No.	Date	Item
1.	12/1993	Leonard Kahn, Exhibit 1, Elimination and Restoration System and Linear Amplifier System
2.	12/1993	Leonard Kahn, Exhibit 2, POWER-side Compatible AM/SSB Broadcasting System
3.	12/21/93	AM Radio Service DA Performance Verification (MM Docket 93-177)
4.	12/3/93	FCC Announces the Interference Improvement Factors for Stations Which Have Petitioned to Migrate to the Expanded Broadcast Band
5.	11-12/93	Stations in the News
6.	11/30/93	AM Groundwave Propagation Curves are Made Available on 8 1/2" by 11" Paper
7.	11/4/93	Comments of du Treil, Lundin & Rackley, MM Docket 93-177, AM Radio Service DA Performance Verification
8.	10/12/93	Memo to Bob Culver re MM Docket 93-177
9.	10/8/93	FCC Letter re WOSU, Columbus, Ohio

10.	10/4/93	AM C.P., WWRC, Washington, D.C.
11.	8/20/93	Order Granting Extension of Time (MM Docket 93-177), AM Service DA Performance Verification
12.	8/12/93	Notice of Inquiry (MM Docket 93-225) Definition and Measurement of Aural Modulation Limits in the Broadcast Service
13.	6/29/93	Notice of Inquiry (MM Docket 93-177) AM Service DA Performance Verification
14.	6/1993	IEEE Transactions on Broadcasting
15.	6/1993	Stations in the News
16.	5/28/93	Petition for Migration, MM Docket 87-267 Technical Assignment Criteria for AM
17.	5/21/93	Letter to FCC Secretary re Petition Requesting Migration to Expanded Band
18.	4/21/93	ET Docket 92-298, Reply Comments of Leonard Kahn, Single AM Radio Equipment Standard

19.	4/20/93	Letter to FCC Secretary re NPRM, ET Docket 92-298
20.	4/15/93	FCC to Open "Filing Window" on AM Expanded Band Applications
21.	4/15/93	Commission Addresses Various Petitions for Reconsideration of Order Concerning Review of the Technical Assignment Criteria for the AM Broadcast Service (MM Docket 87-267)
22.	4/5/93	Letter to FCC, Comments re NPRM, ET Docket 92-298
23.	4/1993	Eng.Statement, CD&E, Reply Comments re NPRM (ET Docket 92-298; FCC 92-546)
24.	4/1993	Eng.Statement, CD&E re NPRM (ET Docket 92-298; FCC 92-546)
25.	3/31/93	Office Memo, Topic: AM
26.	3/24/93	National Effort to Boost Broadcast Compliance
27.	3/3/93	Office Memo, Re: Tower Climbing Procedures

28.	3/1/93	Office Memo, Topic: AM
29.	2/10/93	Fax memo re 90 radials
30.	1/21/93	Establishment of Stereophonic Standard in AM Broadcast Service (ET Docket 92-298)
31.	1/6/93	NPRM, ET Docket 92-298, AM Standard
32.	1/6/93	NPRM (ET Docket 92-298), Single AM Standard
33.	1993	Office Notes
34.	1993	FS vs. DX Graphs
35.	1993	Notice of Inquiry (RM-7594) AM Service DA Performance Verification
36.	1993	Notice of Inquiry (Docket 93-177, RM-7594) AM Radio Service DA Performance Verification

STATIONS IN THE NEWS

NEW BRUNSWICK's IRVING FAMILY TO SELL CHSJ-TV TO CBC, MITV TO CANWEST GLOBAL

If the CRTC approves, CBC affiliate CHSJ-TV Saint John and its rebroadcasters will become CBC O&O stations. New Brunswick is the only province where the CBC does not own a TV station — a situation which has brought considerable criticism over the years. It has been reported that New Brunswick Broadcasting, owned by the Irving family, also offered to sell Maritime Independent TV to the CBC, but that the price was "not one (CBC) could entertain." In any event, CBC stations already cover the areas served by MITV.

CanWest Global Communications has stepped in to buy MITV, a move expected since CanWest executives toured the MITV facilities some months ago. The network covers much of the three Maritime provinces and was recently given approval for four more transmitters in Nova Scotia.

CRTC APPROVES KITCHENER, LINDSAY TRANSFERS

• CHUM Ltd. has won CRTC approval for its purchase of **CKKW/CFCA-FM Kitchener** from CAP Communications. The purchase price is $5 million, and CHUM will is spending $526,000 on new facilities; other benefits include $304,500 over the next seven years for various projects in the broadcast courses at Conestoga College and promotion of Canadian recordings through CHUM's 'Free Ad Plan'.

• A group of 11 shareholders (993682 Ontario Ltd.) bought **CKLY Lindsay** — in receivership since July 15/92 — for $700,000. The new owners, eight of whom live in Lindsay, have undertaken to continue the community's only local station and also plan a slight increase in programming. News staff will be expanded to four full-time, plus a network of 'stringers'.

MORE AMs PLAN MOVE TO FM

Among AM stations applying for FM: • Cogeco's **CHLC Baie-Comeau** (580), for 97.1 MHz, 4.2 kW; • **CFVD Dégelis** (1370), for 95.5, 12.474 kW; • **CKOD Valleyfield**, Québec (1370), for 102.9 MHz, 3 kW. • After losing out to CHQM-FM London for 92.5, **CHLO St. Thomas** (1570) has applied for 'QM's former 103.1 frequency with 50 kW ERP; CHLO proposes a change of format from country, and would simulcast for up to 90 days.

SEPT. 27 HEARING IN HULL

Coming up on the CRTC's agenda: • The renewal of the **CTV Network** licence is expected to focus on its role in the "new broadcasting environment" during the next seven years — particularly plans for cable specialty channels, its new ownership and affiliate structure and Canadian programming.

• Applications for transfer of ownership: Robert Lauzon, for **CHRD Drummondville**, from the trustee in bankruptcy; Wayne Steele, for **CHOK Sarnia**, from Middlesex Lambton Communications; 1019415 Ontario Inc., for **CHOW Welland**, from Wellport Broadcasting (Gordon Burnett); MacEachern Broadcasting, for **CIGO Port Hawkesbury**, NS, from Eastern Group;

— continued on page 9

CALENDAR

Sept. 8-11: **NAB Radio Show**
Dallas Convention Center, Dallas, TX.
Info: NAB Radio, (202) 429-5420

Sept. 27: **CRTC Hearing** (re: CTV renewal)
Hull, Québec

Sept. 28-30: **CCBE — Central Canada Broadcast Engineers**
Skyway Centre & Delta Airport Hotel, Toronto
Info: Bob Findlay, (514) 352-4038, FAX 354-7514

Sept. 29-Oct. 2: **SBE & RTNDA Joint Convention**
Miami, Florida

Oct. 4: **CRTC Hearing**
Vancouver, B.C.

Oct. 4-8: **Image World N.Y.** (Video Expo & Cammp Show)
Jacob K. Javits Convention Center, New York
Info: Benita Roumanis, (914) 328-9157

Oct. 7-10: **AES — Audio Engineering Society**
Jacob K. Javits Convention Center, New York
Info: AES, (212) 661-8528

Oct. 25-28: **WABE — Western Assn. Broadcast Engineers**
Ramada Renaissance Hotel, Saskatoon, SK
(See advertisement in this issue)

Oct. 26-28: **OCTA — Ontario Cable Association**
Le Parc Convention Centre, Toronto
Info: OCTA, (416) 498-1515, FAX (416) 498-1559
(See advertisement in this issue)

Oct. 29-Nov. 2: **SMPTE 135th Technical Conference & Exhibit**
Los Angeles Convention Center
Info: SMPTE, (914) 761-1100

Nov. 1-2: **Fiber Optics for Technicians**
Nov. 3-5: **Fiber Optic Communications**
Arizona State University, Tempe, AZ.
Info: (602) 965-1740, FAX (602) 965-8653

Nov. 7-9: **CAB — Canadian Association of Broadcasters**
World Trade & Convention Centre, Halifax, NS
Info: CAB, (613) 233-4035

Nov. 11-14: **BEAC — Broadcast Education Assn. of Canada**
Prince George Hotel, Halifax, NS
Info: Alex Hall, (416) 926-9616

Dec. 6-10: **Image World Orlando** (Video Expo & Cammp)
Orange County Conv. Center, Orlando, FL.
Info: Benita Roumanis, (914) 328-9157

Dec. 7: **CRTC Hearing**
Halifax, Nova Scotia

1994:

Feb. 4-5: **SMPTE Advanced TV/Electronic Imaging Conf.**
Chicago, Illinois

March 14-17: **Digital Audio Broadcasting Symposium**
Toronto
Info: David Garforth, CBC-EHQ, (514) 485-5301, FAX 485-5885; or Alysone Will, (416) 862-9067

CABLE + SATELLITE NEWS

MANY BIDS EXPECTED FOR SPECIALTY CHANNELS

Deadline moved to September 15th

Following the CRTC call for applications for new specialty channels, some observers believe that up to 200 proposals will be filed, with only half a dozen or so getting approval. The CRTC moved the deadline from Sept. 3 to Sept. 15, and emphasized the necessity that documents be complete. It restated that this is not the last opportunity to apply; another round of applications can be expected, once the successful bidders in this round have established their new services.

Among plans announced: **Comedy Central Canada**, a joint venture of CHUM Ltd. and the U.S. Comedy Central channel. It would be 24-hour and national *(not just Central Canada, although that's probably where it's most needed — ed.) Comedy Central plans its U.S. debut in March/94 and has signed to go on Hubbard Broadcasting's USSB direct broadcast satellite service.* **Lifestyle Television**, a women's channel, has Winnipeg-based Moffat Communications as a major investor. Linda Rankin, a former VP of Telesat Canada and president of Telesat Enterprises, has been appointed by Moffat to lead the project. It proposes to schedule "a significant amount of high quality Canadian production carried out by women."

Others applying are expected to include the CBC and CTV networks. CanCom, operator of HealthSat, a medical channel, is applying for **Vitality Network**, a health and fitness service to be headed by former CBC producer Duncan McEwan. JJL Broadcast Group seeks **Discovery Channel Canada** with former CBC VP Trina McQueen at the helm. Standard Broadcasting plans a country music channel, with partners John Martin, former MuchMusic PD, and Allan Gregg of Decima Research. Another entry is Cogeco Inc., which has the Canadian rights to Time Warner's **Entertainment TV**, a news/variety channel.

In the U.S., **Booknet** plans a mid-1994 launch. It will offer news about books and the publishing industry, interviews, readings and a shopping service to buy books that are featured. Cable systems that put Booknet on the basic tier will not have to pay for the channel and will be able to sell local time and share in the proceeds of books sold to their subscribers.

SPECIALTY CHANNELS TURNING BIG PROFITS

A CRTC report covering the 5-year financial performance of Canada's specialty TV says the 12 channels are making big profits. In 1992, the average profit margin was 25.28%, up from 22.02% in 1990 and 21.77% in 1991. The report was prepared last spring, but not released until early August.

TSN showed a profit margin of nearly 45%, MuchMusic 29%, and The Weather Channel 25%. A spokesman for the Consumers' Assn. of Canada called the profits 'outrageous'.

OCTA 'CABLEMANIA '93' OCTOBER 26-28

Here's the line-up for the Ontario Cable show to be held at Le Parc in Markham (suburban Toronto), October, 26-28.

Tuesday, Oct. 26:
5 to 11pm — Front Liners' Night — a tribute to reps & techs
5 to 9pm — Trade Show Preview

Wednesday, Oct. 27:
8:30am — CPAC Presentation, 'Canada's Town Hall'
9:00 to 10:30am — OCTA-CCTA panel on current issues
10:30am — Trade Show Opening Ceremony
12:30pm — Luncheon — George Cohon, McDonald's, speaker
2:15pm — Cable vs. DBS and Telcos, competition/cooperation?
3:45pm — Pay-Per-View Marketing — panel discussion
6 to 7pm — Reception, hosted by exhibitors
7 to 10:30pm — Gala Dinner & 'Wheel of Misfortune' show

Thursday, Oct. 28
8:30 to 10am — Cable Technology panel on DVC
10:15 to 11:30am — Secret Weapon: The Community Channel
12:30pm — Luncheon — Danny Williams, Cable Atlantic
2:15pm — 'Blood, Sweat and Tears' — Business panel

In addition to the Tuesday evening 'preview', the Trade Show will be open on Wednesday from 10:45am to 6pm, and on Thursday from 9am to 3pm.

CFCF INC. TO INVEST IN REGIONAL CABLESYSTEMS

Montreal-based CFCF Inc. is expanding into Ontario with a $20 million investment in Regional Cablesystems Inc. of Oakville. Regional, with a total of 146,000 subscribers, operates small systems in Canada and the U.S. They include systems close to the major systems operated by CFCF in Montreal and Hull, Quebec. CFCF Inc. would initially hold debentures, with an option to invest a further $55 million; on conversion, the debentures would equate to up to 55% control of Regional.

MUCHMUSIC AWARDS GO LIVE SEPT. 30

The Canadian MusicVideo Awards are scheduled for live presentation on MuchMusic on Thursday, September 30th. They feature 'The Peoples Choice' in four categories: favorite female, male, group and video. From July 19 to Sept. 5, votes have been registered for the five nominees in each category at 'Pepsi Taste Patrol' sites across the country, where a VideoWall, signs and flyers informed participants about the MusicVideo Awards.

Speaking of MuchMusic, The Globe and Mail's Arts+ gave a rave review to *Intimate & Interactive* — a 90-minute show taped live with a studio audience, then edited for broadcast. It's been running since 1991. The interactive part has viewers phoning or faxing their questions to the performers, usually a Canadian act. Reviewer John O'Callaghan notes that about a million viewers tune to MuchMusic at some point in any given day.

PAY-PER-VIEW FOOTBALL SCORES

Viewer's Choice says the pay-per-view telecast of the CFL opening game was 'a great success'. While actual figures weren't released, both Viewer's Choice and its western counterpart, Home Theatre, were happy with the results. Viewers paid $7.95 to see the Calgary-Winnipeg game, blacked out in Calgary, but a 'huge success' in Winnipeg. The pay-per-view promoters hope to tackle more CFL contests.

and in an internal reorganization, the radio stations owned by Western World would be acquired by 602411 Saskatchewan Ltd., both wholly-owned subsidiaries of Forvest Broadcasting.

MARKETING PLAN FOR RADIO GROUP IN EAST

Mulvihill's radio division, as of July 1, is offering a package of 12 stations in N.B. and P.E.I. Eastern Atlantic Radio System (EARS) will give advertisers and agencies the convenience of one buy, and claims maximum saturation reach levels and cost efficiency. The group includes CIHI/CKHJ, CJCJ, CKNB, CFCY/CHLQ, CKCW/CFQM, CFAN, CJCW, CIOK and CHSJ.

Other stations in the news: A new community FM has been licensed to Coopérative Radio Restigouche Ltée at Balmoral, NB, 7,295 watts on 103.9 MHz. The station will provide the first full-time local French service for some 17,000 Francophones in the area. Capital costs are estimated at $430,000, and the municipality has donated land for the studio facilities. The CRTC denied a proposed for on-air bingo in French, English and Micmac... Redmond Broadcasting's **CJEZ-FM Toronto** has applied for a power increase from 4,000 to 28,900 watts ERP... **CFQX-FM Selkirk**, MB, has applied for transfer of control from Robert Chipman and Megill-Stephenson Co. (each 50%) to Craig Broadcast Systems of Brandon... **CFBC Saint John**, NB, citing financial problems, has laid off manager Shirley Crawford and asked longtime talk-show host Tom Young to consider other options. VP Don Brown says no large-scale layoffs are planned for the staff of 35... According to The Weather Network, flooding at the end of July affected the studios of **CKVU-TV Vancouver**, forcing it to go to taped programming... From *DX Ontario:* **CKFX Vancouver** has been off the air and engineer Jack Weibe is quoted as saying it may be back on later this year. (It's the short wave station of CKWX.) A new radio station in southwest Ontario, **CJWD Tilbury**, is said to be in the works; it would operate with 600w on 1490 KHz. And **CKOL Campbellford** is the call of the community station recently established in that eastern Ontario town... Cariboo Central Interior Radio has applied for two low power FMs at Fort St. James to rebroadcast **CIRX-FM Prince George** and **CIVH Vanderhoof**, BC. An AM rebroadcaster of CIVH would cease operation... A judge has ordered **CHER Sydney**, NS, to pay Pat Connolly more than $25,000. His verbal 2-year contract to do play-by-play hockey ended after one season (1988-89) when CHER did not pursue further rights to the games. The judge says CHER has to pay him for year 2, plus 6% interest... **CKRX 1090 Rocks** is the new call for 24-year-old **CHEC Lethbridge.** GM Clyde Ross says the Monarch Broadcasting station is responding to extensive market research that showed listeners wanted a 'true Rock' station in Southern Alberta. A summer promotion has given over $30,000 in prizes... **CIGO Port Hawkesbury**, NS, is being bought by its manager, Bob MacEachern. He's been with CIGO for 18 years, the last six as manager. Owner John Van Zutphen, president of the Eastern Group of Companies, said he wanted to keep the station in local hands... Here's a station that *isn't* in the news: P.E.I. Francophones have been lobbying for a Radio-Canada studio since 1977. SRC regional director Claude Bourque says that with CBC's budget cuts, the Charlottetown studio isn't a priority. *Bonjour Atlantique*, the morning show for P.E.I., is produced in SRC's Moncton studios... **CHSJ Saint John** has been given approval for a power increase from 10 kw day/5 kw night to 25 kw day/10 kw night. A previous bid for 50 kw day was denied; this time CHSJ reduced signal strength towards Fredericton and committed not to sell advertising in Nova Scotia... NewCap Broadcasting received $925,000 when it sold **CHRK-FM Kamloops** to NL Broadcasting. NL agreed to increase news and local production... Border station **CHXL-FM Brockville**, ON, is taking advantage of CRTC guidelines for programming flexibility for small market stations. It has lost money in each of the past four years ... Okanagan Radio has applied for two FM rebroadcasters at Oliver, BC: the **CJOR Osoyoos** rebroadcaster would move from AM to 180w on 102.9, and a rebroadcaster of **CJMG-FM Penticton** would also be on FM, 180w on 99.9...

Janet Maskell, on behalf of a company to be incorporated, has applied for FM at Whitehorse, YT. The Group I rock & dance format and operate on 92.5 MHz with 1.388 kW ERP... Rogers' **CKKS-FM Vancouver has applied for SCMO to carry programming in Chinese. It's reported that the applicants for CHQM Vancouver**, 431881 B.C. Ltd., plan to program mostly in Chinese dialects. CHQM, one of three stations in the city owned by CHUM Ltd., is being divested as required by the CRTC... Diffusion Laurentides Inc. is now networking from 6pm to midnight daily, **CJLM-FM Joliette** picking up the programming of **CIME-FM Ste-Adèle...** Plans for rebroadcasters have been filed by **CFRN-TV Edmonton** (for Athabasca, AB, ch.13, 4 kW); and **CKQR Castlegar** (for Nelson, BC, 103.5, 84w)... **CFMT-TV Toronto** has acquired the Canadian broadcast rights to 1994 World Cup Soccer in languages other than English and French... Five CanWest Global co-productions were among the winners at the Houston WorldFest, the world's largest film and video festival, held earlier this year... **BT**

Comparison of Linear Single-Sideband Transmitters with Envelope Elimination and Restoration Single-Sideband Transmitters*

LEONARD R. KAHN†, SENIOR MEMBER, IRE

Summary—The Elimination and Restoration System was originally described in 1952 [1]. The purpose of the following is to evaluate certain basic characteristics of the Envelope Elimination and Restoration System and to compare it with the Linear Amplifier System [2, 3].

Brief Description of Envelope Elimination and Restoration System

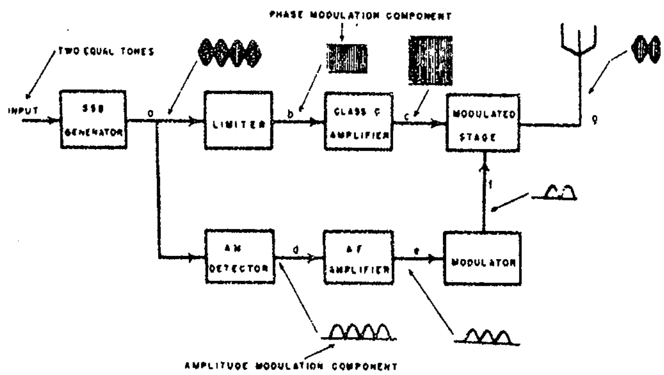

Fig. 1—Simplified block diagram of envelope elimination and restoration system.

PLEASE refer to Fig. 1, which is a simplified block diagram of the envelope elimination and restoration system. The waveshapes shown in this figure are for two equal amplitude tones with the carrier completely eliminated. The single-sideband generator used in practical equipment has been of the filter type but the phase shift techniques may also be used. The output of the single-sideband generator is fed to a limiter wherein the limiter removes the amplitude modulation component from the single-sideband wave producing a pure phase-modulated wave. Since a phase-modulated wave is not distorted by amplitude nonlinearities, this wave may be amplified in highly efficient Class C amplifiers. The Class C amplifier finally drives the modulated stage which may also be designed for Class C operation.

The amplitude modulation component of the single-sideband wave is isolated from the phase modulation component by the AM detector. The AM detector output is identical to the envelope waveshape of the single-sideband wave at point A. This audio frequency wave is amplified and then fed to the modulator.

The modulator modulates the phase-modulated component by the envelope function in the modulated stage. If the time relationship between the phase and amplitude modulation components is properly maintained, the signal at point G will be a high powered replica of the single-sideband wave at point A. It should be stressed that Fig. 1 is a simplified block diagram and in itself is not a practical system. Such important elements as the equipment for equalizing time delays are missing but it is felt that the figure demonstrates the basic technique.

Efficiency of a Linear Amplifier and the Envelope Elimination and Restoration System

In the analysis shown in Appendix I, the efficiency of the linear amplifier system is compared with that of the envelope elimination and restoration system. It might be assumed from a cursory examination of these two systems that the comparison is the same as that of a high-level modulated AM transmitter with a low-level modulated AM transmitter and therefore the high-level (envelope elimination and restoration system) would be slightly superior in efficiency to the linear amplifier low-level system. Actually the analysis is somewhat different because of the special waveshapes peculiar to single-sideband operation.

From the analysis shown in Appendix I, it is seen that, if it is assumed that the linear amplifier has a plate circuit efficiency of 60 per cent under conditions of full drive [4], its average efficiency will be 47.1 per cent for the two-tone case. In Appendix I, it is also shown that the plate circuit efficiency of the envelope elimination and restoration system is approximately 69 per cent.[1] Therefore, the ratio of power output from the envelope elimination and restoration system is 2.53 times that of the linear amplifier system assuming both systems utilize tubes having equal total plate dissipation. (That is, the summation of the plate dissipation capabilities of the tubes in the Class C amplifier, plus those in the Class B modulator, equals the plate dissipation capability of the final linear amplifier tubes.)

* Original manuscript received by the IRE, June 14, 1956; revised manuscript received, October 5, 1956.
† Kahn Research Laboratories, Freeport, N. Y.

[1] See Appendix I for the conditions assumed.

As pointed out in Appendix I, the above comparison is based upon an assumption of plate circuit efficiency for the Class C amplifier of 80 per cent. In both the linear and the envelope elimination and restoration transmitter calculations, we have not taken into consideration loss in the rf coupling networks but since both systems should have approximately the same loss in these circuits, the comparison would not require modification. If we had assumed that the Class C amplifier had a plate circuit efficiency of 75 per cent, the power output of the envelope elimination and restoration system would be 2.1 times as great as that from a linear amplifier system.

Comparison of Means of Modification of High Level AM Transmitters to Single-Sideband Operation

Many firms are reluctant to convert to single-sideband transmission because of the expense of completely replacing AM transmitting equipment. Therefore, there has been considerable interest in proposals for converting AM transmitters to single-sideband operation.

One method proposed is to use envelope elimination and restoration adapters. The second method proposed is to redesign the transmitter for Class B linear operation. This second technique would require appreciable engineering effort and in many cases additional stages would have to be added to make up for the decreased power gain of Class B linear amplifiers. Also, since frequency multipliers are not linear devices, further radical changes would be necessary.

It might be interesting to compare the power output from a high-level amplitude modulated transmitter converted to linear amplifier operation with the power output from the same transmitter utilizing an envelope elimination and restoration adapter.

In Appendix II, it is shown that a high-level amplitude modulated transmitter, if modified for Class B linear single-sideband operation, would have a peak envelope power rating of approximately two-thirds of the carrier rating of the transmitter. If such a transmitter was adapted by the envelope elimination and restoration system, the peak envelope power would be equal to approximately four times the carrier rating for single-sideband telephone operation. The rating of such a transmitter when transmitting multichannel teleprinter single-sideband signals varies between three to four times the carrier rating of the AM transmitter depending upon the number of tones transmitted and whether they are phase-locked. Thus we see that for telephone operation there is a power gain of approximately 6 and for a multichannel teleprinter a power gain of 4.5 to 6 over the power output from a high level modulated transmitter converted to Class B linear operation. If, in the above calculations, a figure of 75 per cent was assumed for the plate circuit efficiency of the final Class C stage, the power gain of the envelope elimination and restoration system, over the linear amplifier system, would be 3.37 to 4.5 times.

It should be noted that the above comparison was based upon the assumption that a modulator for the transmitter was available. If a modulator is not available, it would be necessary to compare the cost of the modulator plus the envelope elimination and restoration adapter with the cost of engineering, labor, and the power disadvantage of converting the rf stages of the transmitter to Class B linear operation.

The above calculations are based upon the carrier rating of an AM transmitter. If the cw rating of the transmitter is used, the peak envelope power of the Class B linear is two-thirds the value above stated or approximately four-ninths of the cw rating of the transmitter. Similarly the peak envelope power of the envelope elimination and restoration adapter transmitter for single-sideband telephone operation is approximately 2.67 times the cw rating and from 2 to 2.67 times the cw rating for multichannel teleprinter operation.

Required Modulator Response

Table I is a tabulation of the required modulator frequency response for given spurious outputs from an envelope elimination and restoration transmitter.

TABLE I

Modulator equalized to pass up to	Worse spurious level for two equal tones
Fundamental of the difference frequency of the two equal tones	−25.3 db relative to 1 of the two tones
Second harmonic	−31.4 db
Third harmonic	−36.2 db
Fourth harmonic	−40.5 db

In the paper published in 1952 [1], a similar chart was furnished based upon the assumption that all the energy in the components not passed by the modulator added up to produce a single spurious component. That chart was therefore pessimistic as pointed out in that article. A new mathematical technique has since been developed [5] and the fact that the figures originally published were pessimistic was confirmed.

