

# Report Of Intermodulation Product Findings

WAPE, WEJZ, WGNE COMBINED BROADCAST FACILITY  
JACKSONVILLE, FLORIDA

WAPE	95.1 MHz
WEJZ	96.1 MHz.
WGNE	99.9 MHz.

MARCH 2005

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# TABLE OF CONTENTS

## Jacksonville, Florida

### Report of Findings for Intermodulation Product Measurements

Page 1 & 2	Introduction
Page 3	Carrier Reference Levels
Page 3	Table of Third Order Products
Page 4	Intermodulation Product Measurements
Page 5	Conclusion
Page 6	Affidavit

### Exhibits Accompanying This Report

<b>EXHIBIT A</b>	Antenna and Filter Specification Sheet and Drawing
A-1	Drawing Depicting Antenna
A-2	ERI Antenna Specification Sheet
A-3	Drawing Depicting Filter System
A-4	ERI Filter Specification Sheet
A-5	Theoretical Vertical Plane Relative Field Antenna Plot
<b>EXHIBIT B-1</b>	Intermodulation Product Measurement Equipment Layout
B-2	Broadcasting Scheme of the System

**REPORT OF FINDINGS**  
**WAPE, WEJZ, WGNE COMBINED BROADCAST FACILITY**  
**JACKSONVILLE, FLORIDA**

**Introduction:** This report of findings is based on data collected at the WAPE, WEJZ and WGNE combined FM broadcast facility located in Jacksonville, FL. The report includes measurements offered as proof that the combined operations of WAPE (95.1 MHz), WEJZ (96.1 MHz) and WGNE (99.9 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). I, Jeff Taylor of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on March 24, 2005.

**The following exhibits are provided:**

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 SHPX-8BC-HW-SP 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 :** All measurements were taken with three FM stations operating from the combined antenna system. The WAPE, WEJZ, and WGNE multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-8BC-HW-SP antenna, 973-8 and 973-6 multiplexer units and MACXLine feedline are products of Electronics Research, Inc. 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 two ERI Model 973-8 and one ERI Model 973-6 Constant impedance combiner modules. The two Model 973-8 modules are forced air cooled while the Model 973-6 module is 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 -65dB. 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 40 dB directivity and a forward signal sample of -60 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 SI 14B 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
WAPE (95.1)	3	-	120	-3	122.7	
WEJZ (96.1)	3	-	120	-7	122.3	
WGNE (99.9)	3	-	120	-3.1	119.9	

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.**

Interfering Frequency MHz	Carrier Frequency MHz.		
	WAPE 95.1	WEJZ 96.1	WGNE 99.9
WAPE 95.1	--	97.1	104.7
WEJZ 96.1	94.1	--	103.7
WGNE 99.9	90.3	92.3	--

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*
90.3	95.1	99.9	3	10.4	20	<-20	13.4	122.7	122.7	
92.3	96.1	99.9	3	10.3	20	<-20	13.3	122.3	122.3	
94.1	95.1	96.1	3	10.1	20	-5.3	27.8	122.7	94.9	
97.1	96.1	95.1	3	10.2	20	-5.6	27.6	122.3	94.7	
103.7	99.9	96.1	3	10.4	20	<-20	13.4	119.9	119.9	
104.7	99.9	95.1	3	10.1	20	<-20	13.1	119.9	119.9	

