



Electronics Research, Inc.

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Report Of Intermodulation Product Findings

*WKDD ~ WZAK
FM BROADCAST FACILITY
AKRON, OHIO*

May 2001

**Electronics Research Inc.
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Akron, Ohio

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REPORT OF FINDINGS WKDD / WZAK BROADCAST FACILITY AKRON, OHIO

Introduction : This report of findings is based on data collected at the WKDD / WZAK FM broadcast facility located near Richfield, OH. This report includes measurements offered as proof that the combined operations of WKDD and WZAK are in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 section 73.317 paragraph (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 (d). Mark Steapleton of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on May 20, 2001.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 SHPX-4AC-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 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, and 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 WKDD and WZAK multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-4AC-SP antenna and TB 63-6/3 multiplexer unit are products of Electronics Research, Inc, whereas the feed line is manufactured by Myat and Andrew Corp, Refer to Exhibit B-2, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a Tee Combiner module was installed. Specifically, the Multiplexer utilizes three ERI Model 963 Bandpass filters for each transmitter. An interconnecting TEE is required to complete the multiplexer module witch is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of - 59dB. 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 Multiplexer 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 -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. 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
WKDD (96.5)	---	---	140	-8.5	131.5	
WZAK (93.1)	---	---	140	-9.8	130.2	

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.

Interfering Frequency (MHz)	Carrier Frequency (MHz)	
	WKDD 96.5	WZAK 93.1
WKDD 96.5	---	89.7
WZAK 93.1	99.9	---

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 *
99.9	96.5	93.1	---	9.0	20	-13.0	16.0	131.5	115.5	
89.7	93.1	96.5	---	10.1	20	- 2.5	27.6	130.2	102.6	

As a final proof of the systems IM Product performance, a wide band search was undertaken using the Potomac FIM71 Detector. The purpose for this measurement was to look for suspicious anomalies that may warrant further investigation. No anomalies were detected and resulted in no additional investigations

Conclusion : Based upon my observations and measurements taken May 20th. 2001 as summarized in this document, I, Mark Steapleton, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the WKDD and WZAK, into the SHPX-4AC-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 WKDD and WZAK are in compliance with the requirements of Section 73.317 paragraph (d) of the FCC Rules and Regulations.

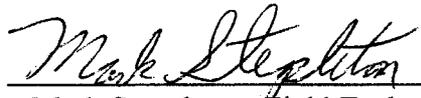
Respectfully submitted,
Electronics Research, Inc.

By Mark Steapleton
Mark Steapleton Field Technician

AFFIDAVIT

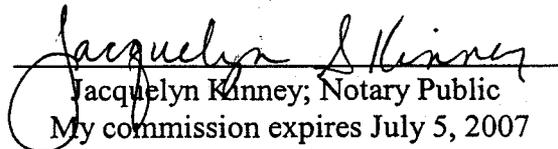
I, Mark Steapleton, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

- 1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 20 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 Clear Channel on behalf of radio Stations WKDD and WZAK in Akron, OH. to prepare this Report Of Findings.