In Appendix III, this new technique is used to solve this problem. *However, it should be pointed out that these figures are still pessimistic because the analysis assumes that two equal amplitude tones are radiated and their frequencies are at the extreme ends of the transmitted band.* Of course, in practice, voice signals have most of their high energy components situated at relatively close spacing at the low-frequency end of the audio band. Another reason why these figures are pessimistic is that in most applications there are many components transmitted simultaneously rather than just the severe two-tone case. Multichannel telegraph single-sideband, and of course voice systems, normally radiate more than two-tones simultaneously.

If, instead of two equal tones, tones of unequal amplitude are transmitted, the frequency response requirements of the modulator are eased.

Another important reason why these figures are quite conservative, is that the response of a conventional amplitude modulator does not suddenly go to zero above a certain frequency. If this effect is analyzed it is seen that the spurious is reduced by this vestigial frequency response because of two reasons. The first reason is that any energy at these higher frequencies assists in reducing the spurious. The second reason is that, for optimum spurious reduction, the highest frequency overtone which is passed by the modulator should have a smaller amplitude than indicated by the Fourier series expansion of the envelope. This may be seen by considering the analysis in Appendix III and examining the effect of reducing the percentage of modulation of the highest order overtone. This effect is considerably more important for high order harmonics.

It has been found, in practical installations, that for a signal bandwidth of up to 6 kc, a modulator, having a flat response or one equalized for a flat response of approximately 8 kc, can be used to produce signals having the worst spurious amplitude down 30 to 35 db relative to one of the two equal desired tones.

Discussion of Practical Installations of Envelope Elimination and Restoration Systems

Fig. 2 is a picture of a commercial single-sideband envelope elimination and restoration transmitting adapter. This adapter may be used to adapt an amplitude modulated transmitter to single-sideband service. The phase modulation component of the single-sideband wave is fed to a low level rf stage of the transmitter. The AM component of the single-sideband wave is fed from the adapter to the audio input of the transmitter. Aside from the installation of a connection for feeding the low level rf stage, no modification of the transmitter is necessary. This adapter may be used to produce independently modulated upper and lower sidebands and is being used in a number of transoceanic multichannel teletype circuits.

A similar model of the single-sideband transmitter adapter may be used for broadcast relay service. This adapter has been used in conjunction with a 100-kw AM transmitter to produce a 400-kw peak envelope single-sideband signal. We understand that this is the most powerful single-sideband transmitter in operation.

No attempt has been made to minimize the size of this equipment and certainly appreciable reduction in size and weight can be accomplished by use of conventional miniaturization techniques.

The average spurious output of systems using these adapters is from −32 to −35 db relative to the amplitude of one of the two equal tones. The best measurement of a practical 40-kw peak envelope power transmitter utilizing this system was slightly better than −40 db.

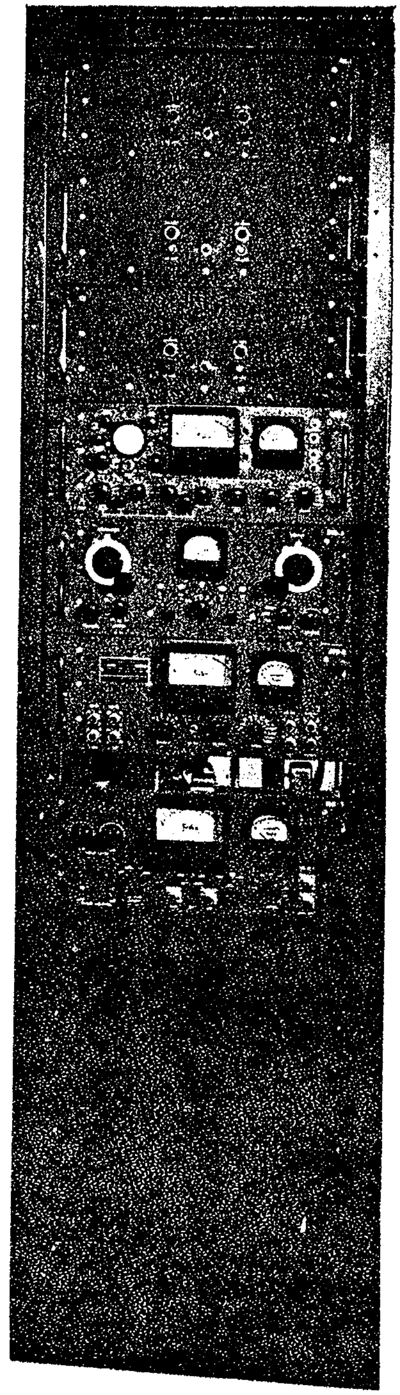

Fig. 2—SSB53-2A. Kahn Research Laboratories' twin sideband adapter.

Résumé of Advantages of Envelope Elimination and Restoration Systems

The advantages of the envelope elimination and restoration system are as follows:

1) The envelope elimination and restoration system produces approximately 2.5 times the power output, as does the linear amplifier system, for a given total plate dissipation.
2) The envelope elimination and restoration system may be used to adapt existing high quality transmitters without any design change of these transmitters. The peak envelope rating of such a system is from 3 to 4 times the carrier rating. Of course, the system may also be used as a component part of new transmitters.
3) The envelope elimination and restoration system is relatively noncritical because Class C amplifiers may be used.
4) Frequency multiplication may be used in the envelope system simplifying design.
5) The envelope elimination and restoration system makes practical low-cost high-powered, 20-kw peak envelope power or more, single-sideband transmitters. In the linear system, each additional stage introduces distortion and this makes it very difficult to obtain satisfactory spurious figures from high-powered transmitters. Also, the high efficiency of envelope elimination and restoration type transmitters is of considerable economic importance.
6) At the present time there are no very high-powered linear amplifier type single-sideband transmitters available, and for such requirements, the envelope elimination and restoration system appears to be the only practical solution.

Appendix I

Comparison of Linear and Envelope Elimination and Restoration Single-Sideband Transmitter Efficiencies

In order to compare the efficiency of the two systems, we will first derive an equation for efficiency of the linear amplifier. We will assume that the standard two equal tone signal is amplified by both systems because power and distortion ratings are generally based upon this specific waveshape.

The efficiency of a Class B linear amplifier is a linear function of the output voltage. (This functional relationship may be established by noting that output power is proportional to the square of the output voltage, yet the voltage from the plate power supply is constant and the current from the power supply is a linear function of the output wave of the amplifier. Therefore, since the output power varies as a square of the output voltage and the power input is merely a linear function, the efficiency must also be a linear function in order to establish the correct product function.)

Let us assume that the linear amplifier is used to amplify a signal composed of two equal amplitude tones and produces a 1-watt peak envelope power output. The average power, P_0, is therefore $\frac{1}{2}$ watt.[2] Since the envelope waveshape of a two equal tone wave is a full wave rectified sine wave and since the efficiency of a linear amplifier is a linear function of signal voltage, the efficiency as a function of time η_t is:

$$\eta_t = k \sin \omega t \tag{1}$$

where ω is the difference in angular velocity between the equal tones and k is the efficiency of the linear amplifier when delivering peak output.

The plate dissipation at any instant, t, is:

$$P_{dt} = P_{it} - P_{0t} = \frac{P_{0t}}{\eta_t} - P_{0t} \tag{2}$$

where

P_{it} = the power input fed to the amplifier from the power supply.

P_{0t} = the desired power output from the tube which is fed to the tank circuit.

($P_{0t} = \sin^2 \omega t \times 1$ watt for a two equal tone wave having a peak envelope power of 1 watt.)

Therefore,

$$P_{dt} = \frac{\sin^2 \omega t}{k \sin \omega t} - \sin^2 \omega t. \tag{3}$$

The average plate dissipation P_d is:

$$P_d = \frac{1}{\pi}\int_0^{\pi/\omega} P_{dt}dt = \frac{1}{\pi}\int_0^{\pi/\omega}\left(\frac{\sin \omega t}{k} - \sin^2 \omega t\right)dt$$

$$P_d = \frac{2}{\pi k} - \frac{1}{2}. \tag{4}$$

Therefore, since the average power output in this case is $\frac{1}{2}$ watt, the efficiency of a linear amplifier when amplifying a two equal tone wave is

$$\eta = \frac{P_0}{P_0 + P_d} = \frac{1/2}{1/2 + 2/\pi k - 1/2} = \frac{\pi k}{4}. \tag{5}$$

We will assume that in the envelope elimination and restoration system the Class C modulated stage has a plate circuit efficiency of 80 per cent (coupling circuit losses are not considered in this comparison) and the Class B modulator stage has an efficiency of 55 per cent. The following calculations show an over-all efficiency of slightly over 69 per cent:

Let $P_0 = 0.5$ watt (1 watt peak envelope power)

[2] The fact that the peak envelope rating of a two equal tone wave is equal to two times the average power rating may be confirmed as follows: consider that each of the two equal amplitude tones has an rms amplitude of one-half volt developed across a one ohm resistance. Each of the tones would dissipate $\frac{1}{4}$ watt and the total power of the two tones would then be $\frac{1}{2}$ watt. The peak envelope power, however, occurs when the two tones are in phase and their combined amplitude would then be 1 volt rms so therefore their peak envelope power would be 1 watt.

$$P_d \text{ Class C stage} = \frac{0.5}{0.8} - 0.5 = 0.125 \text{ watt}$$

Since, for a 0.5 watt SSB signal (1w PEP) there is 0.095 watt in the AM component.

$$P_d \text{ Class B} = \frac{0.095}{0.8 \times 0.55} - \frac{0.095}{0.8} = 0.0971 \quad (6)$$

$$\text{Total } P_d = 0.125 + 0.097 = 0.222 \quad (7)$$

$$\eta = \frac{P_0}{P_0 + P_d} = \frac{0.5}{0.5 + 0.222} = 69.2 \text{ per cent} \quad (8)$$

Appendix II

Power Output of a High Level Modulated Transmitter Converted to Class B Linear Operation

If we assume that the transmitter to be modified utilizes high-level modulation and that the modulated stage plate circuit efficiency is 80 per cent, then the plate dissipation, P_d, of the stage is:

$$P_d = \frac{3}{2} P_{\text{carrier}} \frac{(1 - \eta)}{\eta}$$

$$= \frac{3}{2} \frac{0.2}{0.8} P_{\text{carrier}}$$

$$= 0.375 \ P_{\text{carrier}}. \quad (9)$$

It was shown, in Appendix I, that a reasonable figure for the plate circuit efficiency of the linear single-sideband amplifier is 47.1 per cent. Therefore, the average power output, $P_{SSB\ av}$, of a transmitter altered to linear SSB operation is:

$$P_{SSB\ av} = \frac{\eta}{1 - \eta} P_d = \frac{0.471}{1 - 0.471} 0.375 \ P_{\text{carrier}}$$

$$= 0.334 \ P_{\text{carrier}}. \quad (10)$$

For a two equal tone single-sideband wave, the peak envelope power is equal to two times the average power. Therefore, the peak envelope power output of a transmitter modified for linear amplifier operation is approximately 0.67 times the carrier power output rating of the unmodified transmitter.

Appendix III

Modulator Frequency Response Requirement

The following analysis is accomplished in two segments. In the first part of the analysis the spectrum of the phase modulation component of the single-sideband wave is determined. This is the signal fed to the modulated stage in the envelope elimination and restoration system. In the second part of the analysis the phase-modulated wave is mathematically modulated by the components of the envelope of the two-tone single-sideband wave that are within the frequency response of the modulator. In this manner it is possible to calculate the amount of spurious produced when the modulator can pass only a restricted number of overtones of the envelope function.

Part 1

The method to be used for determining the spectrum of the phase-modulated component of a two equal amplitude tone wave was described in 1953 [5]. This method is based upon the fact that a limiter is an amplitude modulator which modulates the input wave by the inverse function of the envelope of this input wave.

The method may be outlined in the following series of steps.

1) The signal wave fed to the limiter is fully described as to the amplitude, frequency, and relative phase of the spectrum components.
2) The envelope function, $F(t)$, of the input wave is determined.
3) The inverse function of the input envelope function, $1/F(t)$, is next calculated. This is the envelope-limiter gain function, $ELGF(t)$.
4) The Fourier series describing the envelope-limiter gain function determined in step 3 is calculated.[3]
5) Each individual input signal component described in step 1 is amplitude modulated (multiplied) by the Fourier series of the envelope-limiter gain function. The resulting spectrum is the desired output of an ideal limiter and therefore it is the phase-modulation component of the input wave described in step 1.

In accordance with the above procedure, the following calculations may be made.

Step 1: The frequency components of the input wave, to the limiter, are shown in Fig. 3, line 1. Besides these two equal tone components there is assumed to be a noise component which, in the analysis, is made to approach zero. It is assumed that at zero reference time the two tones are exactly out of phase.

Step 2: The amplitude modulation component of the input wave is shown in Fig. 4. In order to simplify the analysis, it is assumed that the bottom part of the wave is a straight line as shown in the figure. Actually the bottom of the wave is not perfectly flat but since this portion of the wave is made to approach a limit of zero this assumption does not affect the accuracy of the analysis. The envelope function may be defined as follows:

$$F(t) \approx [N]_0^{\epsilon} + [S \sin \theta]_{\epsilon}^{\pi-\epsilon} + [N]_{\pi-\epsilon}^{\pi+\epsilon} + [-S \sin \theta]_{\pi+\epsilon}^{2\pi-\epsilon} + [N]_{2\pi-\epsilon}^{2\pi}. \quad (11)$$

Step 3: The envelope-limiter gain function, $ELGF(t)$, which is the inverse function of step 2, is determined.

[3] In many cases, it will be less laborious to do step 4 before step 3.

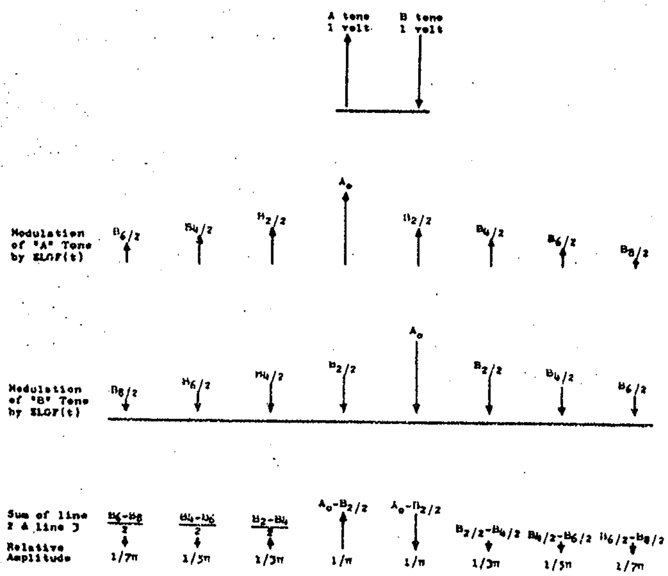

Fig. 3—Spectrum diagram showing calculation of two-tone phase modulation component

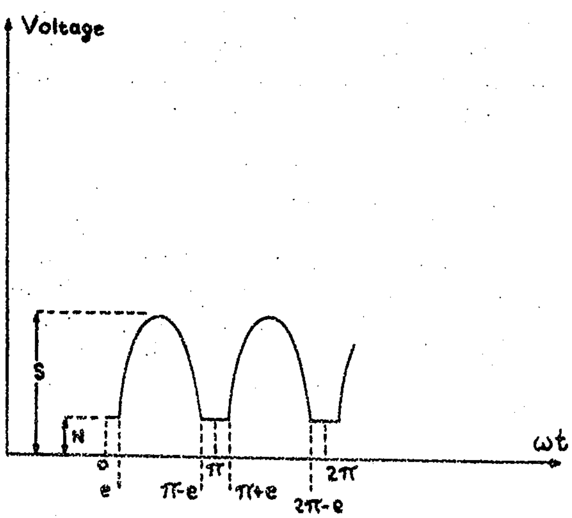

Fig. 4—Envelope wave shape of two tone wave plus noise.

This function may be defined as follows:

$$ELGF(t) = 1/F(t) \approx [1/N]_0^{e} + \left[\frac{1}{\sin\theta}\,\frac{1}{S}\right]_{e}^{\pi-e} + [1/N]_{\pi-e}^{\pi+e} + \left[\frac{-1}{\sin\theta}\,\frac{1}{S}\right]_{\pi+e}^{2\pi-e} + [1/N]_{2\pi-e}^{2\pi}. \qquad (12)$$

Step 4: Next, the Fourier series describing this wave is determined. The fundamental frequency of the Fourier series is assumed to be equal to one-half the frequency separation between the signal frequencies in order to simplify calculations. The dc component equals:

$$A_0 = \frac{1}{\pi}\int_0^{\pi} ELGF(t)d\theta = \frac{1}{\pi}\left[\int_0^{e}\frac{d\theta}{N} + \int_{e}^{\pi-e}\frac{d\theta}{S\sin\theta} + \int_{\pi-e}^{\pi}\frac{d\theta}{N}\right]$$

$$= \frac{1}{\pi}\left[\frac{2e}{N} + \frac{1}{S}\log\left\{\frac{\sin\theta}{1+\cos\theta}\right\}_{e}^{\pi-e}\right]. \qquad (13)$$

Due to the choice of fundamental frequency, all odd harmonics are equal to zero. The following equation defines the B_n Fourier series components where n is an even integer.

$$\frac{Bn}{2} = \frac{1}{\pi}\int_0^{\pi} ELGF(t)\cos n\theta d\theta$$

$$= \frac{1}{\pi}\left[\int_0^{e}\frac{\cos n\theta d\theta}{N} + \int_{e}^{\pi-e}\frac{\cos n\theta d\theta}{S\sin\theta} + \int_{\pi-e}^{\pi}\frac{\cos n\theta d\theta}{N}\right]$$

$$= \frac{1}{\pi}\left[\frac{2\sin ne}{Nn} - 2\int_{e}^{\pi-e}\frac{\sin(n-1)\theta d\theta}{S} + \int_{e}^{\pi-e}\frac{\cos(n-2)\theta d\theta}{S\sin\theta}\right] \qquad (14)$$

but the next lower harmonic component, B_{n-2}, equals

$$\frac{B_{n-2}}{2} = \frac{1}{\pi}\int_0^{\pi} ELGF(t)\cos(n-2)\theta d\theta$$

$$= \frac{1}{\pi}\left[\frac{2\sin(n-2)e}{N(n-2)} + \int_{e}^{\pi-e}\frac{\cos(n-2)\theta d\theta}{\sin\theta}\right]. \qquad (15)$$

For very small values of e, $\sin ne \approx ne$, where e is in radians. The error in this approximation vanishes as e approaches zero. Therefore, the first terms of B_n and B_{n-2} approach equality as e approaches zero. Therefore, the difference between B_n and B_{n-2} is

$$\frac{B_{n-2}}{2} - \frac{Bn}{2} = \frac{4}{S(n-1)\pi}. \qquad (16)$$

Similarly

$$A_0 = \frac{1}{\pi}\left[\frac{2e}{N} + \int_{e}^{\pi-e}\frac{d\theta}{S\sin\theta}\right] \qquad (17)$$

$$\frac{B_2}{2} = \frac{1}{\pi}\left[\frac{2\sin 2e}{N2} - 2\int_{e}^{\pi-e}\frac{\sin\theta d\theta}{S} + \int_{e}^{\pi-e}\frac{d\theta}{S\sin\theta}\right] \qquad (18)$$

Therefore (16) holds even for the difference between A_0 and $B_2/2$.

Step 5: Each of the two equal tone components is modulated by the various Fourier series components of

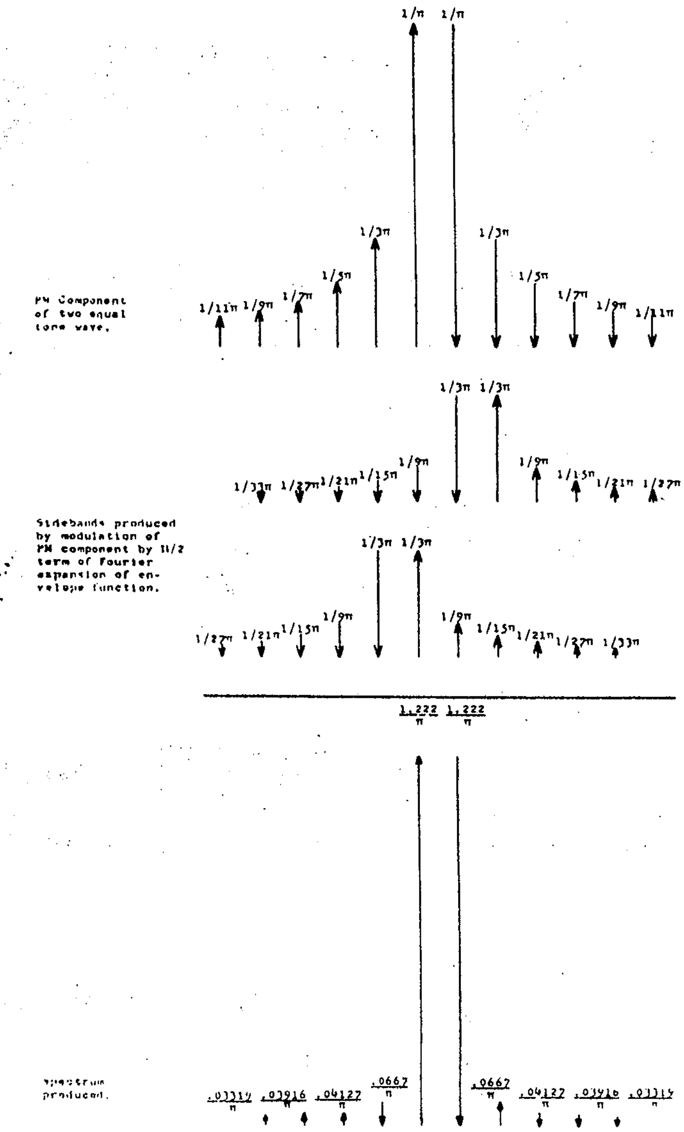

Fig. 5—Calculation of spectrum created when envelope elimination and restoration system is used with a low-fidelity modulator capable of passing only the fundamental beat note.

the envelope limiter gain functions, as shown in Fig. 3, lines 2 and 3. The result of this modulation process is then summated as shown in Fig. 3, line 4. It should be noted that, since the various sideband components are equal to a difference between B_n and B_{n-2}, the resulting spectrum may be readily determined to a very high order of precision by use of (16).

The result of this first part of the analysis is the phase-modulation component spectrum of a two equal tone wave. In addition to its application to single-sideband analysis, this result is of interest to other fields of physics.

Part 2

As mentioned above, the second part of the analysis requires the calculation of the effect of amplitude modulation of the phase modulation spectrum by the Fourier series components of the envelope function of the two equal tone wave. The envelope function of the two equal tone wave is exactly equivalent to that of a full wave rectified sinewave and may be expanded into the following Fourier series:

$$e = \frac{2E}{\pi}\left[1 + \frac{2}{3}\cos 2\theta - \frac{2\cos 4\theta}{15} + \frac{2}{35}\cos 6\theta \ldots (-1)^{n/2+1}\frac{2\cos n\theta}{n^2-1}\right] \qquad (19)$$

where n = even integer.

The result of modulation by merely the fundamental component of the Fourier series is shown in Fig. 5. Thus, it is seen that the worse spurious component is 25.3 db down, relative to one of the two equal tone waves. The results of similar calculations for modulators with better frequency responses are shown in Table I.

Acknowledgment

The author wishes to gratefully acknowledge the advice and encouragement, in writing this paper, of James L. Finch and Walter Lyons of RCA Communications, Inc.; Julius Ross of the United States Information Agency; Edward Pierce and James Alden of Kaiser Aircraft and Electronics Corp.; Alfred W. Barber of Alfred W. Barber Laboratories, and Lloyd Ottenberg of Kahn Research Laboratories.

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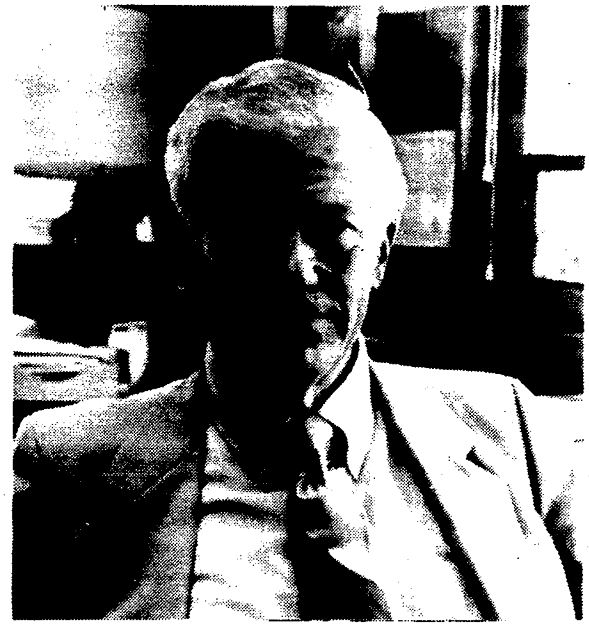
EXHIBIT 2

2.

POWER-side® COMPATIBLE AM/SSB BROADCASTING SYSTEM

by Leonard R. Kahn (M 1953, F 1961)



Leonard R. Kahn was awarded the Armstrong Medal at the 1980 Annual Awards Banquet in recognition of his work in AM stereo, independent sideband, time diversity, voice processing, and other advanced electronic techniques. He presented an outstanding address in response to the award in which he urged a reform in the U.S. patent system. He is president of Kahn Communications, Inc.

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A slightly modified version of the paper was presented by Mr. Kahn at the Technical Seminar of the Radio Club of America on November 18, 1988, at the New York Athletic Club.

ABSTRACT – The Independent Sideband system of AM Stereo can, by use of special audio processing, significantly improve monaural reception. The resulting transmitted signal, called a *"POWER-side"* signal, allows listeners to "sideband tune" with new types of mono receivers so as to reduce co- and adjacent-channel interference, improve the effective fidelity of the AM receiver, and make the receiver's tuning significantly less critical.

Furthermore, due to the inequality of low frequency sideband components, the system reduces selective fading, antenna null distortion and re-radiation problems when the *POWER-side* signal is received by both "side-band tuned" mono receivers as well as digitally-tuned stereo and mono receivers which center tune to the carrier frequency.

Most importantly, this type of wave substantially reduces co-channel "beating" effects that have, since the earliest days of broadcasting, plagued AM signal reception.