**\* 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.

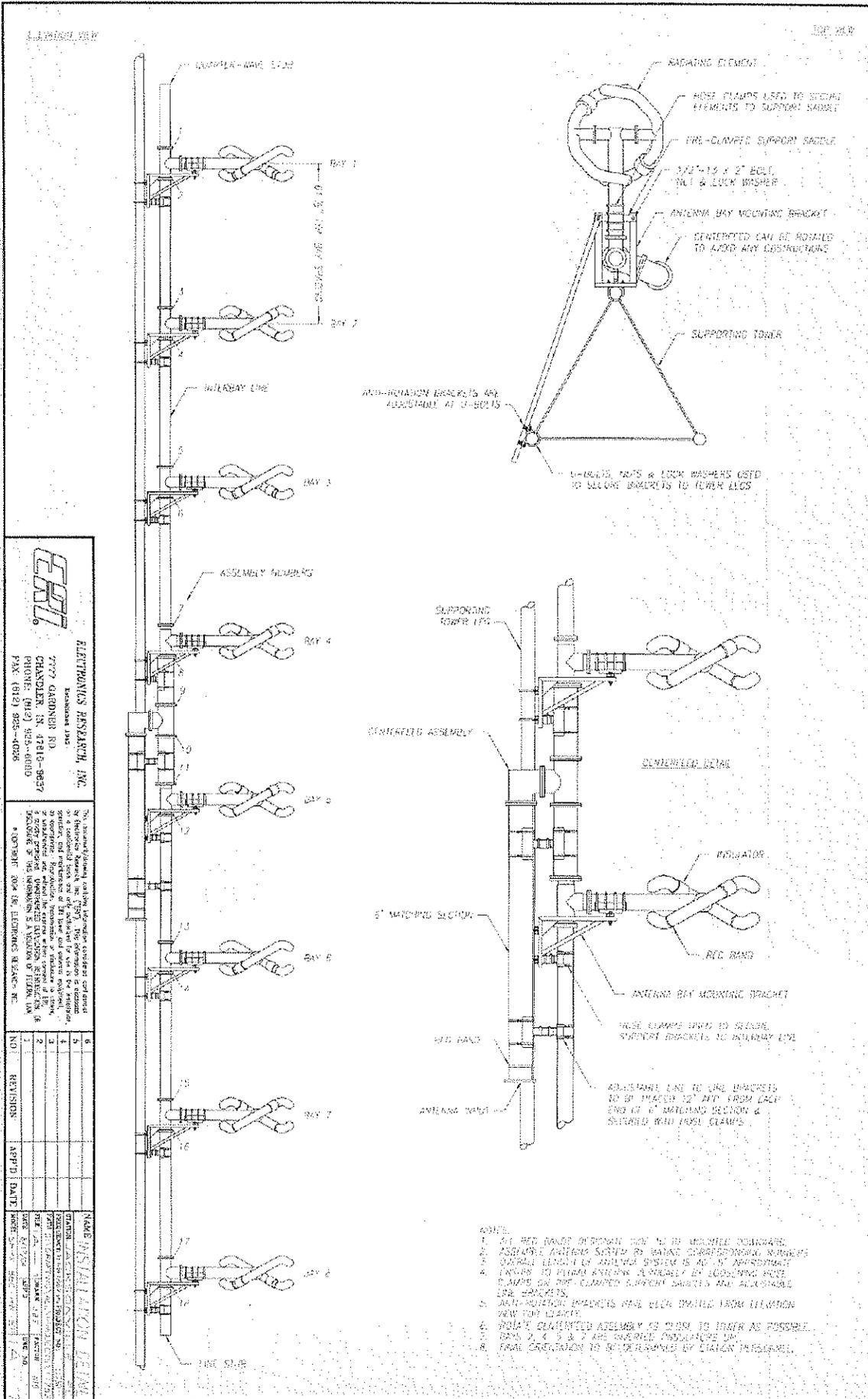
As a final proof of the systems IM Product performance, a wide band search was undertaken using the Spectrum Analyzer. The purpose for this measurement was to look for suspicious anomalies that may warrant further investigation. My search ranged the complete frequency span of the receiver and resulted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

**Conclusion :** Based upon my observations and measurements taken March 24th, 2005 as summarized in this document, I, Jeff Taylor, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the WAPE, WEJZ and WGNE into the SHPX-8BC-HW-SP 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 WAPE, WEJZ and WGNE 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





**ERTL**

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**A-2 ERI Antenna Specification Sheet**  
**JACKSONVILLE, FLORIDA**

**General Specifications**

Antenna Type ..... High Power FM-Broadcast, Suitable For Triplexing  
 Model Number ..... SHPX-8BC-HW-SP  
 Number Of Bay Levels ..... Eight  
 Polarization ..... Right Hand Circular