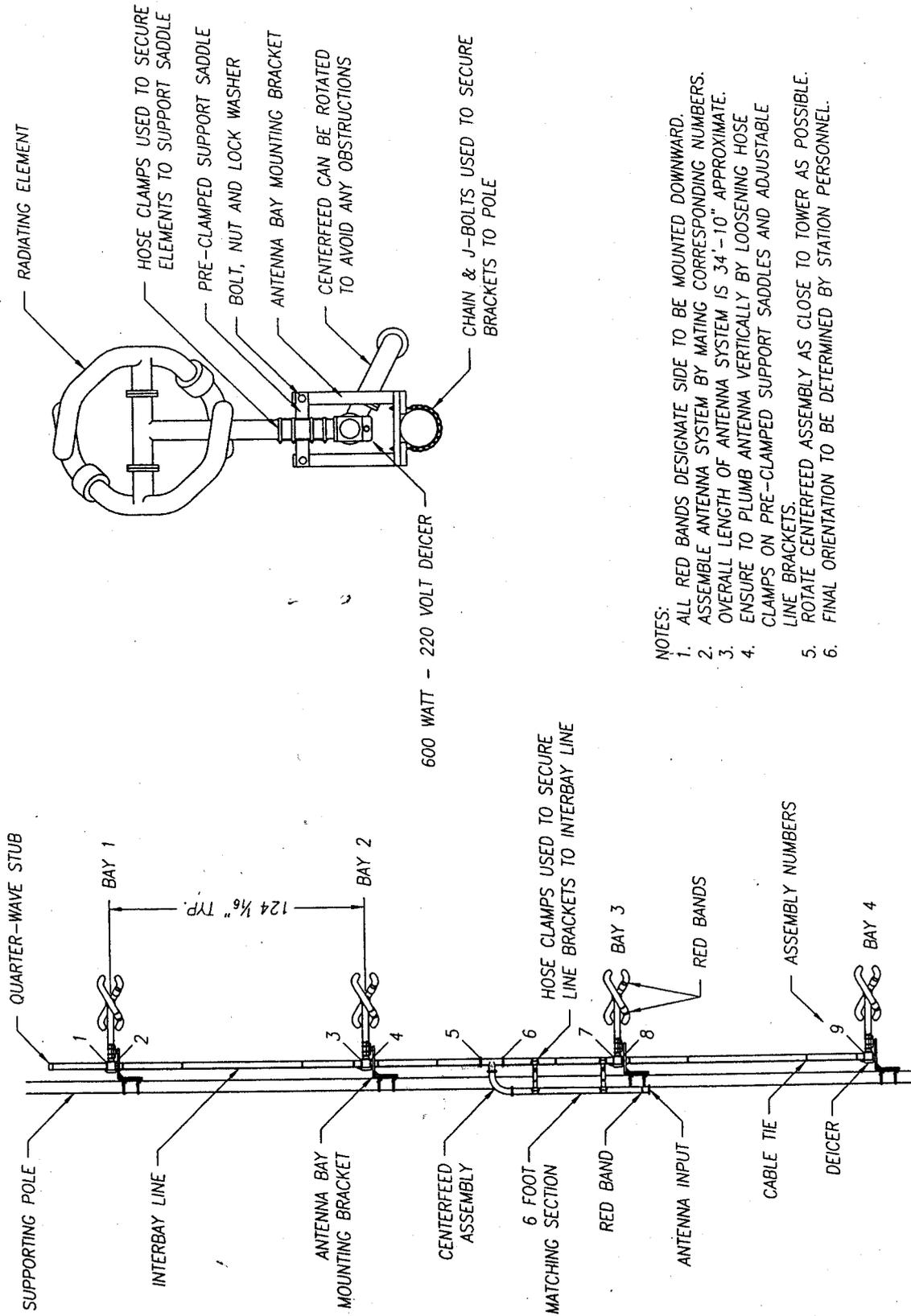


Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 24th. day of May 2001.



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



RADIATING ELEMENT

HOSE CLAMPS USED TO SECURE ELEMENTS TO SUPPORT SADDLE

PRE-CLAMPED SUPPORT SADDLE BOLT, NUT AND LOCK WASHER

ANTENNA BAY MOUNTING BRACKET

CENTERFEED CAN BE ROTATED TO AVOID ANY OBSTRUCTIONS

600 WATT - 220 VOLT DEICER

CHAIN & J-BOLTS USED TO SECURE BRACKETS TO POLE

- NOTES:
1. ALL RED BANDS DESIGNATE SIDE TO BE MOUNTED DOWNWARD.
 2. ASSEMBLE ANTENNA SYSTEM BY MATING CORRESPONDING NUMBERS.
 3. OVERALL LENGTH OF ANTENNA SYSTEM IS 34'-10" APPROXIMATE.
 4. ENSURE TO PLUMB ANTENNA VERTICALLY BY LOOSENING HOSE CLAMPS ON PRE-CLAMPED SUPPORT SADDLES AND ADJUSTABLE LINE BRACKETS.
 5. ROTATE CENTERFEED ASSEMBLY AS CLOSE TO TOWER AS POSSIBLE.
 6. FINAL ORIENTATION TO BE DETERMINED BY STATION PERSONNEL.

NAME		INSTALLATION DRAWING	
STATION:	WZAK	CLEVELAND,	OH.
FREQUENCY:	93.1 & 96.5 MHz	PROJECT NO.:	08536/1
FILE:	G:\DRAFTING\ALL PROJECTS\08536	DATE:	4/26/01
DATE:	4/26/01	APP'D	
MODEL:	SHPX-4AC-SP	FACTOR:	N/S
		DWG. NO.	1A-1

NO	REVISION	APP'D	DATE
6			
5			
4			
3			
2			
1			

This document/drawing contains information considered confidential by Electronics Research, Inc. ("ERI"). This information is disclosed on a confidential basis and only authorized for use in the installation, operation, and maintenance of ERI tower and antenna equipment, as appropriate. Reproduction, transmission or disclosure to others, or unauthorized use, without the express written consent of ERI, is strictly prohibited. UNAUTHORIZED DUPLICATION, REPRODUCTION, OR DISCLOSURE OF THIS INFORMATION IS A VIOLATION OF FEDERAL LAW.