INTRODUCTION

AM broadcasting's main advantage vis-a-vis FM broadcating is superior coverage. FM provides a superior signal when the signal-to-noise ratio is high but AM can, if properly implemented, provide usable signals at far lower pre-demodulation signal-to-noise ratios. Thus, AM is a more rugged form of modulation. Added to AM's superior ruggedness is the coverage advantage of operating at a frequency range of 540 to 1600 KHz rather than in the FM band of 88 to 108 mHz.

The optimum form of amplitude modulation is single-sideband (SSB) with reduced or suppressed carrier. SSB is the most rugged form of analog modulation and also occupies the least bandwidth. While the advantages of SSB were known by many of the pioneers of AM broadcasting, the complexity of SSB receivers restricted SSB's use to commercial, military and amateur applications. However, circuit complexity is no longer a deterrent with the advent of integrated circuits.

There is, unfortunately, a much more serous problem impeding the introduction of SSB operation, and that is the public's huge inventory of envelope-detector type receivers.

Accordingly, the transition from standard double-sideband AM transmission to the optimum SSB forms of AM transmission, (suppressed carrier SSB for monophonic stations and reduced-carrier independent sideband for stereophonic transmissions), must be gradual.

The purpose of this paper is to describe *POWER-side*™ a system that, the author believes, in addition to alleviating some of AM radio's most serious technical problems, can be used to make the transition from conventional double-sideband (DSB) AM to SSB swifter and more graceful.

WHAT IS *POWER-side?*

POWER-side is a form of amplitude modulation which offers some of the transmission advantage of single-sideband (SSB) and which is compatible with both envelope-detector type receivers and SSB receivers incorporating synchronous demodulators. Furthermore, since a *POWER-side* signal better matches SSB receivers than does a conventional AM signal, this new form of transmission should help to expedite to widespread use of these superior SSB receivers.

A *POWER-side* wave is an AM wave having at least a substantial part of one sideband raised in level and the other sideband reduced in level, so that the total envelope modulation is unaltered. The stronger sideband is transmitted free of pre-emphasis, but the weaker sideband incorporates substantial pre-emphasis in order to insure full compatibility with center (carrier) tuned receivers.

Thus, *POWER-side*, while similar to Compatible Single Sideband[1] (CSSB) in use in the air-to-ground communications, is really an independent sideband, Kahn/Hazeltine type, AM stereo wave. (Indeed, *POWER-side* transmission can be implemented using either of the two FCC type-accepted Kahn Communications' stereo exciters (models STR-77 or STR-84) and a special audio processor.)

The reason for the change in emphasis from a CSSB transmission to one based on the independent sideband AM stereo system is the recent widespread use of pre-emphasis in AM broadcasting. A second sideband is needed to support pre-emphasis while still allowing listeners to "sideband tune" to a stronger sideband. (See Below). It is clear that AM broadcasters, faced with serious decline in the fidelity of receivers during the past two decades, are now forced to use large amount of pre-emphasis in order to achieve some semblance of overall fidelity. Thus, given the deplorable state of AM receivers, any new AM transmission system must be able to accommodate pre-emphasis.

As mentioned above, *POWER-side* waves are generated by standard AM transmitters excited by type-accepted Kahn/Hazeltine system AM Stereo units. Taking a very firm conservative stance in terms of occupied bandwidth and minimizing adjacent channel interference, all of these AM Stereo exciters incorporate low-pass filters in the L-R branch.

For example, in the early STR-77 model the lowpass filter was set for 5 kHz, restricting separation to approximately 6 kHz. The new STR-84 model restricts separation to 7.5 kHz. Therefore, *POWER-side* is not effective for frequencies above 7.5 kHz.

Furthermore, since substantial pre-emphasis is used on the weak sideband and no pre-emphasis is used for the stronger sideband, at approximately 5 kHz the two sidebands reach the same level. Thus, the *POWER-side* effect is restricted to the low and medium frequency range of voice and the low frequency range of music. Nevertheless, since a very large percentage of the intelligibility of voice and the fundamental components of musical instruments are at relatively low frequencies, the effects of the frequency limitations imposed on the *POWER-side* system are not substantial as one might expect. (It should be noted that these limitations pertain only to the difference in the treatment of the two sidebands. The overall envelope modulation of the *POWER-side* wave is not restricted and can be used to transmit components up to 15 kHz.)

Block Diagram of a Practical *POWER-side* Transmission System

FIG. 1 shows, in block form, the basic structure of a *POWER-side* system. The audio signal, that comprises all of the necessary components for monophonic listeners, feeds a de-emphasis circuit. This de-emphasis circuit should be adjusted to match the inverse of the pre-emphasis curve used by the station.

Thus, a signal with relatively flat frequency response should appear at the output of the de-emphasis circuit. The output of this circuit feeds an attenuator which reduces the audio level so that the signal has a level that will produce a weaker sideband approximately 15 db below the stronger sideband.

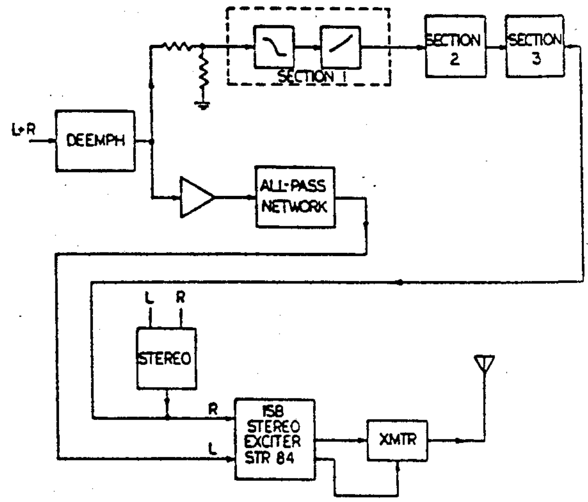


Figure 1.

In other words, assuming the total envelope modulation produced by both sidebands is 100%, the sideband level for the weaker sideband should cause approximately 15% envelope modulation and, therefore, the stronger sideband is increased from a level that would normally cause 50% of the envelope modulation to one that causes 85% of the modulation.

The output of the attenuator feeds one of three equal sections that produces the desired increased pre-emphasis for the weak sideband. The first segment of Section 1 is actually a lowpass filter with a "stop" region limited by a bypass stage.

The second segment of Section 1 introduces a rising response characteristic which is greater than the effect of the prior block. Accordingly, the overall effect of the two segments is to produce a characteristic peaking at 5 db, for 5 kHz (relative to 500 Hz).

Sections 2 and 3, since they are identical to Section 1, make for a total response of three times that of Section 1, i.e. producing a 15 db peak on the weaker sideband.

As shown in FIG. 1, the output of the de-emphasis circuit, in addition to feeding the increased pre-emphasis circuitry for processing the weaker sideband, feeds an amplifier. This amplifier causes the audio level driving the stronger sideband to be proper to elevate the level of the sideband to 85% of the total envelope modulation at 1 kHz.

The output of the amplifier feeds an "all-pass" network which has a phase characteristic that closely approximates that of the overall additional pre-emphasis network in the weaker sideband path. Accordingly, the two sidebands should be approximately in phase, maximizing envelope modulation.

The two-path audio processing system feeds the appropriate L and R inputs of an independent sideband type AM stereo exciter, such as Kahn Communications' Model STR-84.

For example, if it is desired to enhance the lower-sideband, the output of the "all-pass" network is connected to the L input of the exciter and Section 3 output is connected to the R input. The stereo exciter causes the transmitter to produce the desired *POWER-side* RF wave.

It should be noted that a "stereo effects" wave may be added to the audio signal feeding the weak sideband so as to enhance the wave received by stereo listeners. The "stereo effects" signal can take many forms[2], including a special stereo component or certain stereo sounds such as "crowd noise" for a sporting event. (A future paper is planned to discuss further *POWER-side* developments as well as those pertaining to stereo transmissions effects.)

Sideband Tuning

The term "Sideband Tuning", as used in the following, is defined as the tuning of a receiver so as to favor the desired sideband of a *POWER-side* wave. When radios with reasonably flat IF selectivity characteristics are used, one edge of the receiver's passband will fall at approximately the station's carrier frequency in the same fashion as when a conventional SSB receiver is tuned to an SSB wave.

Listeners tuning to a *POWER-side* signal will naturally tune to the stronger sideband because it is louder. Early tests on Compatible Single-Sideband (CSSB) showed that the amount of sideband tuning is a function of the signal-to-noise ratio. The poorer the signal-to-noise ratio the further the listener will tune over towards the sideband and away from the carrier in order to improve intelligibility.

It has been experimentally demonstrated that the optimum amount of "sideband tuning", for typical narrow-band AM radios, is of the order of 2.2 to 3 kHz. The actual amount of "sideband tuning" used is a fuction of the receiver's selectivity characteristic and the cleanliness of the *POWER-side* signal.

Thus, stations that wish to obtain the full benefits of "sideband tuning" will find it necessary to transmit clean signals, thus avoiding negative-going overmodulation, harsh audio-processing procedures and significant amounts of incidental phase modulation in their transmitters[3]. An important by-product of *POWER-side* operation is that all stations using the system will find it advantageous to improve their signal purity, reducing splatter and other sources of adjacent channel interference. (It is pointed out below that *POWER-side* also effectively reduces the so-called "carrier beat" co-channel interference effect.)

The optimum "sideband tuning" point (for a perfect *POWER-side* signal) is the same as it would be for conventional single-sideband (SSB) operation; i.e., tuned to the desired sideband with one of the receiver's passband edges at the carrier frequency.

As an example, assume that the receiver's IF passband is 6 kHz. It should theoretically support 3 kHz audio response when center or carrier tuned to a dsb AM wave, and 6 kHz when tuned to an SSB signal. (Unfortunately, for the AM broadcast industry, current (1988) receivers with 6 kHz passbands may be considered to have reasonable bandwidth and receivers with 4.4 kHz bandwidths are not unusual!) Experiments with a number of *POWER-side* stations show that tuning 2.2 kHz to 3 kHz from the carrier towards the stronger sideband turns out to be an optimum "sideband tuning" point, providing 4.4 to 6 kHz (-6 db) audio fidelity.

It is interesting to note that the matched filter concept of Information Theory would lead to a similar conclusion. In other words, since modern broadcast receivers have such a narrow band characteristic, the *POWER-side* signal better matches typical AM receivers. Thus, the implementation of *POWER-side* signals is consistent with the Matched Filter theory.

Accordingly, typical narrowband AM radios better match one sideband of a *POWER-side* wave than they match the two sidebands of the conventional dsb AM waves which they were designed to receive. In any case, "Sideband Tuning" to *POWER-side* signals, offers almost an effective 2-to-1 gain in frequency response for typical narrowband home and portable radios.

Reduction of Sideband Cancellation Effects

The classical amplitude modified wave has a serious weakness. The two sidebands of an AM wave are of equal amplitude, thus making the wave particularly sensitive to the relative phase of its three components. For example, if the carrier is rotated relative to the sidebands by 90 degrees, the wave is converted from a pure amplitude-modulated wave to a form of phase modulation (quadrature modulation) where there are no desired signal components present in the envelope of the wave.

In other words, the fact that the sidebands are equal in amplitude makes it possible for the desired demodulated audio waves derived from the two sidebands to completely cancel under certain conditions, such as selective-fading multipath conditions, etc.

Since the sidebands of a *POWER-side* wave are unequal, it is a much more rugged wave.

For example, conventional equal amplitude sideband AM waves suffer from a complete loss of fundamental modulation whenever the carrier is shifted odd multiples of 90 degrees; i.e., ±90 degrees, ±270 degrees, etc. In comparison, the *POWER-side* wave loses only 2.7 db under these same conditions. (See FIG. 2)

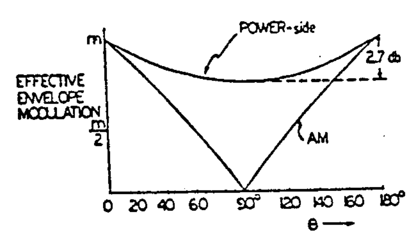
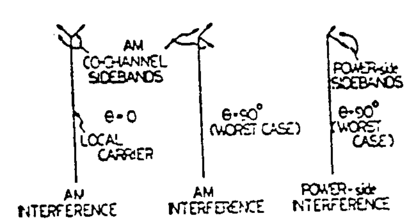


Figure 2



It is noteworthy that the use of a synchronous demodulator[4] does not, in any way, alleviate such losses of fundamental modulation.

It should also be noted that, unlike these advantages of *POWER-side* that are based upon "sideband tuning", the advantages based upon the reduced phase sensitivity of the *POWER-side* wave are available for all types of radios, including digitally tuned radios which center tune to the carrier frequency.

SUMMARY OF ADVANTAGES:

The advantage of the *POWER-side* system are of two basic types:

1) Those due to "Sideband Tuning"; and

2) Those due to reduction of sideband cancellation effects.

Obviously, in order to gain the "Sideband Tuning" advantages, listeners must use a receiver that can be tuned to a sideband such as: a) continuously tunable radios, or b) special digitally-tuned radios that can be stepped in no more than 2 kHz steps, or c) a new type of digitally-tuned radio specifically designed for "Sideband Tuning".

The advantages based upon the reduction of sideband cancellation effects are available with all types of receivers, including digitally-tuned radios which center tune to the carrier frequency. Generally, sideband cancellation effects are further enhanced by "Sideband Tuning", as the pre-detection spectrum of the wave is caused to have additional asymmetry.

Brief Description of the Advantages of "Sideband Tuning"

1) **Increased frequency response.** The frequency response of most receivers is limitd by the IF or RF selectivity characteristic. As discussed above, "Sideband Tuning" almost doubles the overall frequency response of narrow-band receivers.

2) **Reduced adjacent channel interference.** "Sideband Tuning" causes splatter and adjacent channel carrier whistles to fall at a substantiallly lower point on the RF and IF selectivity curve. Furthermore, sideband tuning, by increasing the effective fidelity of the desired received signal, enhances critical sibilant sounds and other mid- and high-frequency sounds, raising their effective signal-to-interference ratios. Since sibilants are weak and generally are the first common sounds to be lost in interference, improving their level significantly improves intelligibility in fringe areas.

3) **Reduced co-channel interferences** due to "Sideband Tuning". (See section below treating "carrier beats", where a much more important advantage is described.) Assuming that the interfering AM station continues to transmit normal, equal amplitude sidebands, the desired station gains up to 4.7 db in addition to the other advantages of "Sideband Tuning".

The station that continues to utilize conventional AM transmission might be expected to gain even a greater advantage than its co-channel neighbor using *POWER-side*. The reason is that the *POWER-side* signal's weaker sideband is reduced approximately 10 db while its stronger sideband is raised only 3.5 to 4.7 db. The flaw in such reasoning is that, absent special *POWER-side* receivers, listeners should not be expected to "sideband tune" their receivers as would listeners to *POWER-side* equipped stations. However, if the two interfering stations, cooperate and both transmit *POWER-side* signals enhancing opposite sidebands, a very significant advantage can be achieved. In this case, as much as 15 db improvement in signal-to-interference ratio can be achieved with high selectivity receivers. (Also, as discussed below, they will both enjoy freedom from serious "beating" problems.)

On-the-air *POWER-side* operation by WMCA, New York, 570 kHz, favoring the upper sideband, and WSYR Syracuse, 570 kHz, favoring the lower sideband, has achieved very substantial interference reduction for both stations. Actually, WSYR has reported that at night, some seven miles from the WSYR transmitter and approximately 250 miles from WMCA, one is able to hear an intelligible signal from WMCA when using an independent sideband type AM stereo receiver.

4) **Less Critical Tuning.** Typically, receivers tuned to a *POWER-side* signal can be sideband tuned from as much as 3 kHz. Thus listeners can tune their radios from as much as 300 Hz on the "wrong side" of the carrier, to 3,000 Hz on the "correct" side, for a total of 3300 Hz spread. In comparison, typical AM signals, utilizing a similar pre-emphasis characteristic, would cause tuning to be limited to approximately ±300 Hz. Thus, the improvement is over five times the normal tuning range.

Brief Description of Reduction of Sideband Cancellation Effects

The relative insensitivity of a *POWER-side* wave, in comparison to the conventional AM wave, results in the following advantages which conform the ruggedness of a *POWER-side* wave:

a) Significant reduction in the selective fading distortion and the depth of the fades;[5]

b) Reduction in distortion in antenna nulls, as well as less loss of modulation in these critical locations[6]

c) Reduction of distortion and less loss of modulation due to reradiation from buildings and power lines:

d) And, most importantly, a dramatic reduction in the beat interference caused to other co-channel stations.

As pointed out above, *POWER-side* advantages a) through d) exist for all types of receivers, whether continuously tunable or digitally tuned.

Co-channel Interference Reduction

There are two distinct aspects to an analysis of the interference characteristics of modulation systems:

1) How does the modulation system influence interferences to other stations; and

2) How does the use of the system influence the interference heard by the station's own listeners?

The latter aspect has been treated above. It is now useful to consider how *POWER-side* operation will affect a station's co-channel neighbors.

Actually, in the long run the most important advantage of *POWER-side* operation may be that the system reduces co-channel interference effects. The reason for this important *POWER-side* characteristics can be best seen by examining the phenomenon commonly (and the author believes improperly) called "carrier beat".

A beating sound is most annoying and creates far more listener annoyance than does normal interfering speech or music. Thus, a clean voice signal (absent beating effects), say 30 db below a desired signal, produces far less disturbance than does a voice signal having the same level but suffering from beating effects.

The term "carrier beating" is generally used to describe this phenomenon. However, it is believed that this term is not truly descriptive of the problem. Typically, co-channel interference beat rates are less than a few Hertz. Such low frequency waves are greatly attenuated by the frequency response of a receiver's amplifier and loud speaker system. Indeed, listeners cannot hear such low-frequency sound waves even though they can feel very-low-frequency vibrations.

One can hear the slow variation in noise level caused by the variation of gain of AVC controlled amplifiers. However, even moderately severe co-channel interference of 20 db, causes the gain of the AVC controlled amplifiers to vary by only 1.74 db, and for interference 30 db below the desired signal the total variation is 0.5 db.

Actually the phenomenon that listeners do hear might best be called "sideband beat". The fact that sidebands beat under normal interference conditions can be understood by considering the following situation where:

1) the frequency of the desired (strong) signal is 900 kHz and the weaker co-channel carrier is 1 Hz higher, i.e. 900.001 kHz;

2) the desired signal is temporarily free of modulation, ("dead air"); and

3) the interfering signal is modulated by a 1 kHz tone.

Since the stronger (900 kHz) carrier dominates the demodulation process, (the envelope detector controls the switching function) the lower sideband will produce a significant demoduation product at a frequency of 999 Hz. The upper sideband produces a demoduation product having a frequency of 1001 Hz. Both of these equal amplitude waves easily pass through the receiver's audio system and are audible to listeners. The beat rate caused by the difference in the frequencies of the upper and lower sideband demodulated audio signals will be 2 Hz or *two times the carrier frequency difference.* (See Appendix A.)

Thus, under normal two-station co-channel interference conditions, the receiver output will be contaminated with two distinct audio signals having a difference in frequency of two times the carrier error.

Referring to FIG. 2, it is seen that conventional AM waves suffer a wide range of effective modulation, from full to complete nulls. On the other hand, a simplified analysis shows that a *POWER-side* wave only suffers a total variation of 2.7 db under the same condition.

In order to experimentally verify the reduction of co-channel beat type interference, a simple, but convincing, experiment was performed. A multi-system AM stereo "boom box" type portable radio, Sanyo model MW-250, operating in the monophonic mode, was tuned to two *POWER-side* stations (WMCA 570 kHz New York, and WTHE 1520 kHz Mineola, Long Island) at Kahn Communications' laboratories in Westbury, New York.

The output of a Hewlett Packard model 606B signal generator was loosely coupled to the input of the Sanyo MW-250 receiver. One of the two *POWER-side* stations was tuned in and the signal generator was adjusted to match the received carrier frequency within 2 Hz.

The output level of the signal generator was adjusted for maximum beat effects, indicating that the signal generator was producing the same signal strength as the received broadcast signal. The output attenuator of the signal generator was then switched, so as to raise the level of the signal generator by 20 db. This properly simulated a strong unmodulated local signal being interfered with by a *POWER-side* signal.

The resulting audible interference from voice and music signals was almost completely free of any beat-type phenomenon.

For comparison, the receiver was tuned to WOR, a New York station transmitting a conventional AM signal and the same procedure produced the very annoying conventional beat-type sound. It is believe that this simple test produced excellent substantiation of the reduction of the so-called "carrier beat" phenomenon by use of *POWER-side* transmission.

By reducing the sensitivity of the AM wave to "Sideband Beating", the widespread implementation of the *POWER-side* system should significantly reduce co-channel interference effects.

POWER-side and Platform Motion

It is important to report that asymmetrical spectrum characteistics of a *POWER-side* wave should reduce one of the basic weaknesses of phase-separated type AM Stereo systems; i.e., the Motorola, Harris and Magnavox systems. (Not the Kahn/Hazeltine ISB AM Stereo system, which is properly classified as a frequency-separated system and which does not suffer from such problems.) Phase-separated type AM stereo systems can, under certain conditions, produce a serious form of stereo image distortion which the author has called "Platform Motion". "Platform Motion" may be defined as the undesirable motion of a stereo image back and forth between the left and right sides.

(The significance of "Platform Motion" cannot be exaggerated and it is indeed the main reason why all stereo receivers designed to receive phase-separated type AM stereo signals must incorporate protection circuitry to switch to monophonic reception under adverse reception conditions. Conversely, receivers designed to receive AM Kahn/Hazeltine system stereo signals, which are free of "Platform Motion", can remain in the full stereo mode under all conditions of reception, insuring stereo coverage equal to the monophonic coverage of the station.)

Platform Motion is created by two main mechanisms:

1) **Multi-path transmission.** In this case, the desired signal reaches the receiver via two paths, such as reradiation from buildings and power lines or from close-in skywave/groundwave paths. (Such groundwave/skywave paths have been reported as close in as a few miles from the transmitter, severely limiting the stereo coverage of the station.) This type of interference causes the desired audio signal to move and is the most serious form of Platform Motion. It can be called "Strong Platform Motion".

2) **From co-channel interference.** In this case, the interference appears to swing back and forth from left to right and can be called "Weak Platform Motion". The net result is a substantial increase in the effect of the interference, because the interference "waves" at the listener.

If the co-channel interfering station operates with *POWER-side*, this second type of stereo image distortion, i.e., "Weak Platform Motion" can be significantly reduced by the interfering station transmitting a *POWER-side* signal instead of a conventional AM signal.

By reducing the sensitivity of the equal sideband AM wave to the phase relationship between the carrier and the sidebands, one type "Platform Motion" should be significantly reduced[7]. The type reduced may be called "Weak Platform Motion" because it is a less important type of platform motion and is created by weak co-channel interference. (See Appendix B.)

Unfortunately, the widely reported close-in skywave/groundwave platform motion, and other "Strong Platform Motion" effects due to power-line and building reradiation, are not alleviated because *POWER-side* is not compatible with phase-separated type AM Stereo systems. Thus, radios designed to receive phase-separated type AM stereo signals will still require protection circuitry to disable stereo reception in less than good reception conditions.

Adjacent Channel Interference

Obviously any modulation procedure has to be evaluated as to its impact on the interference it causes to other stations and also how sensitive the system is to interference from other stations.

It has been pointed out above that substantial advantages accrue to listeners of *POWER-side* stations, whether the station is subjected to co- or adjacent-channel interference. Furthermore, it is shown elsewhere in this paper that *POWER-side* stations are good co-channel neighbors, in that the *POWER-side* wave dramatically reduces co-channel "beat" interference.

Now the question is: what does *POWER-side* operation do to adjacent channel neighbors? Since one sideband is made stronger than the sideband of a normal double-sideband AM wave and the other side is made weaker, one might expect increased interference to neighbors on the strong side of the channel and a reduction of interference to neighbors on the weak side.

Actually, neither sideband of a *POWER-side* signal increases adjacent channel interference. Indeed, stations on both sides, in comparison with normal AM Stereo operation or even normal mono operation, should experience, in practical situations, an improvement in interference. Why this is true can be seen by considering the following:

1) Treating first the extreme case of compliance with occupied-bandwidth rules when only one sideband of the Kahn/Hazeltine AM Stereo wave is used to provide full modulation. This situation goes far beyond *POWER-side* operation in that under worst-case conditions, only 85% of the modulation is in the strong sideband and the remaining 15% is in the weaker sideband. Measurements now on file at the FCC[8] for +125% modulation and −100% single-tone tests covering the range of 100 Hz to 15,000 Hz show that the wave fully complies with Section 73.44 of the FCC rules and regulations. These rules were achieved because the ISB form of AM Stereo is a compact wave (indeed Magnavox, in a forthright report to the FCC, rated this system best in terms of interference production), and the new STR-84 AM Stereo exciter incorporates a sharp filter which eliminates L–R products beyond 7.5 kHz while maintaining L+R response to 15 kHz.

Since the audio processing for *POWER-side* significantly reduces the strength of the stronger sideband over these severe L only, or R only, stereo tests, *POWER-side* fully complies with FCC rules and regulations.

2) The stronger sideband of the *POWER-side* wave is not pre-emphasized. Since pre-emphasis can increase splatter by as much as 10 to 15 db at 10 kHz, this elimination of pre-emphasis on the strong sideband is a significant factor.

3) As mentioned above, the *POWER-side* effect is eliminated at 7.5 kHz by the action of filters in the stereo exciter. Actually, the additional pre-emphasis on the weak sideband causes the weaker sideband to achieve level equality with the stronger sideband at approximately 5 kHz. Thus the impact of *POWER-side*, in terms of causing adjacent channel interference, is restricted to sideband components within ±5 kHz of the carrier.

4) A *POWER-side* signal requires less pre-emphasis because the *POWER-side* wave is less sensitive to loss of modulation caused by phase distortion. The typical RF and IF selectivity characteristic of an inexpensive receiver introduces substantial phase distortion. Therefore, in order to achieve a reasonable brightness of sound quality an equal-sideband AM wave requires substantially more pre-emphasis than does a *POWER-side* wave. Since the amount of pre-emphasis used directly increases splatter interference, a *POWER-side* signal, for a given brightness of sound, should produce substantially less adjacent channel interference.

As an example, if the phase distortion of the overall sytem, including the transmitting antenna, receiving antenna, and the RF and IF selectivity circuits in the receiver, create a phase distortion of 60 degrees at say 6 kHz (12 kHz IF bandwidth), a conventional AM wave will have 25% efficiency in terms of sideband power utilization. Under the same conditions, a *POWER-side* wave provides approximately 64% efficiency. In other words the effective modulation of the conventional AM wave is 50% and the effective modulation of the *POWER-side* wave is 79.9%.