**Electrical Specifications**

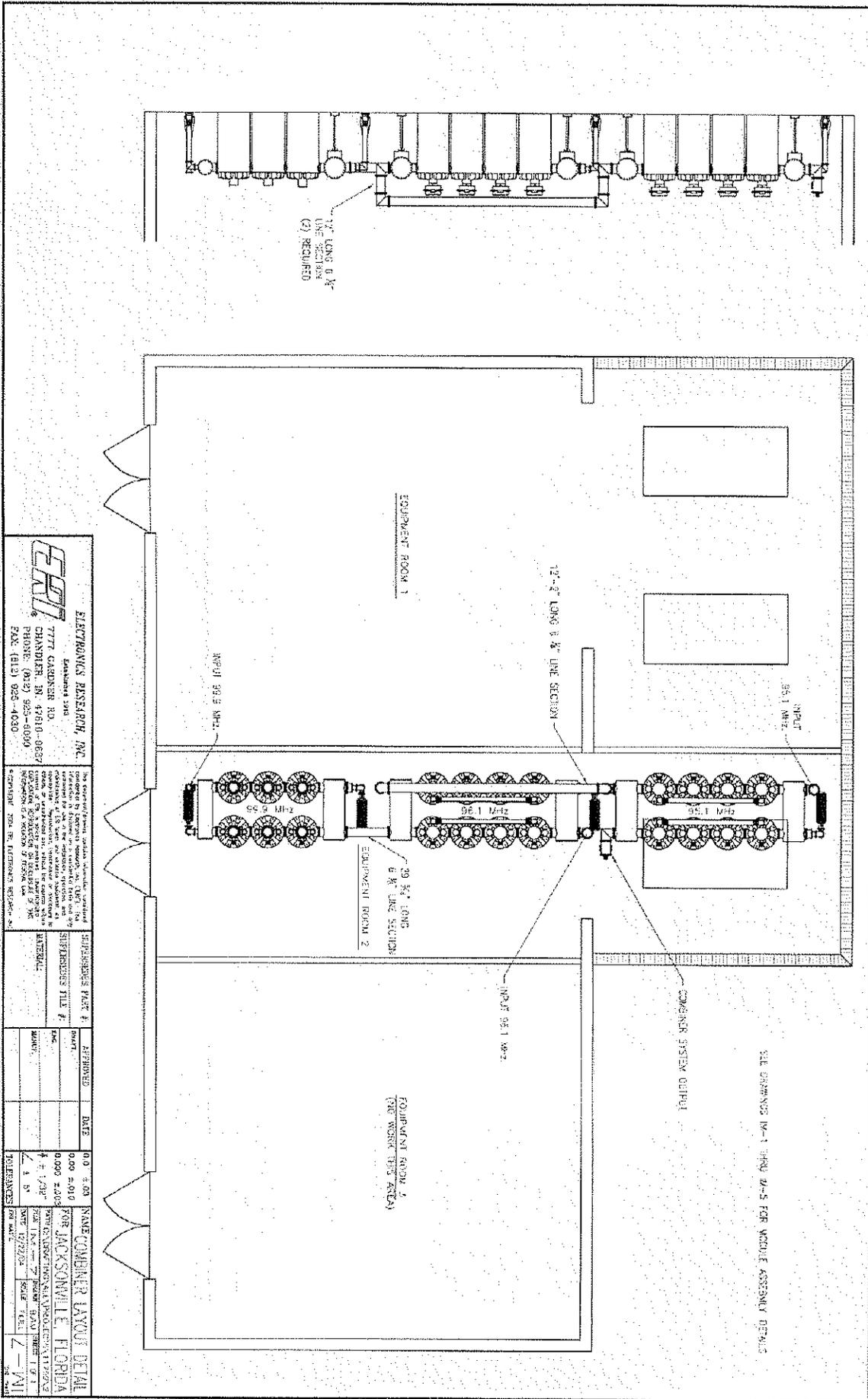
Antenna Input Power Capability (Single Feed) ..... 119 kW Max <sup>(1)</sup>  
 Operating Frequency Band ..... 95.1, 96.1 and 99.9 Megahertz.  
 VSWR ..... 1.15:1 @ Operating Frequencies<sup>(2)</sup>  
 Azimuthal Pattern Circularity ..... Less Than +/- 1.5 dB From RMS (Free Space)  
 Power Split ..... 50/50 ( Horizontal & Vertical )  
 Quarter Wave Shorting Stub ..... Yes  
 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<sup>(3)</sup></u>	<u>Filter Loss<sup>(4)</sup></u>	<u>Computed TPO</u>
95.1	100 (KW)	0.0°	1 %	0%	2.506	.486 dB	.211 dB	46.8 (KW)
96.1	100 (KW)	0.0°	1 %	0%	2.530	.496 dB	.310 dB	47.5 (KW)
99.9	48 (KW)	0.0°	11 %	0%	2.564	.507 dB	.216 dB	22.1 (KW)

**Mechanical Specifications**

Antenna Feed System ..... Fed with Single Line  
 Input Connector ..... 6 1/8" 50 - Ohm EIA Flanged  
 Element Deicing ..... None Ordered  
 Interbay Spacing ..... 61.5" Center to Center  
 Array Length ..... Approximately 40.9'  
 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 A Feed Run of 1034.9 Feet, 6 1/8" ERI MACXLine 650-11 (Rigid).  
 4) Losses Taken From Actual Multiplexer Measurements.