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A-4 ERI Antenna Specification Sheet

WWDD ~ WZAK Akron, Ohio

General Specifications

Antenna Type High Power FM-Broadcast, Suitable For Diplexing
 Model Number SHPX-4AC-SP
 Number Of Bay Levels Four
 Polarization Right Hand Circular

Electrical Specifications

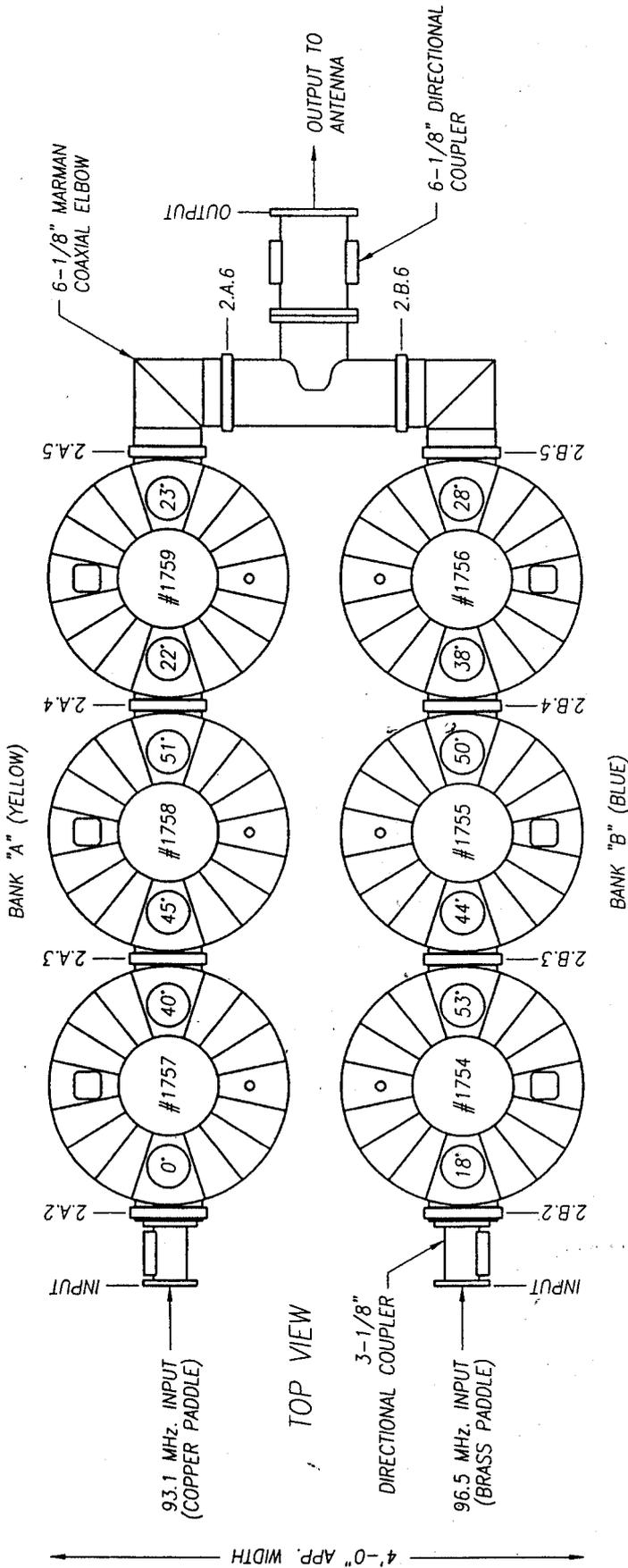
Antenna Input Power Capability 39 KW. Maximum ⁽¹⁾
 Operating Frequency Band 93.1 and 96.5 Megahertz.
 VSWR 1.07 : 1 @ Operating Frequencies.⁽²⁾
 Azimuthal Pattern Circularity +/- 2dB From RMS (Free Space)
 Power Split 50/50 (Horizontal & Vertical)
 Quarter Wave Shorting Stub Yes
 Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain Horizontal	Power Gain Maximum	Line Loss ⁽³⁾	Filter Loss ⁽⁴⁾	Computed TPO
93.1	27.5 KW	-0.0°	4.0 %	0.0%	2.137	2.137	.634 dB ⁽⁵⁾	.156dB	15.44 KW
96.5	31.0 KW	-0.0°	4.0 %	0.0%	2.108	2.108	.528 dB	.128 dB	17.10 KW

