The Combiner To The Antenna. Each Transmitter Incorporates One (1) 3" Motorized Coax Switch And 3" Rigid Coax Between The Filter And Multiplexer. 60 Feet For 93.1 MHz., And 35 Feet For 95.5 Mhz.

4) Losses Taken From Actual Multiplexer Measurements.

5) With Low Q Element Design, Moderate Icing Will Not Cause Appreciable VSWR Rise.



NOTE: ALL DIMENSIONS GIVEN ARE APPROXIMATE

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NAME **SYSTEM ASSEMBLY**
FOR **09680A - INDIANAPOLIS, IN.**
PATH G:\DRAFTING\ALL\PROJECTS\09680A\2
FILE **M-5** DRAWN **R.R.H.** FACTOR **1/16**
DATE **8/8/02** APP'D **S-M**
MAT'L **N/A** CUT **N/A** ON **DM**

ELECTRONICS RESEARCH, INC.
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CHANDLER, IN. 47610

FIGURE 1

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

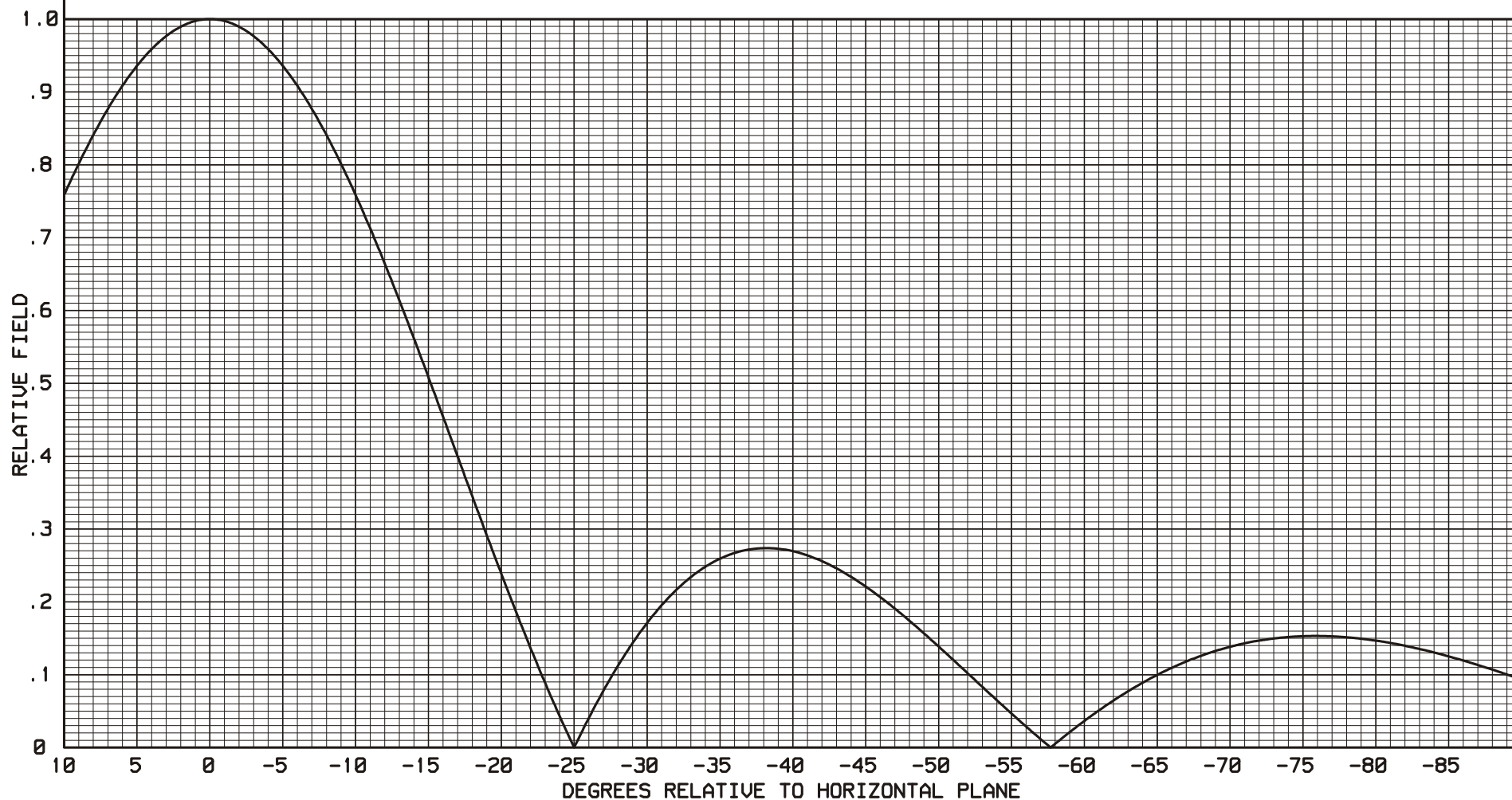
3 LEVELS OF TYPE 1080 ELEMENTS
+0.00 DEGREE(S) BEAM TILT
0 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL

POWER GAIN IS 1.380 IN THE HORIZONTAL PLANE(1.380 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