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By order of the undersigned, I hereby certify that the information furnished herein is true and correct to the best of my knowledge and belief, and that I am duly qualified to give such information.

\_\_\_\_\_  
 MEMBER OF THE BOARD OF DIRECTORS

APPROVED	DATE	NAME	COMPANY
_____ SHEPHERD'S MARK #1	0.0 ± 0.0	MR. JACKSONVILLE	FLORIDA
_____ SHEPHERD'S MARK #2	0.000 ± 0.004		
_____ SHEPHERD'S MARK #3	± 1.00"		
_____ SHEPHERD'S MARK #4	± 1.00"		
_____ SHEPHERD'S MARK #5	± 1.00"		
_____ SHEPHERD'S MARK #6	± 1.00"		
_____ SHEPHERD'S MARK #7	± 1.00"		
_____ SHEPHERD'S MARK #8	± 1.00"		
_____ SHEPHERD'S MARK #9	± 1.00"		
_____ SHEPHERD'S MARK #10	± 1.00"		
_____ SHEPHERD'S MARK #11	± 1.00"		
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_____ SHEPHERD'S MARK #15	± 1.00"		
_____ SHEPHERD'S MARK #16	± 1.00"		
_____ SHEPHERD'S MARK #17	± 1.00"		
_____ SHEPHERD'S MARK #18	± 1.00"		
_____ SHEPHERD'S MARK #19	± 1.00"		
_____ SHEPHERD'S MARK #20	± 1.00"		

SEE DRAWINGS M-1 THRU M-5 FOR WOULD ASSEMBLY DETAILS

**A-4 ERI Combiner Specification Sheet**

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**General Specifications:**

Filter Types ..... (2) 973-8 and (1) 973-6 Constant Impedance Combiner  
 Injected Port to Injected Port Isolation ..... <-65 dB  
 Output Connector ..... 6 1/8 " 50 Ohm EIA (Flanged)  
 Output Power (Designed) ..... 119 KW<sup>(1)</sup>  
 Combiner Units, Size and Weight :

Type 973-8 Tuned To 95.1 MHz. .... 54" ht. X 53" wd. X 146" lg. & 1900 Lbs.  
 Type 973-8 Tuned To 96.1 MHz. .... 54" ht. X 53" wd. X 146" lg. & 1900 Lbs.  
 Type 973-6 Tuned To 99.9 MHz. .... 54" ht. X 53" wd. X 108" lg. & 1500 Lbs.

Heat Removal for 95.1 and 96.1 MHz. .... Forced Air Cooling  
 Heat Removal for 99.9 MHz. .... Natural Convection  
 Physical Arrangement ..... All Components Floor Standing

**Injected Port Specifications:**

Frequency Assignment ..... 95.1, 96.1 and 99.9 MHz.  
 Power Rating, Injected Port (Designed) ..... 49 kW for 95.1 and 96.1 MHz.  
 Power Rating, Injected Port (Designed) ..... 24 kW for 99.9 MHz.  
 Input Connector ..... 6-1/8" 50 Ohm EIA (Flanged) for 95.1 and 96.1 MHz.  
 Input Connector ..... 3-1/8" 50 Ohm EIA (Flanged) for 99.9 MHz.  
 VSWR ..... Less than 1.07:1 @ +/-200 KHz<sup>(2)</sup>  
 Group Delay ..... Less than 260 ns Overall Variation, Carrier @ +/- 200 KHz.  
 Insertion Loss (Measured):