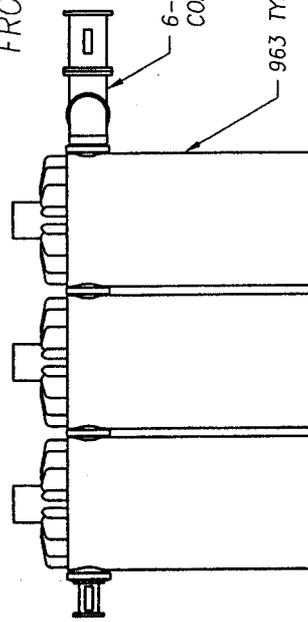
Mechanical Specifications

Antenna Feed System Fed With Single Feed Line
 Input Connector 31/8" 50- Ohm EIA Flanged
 Element Deicing Heaters (600 Watt 240 Volt)
 Interbay Spacing 124.062 Inch Center to Center
 Array Length 34.83 Feet
 Construction Material (Antenna) All Noncorrosive
 Construction Material (Mounting) Stainless Steel
 Mounting Pole Mounted
 Weight (Antenna Only No Ice) 476 Lbs.
 CaAa Wind Load (Antenna Only No Ice) 21.72 sq. ft.⁽⁶⁾

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 120 Feet, Myat Type 301 Rigid 3 18" Coax. and 370 feet Andrew Type HJ11-50 3" Flex Coax.
 4) Losses Taken From Actual Multiplexer Measurements.
 5) Additional Line Loss added for 85 Feet of Andrew Type HJ8-50B between transmitter and input to the combiner.
 6) The surface area is calculated per EIA standard RS-222-F (CaAa)



FRONT VIEW



NOTES:

- 1) ASSEMBLE MODULES BY CORRESPONDING NUMBERS & LETTERS.
- 2) CONNECTIONS ARE DESIGNED BY MODULE NUMBER, BANK LOCATION AND CONNECTION NUMBER. EX. 1.A.1 WOULD BE COMBINER MODULE NO. 1, BANK "A", CONNECTION NO. 1.
- 3) INSURE TO ORIENTATED TUNING PADDLE & TEMPERATURE COMPENSATING DEVICES AS SHOWN TO ALLOW EASE OF SYSTEM MAINTENANCE.
- 4) EACH MODULE BANK IS COLOR-CODED FOR EASE OF INSTALLATION.

NAME TUNING DETAIL	
STATION: WZAK - CLEVELAND, OH.	PROJECT NO: 08536/2
FREQUENCY: AS LISTED	PROJECT NO: 08536/2
PATH G:\DRAWING\ALL\PROJECTS\08536\2	FILE: IMA - 2
DRAWN: BAM	FACTOR: NTS
DATE: 4/18/01	APP'D
MODEL: 963F06-C-U36	DWG. NO. IM-2

NO	REVISION	APP'D	DATE
6			
5			
4			
3			
2			
1			

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A-2 ERI Tee Combiner Specification Sheet

WKDD / WZAK Akron, Ohio

General Specifications:

Multiplexer Type TB 63-6/3 Folded TEE
 Number Of Combining Units Two
 Injected Port to Injected Port Isolation - 58 dB
 Output Connector 6 1/8 " 50 Ohm EIA (Flanged)
 Output Power 60 KW
 Combiner Units, Size and Weight :

Type 963-3 Tuned To 93.1 MHz. 5' ht. X 2' wd. X 9' lng. & 555 Lbs.
 Type 963-3 Tuned To 96.5 MHz 5' ht. X 2' wd. X 9' lng. & 555 Lbs.

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

Injected Port Specifications:

Frequency Assignment 93.1, And 96.5 MHz.
 Power Rating, Each Injected Port (Maximum) 30 KW
 Input Connector 3-1/8" 50 Ohm EIA (Flanged)
 VSWR Less than 1.06:1 @ +/-150 KHz⁽¹⁾
 Group Delay Less than 60 ns Overall Variation, Carrier @ +/- 150 KHz

Insertion Loss (Measured):

93.1 MHz.	- 0.156 dB
96.5 MHz.	- 0.128 dB

Notes:

- 1) When Terminated in 50 Ohm Resistive Load.
- 2) The Combiner room ambient temperature should be maintained between 60 and 70 degrees Fahrenheit.