5) There is also a practical consideration that should substantially reduce adjacent channel interference when broadcasters implement *POWER-side*. This may be seen by recognizing the fact that *POWER-side* stations derive a substantial portion of the system's advantages because listeners can "sideband tune" their radios. "Sideband Tuning" advantages are a function of the amount of off-tuning listeners find advantageous. Thus, the "cleaner" the *POWER-side* signal, the greater the "sideband tuning" advantages.

In other words, a broadcaster that uses the *POWER-side* system will find it important to produce an extremely clean wave that will not "splatter" on the station's own listeners. This means *POWER-side* stations will eschew bad practices like negative overmodulation, using improperly neutralized transmitters, operating with excessive pre-emphasis, etc. Recent tests[9] conducted by adjacent channel neighbors in California, KMNY 1600 kHz and KDAY 1580 kHz Los Angeles, lend support to the fact that *POWER-side* reduces adjacent channel interference.

CONCLUSIONS

It is shown herein that the *POWER-side* system significantly improves monophonic reception using existing Independent-Sideband AM Stereo transmission equipment.

It is also shown that there should be significant reduction of both co- and adjacent-channel interference caused by *POWER-side* signals.

A number of on-the-air evaluations of the system support the results of the above analysis, including the reduction of selective fading and reduction of co- and adjacent-channel interference effects.

The advantages of the system were separated into two types: one group applicable only to mono receivers capable of "Sideband Tuning"; and a second group of advantages that are available to all types of receivers, including carrier or center-tuned mono and stereo radios.

APPENDIX A

Analysis of Co-Channel "Sideband Beat"

The amplitude of the "Sideband Beat" of a co-channel interfering signal is a function of the relative amplitudes of the interfering wave and the desired wave. Under practical operating conditions, the desired signal is at least 20 db greater than the interferring co-channel wave. Accordingly, the envelope-detector performance closely approximates the performance of a product-type detector in that the strong local carrier controls the "switching function" of the envelope detector. (Communication engineers will recognize the similarity of this operation to "exalted carrier" detection which was used in early short wave SSB receivers.)

As pointed out above, the phase of the local carrier, relative to the interfering carrier, is a function of time, and under typical conditions the angle between the two carriers is an unbiased random function, i.e., a rectangular density function.

When there is a specific frequency difference between the two carriers; for example, a 1 Hz error, the beat frequency will equal 2 Hz (two times the carrier difference frequency[10]), ±two times the random frequency errors that would even apply to a phase-locked "synchronous" stations. Such random frequency errors are functions of propagation characteristics, receiver location, etc.

As mentioned above, the most important phenomenon in terms of co-channel interference is the dramatic variation in audio level of the undesired signal as the angle between the two carriers swing over a cycle. When this angle reaches 90 degrees, or any other odd multiple of 90 degrees, the amplitude of the fundamental Fourier component is nulled, leaving a slight amount of second harmonic distortion. (The reason the distortion is small is that the desired carrier causes the envelope detector to approximate the action of a product demodulator, greatly reducing the quadrature distortion effect.)

It is useful to determine the amplitude for the complete range of relative carrier phase between the desired and undesired signals over a 0 to ±90 degree region. (At angles beyond ±90 degrees the amplitude repeats this same shape.)

In the following equations the RF terms, DC terms, and the sub-audible low frequency terms generated by beating the two carrier frequencies are deleted. Thus, the analysis can be restricted to multiplying the local carrier by the two co-channel interference sidebands. It is assumed that the sidebands from the co-channel interfering signal are produced by a single-tone modulation and with a modulation factor of m. It is also assumed that the local station's carrier has an amplitude of K volts and the interfering carrier has an amplitude of unity.

$$e = \underbrace{\left[1 + m \cos(w_A t)\right] \times \cos(w_c t)}_{\text{Interference}} \times \underbrace{K \cos(w_c t + \theta)}_{\text{Local Carrier}}$$

Ignoring interfering carrier

$$= \left[m/2 \times \cos(w_c t + w_A t) + m/2 \times \cos(w_c t - w_A t)\right] \times K \cos(w_c t + \theta)$$

Using product trigometric identities

$$= K\, m/4 \times \cos(w_A t - \theta) + K\, m/4 \times \cos(2w_c t + w_A t + \theta) + K\, m/4 \times \cos(-w_A t - \theta) + K\, m/4 \times \cos(2w_c t - w_A t + \theta)$$

Considering only audio components

$$e = K\, m/4 \times \cos(w_A t - \theta) + K\, m/4 \times \cos(w_A t + \theta)$$

noting $\cos(\phi) = \cos(+\phi)$

Using the following identity:

$$1/2 \left[\cos(A-B) + \cos(A+B)\right] = \cos A \times \cos B$$

We see that:

$$e = \cos\theta \times K\, m/2 \times \cos(w_A t)$$

Thus, the amplitude of the sideband beat wave follows the absolute value of a cosine wave, which is a well known waveshape in radio engineering; i.e., the output of a resistance-loaded full-wave rectifier.

APPENDIX B

Analysis of "Weak Platform Motion"

FIG. 3

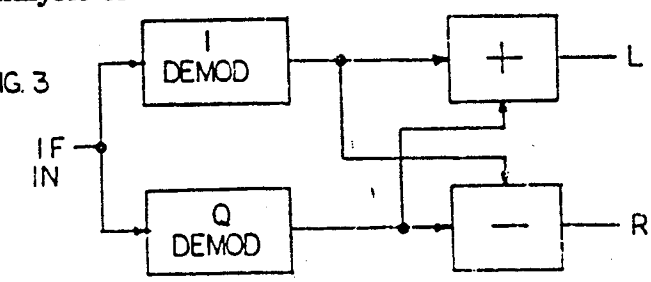


FIG. 3 is a simplified block diagram of a phase separated type AM Stereo decoder. It does not include distortion correction circuitry, as would be required for the Magnavox or Motorola type AM Stereo decoder. (Since the Harris system is a true quadrature system it does not require any distortion correction circuitry.)

Assuming that the receiver is tuned to a strong local signal, which at the insant of analysis is unmodulated, the waveshapes of FIG. 4 show how a conventional AM wave will exhibit severe image notion when demodulated by a phase separated type decoder.

FIG. 4A

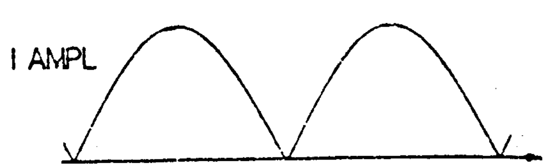


FIG. 4a shows the amplitude of the in-phase audio wave as a function of the phase between the strong local carrier and the weak intefering co-channel carrier. This waveshape has been discussed in Appendix A.

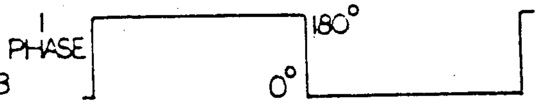


FIG. 4B

FIG. 4b shows the phase of the in-phase component. It is seen that the demodulated audio reverses phase whenever the amplitude function goes through a cusp.

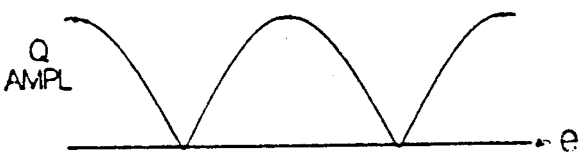


FIG. 4C

FIG. 4c shows the amplitude function of the quadrature component of the incoming interfering wave.

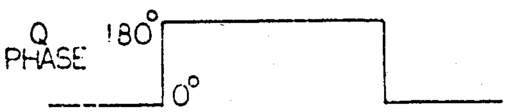


FIG. 4D

FIG. 4d shows the phase function of the quadrature audio wave.

Under normal operating conditions, the outputs of the I and Q detector of FIG. 3 are combined in the sum-and-difference matrix, producing the desired L and R waves. Unfortunately, the interference from the weak co-channel station swings from full left, to center, to full right, as a function of carrier phase. This is shown in FIG. 4e.

IMAGE LOCATION — RIGHT — CENTER — LEFT — CENTER — RIGHT — CENTER — LEFT

FIG. 4E

The reason the wave falls in the center at regular intervals is that at those instances either the I amplitude is zero or the Q amplitude is zero. Under such conditions, since there is only one signal going into the sum-and-difference circuits, the L and R outputs must be equal, causing the image to appear in the center. (When the phase of the L and R outputs are out of phase as they are when the I amplitude is zero, the image will be somewhat strange, as it is with any out-of-phase speaker situation.)

During other conditions of carrier phase, the left and right channels are unequal. Complete separation points will occur when the amplitude of the I wave and the amplitude of the Q waves are equal. In other words, at multiples of 45 degrees between the two carriers the I and Q detector outputs are equal. Since at these instances the I and Q audio signals are either in phase or out of phase, either a full L signal results or a full R.

This simple analysis clearly shows how an interfering co-channel AM wave causes "Weak Platform Motion". Such Platform Motion has been experienced in the field and it results in significantly increased annoyance by causing, in effect, the interference to "wave" at the listener.

Now, let us consider FIG. 5 which shows the phase function of a pure SSB wave. While the *POWER-side* wave is not a pure SSB wave, it should substantially reduce Weak Platform Motion.

In the case of the SSB wave, the amplitude of the I and Q waves are equal under all phase conditions. This is one of the basic reasons why SSB reception is particulary rugged, in terms of providing acceptable performance under disturbed propagation conditions. The phase of the I and Q audio waves linearly swing from −90 degrees to +90 degrees. (This assumes the upper sideband is transmitted. If the lower sideband is transmitted the phase slopes are reversed.)

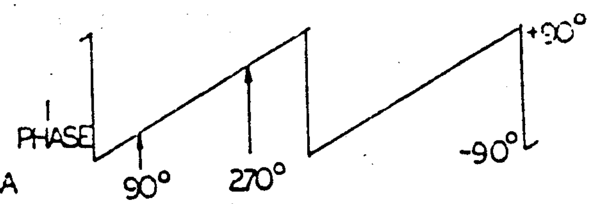


FIG 5A

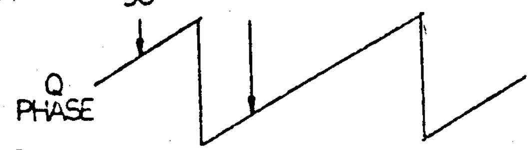


FIG. 5B

Examination of FIGS. 5A and 5B shows the phase difference between the I and Q audio waves is either 90 or 270 degrees. This cases the L and R outputs of FIG. 3 to be equal because the I and Q waves are equal in amplitude and are in quardrature. Thus, under all conditions of relative carrier phase, the L and R waves are equal and the interference will remain in the center, eliminating this one form of Platform Motion.

Unfortunately, the more serious "Strong Platform Motion" is caused by self interference, and there is no apparent mechanism for removing it.

NOTES

1 Leonard R. Kahn, *Compatible Single-Sideband*, Proc. IRE, Vol. 49, No. 10, pp 1503-1527. Also see earlier forms of sideband broadcasting: N. Koomans *Asymmetrical sideband Broadcasting*, Proc. IRE, Vol. 27, pp 687-690, and P.P. Eckersly *Asymmetrical-sideband Broadcasting*, Proc. IRE Vol. 16, pp 1041-1092.

2 Private communication from Dennis R. Ciapura, Vice President, Noble Broadcasting Co. to Leonard R. Kahn, describing special stereo processing used by the recording industry.

3 Leonard R. Kahn, *Amplitude Modulation Theory and Measurements - New and Old Paradoxes*, Proc. 41st NAB Annual Broadcast Engineering Conf. 1987.

4 Synchronous demodulators multiply the carrier components by the sidebands; they also have been called "product demodulators" and "exalted carrier detectors". Synchronous demodulators do, however, eliminate the distortion of an envelope detector when detecting a conventional AM wave suffering from selective phase distortion.

5 Experimental verification first obtained by radio station KSL - Bonneville, engineering department.

6 Experimental verification obtained by radio station WELI - Clear Channel engineering department.

7 The author points out that while there has been no experimental verification, the analysis indicates that there should be some reduction of "Weak Platform Motion." Recognizing the commercial importance of this matter, it is believed that early publication of this particular facet of the *POWER-side* system, absent experimental proof, is justified. The author plans to write a further article covering these effects as well as information concerning methods for enhancing stereo effects when *POWER-side* signals are received with Kahn Hazeltine type AM stereo radios.

8 D.L. Bordonaro, *WFTQ Occupied Spectrum Kahn STR-84*, dated February 26, 1986.

9 Private communication between Mr. Andy Laird, Vice President of Engineering for Heritage Media Corporation (KDAY), and Leonard R. Kahn.

10 The reason for the doubling of the error △ F is that the carrier error displaces the audio from one sideband by + △ F, and the audio from the other sideband aurio by − △ F, making the difference between the two audio waves 2 △ F

AM 3

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

DA 93-1534

In the Matter of)
)
An Inquiry into the Commission's) MM Docket No. 93-177
Policies and Rules regarding AM) RM-7594
Radio Service Directional Antenna)
Performance Verification)

ORDER GRANTING FURTHER EXTENSION OF TIME

Adopted: December 20, 1993; Released: December 21, 1993

Reply Comment Date: March 1, 1994

By the Chief, Mass Media Bureau:

1. On June 14, 1993, the Commission adopted a Notice of Inquiry, 8 FCC Rcd 4345 (1993), ("Inquiry") in MM Docket 93-177 to examine the policies and rules pertaining to the performance verification of directional antenna systems at AM Broadcast Radio Service stations. The directional antenna rules were initially promulgated in the late 1930s when there were few operational stations and all engineering calculations were performed manually. In the years since those rules were established, they have been amended many times, but no thorough top-to-bottom review has ever been undertaken in order to bring them uniformly up to a state-of-the-art status. The purpose of the Inquiry was to commence such a process by gathering all of the data and other information necessary for releasing a comprehensive set of proposals for rule amendments. The original deadlines for filing comments and reply comments to the Inquiry were August 20, 1993 and September 7, 1993, respectively.

2. On July 12, 1993, the Association of Federal Communications Consulting Engineers requested an extension of the comment and reply comment periods. An Order Granting Extension of Time, 8 FCC Rcd 6324 (1993), was adopted on August 19, 1993, extending the dates for comments and replies to October 29, 1993 and December 29, 1993, respectively. As of the end of the comment period, approximately 20 formal comments had been received at the agency. In addition, a meeting was held on November 17, 1993 at the Commission between agency staff and several representatives of engineering consulting firms to discuss the progress of gathering data for use in drafting proposed rule amendments.

3. The Commission now has before it a petition to further extend the date for filing of reply comments by 60 days. The petition was filed by the engineering firms du Treil, Lundin & Rackley; Hatfield & Dawson; Suffa & Cavell; Silliman & Silliman;

and Moffet, Larson & Johnson. These firms are also the petitioners who originally requested this Inquiry. Petitioners state that they and others in the broadcast industry are engaged in a study of the issues raised in the Inquiry and that a forum will be held in January where all interested parties can discuss these matters with the aim of developing reply comments which are thorough and focused.

4. After reviewing the Inquiry comments and discussing some of the relevant issues with industry representatives, it is clear that the technical complexity involved in formulating certain of the necessary amendments to our rules is quite significant. For example, some of the computer software programs now available for analyzing antenna patterns are extremely complicated and any action by the agency to eliminate existing measurement requirements and substitute in their place theoretical calculations based on these programs must be based on a thorough examination of the software and an evaluation of how its use would affect antenna pattern accuracy. We believe that the petitioners and others are making progress in formulating their proposals, but that further work is necessary and that such work would be materially aided by the forum planned for January. Therefore we agree with petitioners that a further extension of the deadline for filing reply comments is warranted.

5. Accordingly, IT IS ORDERED THAT the request to extend the reply comment date filed by du Treil, Lundin & Rackley; Hatfield & Dawson; Suffa & Cavell; Silliman & Silliman; and Moffet, Larson & Johnson IS GRANTED. The date for filing reply comments IS EXTENDED to March 1, 1994.

6. This action is taken pursuant to authority found in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended, and Sections 0.204(b), 0.283, 1.45 and 1.46 of the Commission's Rules.

7. Further information may be obtained from Joseph Johnson, Mass Media Bureau, Engineering Policy Branch, (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

Roy J. Stewart
Chief, Mass Media Bureau

AMPI 4

PUBLIC NOTICE

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET N.W.
WASHINGTON, D.C. 20554

40831

News media information 202/632-5050. Recorded listing of releases and texts 202/632-0002.

December 3, 1993

FCC ANNOUNCES THE INTERFERENCE IMPROVEMENT FACTORS FOR STATIONS WHICH HAVE PETITIONED TO MIGRATE TO THE EXPANDED BROADCAST BAND

In Report and Order, MM Docket 87-267, Review of the Technical Assignment Criteria for the AM Broadcast Service, 6 FCC Rcd 6273 (1991) ("R&O") the Commission's stated goal "[w]as to facilitate an overall improvement and revitalization of the AM broadcast band and to effectuate the necessary incorporation of new AM spectrum between 1605 and 1705 kHz into the existing AM band (535 to 1605 kHz)." The Commission concluded "[t]hat the public interest would be best served by using the expanded band to improve the overall quality of the AM service by lessening interference and congestion in the existing band." As the basis for selecting those to migrate to the expanded band, the Commission established three categories of stations and defined an interference improvement factor to be used to rank eligible migrators within each category. Category one stations are those few stations that are eligible to take advantage of the 1991 amendment to Section 331(b) of the Communications Act of 1934. 47 U.S.C. Sec. 331(b). Category two stations are full-time stations (Class "A" and "B") and category three stations are daytime only stations (Class "D"). The improvement factor is the area of interference caused all other stations divided by the station's interference-free service area. The larger the improvement factor, the greater the reduction of interference in the existing band if the station causing the interference migrates to the expanded band.

This Public Notice lists the stations desiring to migrate, their improvement factors and the order in which the Commission will attempt to find an expanded band frequency for the station. Within each of the three categories of stations eligible to migrate to the expanded band, the Commission has ordered the stations according to the improvement factor. Stations ranked from 1 to 4 are in category one, stations ranked from 5 to 332 are in category two and stations ranked from 333 to 688 are in category three. In accordance with footnote 50 of the R&O, daytime stations which have an improvement factor of zero (0.0), are not eligible to migrate to the expanded band. If a daytime station was included on the list issued on August 15, 1993, but does not appear on this list, it is because its improvement factor was calculated to be zero. These stations are being

A 1-4
B 5-332
C 333-688

informed by separate letter that they are not eligible to migrate to the expanded band.

The next public notice will appear when the allotment plan has been developed. The plan is generated by a computer algorithm which is expected to run continuously for several months. Once a solution is achieved, all participants will be notified of the results individually and a public notice listing the allotments will be released.

For more information, contact Jim Burtle at (202) 632-7010.

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
WTLM	Alexander City	AL	1050	0.0033	665
WVNN	Athens	AL	770	0.0088	642
WGYJ	Atmore	AL	1590	11.2912	13
WJOX	Birmingham	AL	690	4.3234	40
WATV	Birmingham	AL	900	0.0151	614
WFMH	Cullman	AL	1460	0.0055	653
WAGF	Dothan	AL	1320	0.9428	167
WBXR	Hazel Green	AL	1140	0.0066	650
WTAK	Huntsville	AL	1000	0.0319	562
WEUP	Huntsville	AL	1600	4.1785	44
WKRG	Mobile	AL	710	4.9907	34
WXVI	Montgomery	AL	1600	0.3369	249
WELR	Roanoke	AL	1360	0.0113	633
WBTG	Sheffield	AL	1290	0.0580	536
KWHN	Fort Smith	AR	1320	2.3206	87
KFAS	Casa Grande	AZ	1260	0.0790	521
KFWJ	Lake Havasu City	AZ	980	0.0088	643
KIDR	Phoenix	AZ	740	1.8687	105
KHEP	Phoenix	AZ	1280	0.0132	624
KPHX	Phoenix	AZ	1480	1.7754	110
KHYT	South Tucson	AZ	1330	0.0859	302
KXEW	South Tuscon	AZ	1600	0.2301	270
KXEG	Tolleson	AZ	1010	0.2032	276
KRDS	Tolleson	AZ	1190	0.1220	297
KVOI	Tuscon	AZ	690	0.0914	508
KNST	Tuscon	AZ	790	0.4451	224
KWFM	Tuscon	AZ	940	0.4551	222
KBLU	Yuma	AZ	560	0.4266	232
KAHI	Auburn	CA	950	11.1405	15
KBRT	Avalon	CA	740	0.0729	524
KRML	Carmel	CA	1410	1.0068	160
KIEZ	Carmel Valley	CA	540	0.3104	432
KOQO	Clovis	CA	790	1.3554	136
KKFO	Coalinga	CA	1470	0.0044	659
KWUN	Concord	CA	1480	14.7111	9
KOJY	Costa Mesa	CA	540	0.5455	4
KFVR	Cresent City	CA	1310	13.6572	340
KECR	El Cajon	CA	910	24.7904	7
KRGO	Fowler	CA	1210	0.1639	474
KNOB	Frazier Park	CA	1050	0.1205	498
KFRE	Fresno	CA	940	1.5941	120

Call	City of license	State	kHz	Factor	RANK
KEYQ	Fresno	CA	980	0.4015	415
KXEX	Fresno	CA	1550	1.5786	121
KGST	Fresno	CA	1600	1.1737	148
KKMC	Gonzales	CA	880	0.1242	296
KMPG	Hollister	CA	1520	3.4383	352
KTYM	Inglewood	CA	1460	1.4895	130
KXBX	Lakeport	CA	1270	0.2137	458
KHJJ	Lancaster	CA	1380	0.6871	390
KTME	Lompoc	CA	1410	19.9823	336
KFRN	Long Beach	CA	1280	9.3294	16
KGER	Long Beach	CA	1390	0.2924	260
KXED	Los Angeles	CA	1540	6.6635	25
KHOT	Madera	CA	1250	0.1375	486
KLOQ	Merced	CA	1580	45.6684	6
KHPY	Moreno Valley	CA	1530	1.0560	2
KPSL	Palm Springs	CA	1010	8.3755	20
KKXX	Paradise	CA	930	0.4566	220
KAZN	Pasadena	CA	1300	0.4694	219
KTSJ	Pomona	CA	1220	1.9247	101
KMNY	Pomona	CA	1600	0.3497	246
KTRO	Port Hueneme	CA	1520	0.0407	317
KHTE	Redding	CA	600	0.0299	322
KEBR	Rocklin	CA	1210	1.0377	158
KRCX	Roseville	CA	1110	17.3422	8
KCTC	Sacremento	CA	1320	4.1972	42
KRQC	Salinas	CA	1460	1.5214	127
KTGE	Salinas	CA	1570	0.0416	316
KMEN	San Bernardino	CA	1290	1.2725	140
KCKC	San Bernardino	CA	1350	3.8735	49
KURS	San Diego	CA	1040	0.0077	646
KJQI	San Fernando	CA	1260	0.8630	178
KOIT	San Francisco	CA	1260	1.4166	133
KALI	San Gabriel	CA	1430	0.4921	214
KJDJ	San Luis Obispo	CA	1030	3.2008	63
KTID	San Rafael	CA	1510	0.5271	406
KSCO	Santa Cruz	CA	1080	0.0023	327
KTAP	Santa Maria	CA	1600	0.2472	444
KBLA	Santa Monica	CA	1580	0.6417	204
KQKE	Soledad	CA	700	0.8944	173
KXER	Templeton	CA	1060	0.0102	636
KCTQ	Thousand Oaks	CA	850	0.0000	329

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
KMIX	Turlock	CA	1390	5.6260	31
KNBA	Vallejo	CA	1190	0.5555	3
KOGO	Ventura	CA	1590	0.8613	181
KGRB	West Covina	CA	900	0.1474	480
KIQS	Willows	CA	1560	0.0983	507
KRKS	Denver	CO	990	0.5130	211
KCOL	Ft. Collins	CO	1410	0.3080	256
KRRU	Pueblo	CO	1480	0.0858	514
WXCT	Hamden	CT	1220	0.1661	472
WPOP	Hartford	CT	1410	1.8041	109
WMMW	Meriden	CT	1470	0.3925	237
WFIF	Milford	CT	1500	1.9228	362
WRYM	New Britain	CT	840	0.7315	383
WNEZ	New Britain	CT	910	1.5106	128
WNLC	New London	CT	1510	0.2305	269
WNLK	Norwalk	CT	1350	2.0756	97
WKZE	Sharon	CT	1020	0.0349	557
WNTY	Southington	CT	990	0.1100	502
WCTF	Vernon	CT	1170	2.5359	358
WMMM	Westport	CT	1260	1.0509	376
WKND	Windsor	CT	1480	0.0853	515
WKEN	Dover	DE	1600	2.9141	71
WYUS	Milford Prettyman?	DE	930	0.5738	401
WNRK	Newark	DE	1260	0.1317	490
WAMS	Wilmington	DE	1380	1.1793	147
WNCM	Atlantic Beach	FL	1600	0.3112	430
WELX	Callahan	FL	1160	5.9683	30
WKGT	Cantonment	FL	1090	22.4026	335
WLQH	Chiefland	FL	940	0.2629	438
WORL	Christmas	FL	650	0.3112	431
WWHL	Cocoa	FL	1350	0.2020	278
WNDB	Daytona Beach	FL	1150	3.6401	53
WLVU	Dunedin	FL	1470	4.0264	47
WENG	Englewood	FL	1530	0.5772	400
WLQY	Hollywood	FL	1320	2.8114	76
WXYB	Indian Rocks Beach	FL	1520	0.2270	451
WINV	Inverness	FL	1560	0.0121	632
WOKV	Jacksonville	FL	600	0.1650	289
WVOJ	Jacksonville	FL	970	1.8623	363
WXTL	Jacksonville Beach	FL	1010	0.7792	190
WMLZ	Jupiter	FL	1000	0.1761	470
WKIZ	Key West	FL	1500	0.0000	331 ← Re WTOP
WKWF	Key West	FL	1600	1.6006	118
WLVS	Lake Worth	FL	1380	8.6471	344
WLKF	Lakeland	FL	1430	2.3059	88
WWCL	Lehigh Acres	FL	1440	1.9059	103
WMIB	Marco Island	FL	1480	2.7630	77
WCMQ	Miami Springs	FL	1210	1.2067	145
WPGS	Mims	FL	840	1.1715	372
WPSO	New Port Richey	FL	1500	2.4739	359
WWCN	North Ft. Myers,	FL	770	0.4771	217 WWN Constrained?
WOCA	Ocala	FL	1370	0.0726	525
WUNA	Ocoee	FL	1480	0.0154	610
WRMQ	Orlando	FL	1140	2.2088	361
WPCF	Panama City Beach	FL	1290	0.0704	526
WPFA	Pensacola	FL	790	0.0014	677
WMTX	Pinellas Park	FL	1040	0.1404	292
WRBD	Pompano Beach	FL	1470	0.0535	313
WPSL	Port St. Lucie	FL	1590	2.7320	356
WLVJ	Royal Palm Beach	FL	640	1.0590	156
WPUL	South Daytona	FL	1590	12.1255	342
WRXB	St. Petersburg Beach	FL	1590	3.0594	68
WAMR	Venice	FL	1320	4.3989	38
WEXY	Wilton Manors	FL	1520	0.3047	258
WXTO	Winter Garden	FL	1600	4.9647	35
WBIT	Adel	GA	1470	8.3137	21
WRFC	Athens	GA	960	0.4277	230
WAOK	Atlanta	GA	1380	13.3637	11
WRDW	Augusta	GA	1480	3.5187	54
WPIQ	Brunswick	GA	790	3.6398	350
WGIG	Brunswick	GA	1440	0.2015	279
WXEM	Buford	GA	1460	0.0004	686
WYXC	Cartersville	GA	1270	0.0033	666
WPBE	Conyers	GA	1050	0.3344	422
WLJA	Ellijay	GA	1560	0.3674	418
WFTD	Marietta	GA	1080	0.1232	494
WZOT	Rockmart	GA	1220	0.0484	541
WTSH	Rome	GA	1360	0.0019	675
WBIC	Royston	GA	810	0.0517	540
WRCC	Warner Robins	GA	1600	8.6205	19
WBRO	Waynesboro	GA	1310	0.0253	583
KASI	Ames	IA	1430	0.0011	682

No WOOD ? No Yes ?