95.1 MHz. .... - 0.211 dB  
 96.1 MHz. .... - 0.310 dB  
 99.9 MHz. .... - 0.216 dB

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

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FIGURE 2

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

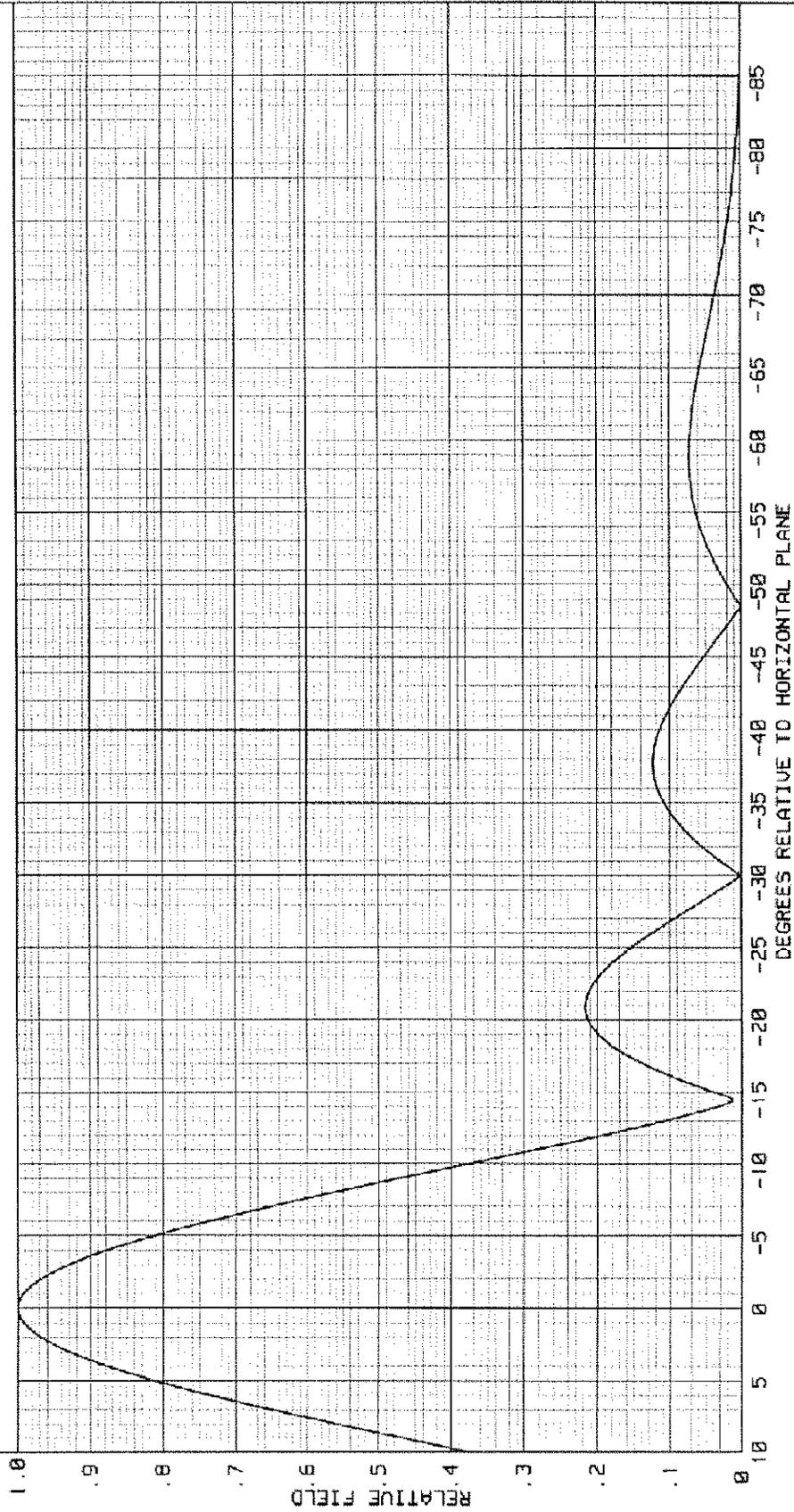
8 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS  
+0.00 DEGREE(S) ELECTRICAL BEAM TILT  
1 PERCENT FIRST NULL FILL  
0 PERCENT SECOND NULL FILL

POWER GAIN IS 2.530 IN THE HORIZONTAL PLANE(2.530 IN THE MAX.)