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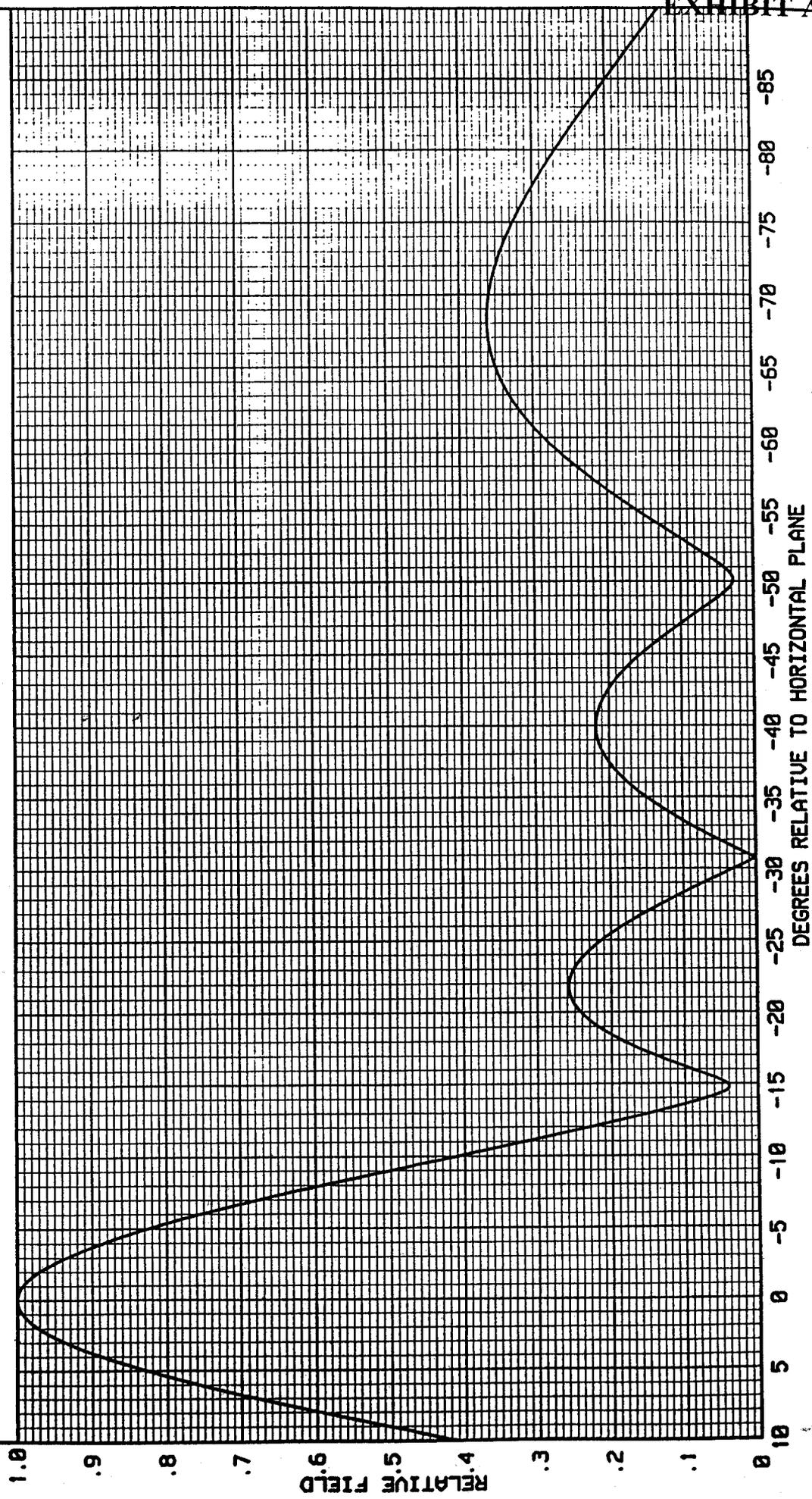
-----THEORETICAL-----
VERTICAL PLANE RELATIVE FIELD

MARCH 12, 2001
93.1 MHz
ELEMENT SPACING
124 INCHES

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

POWER GAIN IS 2.137 IN THE HORIZONTAL PLANE(2.137 IN THE MAX.)