SEPTEMBER 11, 2002

93.1 MHz.

BAY SPACING:
100.00 INCHES
(.7888 WAVELENGTH)



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FIGURE 2

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

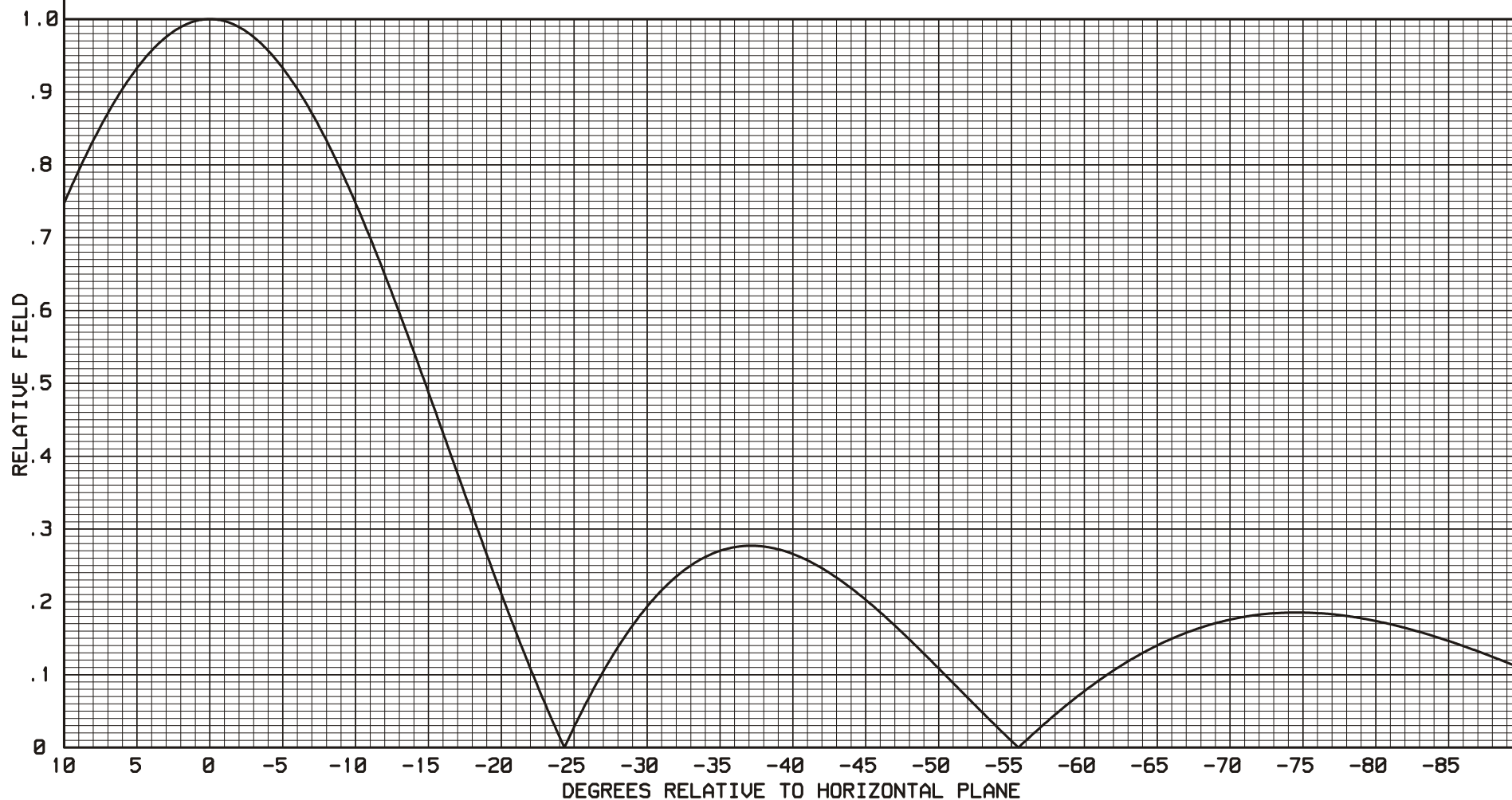
3 LEVELS OF TYPE 1080 ELEMENTS
+0.00 DEGREE(S) BEAM TILT
0 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL

POWER GAIN IS 1.406 IN THE HORIZONTAL PLANE(1.406 IN THE MAX.)
[POWER GAINS AT 95% ANTENNA EFFICIENCY]