SEPTEMBER 10, 2003

96.1 MHz.

ELEMENT SPACING:  
61.5 INCHES



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

SEPTEMBER 10, 2003

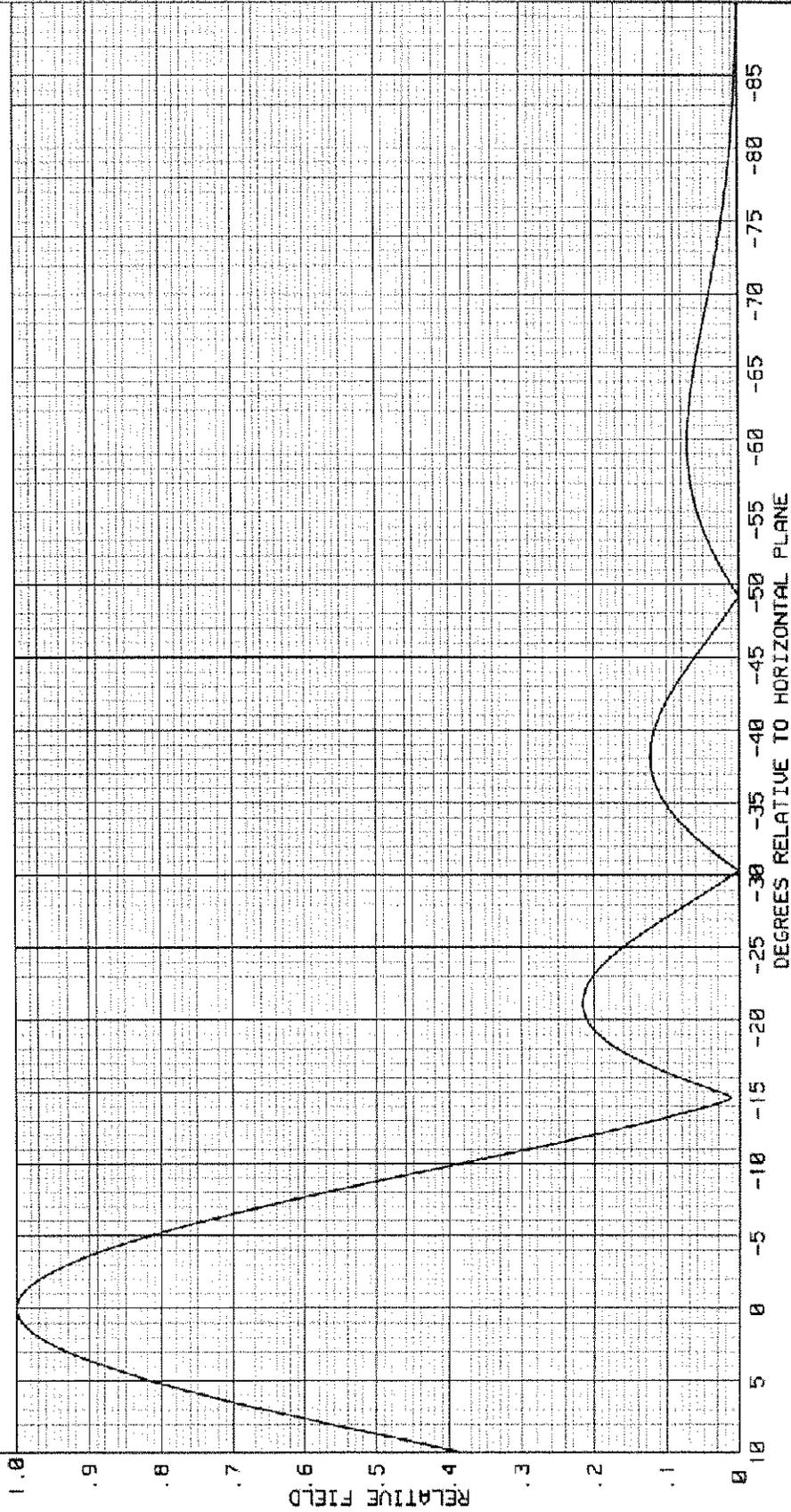
95.1 MHz

ELEMENT SPACING:  
61.5 INCHES

8 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS  
+0.00 DEGREE(S) ELECTRICAL BEAM TILT  
1 PERCENT FIRST NULL FILL  
8 PERCENT SECOND NULL FILL

POWER GAIN IS 2.506 IN THE HORIZONTAL PLANE (2.506 IN THE MAX.)