FIGURE 1



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

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

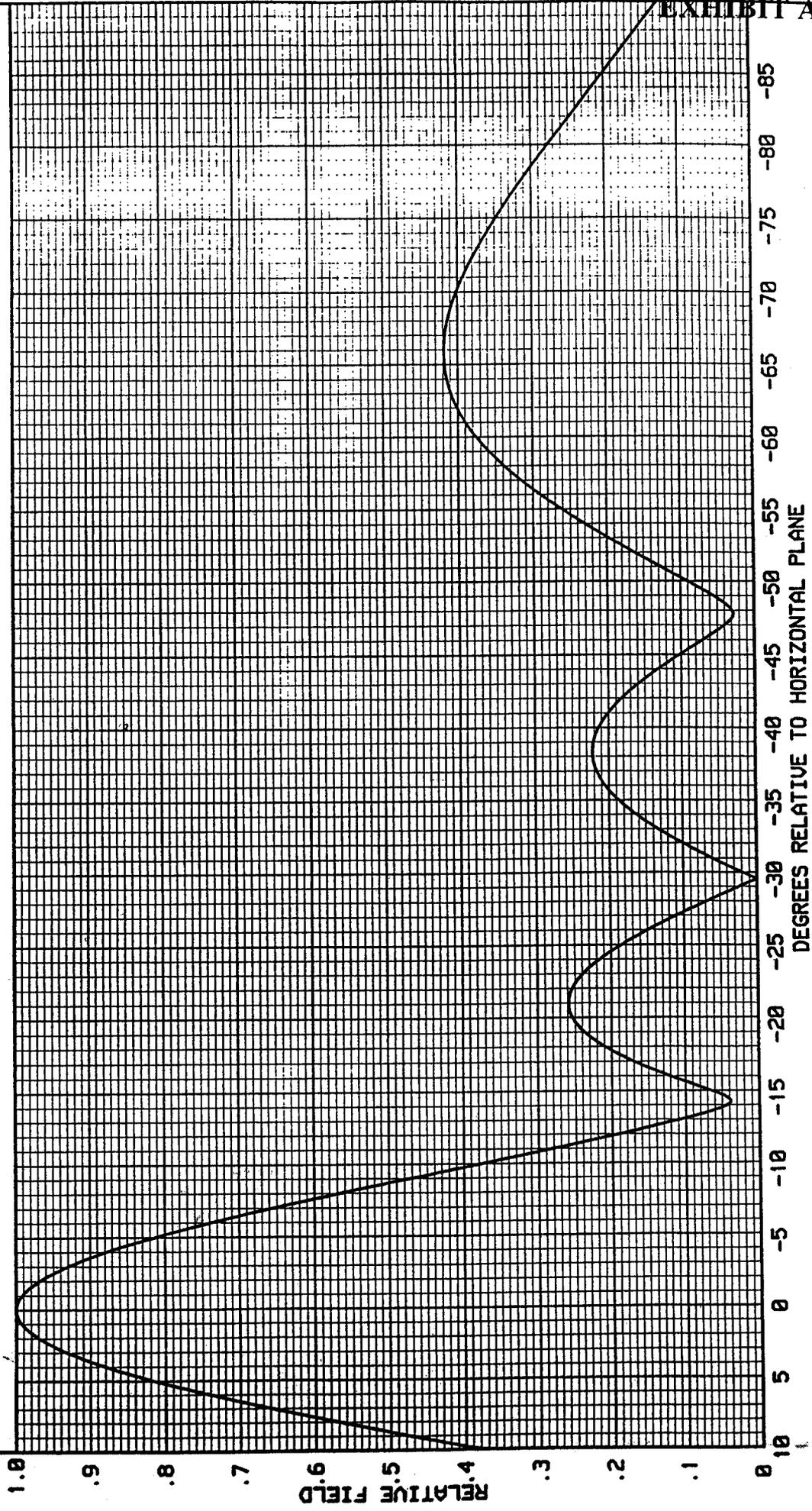
MARCH 12, 2001
96.5 MHz

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

ELEMENT SPACING
124 INCHES

FIGURE 2

POWER GAIN IS 2.108 IN THE HORIZONTAL PLANE(2.108 IN THE MAX.)



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

WKDD ~ WZAK Broadcasting Scheme EXHIBIT B1

ANTENNA
ELECTRONICS RESEARCH
MODEL SHPX-4AC-SP

COMBINER
ELECTRONICS RESEARCH
TB 63-6/3 TEE COMBINER

FM TRANSMITTERS
WKDD 96.5 MHz.
WZAK 93.1 MHz.