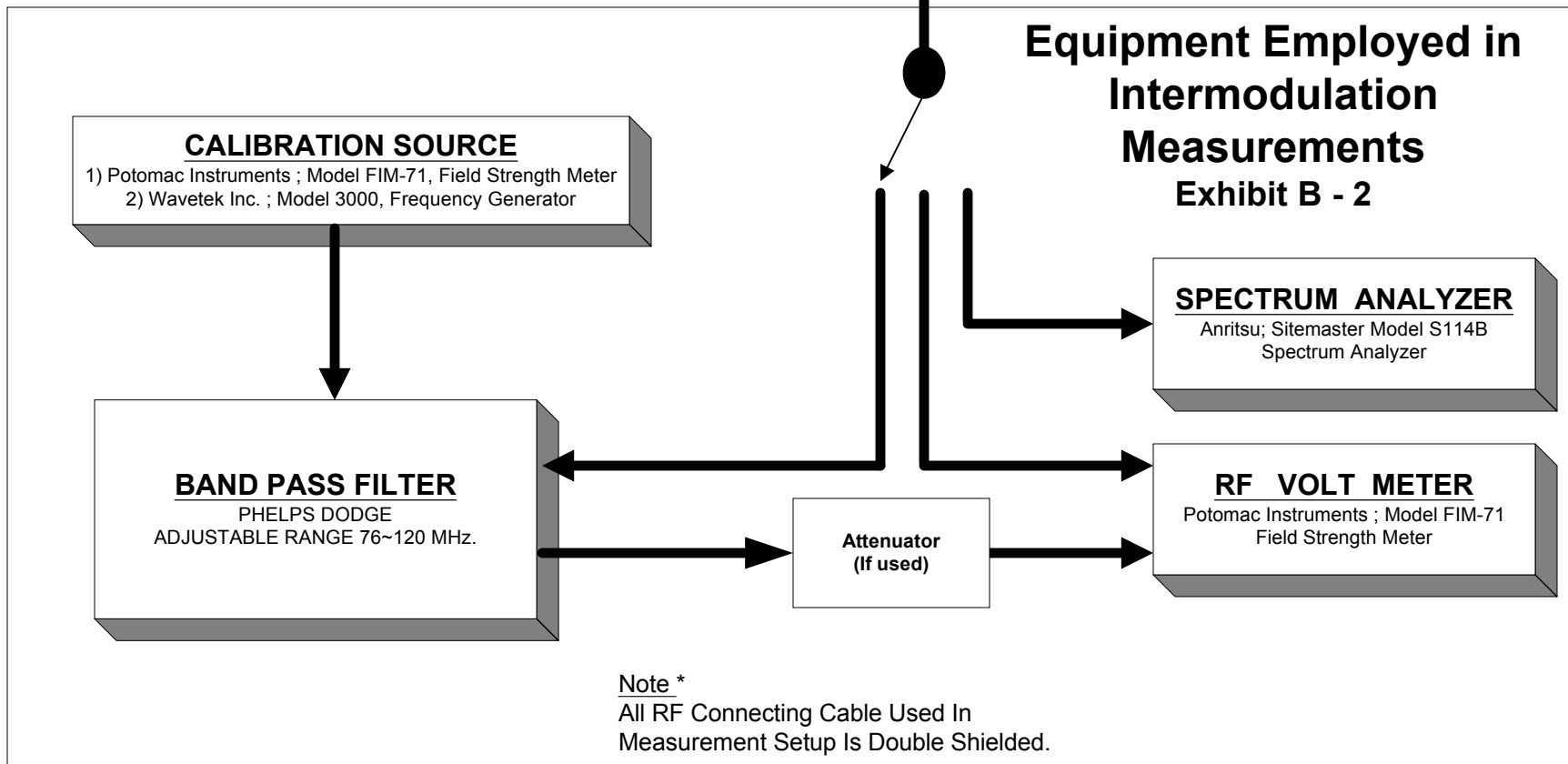
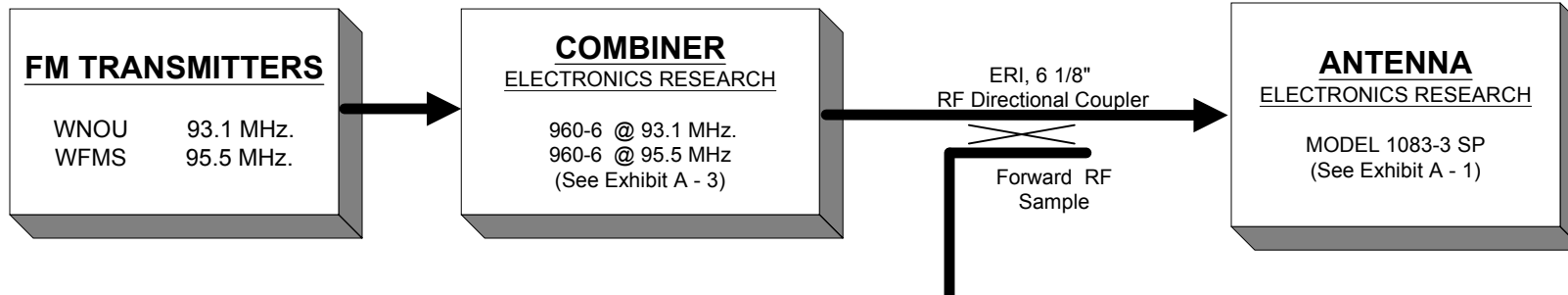
SEPTEMBER 11, 2002

95.5 MHz.

BAY SPACING:
100.00 INCHES
(.8091 WAVELENGTH)



WNOU ~ WFMS Broadcasting Scheme EXHIBIT - B1



Broadcasting Scheme and Equipment Employed in
Intermodulation Measurements

EXHIBIT B