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
KCPS	Burlington	IA	1150	0.0553	537
KCIM	Carroll	IA	1380	0.2743	266
KCFI	Cedar Falls	IA	1250	1.4474	132
KDSN	Denison	IA	1530	0.1999	464
KKSO	Des Moines	IA	1390	1.2627	142
KILR	Esterville	IA	1070	0.0019	674
KCJJ	Iowa City	IA	1560	6.0235	29
KDAO	Marshalltown	IA	1190	0.2163	454
KBOE	Oskaloosa	IA	740	0.3017	433
KYFR	Shenandoah	IA	920	0.2167	272
KECN	Blackfoot	ID	690	0.1122	501
WBIG	Aurora	IL	1280	1.4075	134
WKKD	Aurora	IL	1580	0.1417	483
WIBV	Belleville	IL	1260	0.1966	280
WCIL	Carbondale	IL	1020	0.5187	407
WROY	Carmi	IL	1460	0.0350	556
WEIC	Charleston	IL	1270	0.8885	174
WCGO	Chicago Heights	IL	1600	0.6344	399
WIXN	Dixon	IL	1460	0.0531	539
WDLM	East Moline	IL	960	0.0150	615
WRYT	Edwardsville	IL	1080	0.0362	318
WCRA	Effingham	IL	1090	0.0052	656
WRMN	Elgin	IL	1410	0.0757	303
WKTA	Evanston	IL	1330	0.0099	640
WONX	Evanston	IL	1590	0.9914	161
WMPP	Ford Heights	IL	1470	2.9830	70
WAIK	Galesburg	IL	1590	0.0154	611
WGEN	Geneseo	IL	1500	0.8532	379
WFXW	Geneva	IL	1480	0.4056	235
WBEE	Harvey	IL	1570	0.3749	240
WLDS	Jacksonville	IL	1180	0.0154	609
WJIL	Jacksonville	IL	1550	7.6186	345
WJBM	Jerseyville	IL	1480	0.0429	549
WDDD	Johnson City	IL	810	1.1586	149
WLPO	La Salle	IL	1220	0.3157	255
WPRC	Lincoln	IL	1370	0.0406	552
WLUV	Loves Park	IL	1520	0.0218	590
WGGH	Marion	IL	1150	0.0044	658
WCSJ	Morris	IL	1550	0.1546	477
WBCI	Normal	IL	1440	2.0694	98
WVLN	Olney	IL	740	1.3472	368

Call	City of license	State	kHz	Factor	RANK
WVEL	Pekin	IL	1140	0.0152	613
WPEO	Peoria	IL	1020	0.6998	388
WPOK	Pontiac	IL	1080	0.0738	523
WGEM	Quincy	IL	1440	1.3212	138
WNTA	Rockford	IL	1150	0.0023	669
WMAY	Springfield	IL	970	0.5674	207
WTIM	Taylorville	IL	1410	0.6620	395
WBCP	Urbana	IL	1580	0.0298	571
WGCL	Bloomington	IN	1370	1.8370	107
WSDM	Brazil	IN	1130	0.2209	452
WOCC	Corydon	IN	1550	0.0218	591
WCVL	Crawfordsville	IN	1550	0.1207	497
WFRN	Elkhardt	IN	1270	1.2280	144
WVHI	Evansville	IN	1330	0.4876	216
WILO	Frankfort	IN	1570	1.5344	125
WLTH	Gary	IN	1370	2.8268	75
WXLW	Indianapolis	IN	950	0.0616	530
WITZ	Jasper-Huntingburg	IN	990	0.0309	567
WAWK	Kendallville	IN	1140	0.0314	564
WKVI	Knox	IN	1520	0.2417	447
WIOU	Kokomo	IN	1350	0.8441	185
WLOI	La Porte	IN	1540	0.0897	509
WBTO	Linton	IN	1600	0.1562	475
WORX	Madison	IN	1270	0.0299	570
WGOM	Marion	IN	860	0.4485	223
WMCB	Martinsville	IN	1540	0.1356	489
WPCO	Mt. Vernon	IN	1590	0.3617	419
WERK	Muncie	IN	990	0.0330	561
WMDH	New Castle	IN	1550	0.0481	315
WGAB	Newburgh	IN	1180	0.0231	587
WSEZ	Paoli	IN	1560	0.1375	487
WPGW	Portland	IN	1440	0.0132	625
WZZB	Seymour	IN	1390	0.0026	668
WOOO	Shelbyville	IN	1520	0.6750	199
WAMJ	South Bend	IN	1580	11.1797	14
WTHI	Terre Haute	IN	1480	1.5755	122
WBNN	Union City	IN	1030	0.0473	543
WAKE	Valparaiso	IN	1500	0.0179	600
KJCK	Junction City	KS	1420	0.8754	177
KANS	Larned	KS	1510	0.0035	664
KYUU	Liberal	KS	1470	0.0308	568

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

all	City of license	State	kHz	Factor	RANK	Call	City of license	State	kHz	Factor	RANK
JRG	Newton	KS	950	0.0835	516	WESO	Southbridge	MA	970	5.5239	32
REN	Topeka	KS	1250	0.8581	182	WGFP	Webster	MA	940	0.2706	437
BRT	Bardstown	KY	1320	0.1884	465	WVEI	Worcester	MA	1440	2.4805	83
KCT	Bowling Green	KY	930	2.8862	74	WYRE	Annapolis	MD	810	0.3179	427
KYR	Burkesville	KY	1570	0.0143	620	WANN	Annapolis	MD	1190	1.6291	365
AIN	Columbia	KY	1270	0.0100	638	WBMD	Baltimore	MD	750	0.0185	599
CVG	Covington	KY	1320	6.1519	27	WERQ	Baltimore	MD	1010	0.0877	511
HLN	Harlan	KY	1410	0.0011	681	WHRF	Bel Air	MD	1520	0.0308	321
KCM	Hawesville	KY	1160	0.9549	165	WTEM	Bethesda	MD	570	6.8283	24
LBN	Lebanon	KY	1590	0.0594	532	WCTR	Chestertown	MD	1530	0.4916	408
MTL	Leitchfield	KY	870	0.2882	436	WMET	Gaitherburg	MD	1150	1.6790	114
LXG	Lexington	KY	1300	2.6357	80	WJRO	Glen Burnie	MD	1590	1.7217	112
WKY	Louisville	KY	790	0.9452	166	WASA	Harve De Grace	MD	1330	0.2344	268
KLB	Manchester	KY	1290	0.0054	654	WPTX	Lexington Park	MD	920	1.2768	139
SJP	Murray	KY	1130	0.0440	548	WINX	Rockville	MD	1600	1.8858	104
XKN	Newburg	KY	680	3.1774	64	WLVW	Salisbury	MD	960	0.1801	283
CGW	Nicholasville	KY	770	0.0099	639	WICO	Salisbury	MD	1320	0.5526	403
RLV	Salyersville	KY	1140	0.2156	455	WJDY	Salisbury	MD	1470	0.0286	575
TCW	Whitesburg	KY	920	0.5368	404	WKDL	Silver Spring	MD	1050	0.4521	411
ASO	Covington	LA	730	0.1140	500	WTTR	Westminister	MD	1470	0.6617	202
PWS	Crowley	LA	1560	3.5372	351	WMDO	Wheaton	MD	1540	0.6797	392
PWS	Crowley	LA	1560	3.4382	353	WNSW	Brewer	ME	1200	0.0047	326
KNO	Gretna	LA	750	0.6732	394	WLCM	Charlotte	MI	1390	0.3127	429
GLA	Gretna	LA	1540	0.8029	381	WLQV	Detroit	MI	1500	0.0616	310
MLB	Monroe	LA	1440	1.6022	117	WTAC	Flint	MI	600	0.2551	441
NIR	New Iberia	LA	1360	4.1802	349	WKMF	Flint	MI	1470	0.4562	221
NOE	New Orleans	LA	1060	0.7134	195	WKNX	Frankenmuth	MI	1210	0.0121	631
ICR	Oakdale	LA	900	0.0827	517	WFUR	Grand Rapids	MI	1570	0.1317	293
AGY	Port Sulpher	LA	1510	0.3300	424	WMKM	Inkster	MI	1440	0.3344	250
EZM	Sulpher	LA	1310	0.3784	417	WJCO	Jackson	MI	1510	0.0006	685
NSH	Beverly	MA	1570	0.0750	304	WKMI	Kalamazoo	MI	1360	5.4948	33
UNR	Brookline	MA	1600	0.6848	197	WKPR	Kalamazoo	MI	1420	0.0253	584
JIB	Cambridge	MA	740	14.1515	338	WQSN	Kalamazoo	MI	1470	4.1929	43
AQY	East Longmeadow	MA	1600	0.1583	290	WILS	Lansing	MI	1320	0.9574	164
XKS	Everett	MA	1430	0.6709	200	WCAR	Livonia	MI	1090	0.3779	239
SBS	Great Barrington	MA	860	0.2400	449	WBRB	Mount Clemens	MI	1430	0.2666	267
CCM	Lawrence	MA	800	0.0264	579	WSFN	Muskegon	MI	1600	2.2792	89
BIV	Natick	MA	1060	0.0165	607	WOAP	Owosso	MI	1080	0.7018	387
NTN	Newton	MA	1550	0.0634	529	WDEE	Reed City	MI	1500	0.2148	456
UHN	Pittsfield	MA	1110	0.0121	630	WSDS	Salem Township	MI	1480	0.2207	271
JDA	Quincy	MA	1300	0.1397	485	WAMX	Saline	MI	1290	0.0286	574

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

all	City of license	State	kHz	Factor	RANK	Call	City of license	State	kHz	Factor	RANK
WKMC	Parsippany-Troy Hills	NJ	1310	1.6663	115	WLNG	Sag Harbor	NY	1600	15.8095	337
ERA	Plainfield	NJ	1590	0.9208	170	WBGG	Saratoga Springs	NY	900	1.2738	370
KER	Pompton Lakes	NJ	1500	0.4429	412	WSTL	South Glen Falls	NY	1410	0.0341	558
HWH	Princeton	NJ	1350	0.3561	242	WLIR	Spring Valley	NY	1300	0.4092	414
KMB	Stirling	NJ	1070	0.2069	461	WOLF	Syracuse	NY	1510	0.0056	652
JRZ	Toms River	NJ	1550	0.9763	163	WTRY	Troy	NY	980	9.1062	17
BUD	Trenton	NJ	1260	0.8615	180	WHAZ	Troy	NY	1330	0.0583	535
KQEO	Albuquerque	NM	920	0.4270	231	WPIE	Trumansburg	NY	1160	0.8522	183
SVP	Artesia	NM	990	2.1750	93	WRUN	Utica	NY	1150	1.0964	155
IVA	Corrales	NM	1310	0.9023	171	WUTQ	Utica	NY	1550	0.0473	546
ENN	Farmington	NM	1390	1.5037	129	WNCQ	Watertown	NY	1410	0.1929	281
KEL	Hobbs	NM	1480	3.4832	56	WSLR	Akron	OH	1350	0.6454	203
KFMS	North Las Vegas	NV	1410	0.1836	282	WDPN	Alliance	OH	1310	0.9253	169
WGNA	Albany	NY	1460	0.3219	253	WOMP	Bellaire	OH	1290	0.0143	618
GLI	Babylon	NY	1290	4.3434	39	WBLL	Bellefontaine	OH	1390	0.6435	397
ABH	Bath	NY	1380	0.3207	254	WZKC	Campbell	OH	1330	0.2936	259
BRV	Boonville	NY	900	0.2628	440	WRCW	Canton	OH	1060	0.0176	603
PUT	Brewster	NY	1510	0.6740	393	WINW	Canton	OH	1520	0.0040	660
EBR	Buffalo	NY	970	0.3985	236	WATJ	Chardon	OH	1560	0.3834	416 — WKKY ?
HTT	Buffalo	NY	1120	0.0314	565	WTSJ	Cincinnati	OH	1050	3.1712	65
CGR	Canadaigua	NY	1550	0.5211	210	WCIN	Cincinnati	OH	1480	1.2093	371
CHP	Champlain	NY	760	0.1870	466	WERE	Cleveland	OH	1300	0.7600	193
CBA	Corning	NY	1350	0.0030	667	WABQ	Cleveland	OH	1540	0.8444	380
RWD	Cornwall	NY	1170	0.1305	491	WMNI	Columbus	OH	920	0.1667	288
KRT	Cortland	NY	920	2.8884	73	WVKO	Columbus	OH	1580	0.2785	265
ELM	Elmira	NY	1410	0.3377	248	WCUE	Cuyahoga Falls	OH	1150	0.3330	251
EHH	Elmira Heights-Horseheads	NY	1590	1.5428	123	WDAO	Dayton	OH	1210	0.1001	506
HLI	Hempstead	NY	1100	0.1782	468	WING	Dayton	OH	1410	2.0530	99
IZR	Johnstown	NY	930	0.9229	378	WGNZ	Fairborn	OH	1110	0.0198	595
YBG	Massena	NY	1050	0.0040	661	WCNW	Fairfield	OH	1560	0.2118	459
RKL	New City	NY	910	0.6552	396	WHTH	Heath	OH	790	0.4895	409
KDM	New York	NY	1380	1.7705	111	WSRW	Hillsboro	OH	1590	0.3269	425
WRL	New York	NY	1600	1.8472	106	WJMP	Kent	OH	1520	0.0196	597
ACK	Newark	NY	1420	0.3706	241	WLOH	Lancaster	OH	1320	0.1015	505
GNY	Newburgh	NY	1220	3.8929	48	WCIT	Lima	OH	940	0.0330	559
JJL	Niagara Falls	NY	1440	0.0143	619	WRKG	Lorain	OH	1380	0.5544	402
ALK	Patchogue	NY	1370	2.3465	360	WUCO	Marysville	OH	1270	0.3559	243
EOK	Poughkeepsie	NY	1390	3.1143	66	WTIG	Massillon	OH	990	0.0003	687
QBK	Rensselaer	NY	1300	0.2154	273	WPFB	Middletown	OH	910	0.0312	566
BBF	Rochester	NY	950	0.1771	284	WCLT	Newark	OH	1430	0.3454	420
PXY	Rochester	NY	1280	0.2049	275	WJTB	North Ridgefield	OH	1040	0.2629	439

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
WPON	Walled Lake	MI	1460	0.1287	295
WYGR	Wyoming	MI	1530	0.0275	578
KBEW	Blue Earth	MN	1560	0.1295	492
KROX	Crookston	MN	1260	0.0325	319
WEBC	Duluth	MN	560	1.9228	102
KBRF	Fergus Falls	MN	1250	0.1700	287
KDWA	Hastings	MN	1460	0.0473	545
KKOJ	Jackson	MN	1190	0.1357	488
WCTS	Maplewood	MN	1030	0.0000	330
KTCJ	Minneapolis	MN	690	0.1748	285
KUOM	Minneapolis	MN	770	0.0000	328
KNUJ	New Ulm	MN	860	0.6358	398
KYMN	Northfield	MN	1080	0.0152	612
KRFO	Owatonna	MN	1390	0.0288	572
KCUE	Red Wing	MN	1250	0.0168	606
KRXX	Richfield	MN	980	0.0892	301
KWMB	Wabasha	MN	1190	0.0473	544
KAGE	Winona	MN	1380	0.0124	627
KWOA	Worthington	MN	730	0.0140	621
KTGR	Columbia	MO	1580	0.0353	555
KEXS	Excelsior Springs	MO	1090	0.2387	450
KXEN	Festus-St.Louis	MO	1010	0.4159	234
KHMO	Hannibal	MO	1070	4.0728	45
KLIK	Jefferson City	MO	950	0.7792	189
KQYX	Joplin	MO	1560	0.1537	478
KFEZ	Kansas City	MO	1190	0.1737	286
KBTN	Neosho	MO	1420	1.8292	108
KSIS	Sedalia	MO	1050	0.0305	569
KMPL	Sikeston	MO	1520	0.0087	323
KGNM	St. Joseph	MO	1270	0.0143	617
WRTH	St. Louis	MO	1430	0.2801	264
WVMI	Biloxi	MS	570	6.2646	26
WONG	Canton	MS	1150	0.0022	671
WDTL	Cleveland	MS	1410	0.6289	206
WTWZ	Clinton	MS	1120	0.0541	538
WKXG	Greenwood	MS	1540	0.0759	522
WJNT	Pearl	MS	1180	1.2507	143
WPMX	Tupelo	MS	1060	0.0420	551
KJJR	Whitefish	MT	880	0.2023	277
WVIO	Blowing Rock	NC	1510	0.0102	637
WBAG	Burlington	NC	1150	0.1144	499

Call	City of license	State	kHz	Factor	RANK
WRTP	Chapel Hill	NC	1530	0.0040	662
WGIV	Charlotte	NC	1600	2.3419	85
WCSL	Cherryville	NC	1590	0.0319	563
WRNA	China Grove	NC	1140	0.0077	647
WDNC	Durham	NC	620	0.2838	263
WGHB	Farmville	NC	1250	4.8985	36
WAJA	Franklin	NC	1480	0.0198	596
WCRY	Fuquay-Varina	NC	1460	0.2178	453
WSSG	Goldsboro	NC	1300	0.0008	684
WGLD	Greensboro	NC	1320	0.4351	229
WWBG	Greensboro	NC	1470	2.9140	72
WQMG	Greensboro	NC	1510	0.0805	519
WLNC	Laurinburg	NC	940	3.8345	50
WSYD	Mount Airy	NC	1300	14.2585	10
WYCM	Murfreesboro	NC	1080	0.0583	534
WAYN	Rockingham	NC	900	0.0239	585
WRGC	Sylva	NC	680	4.4627	37
WACB	Taylorsville	NC	860	0.1770	469
WSJS	Winston-Salem	NC	600	0.8191	188
WYNC	Yanceyville	NC	1540	0.0036	663
KLXX	Bismark/Mandan	ND	1270	0.5100	212
KQWB	Fargo	ND	1550	0.4436	225
KHRT	Minot	ND	1320	0.0015	676
KDDR	Oakes	ND	1220	0.0311	320
KKAR	Bellevue	NE	1180	0.0626	308
KTTT	Columbus	NE	1510	0.0231	588
KRGI	Grand Island	NE	1430	0.0519	314
KHAT	Lincoln	NE	1530	0.0013	678
KOTD	Plattsmouth	NE	1000	0.0143	616
WMYF	Exter	NH	1540	3.0030	355
WMVU	Nashua	NH	900	0.1507	479
WCQL	Portsmouth	NH	1380	0.9912	162
WZNN	Rochester	NH	930	3.4893	55 ← WKST
WBRW	Bridgewater	NJ	1170	0.6915	389
WHTG	Eatontown	NJ	1410	0.9383	377
WJDM	Elizabeth	NJ	1530	1.0885	1
WRNJ	Hackettstown	NJ	1000	0.3010	434
WONZ	Hammonton	NJ	1580	13.3379	341
WSKQ	Newark	NJ	620	2.3284	86
WNJR	Newark	NJ	1430	0.4891	215
WNNJ	Newton	NJ	1360	1.1077	153

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
WYSH	Clinton	TN	1380	2.5100	82
WITM	Elizabethton	TN	1520	0.1216	495
WNWZ	Germantown	TN	1430	2.1541	94
WKTP	Jonesborough	TN	1590	0.8208	187
WIVK	Knoxville OLD WNOX	TN	990	3.0670	67
WHNK	Madison	TN	1430	0.6409	205
WHBQ	Memphis	TN	560	2.0061	100
WREC	Memphis	TN	600	0.8300	186
WATO	Oak Ridge	TN	1290	3.3216	59
WSTN	Somerville	TN	1410	0.4356	227
WDBL	Springfield	TN	1590	0.0011	683
WPHC	Waverly	TN	1060	0.0421	550
WTNR	Waynesboro	TN	930	0.2483	443
KALT	Atlanta	TX	900	0.2435	445
KSKY	Balch Springs	TX	660	0.0085	324
KACO	Bellville	TX	1090	3.0041	354
KBRN	Boerne	TX	1500	0.7249	384
KWHI	Brenham	TX	1280	0.2145	457
KBOR	Brownsville	TX	1600	2.6390	79
KAGC	Bryan	TX	1510	0.0482	542
WTAW	College Station - Bryan	TX	1150	3.3400	58
KEYS	Corpus Christi	TX	1440	0.1504	291
KYND	Cypress	TX	1520	0.0107	635
KEGG	Daingerfield	TX	1560	0.0088	644
KGGR	Dallas	TX	1040	0.0121	629
KAAM	Dallas	TX	1310	0.3516	244
KDSX	Denison-Herman	TX	950	1.3878	135
KURV	Edinburg	TX	710	3.2814	61
KBNA	El Paso	TX	920	1.0476	157
KSVE	El Paso	TX	1150	6.0273	28
KHVN	Fort Worth	TX	970	2.4462	84
KNRB	Fort Worth	TX	1360	1.1364	151
KPAR	Grandbury	TX	1420	1.4726	131
KEYH	Houston	TX	850	0.0110	634
KRBE	Houston	TX	1070	0.1098	299
KRBE	Houston	TX	1070	0.0681	527
KCOH	Houston	TX	1430	0.0165	608
KLAT	Houston	TX	1010	0.4239	233
KGOL	Humble	TX	1180	0.3077	257
KINE	Kingsville	TX	1330	1.5329	126
KVLG	LaGrange	TX	1570	0.1265	493
KLLL	Lubbock	TX	1590	0.6679	201
KRQX	Mexia	TX	1590	1.6137	366
KQHN	Nederland	TX	1510	0.0012	679
KGNB	New Braunfels	TX	1440	0.0674	528
KNDA	Odessa	TX	1000	0.0801	520
KMPQ	Rosenberg-Richmond	TX	980	0.0121	628
KXTN	San Antonio	TX	1310	0.8624	179
KCOR	San Antonio	TX	1350	0.5646	208
KJIM	Sherman	TX	1500	0.3300	423
KDAE	Sinton	TX	1590	0.3449	247
KCAS	Slaton	TX	1050	0.3157	428
KSTV	Stephenville	TX	1510	0.0194	598
KTER	Terrell	TX	1570	0.4219	413
KNAL	Victoria	TX	1410	2.1043	96
KRZI	Waco	TX	1580	2.1214	95
KBEC	Waxahachie	TX	1390	0.4354	228
KSOS	Brigham City	UT	800	0.1553	476
KTKK	Sandy	UT	630	0.0576	311
WKBY	Chatham	VA	1080	0.0022	670
WSTK	Colonial Heights	VA	1290	0.0209	593
WBTM	Danville	VA	1330	0.3285	252
WGFC	Floyd	VA	1030	0.1639	473
WLQM	Franklin	VA	1250	0.0370	553
WFLS	Fredericksburg	VA	1350	0.0613	531
WSVA	Harrisonburg	VA	550	2.5402	81
WAGE	Leesburg	VA	1200	8.9615	18
WLVA	Lynchburg	VA	590	2.7422	78
WPRW	Manassas	VA	1460	0.0622	309
WPMH	Portsmouth	VA	1010	7.8495	22
WLPY	Purcellville	VA	840	0.1793	467 ? C.P.?
WREJ	Richmond	VA	1540	0.0136	623
WVAB	Virginia Beach	VA	1550	1.0608	375
WPRZ	Warrenton	VA	1250	0.0077	648
WUSQ	Winchester	VA	610	3.6993	51
WRRA	Frederiksted	VI	1290	6.4077	346
WGOD	St. Thomas	VI	1090	23.8555	334
KGMI	Bellingham	WA	790	0.3501	245
KEYF	Dishman	WA	1050	2.2503	90
KARR	Kirkland	WA	1460	0.0048	325
KQEU	Olympia	WA	920	0.9367	168
KRIZ	Renton	WA	1420	7.4136	23

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
WVAC	Norwalk	OH	1510	0.0022	673
WOBL	Oberlin	OH	1320	1.6111	116
WBKC	Painesville	OH	1460	0.4736	218
WCCD	Parma	OH	1000	0.0045	657
WPTW	Piqua	OH	1570	0.5060	213
WMVR	Sidney	OH	1080	0.2897	435
WWWM	Toledo	OH	1470	1.1552	150
WJCM	Toledo	OH	1520	0.0000	332
WTOD	Toledo	OH	1560	0.3422	421
WBTC	Uhrichsville	OH	1540	0.0870	513
WOFR	Washington Court House	OH	1250	0.0232	586
WYPC	Wellston	OH	1330	0.0891	510
WELW	Willoughby	OH	1330	1.1103	152
KTRT	Claremore	OK	1270	3.4319	57
KCRC	Enid	OK	1390	1.1024	154
KVSP	Oklahoma City	OK	1140	0.1088	503
KMYZ	Pryor	OK	1570	0.0280	577
KSPI	Stillwater	OK	780	0.1078	504
KAST	Astoria	OR	1370	0.7079	196
KPHP	Lake Oswego	OR	1290	4.2591	41
KTMT	Phoenix	OR	880	0.7768	191
KSLM	Salem	OR	1390	4.0704	46
WNCC	Barnesboro	PA	950	0.0201	594
WGPA	Bethlehem	PA	1100	0.2487	442
WCBG	Chambersburg	PA	1590	3.6465	52
WCZN	Chester	PA	1590	0.8982	172
WRDD	Ebensburg	PA	1580	0.7149	386
WHVR	Hanover	PA	1280	2.2306	91
WMRE	Hughesville	PA	1190	1.5369	124
WLAN	Lancaster	PA	1390	1.3317	137
WNPV	Lansdale	PA	1440	1.0089	159
WTGC	Lewisburg	PA	1010	0.0871	512
WJUN	Mexico	PA	1220	0.0178	601
WNAP	Norristown	PA	1110	0.0590	533
WKQW	Oil City	PA	1120	0.1429	482
WMXH	Olyphant	PA	750	0.0053	655
WTEL	Philadelphia	PA	860	0.1055	300
WDAS	Philadelphia	PA	1480	0.2855	262
WPGR	Philadelphia	PA	1540	0.0137	622
WPHE	Phoenixville	PA	690	0.1719	471
WEEP	Pittsburgh	PA	1080	0.0209	592