ERI, 6 1/8"
RF Directional Coupler

Forward RF
Sample

Equipment Employed in Intermodulation Measurements Exhibit B - 2

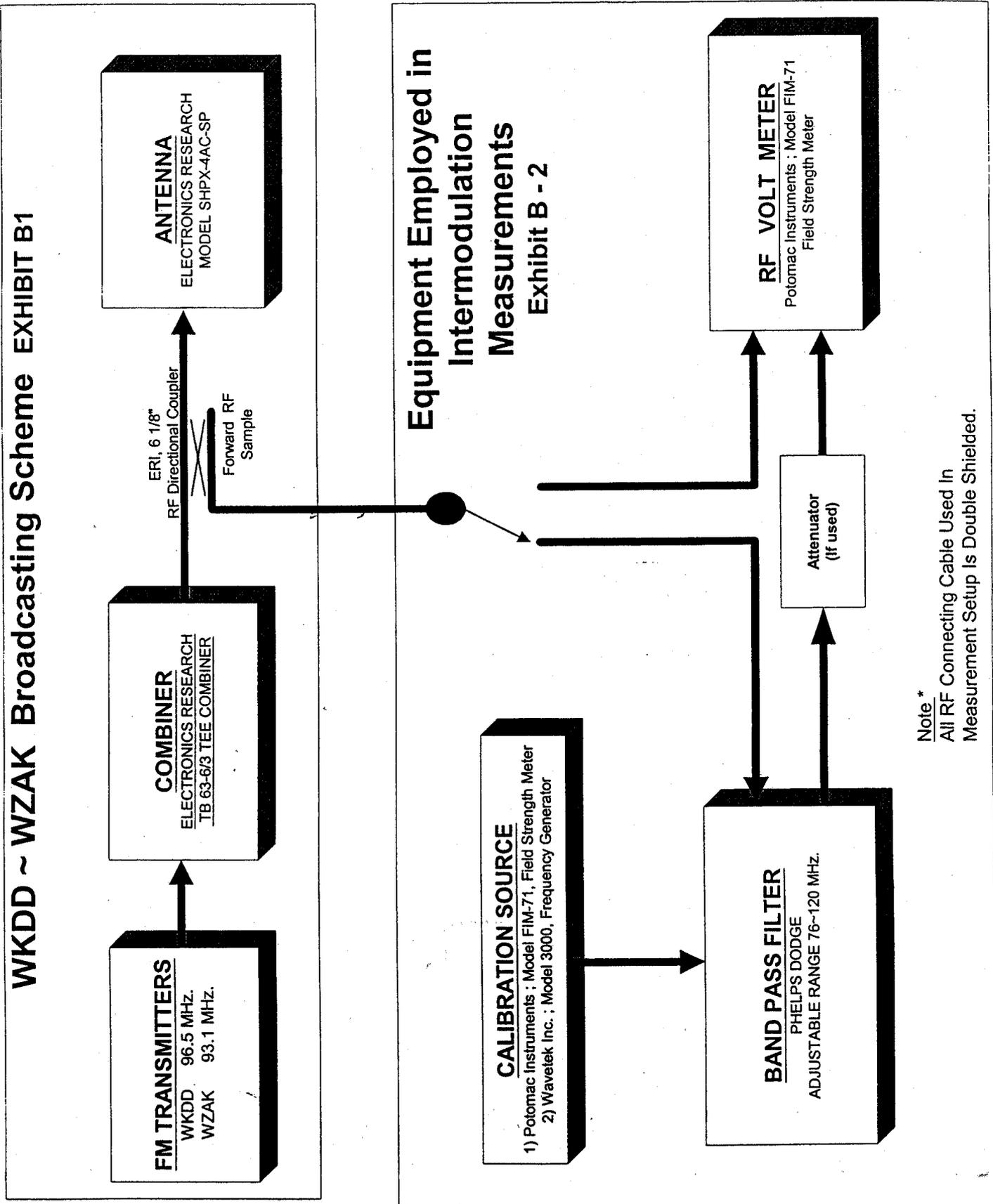
CALIBRATION SOURCE
1) Potomac Instruments ; Model FIM-71, Field Strength Meter
2) Wavetek Inc. ; Model 3000, Frequency Generator

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

Attenuator
(if used)

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

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





United States of America
FEDERAL COMMUNICATIONS COMMISSION
FM BROADCAST STATION CONSTRUCTION PERMIT

Authorizing Official:

Official Mailing Address:

CAPSTAR TX LIMITED PARTNERSHIP
2625 S. MEMORIAL DRIVE, SUITE A
TULSA OK 74129

Edward P. De La Hunt
Assistant Chief
Audio Services Division
Mass Media Bureau

Facility ID: 49952

Grant Date: April 11, 2001

Call Sign: WAKS

This permit expires 3:00 a.m.
local time, 36 months after the
grant date specified above.

Permit File Number: BPH-20001006ABM

Subject to the provisions of the Communications Act of 1934, as amended, subsequent acts and treaties, and all regulations heretofore or hereafter made by this Commission, and further subject to the conditions set forth in this permit, the permittee is hereby authorized to construct the radio transmitting apparatus herein described. Installation and adjustment of equipment not specifically set forth herein shall be in accordance with representations contained in the permittee's application for construction permit except for such modifications as are presently permitted, without application, by the Commission's Rules.