FIGURE 1



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FIGURE 3

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

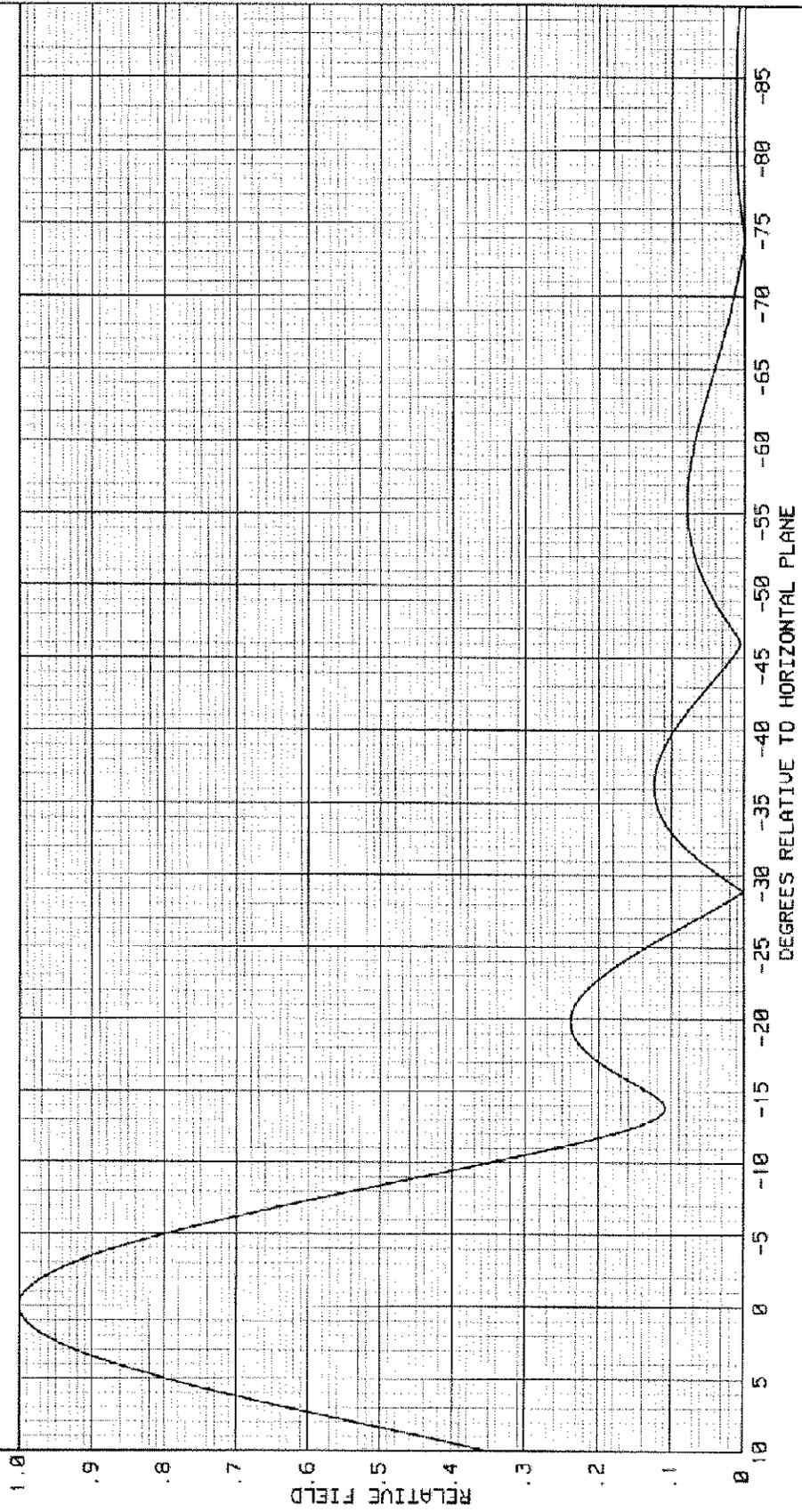
SEPTEMBER 10, 2003

99.9 MHz.

ELEMENT SPACING:  
61.5 INCHES

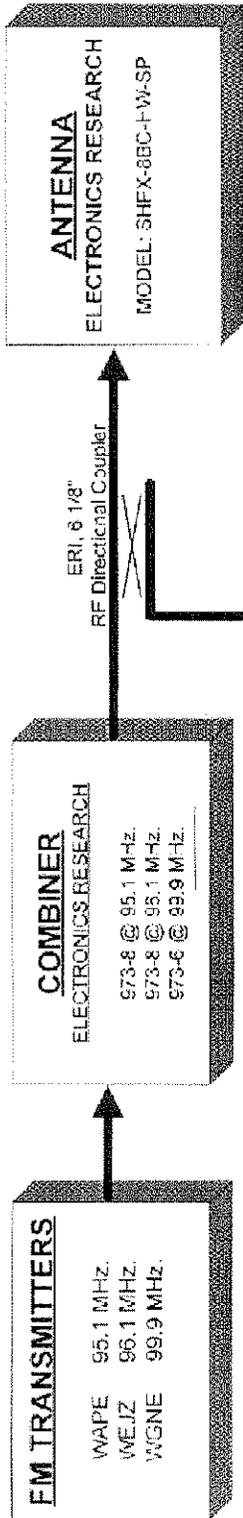
8 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS  
+0.00 DEGREE(S) ELECTRICAL BEAM TILT  