Call	City of license	State	kHz	Factor	RANK
WEJL	Scranton	PA	630	0.0286	573
WCHE	West Chester	PA	1520	0.7844	382
WPJC	Adjuntas	PR	1020	90.9212	5
WCHQ	Camuy	PR	1360	14.1163	339
WIBS	Guayama	PR	1540	2.5446	357
WCXQ	Moca	PR	1040	4.7586	348
WPPC	Peñuelas	PR	1570	0.4527	410
WJIT	Sabana	PR	1250	0.0086	645
WSOL	San German	PR	1090	11.2135	343
WRSS	San Sebastián	PR	1410	1.1259	373
WLRP	San Sebastián	PR	1460	12.5030	12
WKFE	Yauco	PR	1550	58.2731	333
WHIM	East Providence	RI	1110	5.3210	347
WRIB	East Providence	RI	1220	0.1461	481
WJJF	Hope Valley	RI	1180	0.2074	460
WHJJ	Providence	RI	920	0.1110	298
WARV	Warwick	RI	1590	0.8833	176
WBEU	Beaufort	SC	960	0.0253	582
WPAL	Charleston	SC	730	0.3267	426
WXTC	Charleston	SC	1390	0.0647	307
WPCC	Clinton	SC	1410	0.0022	672
WOMG	Columbia	SC	1320	1.7023	113
WFIS	Fountain Inn	SC	1600	0.0363	554
WEAC	Gaffney	SC	1500	0.0059	651
WLBG	Laurens	SC	860	0.0264	580
WKZQ	Myrtle Beach	SC	1520	1.4113	367
WKZK	North Agusta	SC	1600	0.0077	649
WGUS	North Augusta	SC	1380	0.0176	604
WNFO	Ridgeland	SC	1430	0.6841	391
WGAS	South Gastonia	SC	1420	0.5302	405
WBCU	Union	SC	1460	0.0549	312
WALD	Walterboro	SC	1080	1.8524	364
KXRB	Sioux Falls	SD	1000	0.0092	641
KOSZ	Vermillion	SD	1570	0.0178	602
KSDR	Watertown	SD	1480	0.0286	576
WATX	Algood	TN	1590	0.0462	547
WGSF	Bartlett	TN	1210	1.2654	141
WVOL	Berry Hill	TN	1470	0.7602	192
WYOR	Brentwood	TN	560	0.0131	626
WCTZ	Clarksville	TN	1550	0.2409	448
WCLE	Cleveland	TN	1570	0.0174	605

IMPROVEMENT FACTORS OF STATIONS PETITIONING TO MIGRATE TO THE EXPANDED BAND

Call	City of license	State	kHz	Factor	RANK
KJR	Seattle	WA	950	0.5441	209
KKDZ	Seattle	WA	1250	0.0648	306
KZOK	Seattle	WA	1590	3.3129	60
KJRB	Spokane	WA	790	0.0744	305
KMTT	Tacoma	WA	850	0.4426	226
KBMS	Vancouver	WA	1480	0.8455	184
WBEV	Beaver Dam	WI	1430	1.1834	146
WMBE	Chilton	WI	1530	0.0002	688
WTKM	Hartford	WI	1540	0.2431	446
WKBH	Holmen	WI	1570	0.6763	198
WLIP	Kenosha	WI	1050	0.7153	194
WMIR	Lake Geneva	WI	1550	0.0263	581
WTDY	Madison	WI	1480	0.2121	274
WHIT	Madison	WI	1550	0.1210	496
WRJC	Mauston	WI	1270	1.1022	374
WNBI	Park Falls	WI	980	0.0330	560
WJUB	Plymouth	WI	1420	0.1415	484
WGLB	Port Washington	WI	1560	0.7233	385
WKKV	Racine	WI	1460	1.2935	369
WCWC	Ripon	WI	1600	0.3896	238
WKSH	Sussex	WI	1370	3.2230	62
WTRW	Two Rivers	WI	1590	0.8864	175
WTTN	Watertown	WI	1580	0.1289	294
WAUK	Waukesha	WI	1510	0.2059	463
WMRH	Waupun	WI	1170	0.0814	518
WNNO	Wisconsin Dells	WI	900	0.2068	462
WWNR	Beckley	WV	620	3.0178	69
WTCR	Kenova	WV	1420	1.5995	119
WRNR	Martinsburg	WV	740	0.0011	680
WCOZ	St. Albans	WV	1300	0.0220	589
WEIR	Weirton	WV	1430	0.2896	261
KSHY	Fox Farm	WY	1530	2.1825	92

STATIONS IN THE NEWS

NEW TV STATIONS FOR OSHAWA, OTTAWA: The CRTC has approved local programming for a new TV station at Oshawa, 40 km east of Toronto. Power Broadcasting had already been given approval for a rebroadcaster of CHEX-TV Peterborough, 2,445 watts ERP on channel 22, to overcome a 'shadow' effect created by the topography of the Pine Ridge. Power will introduce local programming gradually, building to 3 hrs/week in year 3. Local spots, separate from those on CHEX-TV, are limited to 6.5% of commercial time for each hour of local progamming per week, or 19.5% in year 3. (Power had asked for 40%.) Power has no plans to seek access to the Toronto market and has agreed to Rogers Cable TV in Oshawa dropping CHEX-TV when the Oshawa station goes on the air.

In Ottawa, **CFMT-TV Toronto** will be adding a rebroadcaster, 573 kW on ch. 60. With the addition of London and Ottawa, Multilingual TV will cover 77.5% of Ontario's population. Capital and operating costs are placed at $665,000 over 5 years to establish an Ottawa news bureau with one reporter and one camera operator. Also, $50,000 will be added to CFMT's scholarship fund for ethnic TV/radio students at Ryerson U.

CJSB TO GO FM: Standard's CJSB Ottawa, unprofitable in each of its 11 years, has been licensed to move to the former CKO frequency, 106.9, with 84 kW ERP. For a 3-month phase-in period, CJSB will simulcast on 540 kHz. Commitments to Canadian talent are to be increased from $12.8 to $50,000. The format will be hard rock, heavy on current releases. Also approved: FM for **CIPC Port-Cartier**, Québec, 7.4 kW on 99.1. Simulcast on 710 kHz will be for 45 days. **CKCN Sept-Iles** opposed the application, however CIPC argued that FM would allow it win back listeners who had switched to Montréal FMs on cable... **CJCJ Woodstock**, NB, is now a rebroadcaster of **CIHI Fredericton** 118 hrs/week (including overnight)... More on the **CanWest AltaWest** bid for Alberta TV: Channels proposed are 2 Lethbridge, 4 Red Deer, 5 Calgary and 17 in Edmonton. Terry Coles, a former president and GM of CFCN-TV Calgary, has joined AltaWest... Craig Broadcasting of Manitoba also filed for Alberta TV. Wendell Wilks, who had worked towards a new Alberta TV service since 1987, withdrew from his group's application. It will proceed as Alberta Interractive Multi-Media Inc., backed by David MacKenzie and Wayne Fipke of Edmonton... The Broadcast Standards Council, B.C. Region, has rejected a complaint against **CFOX-FM Vancouver** and commended GM Alden Diehl for his "exemplary" handling of the complaint. It all stemmed from 'Irish jokes' aired on the morning show last March... With the recent $500,000 move to FM, CFOR became **KICX 106 Orillia** and CKMP became KICX 104 Midland. The AM txs will go silent by the end of the year... **CJOJ-FM Belleville** was due on-air Nov. 1. Tony Zwig is manager, Greg Southhorn SM and Mike Christos PD... **CFRN-TV Edmonton** will add a rebroadcaster at Athabasca, 4 kW on ch. 13... The West's first 'instructional' FM, **CKMO Victoria** went on-air Oct. 18 from Camosun College, 50W on 103.1. Management includes Gary Wheeler and Helen Pearce ... Another instructional FM has been licensed for Algonquin College in Ottawa, 8W on 96.9... 'Acoustic Rock' is the new country crossover format on **CIXK-FM Owen Sound** — "The Mix that Kicks"... Western World wants **CFQC Saskatoon** as well as **CKIT-FM Regina** to switch to 'new country'. 'Hold on,' says **CHMX-FM Regina** (now A/C Mix 92) — 'we applied first'!

INDUSTRY NEWS

POLL SUPPORTS CBC FUNDING

A national poll by the Friends of Canadian Broadcasting has indicated that 63% of Canadians support CBC funding at its current levels. A $250 million cut was planned by the former Conservative government, to take effect in 1995. The cuts were supported by 31%. Among decided voters, support for present funding to continue was: Liberal 75%, NDP 73%, BQ 67%, Conservative 59% and Reform 49%. 'Friends' spokesman Ian Morrison believes that Canadians want a strong CBC to to counter the weakening of "the ties that bind us together" as a result of cuts in government funding for CBC and the arts.

TELESAT WANTS TO CLEAR WAY FOR DTH

Telesat Canada has applied to the CRTC to exempt Direct-to-Home satellite providers from licensing. DTH providers would still be under CRTC jurisdiction and have to meet criteria related to ownership, programming and fees. Larry Boisvert, president of Telesat, says that a number of Canadian organizations are preparing to launch DTH services and that licence exemption will enable them to compete with U.S. Direct Broadcast Satellite services expected to start early in 1994.

BBM PLANS NEW NETWORK MEASUREMENT

The BBM Bureau of Measurement says the 1995 launch of the '4P' personal, portable, passive, people meter will include a new national network audience measurement service. This will be in addition to plans already announced to provide new services for Ontario and Quebec regions and the Toronto, Montreal and Vancouver markets. Owen Charlebois, BBM president, says the 4P system allows regular sample rotation, unlike the set meter, and that soon-to-be-licensed specialty channels will help to amortize the costs of the 4P project.

U.K., CANADA PREPARE FOR DAB

Current DAB engineering tests by the BBC include a 10 kW transmitter in London, and 1 kW transmitters at three other sites testing network operation on 226 MHz. Specially-equipped survey vehicles are measuring the field strengths of the individual transmitters and the way they perform as a single frequency network. After the tests are completed, the BBC expects to produce detailed plans to introduce DAB services throughout the U.K. In Canada, it is hoped to introduce digital radio by 1995. A working group on Frequency Allocation is developing methodology for an allotment plan in the proposed L-band range of 1452-1492 MHz. CAB reports "strong doubts" that In-Band, On-Channel (IBOC), favored in the U.S., will meet the future needs of AM and FM radio.

CABLE + SATELLITE NEWS — Specialty Channel Proposals *(continued from page 7)*

The Democracy Channel Inc. — POLITICAL — English, National. Contact: Gregory H. Vezina, (416) 255-2038
Greater Toronto News (GTN) (OBCI) — ALL NEWS — English, Greater Toronto. Contact: James B. MacDonald, (416) 260-3632
Your Channel Television Inc. — HEALTH — English, National. Contact: Alexandra Brown, (416) 462-0246
MusiquePlus Inc. — MUSIC — French, Québec. Contact: Michel Arpin, (514) 529-3210
Canadian Learning Television Ltd. — EDUCATIONAL — English, National. Contact: Ron Keast, (416) 368-3194
World Television Network — GENERAL INTEREST — Bilingual, 3rd Language, National. Contact: Dan Iannuzzi, (416) 785-4300
QVC Canada Inc. — INTERACTIVE — English, National. Contact: Allan Schwebel, (416) 785-2602
QTN Networks Inc. — DOCUMENTARIES — Bilingual, National. Contact: Bob Burton, (416) 484-8050
Gene W. Plouffe (OBCI) — SENIORS — English, National. Contact: Gene Plouffe, (416) 483-4462
Down East Channel Co-Operative Ltd. (OBCI) — Not stated — National. Contact: Charles Capstick, (416) 533-6854
Note: At the time of the release of this information, the CRTC had not yet determined whether these proposals were complete or met the necessary criteria. Also, (416) telephone numbers outside of Metro Toronto have since been changed to area code (905).

The Second Annual **Digital Television Symposium** will be held Nov. 16-17 at the Four Seasons Inn on the Park in Toronto.
• Day 1 offers "a comprehensive introduction" to the latest developments in Digital Video Compression. Topics include the Wired Future (integration of computers and telecommunications); MPEG standard; digital terminals for the home; digital TV implementation; and DVC demos by corporate sponsors Jerrold, Scientific Atlanta, TV/COM and Zenith.
• Day 2 will provide more intensive background on DVC and "the technology that will bring TV into the 21st century." Among the topics are digital transmission; encryption/access; and a panel of experts fielding questions from attendees.
For further info, call Chris Harrington, CCTA, (613) 232-2631.

CCTA Call for Papers: Persons interested in preparing a technical paper (in English or French) for the 1994 CCTA convention should submit a one-page, 150-200 word abstract by January 10. Accepted papers will be due March 14. The abstracts should be submitted to Antoine Boucher, Director of Technology at CCTA, 360 Albert St., Suite 1010, Ottawa, ON K1R 7X7. The Convention will be in Montreal, May 15-18/94.

In the U.S., that offer from Bell-Atlantic Corp. to buy the cable and programming operations of Tele-Communications Inc. works out to **$2,100 per subscriber.** Other smaller deals have gone as high as $2,500. While it's a different story in Canada, the U.S. activity helps to reinforce the value of cable systems... **TV Guide** has applied for a U.S. patent for TV Guide on Screen Interactive. The software is described as "full-featured, economical, easy to use and designed for use with a variety of analog or digital converters"... Compression Labs reports a $2 million order from Keytech of Argentina for compressed digital video satellite systems. Keytech has established the first digital broadcast teleport in Latin America at Buenos Aires... More on the 'war' against signal piracy from **Fundy Cable** of Saint John, NB. Fundy has developed and is successfully marketing a device that "cracks down on the use of illegal Pay-TV decoders." Cecilia Flanagan, marketing director, says Fundy's R&D division, NCA Microelectonics, spent two years on 'Chameleon' — launched this year throughout the major systems of the company in New Brunswick. Pay-TV signals are now tranmitted in multiple codes per second, which change so rapidly that only Fundy's equipment can interpret them. Chameleon is now selling in the U.S., Central and South America. If you'd like more information, call 'Ceci' at (506) 634-5814... Another interesting technology is planned by Time Warner and Hewlett Packard: **printers for cable subscribers** that would print out a hard copy of items such as coupons, ads, news, articles, maps, etc. that appear on the TV screen... **The Family Channel** says that as of Nov. 10 it's the first broadcaster in Canada to present narrated TV for the visually impaired as part of its regular programming. It has acquired 12 classic movies which have unobtrusive narration added to the existing soundtracks, to describe the action, settings and costumes... The Family Channel has established a Program Development Fund of $100,000, to be administered by The Owl Centre, to help develop family-oriented programs... Congratulations to **TV5**, now 5 years in Canada... Canadian production got a boost with a deal between **A&E** and Toronto-based **Rhombus International Inc.** for arts programming.

AM 6

Warren

PUBLIC NOTICE

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November 30, 1993

AM GROUNDWAVE PROPAGATION CURVES ARE MADE AVAILABLE ON 8 1/2" by 11" PAPER

In the Report and Order in MM Docket No. 88-510, 5 FCC Rcd 4489 (1990), the Commission adopted new groundwave propagation curves to supersede the set of curves currently in use under 47 C.F.R. Section 73.184. The use of these new curves was stayed until such time as all the rule changes included in MM Docket No. 87-267, 6 FCC Rcd 6273 (1991), became effective. This date has been fixed as April 19, 1992. The curves have been available on 11" by 17" paper.

The curves (Graphs 1 through 20) are now available on 8 1/2" by 11" paper and can be purchased through the Commission's contractor for public records duplication, International Transcription Service, 2100 M Street, N.W., Washington, D.C. 20037, telephone (202) 857-3800. For those interested in utilizing computerized methods, this material is also available on PC compatible floppy discs. These discs contain the groundwave data points which constitute the essence of the curves and also contain the source listings (VAX Fortran) of the main programs and subroutines for generating the PostScript graph files. These floppy discs can also be procured from International Transcription Service. For further information on this matter, contact: Thomas Lucey, 2025 M St. N.W. Room 8111, Washington, D.C. 20554, telephone (202) 254-3394.

- FCC -

AM 7

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COHEN, DIPPELL AND EVERIST, P.C.
WASHINGTON, D.C.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

In the Matter of	)	
	)	
An Inquiry into the Commission's Policies and Rules Regarding AM Radio Service Directional Antenna Performance Verification	)	MM Docket No. 93-177
	)	RM-7594

Comments of du Treil, Lundin & Rackley, Inc.

du Treil, Lundin & Rackley, Inc., (herein "dLR") hereby submits the following comments in response to the Notice of Inquiry in the above referenced proceeding. dLR and its parent company, A.D. Ring, P.C. have provided technical services to the broadcast industry since 1941.

I. Introduction

dLR applauds the Commission's initiative in opening this inquiry into how the present policies and rules, many of which had their origins over 50 years ago, might be modified to allow AM broadcasters to make use of modern technology and analysis methods in evaluating AM directional antenna performance. This firm believes that, with present-day technology, it should be possible to improve the Commission's ability to ensure that the directional antennas of AM stations operate properly, while greatly reducing their licensees' burden of paying for the services of technical consultants to perform lengthy procedures and prepare voluminous paperwork.

Following a presentation of general considerations and historical information, suggestions for topics to be explored in the rulemaking for the pertinent regulations will be presented section-by-section. In order that the changes proposed herein might be better understood by representatives of the broadcasting industry at large, a discussion of possible adverse concerns will be presented prior to the conclusion of these comments.

II. Background

Over the past 52 years that this firm has been providing technical services to the broadcast industry, many hundreds of AM directional antennas have been designed, adjusted, and measured for proof-of-performance by its representatives. The firm's staff members have closely followed the advances in science and technology related to AM antennas over the years and have been directly involved in the development process themselves.

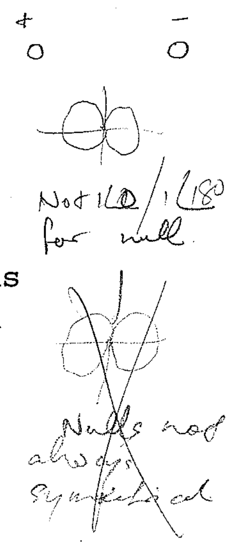
Those with this firm who are currently involved in AM directional antenna adjustment and proof-of-performance work have adjusted many systems in recent years utilizing modern methods of computer modeling. From these experiences, it has become evident to us that the field strength measurement requirements of the present rules are outdated and that proof-of-performance reports are required to contain an inordinate amount of information. Most of the required information is not necessary to ensure proper directional antenna operation.

The costs of meeting the unnecessary requirements of the present rules are great. Repair, refurbishment, and modification projects which could cost in the hundreds or thousands of dollars instead have costs which total in the tens of thousands of dollars because of these requirements. This is a deterrent for the owners of stations who could better serve the public by making directional antenna pattern modifications, as well as those of stations with directional antenna equipment in need of repair and/or readjustment. No doubt many stations are operating today with malfunctioning antenna systems, and producing interference, out of their fear of the high costs of bringing in technical consultants to meet the proof-of-performance requirements of the present rules.

The reason that the present rules require so much unnecessary work is that their fundamental framework has not changed since the 1930s, when directional antennas were still being invented and AM radio stations provided the only over-the-air broadcasting service. The methods of predicting directional antenna characteristics were crude at that time and only primitive equipment was available for monitoring internal array characteristics. The owners of the few hundred AM stations in operation at that time, who shared the national audience which is today shared by the many thousands of broadcast stations (AM, FM and TV) and numerous cable and satellite programming providers, obviously did not have to be as concerned about costs as do today's AM broadcasters.

III. <u>Early Proof-of-Performance Requirements</u>

AM directional antenna specialists first earned their reputation as practitioners of "black magic" back in the very beginning. Patterns were designed using the sinusoidal current distribution assumption (which is not too bad where far-field radiation is concerned) to make the pattern shape calculations straightforward. When it came to making directional antennas work, however, calculations which could be done using the methods available at that time were only able to provide reasonably good starting points for pattern adjustment. Considerable trial-and-error effort was often needed to find an adjustment which produced field strength measurements indicative of the proper pattern shape.



Upon completion of the adjustments, proof-of-performance field strength measurements were made. Out of concern for inaccuracies in the field strength measurement process (see section V of these comments), as well as array proximity effects, a great number of measurements were made. Once the desired pattern shape was confirmed by proof-of-performance field strength measurements, the element currents were measured and recorded to serve as an internal reference to evaluate the future stability of the array.

Currents were monitored because of the convenient, approximate relationship between the current in an array element and the field radiated by it. Element currents cannot be relied upon to have exactly the same magnitude and phase relationships as the fields produced by the elements functioning in an array. Each element in an array simultaneously functions in radiating (with nearly sinusoidal current distribution) and receiving (with decidedly non-sinusoidal current distribution dependent on the terminal loading conditions) modes and its operating current distribution is a combination of the current distributions of the two modes. There was no way of calculating the combined-mode element current distributions at that time. Current samples bear at least some resemblance to the desired field parameters, though, and can be monitored to observe changes in the operating conditions of a directional antenna system.

IV. Base Current Readings

When the first AM directional antennas were built, there was no equipment available to measure the phase relationships of their tower currents. Thermocouple ammeters connected in series with the tower base feeds were observed. A tolerance of plus-or-minus five percent was established for the base current ratios.

Base currents were the only internal array parameters which could be monitored in the beginning, and a change in the true operating characteristics of a pattern could result in changes in their ratios outside the five percent tolerance. This was not true in every case, because the fields produced by the elements of a directional antenna are two-dimensional quantities and base current magnitudes are one-dimensional. It was not possible to monitor current phases, however, so the magnitudes had to do. Although thermocouple ammeters were notoriously subject to inaccuracy due to ambient temperature effects and changes in their internal characteristics[1], they were the best instruments available at the time for measuring RF currents.

[1] Someone once described their function as measuring current with a thermometer mounted on a fuse.

SO ?

V. Monitor Points

Lacking any better way to monitor internal array operating characteristics, regularly scheduled external field strength observations, even if subject to inaccuracy, were desirable. It became a standard requirement to select certain monitor points from the many field strength measurement locations at the time of a proof-of-performance. They were selected along the measurement radials considered to be critical; often toward other stations rather than at null azimuths. Field strength measurements were required to be made periodically at these locations and to be maintained below the maximum values assigned by the Commission.

Field strength measurements are subject to myriad influences having to do with groundwave propagation and local disturbances in magnetic field (AM field strength meters actually sample the magnetic component of field even though their meter scales indicate the far-field equivalent electric field strength). Seasonal effects (from frozen-ground winter conditions to dry, hot summer conditions) can cause monitor point field strengths to vary over a range of greater than two-to-one. If their limits are based on readings taken when conditions promoted abnormally high field strengths, monitor point observations made under normal conditions can seem deceptively low. If adjustments are made based on such readings, excessively high unattenuated radiation can result.

VI. Phase Monitors

Later in the history of AM directional antennas, "phase monitors" and remote tower loop current indicators became available. These units were the predecessors of today's antenna monitors. The requirement to read array element currents and phases was added to the requirements for base currents and monitor points. Stations were required to maintain the loop current ratios within five percent and the phases within three degrees. This was to provide a complex-plane current tolerance of approximately five percent.[2] From this time on, stations were responsible for maintaining three internal parameters and one external quantity (base currents, loop currents, loop current phases, and monitor point field strengths) within their respective tolerances.

VII. Critical Directional Antennas

As the AM band filled up with stations, the question of loop current and phase tolerance was revisited, at least for stations unfortunate enough to file applications for facilities on the frequencies of well-to-do broadcasters who jealously monitored activity on their channels. Facing arguments that the new stations' directional antennas might theoretically cause interference to the older stations if the wrong set of simultaneous parameter changes happened to take place, the Commission created the category of "critical directional antenna."

For these stations, licenses were issued with parameter tolerances much more restrictive than for the others. For instance, a tolerance of 0.8 degree might have been placed on the phase of every element in a system because a study showed that such an excursion for one of the elements could theoretically cause interference. It was not necessary for the complainant to demonstrate that the phase drift of this element would ever occur in concert with the other element parameter changes to produce the condition of interference assumed in the calculations. It was not considered that the requirement for elements with much smaller field contributions, the ones that are more difficult to control, might not be justified at all.

This was done, in our opinion, without proper consideration of the nature of array parameter variation viewed in the light of

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[2] It can be seen from trigonometry that a three degree change in the angle of a vector will cause a complex-plane change of slightly over five percent, roughly perpendicular to the change which would result from a change in the vector's length.

signal propagation uncertainty. It seems ludicrous to us to require a station to maintain loop currents and phases within very tight tolerances for each array element all of the time because a set of parameters with small changes in ratio and phase could be found (without evidence that the simultaneous parameter changes would likely ever occur) to produce interference as defined by a model which predicts propagation conditions for ten percent of the time. Considering the fact that the directional antennas of many, if not most, of the stations in operation in the United States could be demonstrated to be "critical" using these procedures, the process has not been applied fairly, either.

VIII. Recent Trends in Regulation

In recent times, the FCC's rules have been changed to require modern equipment for sampling current ratios and phases, allow the use of toroid sampling devices at tower bases, upgrade the sampling system requirements and relax many of the labor-intensive operating requirements. The proof-of-performance requirements are still geared to the gathering of an enormous amount of external field strength information which must be included in a lengthy (and expensive to produce) report and stations are still responsible for maintaining all of the same internal and external readings that were established in the early days of AM directional antenna technology.

The process since the beginning has been one of layering on additional requirements as new technology has become available without reducing the burden of previous ones. For instance, was it still necessary to measure element base currents once remote readings of current ratios and phases became possible? Is it still necessary for stations with antenna monitor systems meeting the current rules to measure monitor point field strengths? Both are heavy burdens on AM broadcasters, even though the present rules do not require that they be read, because their tolerances are still specified and they are required to be within them.