Commission rules which became effective on February 16, 1999, have a bearing on this construction permit. See Report & Order, Streamlining of Mass Media Applications, MM Docket No. 98-43, 13 FCC RCD 23056, Para. 77-90 (November 25, 1998); 63 Fed. Reg. 70039 (December 18, 1998). Pursuant to these rules, this construction permit will be subject to automatic forfeiture unless construction is complete and an application for license to cover is filed prior to expiration. See Section 73.3598.

Equipment and program tests shall be conducted only pursuant to Sections 73.1610 and 73.1620 of the Commission's Rules.

Name of Permittee: CAPSTAR TX LIMITED PARTNERSHIP

Station Location: OH-AKRON

Frequency (MHz): 96.5

Channel: 243

Class: B

Hours of Operation: Unlimited

Transmitter: Type Accepted. See Sections 73.1660, 73.1665 and 73.1670 of the Commission's Rules.

Transmitter output power: As required to achieve authorized ERP.

Antenna type: (directional or non-directional): Non-Directional

Antenna Coordinates: North Latitude: 41 deg 16 min 50 sec
 West Longitude: 81 deg 37 min 22 sec

	Horizontally Polarized Antenna	Vertically Polarized Antenna
Effective radiated power in the Horizontal Plane (kW):	31	31
Height of radiation center above ground (Meters):	135	135
Height of radiation center above mean sea level (Meters):	491	491
Height of radiation center above average terrain (Meters):	189	189

Antenna structure registration number: 1013156

Overall height of antenna structure above ground (including obstruction lighting if any) see the registration for this antenna structure.

Special operating conditions or restrictions:

1 During installation of the antenna authorized herein, AM Station(s) listed below shall determine operating power by the indirect method. Upon completion of the installation, antenna impedance measurements on the AM antenna shall be made and, prior to or simultaneous with the filing of the application for license to cover this permit, the results submitted to the Commission (along with a tower sketch of the installation) in an application for the AM station to return to the direct method of power determination.
 (Revised January 28, 1983)

WTAM(AM), 1100 kHz, Cleveland, OH (Facility ID Number 59595)

2 Prior to construction of the tower authorized herein, permittee shall notify AM Station(s) listed below so that the station(s) may commence determining operating power by the indirect method. Permittee shall be responsible for the installation and continued maintenance of detuning apparatus necessary to prevent adverse effects upon the radiation pattern of the AM station(s). Both prior to construction of the tower and subsequent to the installation of all appurtenance thereon, antenna impedance measurements of the AM station(s) shall be made and sufficient field strength measurements, taken at 10 locations along each of eight equally spaced radials, shall be made to establish that the AM radiation pattern is essentially omnidirectional. Prior to or simultaneous with the filing of application for license to cover this permit, the results of the field strength measurements and the impedance measurements shall be submitted to the Commission in an application for the AM station(s) to return to the direct method of power determination.
 (Revised March 14, 1983)

WWMK(AM), 1260 kHz, Cleveland, OH (Facility ID Number 17015)

Special operating conditions or restrictions:

- 3 The permittee/licensee in coordination with other users of the site must reduce power or cease operation as necessary to protect persons having access to the site, tower or antenna from radiofrequency electromagnetic fields in excess of FCC guidelines.

- 4 ***** This is a Section 73.215 contour protection grant *****
 ***** as requested by this applicant *****

- 5 BEFORE PROGRAM TESTS COMMENCE, sufficient measurements shall be made to establish that the operation authorized in this construction permit is in compliance with the spurious emissions requirements of 47 C.F.R. Sections 73.317(b) through 73.317(d). All measurements must be made with all stations simultaneously utilizing the shared antenna. These measurements shall be submitted to the Commission along with the FCC Form 302-FM application for license.

- 6 Permittee has specified use of the antenna listed below to demonstrate compliance with the FCC radiofrequency electromagnetic field exposure guidelines. If any other type or size of antenna is to be used with the facilities authorized herein, THE AUTOMATIC PROGRAM TEST PROVISIONS OF 47 C.F.R. SECTION 73.1620 WILL NOT APPLY. In this case, a FORMAL REQUEST FOR PROGRAM TEST AUTHORITY must be filed in conjunction with FCC Form 302-FM, application for license, BEFORE program tests will be authorized. This request should be made at least 10 days prior to the date on which program tests are desired to commence. The request must include a revised RF field showing to demonstrate continued compliance with the FCC guidelines.

Documentation demonstrating compliance with the FCC radiofrequency field exposure guidelines may be submitted in advance of the filing of FCC Form 302-FM. The Commission's staff will review it for compliance and respond by letter stating whether automatic PTA has been reinstated.

Four bay, rototiller-type, circularly polarized, nondirectional, multi-station antenna with 1.0 wavelength bay spacing

*** END OF AUTHORIZATION ***