11 PERCENT FIRST NULL FILL  
0 PERCENT SECOND NULL FILL

POWER GAIN IS 2.564 IN THE HORIZONTAL PLANE(2.564 IN THE MAX.)

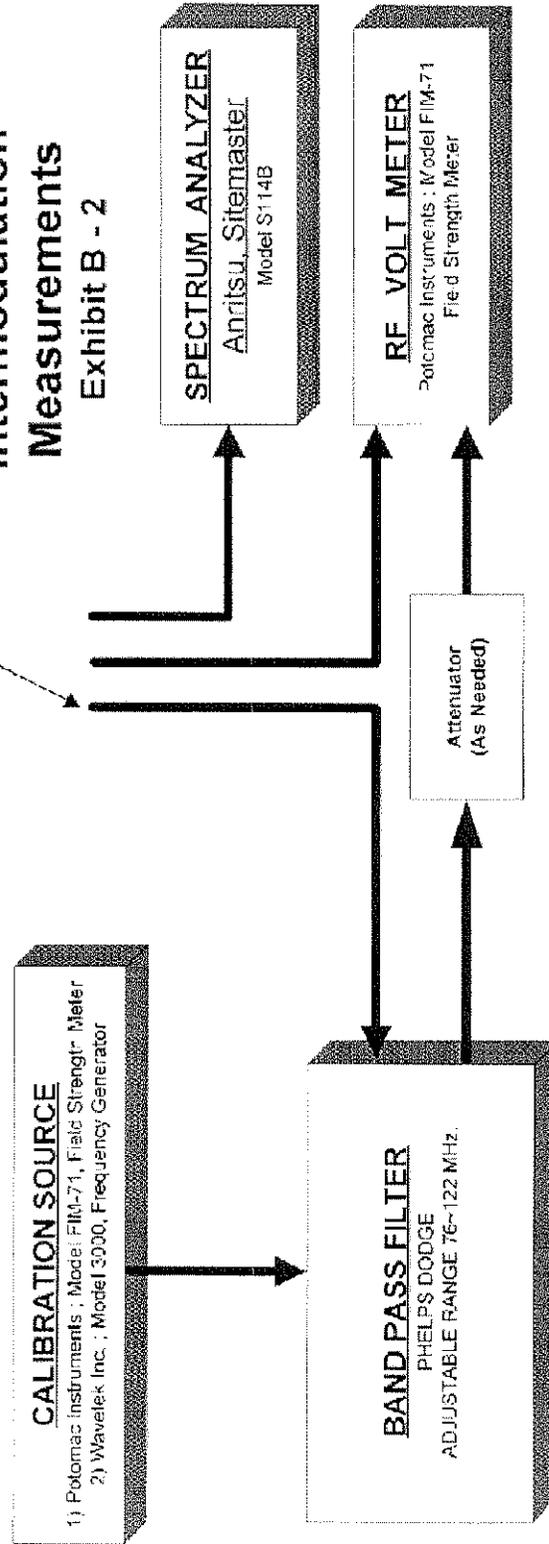


# Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

## Broadcasting Scheme EXHIBIT - B1



## Equipment Employed in Intermodulation Measurements EXHIBIT B - 2



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