IX. What do Proofs-of-Performance Prove?

As things stand now, technical consultants do a lot of expensive work running lots and lots of field strength measurements and making hair-splitting adjustments to control their values to within tenths of a decibel (herein dB). If we think that, just because we can read our field strength meters to within tenths of a dB, we can adjust patterns to produce the far-fields that protect other stations to that degree, we are deluding ourselves. The present requirements for directional antenna performance verification cannot define pattern radiation with that precision.

Full proofs of performance are subject to errors due to the complex electromagnetic environment that stations exist in, as well as to proximity effects which can be easily misinterpreted. Anyone who has adjusted and made field strength measurements on a directional antenna with deep nulls has probably observed scattering of field strength along a measurement radial spanning several dB. It is a mistake to assume that an adjustment to produce acceptable magnetic fields at the points that one decides to measure, compensating for local and, possibly, proximity effects, necessarily produces the desired far-field pattern. Adjustment to an entirely different set of parameters might produce excessive field strengths at these points while producing acceptable field strengths at other points along the radial.

The efficacy of proof-of-performance measurements to prove the real interference potential of directional antennas can be better understood by examining the information presented in the FCC memorandum concerning "Suppression Performance of Directional Antenna Systems in the Standard Broadcast Band" by Harry Fine and Jack Damelin, dated September 6, 1957. In this report (which was prepared before the advent of standard patterns), analysis methods to correlate measured and theoretical far-field skywave protection for a number of actual stations were examined. All stations studied were verified to be operating properly, under the rules, prior to the observations. A quadrature component of

9.0 percent of pattern RSS was found to produce standard errors in the range of four to six dB. Since the present standard pattern rules specify a quadrature factor of 2.5 percent (above a certain threshold), standard errors would be even higher if the 1957 data were analyzed under the present standards for defining patterns.

X. What do Partial Proofs-of-Performance Prove?

Partial proof-of-performance measurements are subject to additional difficulties. Since field strength measurements are analyzed with the original proof-of-performance as the standard, changes in the electromagnetic environment during the intervening time period can introduce substantial errors. Seasonal differences in ground conditions and changes in effective ground conductivity due to land development within ten miles of an array can result in errors on the order of several dB. Local effects, due to changes near the measurement points, introduce another layer of uncertainty.

Partial proofs-of-performance cannot prove that directional antennas function the same as they did at the time the most recent full proof-of-performance was run on them. In trying to do so, one encounters a margin of error that can be as high as several dB.

XI. Are Monitor Points Reliable?

Monitor point field strengths are subject to the same changes over time as partial proof-of-performance field strengths. It is possible for a station to conclude, from monitor point readings, that it is operating in accordance with the rules, even though the actual radiated field from the directional antenna might have strayed several dB from the value determined in the original proof-of-performance. On the other hand, it is also possible for monitor point field strengths to read high for the same reasons.

Most stations stopped reading monitor points on a weekly or even monthly schedule when the requirement for logging them was eliminated from the rules. Many stations stopped reading them at all. When monitor point field strengths are above their licensed limits today, with proper antenna monitor indications, it often means that either a seasonal change in effective ground conductivity or some new source of scattered field near the monitor points is at work. Even when the directional antenna pattern is in perfect adjustment, its licensee will have to spend thousands of dollars on partial proof-of-performance work to either move the point or show that the limit should be raised.

XII. What do Base Currents Show?

Most AM stations stopped reading base currents when the Commission dropped the requirement to log them about a decade ago. Many still have thermocouple ammeters in place at their tower bases. If they were to be read and found to be out of tolerance today, with correct antenna monitor indications showing, it would most likely mean that either their calibrations have drifted over the years or that they have been damaged by lightning. Those stations employing the more modern toroid sampling ammeters would probably not find that their calibrations have drifted, but many would discover lightning damage.

Woe unto any station operator with base current meters giving improper indications if one of the Commission's inspectors happens along. The ratio tolerances still apply, even though there is no longer any requirement for logging the readings.

XIII. Are Antenna Monitor Readings Reliable?

Antenna monitor readings, for stations employing approved sampling systems, are very reliable indicators of array stability. Stations that employ sampling loops on their towers, providing that their properties and those of the sampling lines used to connect them to the antenna monitor are known, can rely on their antenna monitor readings as indications of the actual tower current relationships. Those employing toroid samplers at the tower bases can do so if the shunt effects at the tower bases can be accounted for.

We believe that, with proper modification of the sampling system requirements, the Commission can ensure that actual array operating parameters are monitored. The present rules provide for systems that can accurately monitor changes in parameters from those established at the time of a proof-of-performance. It will be a small step to provide for actual indications of ratio and phase using the same antenna monitors that are on the market and in use at most stations today.

XIV. <u>Preparing for the Future</u>

It is clearly time for a change. Many of the present directional antenna performance verification requirements are unnecessary. They can lead, though, to considerable maintenance expense for the licensees who wish to keep their facilities in total compliance with the rules.[3] The AM radio industry cannot afford these regulations in today's economic environment.

When this firm co-sponsored the original request for this Notice of Inquiry in 1989, it was our position that the rules should be changed to greatly simplify the measurement program and report requirements required for a proof-of-performance. We envisioned, based on our experiences with pattern analysis utilizing far fewer field strength measurements than are presently required for a proof-of-performance, that the rules could be changed to require less measurement work, and a simpler report, than required today for a partial proof-of-performance. The distinction between full and partial proofs-of-performance could, we thought, be eliminated. We also believed that the base

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[3] It is a temptation for some to risk a fine if an inspection occurs rather than take care of violations that would be costly to remedy.

current ratio tolerances of the rules served no purpose and could be eliminated.

We believed that these changes would be good for the AM radio industry, since the licensees of stations with directional antenna problems could much more easily afford to remedy them. Directional antenna pattern changes for coverage improvement could also be made more affordable under such a plan.

Our experience over the four years since we originally joined in petitioning for this Notice of Inquiry, considered along with our previous experience with modern computational techniques, has shown to our satisfaction that the computer software and instrumentation hardware available today make possible the satisfactory adjustment and maintenance of directional antennas without reliance on field strength measurement data.

We believe that a proof-of-performance report can be reduced to provide only information concerning the moment method model to predict the array parameters observed by the antenna monitor system, the design of the antenna monitoring system, measurements on the sampling devices and transmission lines, calibration information for the antenna monitor employed, information pertinent to the determination of operating power, a surveyor's certification to the tower alignment, and a certification from the technical consultant that the array and sampling system were built according to the submitted design and that the indicated parameters were adjusted to the calculated values.

We believe that the requirements for reading base currents and monitor point field strengths can be eliminated for AM stations meeting the new requirements and that the separate requirements for stations employing so-called "critical directional antennas" should be eliminated. A number of additional proposals which we believe would lead to AM improvement are presented in the section-by-section suggestions for rule changes appearing in these comments.

XV. Moment Method Modeling

The single most significant improvement in the state of the art to come along since the early days of AM directional antennas has to be moment method modeling. With moment method modeling, it is possible to solve for actual system currents and voltages to produce a desired antenna pattern. No longer is it necessary to make assumptions about the current distribution characteristics of elements in an array (see section III of these comments). Actual drive conditions can be accurately predicted for the desired pattern shape, instead of just an estimate of parameters to serve as the starting point for a trial-and-error adjustment effort.

Our experience with moment method modeling techniques for AM directional antennas goes back approximately ten years. Originally, we were interested in moment method modeling because of the advantages it offered for base impedance calculations and phasing system bandwidth optimization. As we began to tune new antenna patterns to the parameters predicted with moment method modeling, we noticed that the patterns measured before any field adjustment efforts were made agreed much more closely to the theoretical pattern shapes calculated by the methods specified in the rules than we had ever seen in the past. In some cases, no further adjustments were necessary prior to the proof-of-performance. In others, only slight differences were required. In no case have we found any indication of radiation that we would characterize as likely to cause objectionable interference, given the uncertainties of the proof-of-performance process (see section IX of these comments). We have successfully modeled arrays utilizing both guyed and self supporting towers, as well as both "top hat" and guy-wire forms of top loading.

If the Commission, in a Rulemaking, requests comments on the proposals presented herein, we believe that a great body of evidence will be submitted for consideration. This firm will devote considerable time and effort to providing the most up-to-date information available at that time. Others from within the broadcasting community and outside experts who work regularly with numerical electromagnetic techniques will certainly provide valuable input to the process.

Although the techniques are relatively new to the AM antenna industry, moment method computer programs go back at least to the 1960s. Several modern programs are in the public domain today. Two of the most useful, NEC and MININEC were developed with United States government funds, and are available at nominal cost. Certain modifications and auxiliary programs, which are helpful for using NEC and MININEC to model AM directional antennas, have been the subject of technical papers presented at conferences and conventions.

NEC is a very powerful program, capable of analyzing extremely complicated antennas and environments. It can be used to model, for instance, the effects of real soil conditions on the far-field radiation characteristics of an AM directional antenna at angles above the horizon. MININEC is much simpler and will run on common office-type microcomputers (although slowly if a math co-processor is not installed). The later versions of MININEC solve simple problems, such as AM array elements over an assumed perfectly conducting surface, very efficiently. Since the present AM allocation rules are based on sinusoidal current distribution and perfect-earth assumptions for calculating antenna patterns, we believe that the additional features of NEC are unnecessary and that either program can be used to determine the appropriate parameters for a directional antenna. The allocation and pattern design requirements of the rules are not within the scope of this Notice of Inquiry.

XVI. Suggested Rulemaking Topics

73.14

Critical directional antennas should be eliminated. All stations should have the same parameter tolerances and be able to utilize modern antenna monitors. Better antenna monitors are available today than those which were outfitted for the precision monitor adapters required to be installed by the stations whose directional antennas were designated critical.

73.44

The emissions requirements of the rules should specify that measurements of both desired and undesired signals be measured within the major lobe of an AM directional antenna. This will make the process much simpler than the one described in the rules. We believe that major lobe measurements should suffice to ensure that AM stations meet the requirements of the emissions rules.

73.45

The minimum field strength requirements should be eliminated. In the case of conventional nondirectional and directional antennas, their radiation shall be calculated according to the provisions of the present rules. For nonconventional antennas, the radiation predicted using moment method techniques with a loss assumption of one ohm at the maximum current point of each element shall be used. No field strength measurements should be required to establish the radiated field.

73.51

The rules should allow stations with negative resistance elements to terminate them into power-absorbing loads, determine the power lost in the loads, and consider it along with the common point input power to determine the antenna input power. This will allow substantial improvement in pattern bandwidth for many such stations, without penalizing them with poor antenna efficiency.

73.53

The reference to critical arrays should be eliminated. (see 73.14)

73.54

The requirement to set directional antenna common point reactance to zero should be eliminated. The requirement for an impedance versus frequency sweep should be eliminated.

73.58

The requirements for measuring antenna base currents in directional antennas should be eliminated.

73.61

The requirement for monitor point field strength measurements should be eliminated.

73.62

The parameter tolerances should be the same for all stations. Special requirements for "critical" stations should be eliminated (see 73.14).

Comments should be sought on whether the tolerances for magnitude and phase of sampled base voltages (see 73.68) should be the same as they presently are for current samples.

73.68

Base voltage sampling for the antenna monitor should be allowed for any tower height. Moment method techniques make possible the precise prediction of base drive voltage relationships for elements of an array. Base voltage sampling, we believe, can be more indicative of actual pattern operation than current sampling, as it is not subject to the effects of shunt currents (both displacement and conduction) across the tower bases.

If tower base current sampling is allowed, it should only be done where verifiable shunt effects can be accounted for in the calculation of operating parameters.[4] Comments should be sought on these issues.

Reference to critical directional antennas should be eliminated.

The requirement for a partial proof-of-performance following a change above any tower base should be eliminated. A full proof-of-performance should be required instead. Our proposed full proof-of-performance will be much less costly than is a partial proof-of-performance under the present rules.

The rules should specify the tests and measurements necessary to validate the antenna sampling system. We recommend open-circuit impedance observations at frequencies found to produce resonance[5] for the sampling lines, so that their lengths at carrier frequency can be scaled from the nearest resonant frequency, and impedance measurements at carrier frequency with the sampling devices connected for normal operation. The observations should be made at the antenna monitor ends of the lines. The impedances should indicate identical[6] loads with the sampling devices connected. In the case of tower-mounted, single turn, unshielded loops, this will indicate that their pickup characteristics are identical. In the case of base sampling

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[4] It might be necessary to restrict base current sampling to towers of certain heights and without certain types of circuits across their bases.

[5] Resistance determined by line losses and zero reactance.

[6] Plus-or-minus one ohm and two percent resistance and reactance.

devices, they will provide a reference for the devices' internal terminations.

Specific information on the acceptability of antenna monitor sampling systems should be in the rules.

73.151

The proof of performance should provide the following information:

1.) Information concerning the moment method model to predict the array parameters observed by the antenna monitor system

2.) The design of the antenna monitoring system

3.) Measurements on the sampling devices and transmission lines

4.) Calibration information for the antenna monitor

5.) Information pertinent to the determination of operating power

6.) A surveyor's certification as to the tower alignment

7.) A certification from the technical consultant that the array and sampling system were built according to the submitted design and that the indicated parameters were adjusted to the calculated values.

The requirements should be the same for all AM stations (the expanded band included).

73.153

The apparent conflict with the requirements of 73.185(a) should be resolved.

73.154

Following the changes suggested for 73.151, there will no longer be any need for a distinction between partial and full proofs of performance.

73.158

Deleted.

73.189

The minimum height and field strength requirements should be eliminated.

XVII. Possible Adverse Concerns

There is a certain hypnotic effect to doing the same tasks, the same way, over and over again for fifty-plus years. Radically new technology looming just over the horizon can often seem frightful, too. No doubt, objections have come to the minds of many of the readers of these comments as the proposed changes have been presented. We would like to share our positions on some of the concerns that we expect have arisen.

"If so many stations are out of tolerance, the rules should be made harder, not easier." - The fact is that our proposal should help this situation quite a bit. Changing the rules to turn a proof-of-performance into something like a one-day affair will actually help this situation in two ways. Stations will be much more easily able to afford the technical services they need and the Commission's field inspectors will be able to duplicate entire proofs-of-performance to aid in their enforcement efforts.

"Making proofs-of-performance simpler will make it easier for the devious." - In fact, deceitful practices will be discouraged. Much more effort and expense can be saved under the present rules if anyone is unscrupulous enough to falsify field strength measurements. If the proposals appearing herein are enacted, this incentive for less-than-honest behavior will disappear. Additionally, it will be much easier for the Commission to check up on suspected violators.

"Moment method models cannot be trusted." - We believe that, if a Rulemaking is initiated to examine the proposals herein, the record will show to the satisfaction of all open-minded interested parties that monitoring and modeling methods can be specified which will provide interference protection no worse than would be the case under the present rules if all stations obeyed them.

"The proposals will make it impossible for technical consultants without great, big computers to do proof-of-performance work." - This is untrue. First of all, we believe that the necessary calculations can be performed on the average microcomputer. No secrets are involved in the moment method and auxiliary software employed by this firm and others who are doing such modeling today. The methods employed have been presented at public technical conferences. Market place forces should see to it that software packages with straightforward instructions will be available before the changed rules become effective, if they are enacted.

"The proposals will make it impossible for station personnel to do proof-of-performance work." - This is untrue. The station personnel who do not have the necessary computer equipment and software to do the calculations themselves could rely on the directional antenna equipment suppliers for the appropriate numbers. This situation would be similar to the situation for FM directional antennas today, where the manufacturers are responsible for their pattern-determining qualities.

"The proposals will cut into consultants revenues." - We hope that no one is motivated adversely by this concern.

XVIII. <u>Conclusion</u>

Rule changes similar to those proposed herein should improve the Commission's ability to know that our nation's AM directional antenna systems are functioning properly while greatly reducing the cost burden on their licensees. We estimate that proof-of-performance costs will decrease something like ten-fold if such rules are enacted.

We ask the Commission to give our proposals serious consideration and to include them soon in a Rulemaking proceeding.

Louis R. du Treil

John A. Lundin

Ronald D. Rackley

du Treil, Lundin & Rackley, Inc.
240 North Washington Street
Suite 700
Sarasota, Florida 34236
(813) 366 2611

October 28, 1993

COHEN, DIPPELL AND EVERIST, P. C.

TO:	Robert Culver
FROM:	Don Everist
TOPIC:	MM Docket 93-177
DATE:	October 12, 1993

We have identified thus far several broad areas for which we are developing comments.

Section 73.51 -- Update F factor for newer transmitters.

Section 73.58 -- Substitute automatic power control when common point or ND base meter fails.

Section 73.68 -- Replacement or identical items (except loop) above base insulator should not automatically trigger partial proof.

Section 73.88 -- Revise blanketing percentage since 25 mV/m no longer used by FCC. Difficulty in urban area stations meeting current rule. We suggest 1% of 5 mV/m contour.

Section 73.158 -- Let monitor points be established by ratio method, i.e., when stations can automatically operate non-directional; permit ratio maximum.

<u>Computation Methods Revision</u>

We do not favor wholesale changes in computational methods to the exclusion of proof-of-performance measurements or total reliance in sample systems to establish any directional pattern.

<u>Frequency tolerance</u>

We may advocate tighter frequency tolerance with the advent of stereo.

To: Don Everist From: Scot Freeman → OCT 12 1993 Will Bevis will be calling [illegible] Regarding

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, DC 20554

8 OCT 1993

IN REPLY REFER TO:
1800B3-DEB

The Ohio State University
2400 Olentangy River Road
Columbus, Ohio 43210

In re: WOSU-FM; Columbus, Ohio
The Ohio State University
BPED-921215IF

Gentlemen:

This letter is reference to WOSU-FM's construction permit BPED-921215IF. That permit contained a condition requiring WOSU-FM to conduct measurements to insure that construction of the tower authorized therein did not affect the radiation pattern of AM station WCOL, Columbus, Ohio. Due to the unusual circumstances detailed in your attorney's letter dated October 7, 1993 (copy attached), this condition has not been fulfilled. However, now that the omission has been discovered, we understand that WSYX (TV) and WOSU-FM have committed themselves to satisfying WCOL (AM) and the Commission's AM Branch that the tower structure authorized by the FM and TV permits did not affect WCOL's radiation pattern. Consequently, we HEREBY GRANT automatic program test authority to WOSU-FM to permit that station to commence operations at such time as it is ready to do so. However, please be advised that the license application (on FCC Form 302-FM) to cover permit BPED-921215IF will be held in abeyance until the Commission's AM Branch is satisfied that WCOL's radiation pattern is in compliance with its rules and policies.

Please include a copy of this letter with WOSU-FM's FCC Form 302-FM application for license to demonstrate that program test authority has been authorized.

Sincerely,

Dale E. Bickel

Dale E. Bickel
Supervisory Electronics Engineer
FM Branch
Audio Services Division
Mass Media Bureau

cc: Dow, Lohnes & Albertson
: Continental Broadcasting, Ltd. (WSYX)
: Great Trails Broadcasting Corp. (WCOL)

Attachment

DOW, LOHNES & ALBERTSON
ATTORNEYS AT LAW
1255 TWENTY-THIRD STREET
WASHINGTON, D. C. 20037-1194

COPY

MM-LC
93007WQ

TELEPHONE (202) 857-2500
FACSIMILE (202) 857-2900

MARGARET L. MILLER
DIRECT DIAL NO.
857-2914

October 7, 1993

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554
Attn: FM Branch
Dale Bickel
STOP CODE 1800B3

Note: Exempt from Filing Fees

Re: Request for Expedited Program Test Authority for Modified Operations of Station WOSU-FM, Columbus, Ohio

Dear Mr. Caton:

On behalf of The Ohio State University ("OSU"), we transmit herewith, in triplicate, a request for expedited program test authority for the modified operations of noncommercial educational Station WOSU-FM, Columbus, Ohio. OSU requests program test authority be granted by the end of the business day on Friday, October 8, 1993.

WOSU-FM's modified operations involve relocation of WOSU-FM to a new tower built by collocated Television Station WSYX, Columbus, Ohio.[1/] Expedited authority is necessary in order to allow Station WOSU-FM to commence program tests on Monday, October 11, 1993 in conjunction with planned program tests of Station WSYX on that same day.

1/ Station WOSU-FM, Channel 209, and Station WSXY, Channel 6, are collocated in order to reduce harmful interference from there adjacent frequency operations.

The construction permit issued to WOSU-FM contained special operating conditions, including a condition requiring the permittee to make certain efforts to prevent adverse effects upon the radiation pattern of WCOL(AM) before program tests commenced.[2/] Unfortunately, Station WOSU-FM never received this construction permit from the Commission and, thus, was unaware of the existence of the special operating conditions until yesterday, October 7, 1993, when its FCC counsel retrieved a copy of the permit from the FCC.

Moreover, compliance with this special operating condition is not properly the responsibility of WOSU-FM. WOSU-FM is not the owner of the tower, nor responsible for its construction, maintenance or existence. The collocated Channel 6 Television Station, WSYX, is the tower owner and party responsible for its construction and maintenance. WOSU-FM is merely a tower lessee that collocated with Station WSYX to lessen possible interference between the stations. However, the construction permit for WSYX contained no condition with respect to tower construction and WCOL(AM) radiation patterns, thus, the tower was constructed without meeting the obligations of the special operating condition with respect to WCOL(AM).

Since becoming aware of this special operating condition, however, Station WOSU-FM and Station WSYX have consulted about techniques to minimize the effects of the tower, if any, upon the radiation pattern of WCOL(AM). As the attached letter from Station WSYX demonstrates, WSYX, as tower owner and manager, will undertake such steps as are necessary to ensure that the adverse effects to WCOL(AM) are eliminated. Please note that, since the new tower was constructed neither Station WOSU-FM nor Station WSYX have received any complaints or other communications from WCOL(AM) regarding its radiation pattern. Moreover, as the attached letter demonstrates, engineering personnel at WCOL(AM) have been fully cognizant of the construction of the tower and have discerned no adverse effects on WCOL(AM) from its construction.

2/ The construction permit also contained a special operating condition requiring WOSU-FM to take measurements sufficient to ensure spurious emissions from the multiplexed antenna of WOSU-FM and WSYX remained within authorized bounds and a special operating condition requiring WOSU-FM to submit a copy of the vertical plan pattern for its beam tilt antenna. Copies of both of these measurements will be submitted with FCC Form 302-FM; WOSU-FM is in the process of preparing its license application on FCC Form 302-FM and anticipates that its license application will be filed with the FCC in the near future.

For all of these reasons, WOSU-FM respectfully requests program test authority for its modified operations to commence on Monday October 11, 1993.

Should any questions arise concerning this matter, kindly contact this office.

Very truly yours,

Margaret L. Miller

MLM:vcs

Attachments

cc: James Burtle, Chief, AM Branch
Dale Bickel, FM Branch
William S. Reyner, Esq.

6 WSYX TV
COLUMBUS
[illegible] Dublin Road, P.O. Box 718, Columbus, OH [illegible]

October 7, 1993

Mr. Dale Gurta
WOSU-FM
WOSU Stations
2400 Olentangy River Road
Columbus, OH 43210

Dear Dale:

This is to confirm the willingness of Continental Broadcasting, Ltd., licensee of WSYX, Columbus, OH, to eliminate any adverse interference conditions caused by the construction of the new WSYX tower at 930 Stimmel Rd.

With respect to this matter, we have been in contact with the chief engineer of WCOL(AM). He has been fully cognizant from the beginning of the construction of the new WSYX tower and has been monitoring WCOL(AM)'s operations for changes in its parameters during the course of that construction

WCOL(AM)'s chief engineer advised me that upon completion of the WSYX tower, there was no difference in WCOL(AM)'s operating parameters from those existing prior to the commencement of construction of the WSYX tower. Furthermore, WCOL(AM)'s chief engineer advised me that he is not aware of any listener comments attributable to changes in its technical operations during the course of or upon completion WSYX's tower construction.

I trust that this information will be helpful. Please contact me if there is anything further I can provide.

Sincerely,
Continental Broadcasting, Ltd./WSYX

P. [illegible] Ford
VP/Director of Engineering

EVERIST 10/13

Fax Transmittal Memo 7672

No. of Pages: 3	Today's Date: 10/[illegible]/93
Time: ~~4:15 p.m.~~	
To: Bob Guill	From: J. Whitley 10.
Company: Cohen & Dippell	Company: FCC
Location:	Location: AM Br.
	Dept. Charge:
Fax #: 898-0895	Fax #:
Telephone #: 898-0111	Telephone #: 632-7010
	Original Disposition: ☐ Destroy ☐ Return ☐ Call for pickup

Comments

WWRC, Washington, D.C.
C.P.

[redacted]

United States of America
FEDERAL COMMUNICATIONS COMMISSION

FCC 351
December 1985

File No.: BMP-930302AC
Call Sign: WWRC

AM BROADCAST STATION CONSTRUCTION PERMIT

1. Permittee: GREATER WASHINGTON RADIO, INC.

2. Station location: Washington, D C
3. Transmitter location: 6000 Ager Rd.
Chillum Township
Prince Georges County, Maryland

North Latitude: 38° 57' 43"
West Longitude: 76° 58' 24"

4. Main studio location:
(Listed only if not at transmitter site or not within boundaries of principal community.)

5. Remote control location: 8121 Georgia Ave
Silver Spring, MD

6. Transmitter: Type accepted
(See Section 73.1660, 73.1665 and 73.1670 of the Commission's Rules.)

Average hours of sunrise and sunset:
Standard Time (Non-Advanced)

PROVIDED WITH PREVIOUS AUTHORIZATION

FCC-353 FILE NO. BMP-930302AC CALL LETTERS W W R C

FREQ: 980 kHz **Nominal Power:** 5.0 kW, 50 kW-LS, DA-2,U

1. **DESCRIPTION OF DIRECTIONAL ANTENNA SYSTEM**

No. and Type of Elements: Three (3) vertical, series-excited, steel radiators. Tower #1(S) is guyed with a capacity top; tower#2 (NW) and #3(NE) are tapered, self-supporting & insulated. Theoretical RMS: 2186.99 mV/m/km, day; 667.88 mV/m/km, night. Standard RMS: 2297.54 mV/m/km, day; Aug.RMS: 707.64 mV/m/km, night. Q factor: 70.71, day; 21.59, night.

Height above Insulators: #1(S)= 121.9 m (143.5° + 32.5°TL)
#2(NW) and #3(NE)= 76.2 m (89.7°)
Overall Height: #1(S)= 125.1 m ; #2 and #3= 79.2 m

Spacing and Orientation: with tower #1(S) as reference, tower #2(NW) is spaced 90° on a bearing of 336° T and tower #3(NE) is spaced 157° on a bearing of 49.6° T.

Non-Directional Antenna: None Authorized

Ground System: consists of 120 equally spaced, buried copper radials with an average length of 109.9 meters, bonded to copper buses where they overlap.

2. **THEORETICAL SPECIFICATIONS**

TOWER	#1(S)	#2(NW)	#3(NE)
Phasing:			
Night	0°	135°	-115°
Day	0°	---	39°
Field Ratio			
Night	1.0	1.85	0.482
Day	1.0	---	1.556

The inverse distance field strength at a distance of one kilometer from the above antenna in the directions specified shall not exceed the following values:

DAYTIME		NIGHTTIME	
Azimuth	Radiation	Azimuth	Radiation
23.5°	738.64 mV/m	NO CHANGE	
75.5°	738.64 mV/m		

A monitoring point in each of the above directions in which a field intensity is specified shall be designated with complete detail including a description of the point, directions of proceeding thereto and the field intensity measured at this point after final adjustment of the antenna system in exact accordance with the terms of this authorization and the Rules and Regulations and Standards of Good Engineering Practice Governing Standard Broadcast Stations. The Points shall be in the clear so as to permit the taking of unobstructed field intensity measurements and shall be located not less than one mile nor more than four miles from the antenna in the direction specified.
No operation shall occur other than during the experimental period until data has been submitted showing that operation is in accordance with the above specifications and that the field intensity pattern is in substantial agreement with the theoretical pattern specified in the application.

THE AUTHORITY GRANTED IS SUBJECT TO THE FOLLOWING CONDITIONS:

CALL SIGN W W R C   File No. BMP-930302AC

A complete nondirectional proof of performance, in addition to a complete proof on the day directional antenna system, shall be submitted before program tests are authorized. The nondirectional and directional field strength measurements must be made under similar environmental conditions.

Operation by remote control authorized.

Permittee shall install a type accepted transmitter, or submit application (FCC Form 301) along with data prescribed in Section 73.1660(b) should non-type accepted transmitter be proposed.

Before program test authority is authorized by the Commission, a fence must be erected at such distances and in such a manner as to prevent the exposure of humans to radiofrequency radiation in excess of the American National Standards Institute Guidelines (OST Bulletin No. 65, October 1985). The fence must be of a type which will preclude casual or inadvertent access, and must include warning signs at appropriate intervals which describe the nature of the hazard. Permittee shall submit documentation of compliance with this special operating condition along with the Form 302, application for license, and the request for program test authority.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

DA 93-1024

In the Matter of	)	
	)	
An Inquiry into the Commission's Policies and Rules regarding AM Radio Service Directional Antenna Performance Verification	)	MM Docket No. 93-177 RM-7594

ORDER GRANTING EXTENSION OF TIME

Adopted: August 19, 1993; Released: August 20, 1993

Comment Date: October 29, 1993
Reply Comment Date: December 29, 1993

By the Chief, Mass Media Bureau:

1. On June 14, 1993, the Commission adopted a Notice of Inquiry, 8 FCC Rcd 4345 (1993), ("NOI") in MM Docket No. 93-177 to examine the policies and rules pertaining to the performance verification of directional antenna systems at AM Broadcast Radio Service stations. Since those rules were established in the late 1930s, they have been amended many times, but the entire framework has never been comprehensively reexamined. The NOI initiates that broad review and seeks to identify those portions of the current rules affecting AM directional arrays which ought to be the subject of a Notice of Proposed Rule Making. The deadlines for filing comments and reply comments were, respectively, August 20, 1993 and September 7, 1993.

2. On July 12, 1993, the Association of Federal Communications Consulting Engineers ("AFCCE") requested an extension of the comment period. AFCCE is an association of consulting engineers, engineers employed by broadcast stations, networks and equipment manufacturers. AFCCE indicates that it will not be meeting during the summer and therefore will be unable to file comments on the established deadline. Thus, they request that the filing deadlines be extended by approximately 60 days.

3. Five consulting engineering firms that are members of AFCCE filed the petition that initiated this proceeding. The continued participation of those firms, of other AFCCE members, and of AFCCE as an organization should provide valuable assistance in our effort to update our AM directional antenna rules. We agree that it is important that the parties knowledgeable in this area have an adequate opportunity to base comments on a careful analysis of the issues. Therefore, we are persuaded that the extension now under consideration should be approved.

4. Accordingly, IT IS ORDERED THAT the request to extend the comment date filed July 12, 1993 by the Association of Federal

Communications Consulting Engineers IS GRANTED. The date for filing comments in this proceeding IS EXTENDED to October 29, 1993 and the date for filing reply comments IS EXTENDED to December 29, 1993.

5. This action is taken pursuant to authority found in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended, and Sections 0.204(b), 0.283, 1.45 and 1.46 of the Commission's Rules.

6. Further information may be obtained from Joe Johnson, Mass Media Bureau, Engineering Policy Branch, (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

Roy J. Stewart
Chief, Mass Media Bureau

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 93-225

In the Matter of

Amendment of Part 73 of the Commission's Rules to Clarify the Definition and Measurement of Aural Modulation Limits in the Broadcast Services

NOTICE OF INQUIRY

Adopted: July 23, 1993; Released: August 12, 1993

Comment Date: November 5, 1993
Reply Comment Date: December 15, 1993

By the Commission:

INTRODUCTION

1. The purpose of this *Inquiry* is to explore the Commission's rules and policies that relate to the definition and measurement of aural modulation[1] limits. Having appropriate limits on modulation, or on the emitted sidebands resulting from modulation, is essential to controlling adjacent channel interference levels. Although the discussion herein focuses principally on the measurement of FM modulation, we welcome comments addressing aural modulation measurement in the AM and TV services.

BACKGROUND

2. Limits on station aural modulation traditionally have been considered among the most important of the Commission's technical standards due to their direct effect on the quality of radio service.[2] Maximum and minimum levels of aural modulation are specified in Section 73.1570 of the Commission's Rules for the broadcast services and are intended to ensure that a quality signal is available throughout the service area. In general, our rules require that loud program material modulate the transmitter at least 85% to ensure reasonable consistency among broadcast stations.[3] However, as a practical matter, undermodulation is seldom a problem in the broadcast services and is not an issue in this proceeding.

3. Limits on aural overmodulation serve a variety of purposes. First, they help to insure that excessive sideband energy is not generated, which could exacerbate adjacent channel interference levels. In the case of AM stations, the limit on positive peak modulation limits the average power to an extent consistent with the authorized carrier power; the limit on negative peak modulation controls distortion. Also, many AM broadcast transmitters handle large negative peaks in a nonlinear fashion and produce out of band emissions when negative peaks near or above 100% are encountered. In the television service, the limits serve to prevent degradation of the video signal and minimize adjacent channel interference in cable TV systems. In receivers, which are designed to receive signals with certain predetermined characteristics, modulation limits help prevent distortion. This *Notice of Inquiry* principally will examine the subject of aural modulation and to a lesser extent, the subject of aural station bandwidth and emission, inasmuch as bandwidth and emission standards are derived primarily from the study of modulation and to a lesser degree, power.[4]

4. Prior to 1983, FM licensees were required to monitor their stations' modulation using modulation monitors authorized by the Commission under its type-approval procedure.[5] Such equipment was required to embody certain design characteristics specified in Section 73.332 of the Commission's Rules (Requirements for type approval of FM modulation monitors). However, as a result of action taken in MM Docket No. 81-698,[6] Section 73.332 was deleted and type approval of modulation monitors was no longer required, nor were modulation monitors. Other rules also were eliminated or modified to give licensees more flexibility in measuring modulation. However, the rules limiting modulation were left essentially unchanged.

5. Section 73.1570 limits FM modulation levels, stating that "the total modulation must not exceed 100 percent on peaks of frequent reoccurrence referenced to 75 Khz deviation."[7] Licensees are free to use whatever methods they wish to ascertain conformance with these requirements. Some continue to use monitors which were type approved

[1] Modulation is the process by which some characteristic of a radio frequency (RF) signal is varied in accordance with the changes that occur in a program signal. For example, in FM broadcasting the frequency of the RF signal is made to vary by both the audio frequencies and loudness levels present in the voices and music of the program material. Similarly, in AM broadcasting the program source causes variations in the amplitude of the RF signal. All forms of modulation generate energy in "sidebands" which surround the main carrier. Modulation that exceeds our standards can cause excessive sideband energy, which can interfere with the reception of signals on adjacent channels.

[2] Other fundamentally important operational standards regulate power, frequency stability and out-of-band and spurious emissions.

[3] An exception to this requirement is made to avoid objectionable loudness or to maintain the dynamic range of program material. *See* Section 73.1570(a).

[4] Emission limitations often incorporate a power dependent term to limit harmonic and spurious emissions (emissions outside the authorized bandwidth).

[5] Under type-approval, the Commission tested the modulation monitors to ensure that they complied with the standards in Sections 73.50 (for AM), 73.332 (for FM) and 73.694 (for TV).

[6] *See Report and Order* in BC Docket No. 81-698, 54 RR 2d 435 (1983), 48 Fed. Reg. 36459, August 11, 1983.

[7] An exception is made for FM stations using subcarriers to provide subsidiary communications services, where somewhat greater modulation and deviation are permitted. Stations providing subcarrier services may transmit with peak modulation up to 110%, which is equivalent to 82.5 Khz deviation. We understand that some broadcasters are misinterpreting this provision by assuming that the mere presence of subcarriers permit increasing modulation to 110%. The rule requires that the total

by the Commission in earlier years, while others use a variety of newer devices employing sophisticated circuits which can be adjusted to respond to or ignore modulation peaks of different intensities and durations. Thus, while some modulation monitors may conform to the standards formerly specified for type approval of modulation monitors, they can be adjusted so as to give differing indications for the same transmissions.

6. Many broadcast station licensees choose to keep their average modulation levels as high as possible in order to keep their signal above noise at the limits of their service areas and to attract the attention of listeners who are tuning across the dial.[8] To achieve this objective, licensees use audio signal processing devices that automatically compress the dynamic range of the original program. That is, the quiet passages of music are increased in volume and the very loud passages are suppressed. When used correctly, this improves the listenability of the program, particularly for automobile reception where high surrounding noise levels could exceed low volume program passages. When used to excess, the result is uniformly loud music with little discernible dynamic range and a "flat" quality. Some licensees, by using monitors which disregard very brief or infrequent bursts of high modulation, find they need employ only moderate audio compression to attain reasonably high modulation levels. This approach preserves more of the dynamic range inherent in live music.

7. The marketing of monitors which give different indications is the catalyst for this reexamination of modulation measurement. Some equipment suppliers believe that no modulation in excess of 100% should be permitted. Others, due to differences in interpreting previous FCC rules relating to modulation monitor type approval and automatic transmission system monitoring, have concluded that occasional modulation peaks of very short duration exceeding 100%[9] or occurring infrequently (i.e., less than 10 per minute)[10] do not contribute to interference to adjacent channel stations. The resulting differences in modulation monitor operation can result in significant variations in loudness from one station to another and possibly, differing opinions in the industry regarding compliance with our modulation rules.[11]

8. As the foregoing discussion demonstrates, there is some confusion over what constitutes overmodulation and how it should be measured. Another difficulty is that the methods of modulation measurement used by broadcasters differ from that used by our staff in the Field Operations Bureau (FOB). The most common circuitry in the newer monitors detects peak deviation levels exceeding a user specified level (usually 100%) and flashes a warning light. Our personnel, on the other hand, usually monitor broadcasts by connecting an oscilloscope to an FM receiver's discriminator and calibrating it to display deviation in excess of the legal limit. This basic method is the same one that was used when the Commission mandated type-approved modulation monitors. The different methods can lead to different conclusions which have consequences for broadcasters.[12] All of these factors warrant examination and, if necessary, clarification by the Commission to ensure a proper and uniform understanding of their responsibilities by all licensees.

---

modulation may be increased over 100% in the amount of a half of a percent for each one percent of subcarrier modulation injection, up to a maximum of 110%. Thus, only if 20 percent subcarrier modulation was used at an FM station, could the total modulation be increased to 110%. This exception is permitted so that stations providing subcarrier services do not have to sacrifice the competitive loudness of their broadcast programming.

[8] We are aware that the "loudness" of an FM station depends principally on the modulation level and the audio compression used, and that station revenues often depend on being heard over as wide an area as possible. However, the bandwidth occupied by an FM signal is a direct function of its level of modulation and the mix of modulating frequencies, and all licensees must stay within their assigned channels in order to assure that interference levels will remain within designed limits.

[9] The former Section 73.332 required that the peak preset indicator light, usually set to flash when modulation exceeded 100%, respond to tone bursts occurring at repetition rates from one to ten "bursts" per second. A "burst" consisted of: Ten consecutive cycles of a constant amplitude 10 kHz sinusoid (a 1 millisecond tone burst) and five consecutive cycles of a constant amplitude 1 kHz sinusoid (a 5 millisecond tone burst). This indicator was required for FM modulation monitors designed for use at stations transmitting stereophonic and/or subcarrier signals *only* (but *not* monophonic FM signals). Because sensitivity to the one millisecond tone burst is more demanding than responding to a 5 millisecond burst, and because nearly all FM stations today transmit stereophonic signals (many with additional subcarriers), a "1 millisecond response" characteristic has continued to be used as an equipment design standard by some manufacturers of modulation monitors. However, current rules do not require the use of this test procedure.

[10] Former Section 74.342 contained special rules pertaining to modulation monitoring and control devices used at stations under automatic transmitter control. Section 73.342(a) permitted no more than 10 bursts of modulation per minute in excess of 100%. For the purposes of this requirement, a sequence of repetitive instances of modulation exceeding the prescribed limits occurring within a single 5 millisecond interval was to be considered as one burst. However, this rule was never invoked by the Commission as comprising a general definition of the term "peaks of frequent reoccurrence." Nevertheless, it has been used as such a definition by some modulation monitor manufacturers.

[11] A case in point occurred several years ago when a well-known equipment manufacturer marketed a state-of-the-art television stereo modulation monitor which could detect overmodulation transients as short as several microseconds. Traditional modulation monitors only detected and indicated peaks that had a much longer duration. Engineers using the more sensitive monitor noticed that when their stations' operating parameters were set using this device, their average modulation (i.e., the loudness of their TV stations' aural signals) was noticeably less than that of stations using older monitors. Attempts to resolve the discrepancy between traditional versus state-of-the-art methods of modulation measurement were unsuccessful. Ultimately, an electronic "correction" was made to the new monitor to make its indications match more closely those of modulation monitors made by other manufacturers.

[12] However, we note from our enforcement experience that instances of overmodulation do not commonly involve borderline judgments; stations which overmodulate tend to do so in an egregious manner which is apparent from any measurement method used.

THE INQUIRY

9. We seek comments on two basic issues: (1) What should be the definition of overmodulation (including whether new emission limitations should be adopted in lieu of an overmodulation standard); and (2) What methods or procedures are necessary to implement any proposed limits on modulation levels.

10. *Definition of overmodulation.* As noted above, the current definition of permissible modulation sets out frequency deviation limitations and states that these limitations must not be exceeded by "peaks of frequent reoccurrence." No definition of this phrase is given in the rules. Should this rule remain unchanged, or should it be modified or interpreted with more specificity? In particular, should consideration be given to the amplitude of the modulation peaks beyond 100%, to the time duration of such peaks, or to the number of peaks within a given span of time? Experience indicates that a few overmodulation peaks per minute can be tolerated without causing perceptible adjacent channel interference. Such peaks may even be unavoidable if a station seeks to promote fidelity and a natural dynamic range without excessive signal processing. Thus, while some engineers might argue that no overmodulation should be tolerated, such a rigid rule could pose considerable problems with respect to compliance. Therefore, we seek information on what maximum peak overmodulation amplitude, frequency or duration (or some defined interrelationship between these three parameters) should be considered overmodulation capable of causing harmful adjacent channel interference.[13] We also note that theory tells us that peaks of very short duration result from high bandwidth baseband signals and can result in excessive sidebands for reasons other than overmodulation. Are there other relevant modulation parameters which should be considered as well? We request that commenters consider submitting empirical or theoretical data to support their views in this area.

11. We also wish to examine a different approach to resolving the overmodulation issue. Namely, should we eliminate specific limits on modulation *per se* and replace them with a new emission limitation (or standard) designed to prevent harmful adjacent channel interference? Traditionally, emission limitations have taken the form of "step-function" formulas relating transmitter output power to transmitter bandwidth, with permissible power dropping in steps as the bandwidth increases. These "step function" limitations, however, were developed decades ago, are extremely simplistic approximations of signal envelopes and, for this reason, do not afford adequate adjacent channel protection. However, in recent years more sophisticated versions of these limits have been developed which use continuous power "roll-off" formulas derived from Bessel function analysis. These newer emission standards provide a readily quantifiable degree of adjacent channel protection. It may be possible to develop analogous formulas for FM and TV aural signals which could replace the current modulation limits and avoid the definitional problems inherent in the current regulations.

12. For example, in the 1970s, Motorola, Inc. requested that the Commission amend the rules in the private land mobile services to provide for the use of what is popularly called F3Y ("digitized voice") emission.[14] This led to the development of a new emission limitation, custom-tailored to permit digital modulation without significantly increasing adjacent channel interference.[15] The new emission standard became the primary means of limiting adjacent channel interference, while providing land mobile licensees with considerable flexibility in using digital modulation. The same standard recently was adopted for use in the Remote Pickup Broadcast Service.[16]

13. In addition, the Commission recently adopted in MM Docket No. 88-376, a new emission limitation for AM broadcast stations.[17] This new emission standard is intended to reduce levels of adjacent channel interference in the AM service while giving licensees considerable flexibility in program audio signal processing. While modulation limits in the AM service were retained, their practical function is

[13] Generally, discussions on overmodulation have not focused on the degree or percentage of overmodulation. Usually, individuals debate whether peaks of less than 1 millisecond duration are inconsequential, and whether a small number of peaks (such as less than 10) within a one-minute period are significant.

[14] F3Y was the original emission designator for "digitized voice modulation." To conform with current International Telecommunications Union (ITU) specifications, it should now be termed F1E (frequency modulated single-channel digital telephony) or G1E (phase modulated single-channel digital telephony) emission. However, the old terminology persists and is used in Sections 74.462 and 74.482 of the Commission's Rules. For the sake of consistency, we will use F3Y here to refer to the F1E and G1E emissions. The signal comprising this emission was incompatible with the low pass audio filtering requirements that, along with modulation limits, were the principal means of preventing adjacent channel interference at that time. There was (and still is) a very broad emission limitation specified for land mobile transmitters but its adequacy was questioned. (Whereas normal voice emissions fell far below the emission limits, the F3Y emission, containing a higher than normal fundamental modulating frequency with attendant harmonics, approached it much more closely.) This created the need for a more exact emission limitation for digital modulation.

[15] *See First Report and Order* in Docket No. 21142, 42 RR 2d 355 (1978) and *Second Report and Order* in Docket 21142, 46 RR 2d 937 (1979). The emission limitation developed in that proceeding was based on a Bessel function analysis of the emitted signal based on the use of a low-pass audio filter to attenuate high frequency components of the modulating signals. The low-pass filter requirements were deleted for transmitters which comply with this derived emission limitation. Its efficacy in preventing adjacent channel interference was proven by over-the-air tests conducted at the time and have since been confirmed by years of operating experience.

[16] *See Report and Order,* MM Docket No. 90-499, adopted May 22, 1991, released June 11, 1991, 56 Fed. Reg. 28497, June 21, 1991.

[17] *See Notice of Proposed Rule Making* in MM Docket No. 88-376, 3 FCC Rcd 5687, 1988 , *Report and Order* in MM Docket No. 88-376, 4 FCC Rcd 3835 (1989) and *Memorandum Opinion*

to limit the average transmitter output power.[18] The new emission limit is controlling with respect to limiting interference caused by excessive sidebands.[19]

14. Inasmuch as a station's total power output does not change with modulation in the case of FM and TV aural transmitters, it is possible that appropriate emission limitations could be developed for those stations which could render specific limits on modulation unnecessary. The rationale for this approach would be that the interference potential of these transmitters is determined by their occupied bandwidth. Therefore, a carefully defined limit on occupied bandwidth could be effective in preventing interference and give licensees more flexibility in audio processing as well as the use of multiplexed subcarriers.

15. However, signals broadcast by FM and TV aural transmitters are much more complex than those typically transmitted in the land mobile services and in AM broadcasting. Comment is requested on whether anyone has developed mathematical models for FM or TV aural multiplex signals. Should there be uncertainties or disagreement over how such a task should be approached, an empirical approach may provide the solution. Radiated emissions of FM and TV aural transmitters transmitting different kinds of programming and multiplexed subcarriers could be measured using spectrum analyzers to develop an emission profile that would accommodate all current transmission system configurations not deemed to cause more than the normally expected amount of adjacent channel interference. Comment is requested on the desirability of developing more precise emission limitations for FM and TV aural transmitters, and whether an analytic or empirical approach would be preferable.

16. *Instrumentation.* In MM Docket No. 81-698, referenced above, the Commission deleted the requirement that the modulation monitoring equipment used by each station be FCC type approved. This deregulatory action was meant to provide licensees with some flexibility in achieving compliance with modulation limits and to eliminate a burden (equipment authorization) on equipment suppliers and the Commission. It was not meant to excuse licensees from using whatever means were necessary to ensure compliance with the modulation limits. This will continue to be the case if the current modulation limits are retained or revised, i.e., we do not expect to type approve monitoring equipment or specify what type of equipment licensees should employ to maintain their compliance with any modulation limits that may emerge from this rulemaking.

17. It is possible that the equipment needed to determine compliance with emission limitations may be more expensive than that used to make traditional modulation measurements.[20] We seek information on what equipment would be required, its costs, and the skills needed to operate it properly. If the emission limitation approach is adopted, what devices (other than spectrum analyzers) would be suitable for detecting excessive bandwidth?[21] We note that even the use of such devices may not eliminate some of the problems facing the current generation of modulation monitors, because a limit may be necessary on the time duration and recurrence rate of peak tolerable out-of-band power. Lastly, if we adopt new emission limitations, should we continue to allow the use of conventional modulation monitors as an alternative?[22]

SUMMARY

18. In this proceeding we seek to obtain information that will enable us accurately to set meaningful modulation limits on peak amplitude, peak duration, peak recurrence rates and the time interval over which the peaks are to be counted. Finally, we wish to examine an alternative concept -- that emission limitations can replace modulation limitations. We seek information on this concept's application to modulation, modulation measurement, the control of interference and its implications for broadcasters, equipment manufacturers and the Commission's enforcement efforts.

Procedural Matters

19. This Notice of Inquiry is issued pursuant to authority contained in Sections 4(i), 303 and 403 of the Communications Act of 1934, as amended. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, 47 CFR 1.415 and 1.419, interested parties may file comments on or before **November 5, 1993,** and reply comments on or before **December 15, 1993**. All relevant and timely filed comments will be considered by the Commission before taking further action in this proceeding. To file formally in this proceeding, participants must file an original and four copies off all comments, reply comments and supporting documents. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Offices of the Secretary, Federal Communications Commission, Washington D.C., 20554. Comments and reply com-

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and Order in MM Docket No. 88-376, 5 FCC Rcd 2598 (1990).

[18] The nature of amplitude modulation limits acceptable negative modulation to 100% if significant signal distortion is to be avoided. Section 73.1570(b)(1) limits positive peak modulation to 125%. This permits licensees to take advantage of asymmetries in human speech waveforms without increasing the average output power to the point where co-channel or adjacent channel interference would occur.

[19] We note that the existing FM broadcast emission standards in Section 73.317 may be ambiguous with respect to actual signals since the measurement resolution bandwidth is not specified. By contrast it is specified in the corresponding AM standard in Section 73.44.

[20] Broadcasters should note that our final decision adopting the new emission limitation in MM Docket No. 88-376 gave little weight to such a possibility, since nothing prohibits licensees from sharing more expensive measurement equipment, or subscribing to over-the-air monitoring services, or depending on their consulting engineers to provide necessary equipment measurement capabilities.

[21] About the time the new AM emission was adopted, a so-called "splatter monitor" (a homodyne receiver followed by a high pass filter) was marketed for slightly over $2000. Essentially, it measures all out of authorized emission bandwidth power. Depending upon the capabilities provided, spectrum analyzers cost five to ten or more times as much. Similarly less expensive emission monitoring equipment may be possible for FM and TV use.

[22] In MM Docket No. 88-376, we permitted AM licensees to omit periodic measurements to determine compliance with the then-developed emission limitations for a period of 5 years, provided they installed audio equipment that conformed to the ANSI NRSC-1 specifications (*see* Section 73.44(e)) and further provided there was no other evidence of non-compliance.

ments will be available for public inspection during regular business hours in the FCC Reference Center (Room 239) of the Federal Communications Commission, 1919 M Street N.W., Washington D.C., 20554. For further information contact James E. McNally, Jr., Engineering Policy Branch, Policy and Rules Division, Mass Media Bureau, Federal Communications Commission, Washington D.C., 20554, telephone (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

William F. Caton
Acting Secretary

Mfarmer AM/13

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 93-177

In the Matter of

An Inquiry into the Commission's Policies and Rules regarding AM Radio Service Directional Antenna Performance Verification — RM-7594

NOTICE OF INQUIRY

Adopted: June 14, 1993; Released: June 29, 1993

Comment Date: August 20, 1993
Reply Date: September 7, 1993

By the Commission: (staff working on it)
Will be an extension:
Comments October 29th ?
Replies Dec 29th

INTRODUCTION

1. The Commission has before it a petition for rulemaking (petition) submitted by the technical consulting firms duTreil. Lundin & Rackley. Inc.: Hatfield & Dawson Consulting Engineers, Inc. (Hatfield and Dawson): Lahm, Suffa & Cavell. Inc.: Moffet. Larson & Johnson. Inc.: and Silliman & Silliman (petitioners). The firms are jointly requesting that the Commission initiate an inquiry into the policies and rules pertaining to the performance verification of directional antenna systems at AM Broadcast Radio Service stations.[1] Specifically, petitioners ask that the Commission: (1) review the pertinence of the present regulations concerning AM directional antenna performance verification, given the significant environmental, technological and economic changes which have occurred since the present policies and rules were adopted: (2) determine whether the present regulations are effective in controlling interstation interference, particularly at night: and (3) consider the adoption of alternative regulatory means made possible by advances in antenna analysis methods and instrumentation technology.

2. Petitioners argue that the physical environment in which AM stations now operate is significantly changed from that which existed when our current rules were adopted. Many stations once located in rural areas have now been absorbed into expanding suburban and urban development, putting them in proximity to new buildings and other obstacles which can affect the magnitude and or phase of the signals from AM antenna arrays. It is becoming increasingly difficult to find unobstructed field strength measurement locations in accordance with Section 73.186 of the rules. Petitioners also argue that improvements in technology, such as computer-aided numerical modeling of antenna performance, could lead to advances in antenna design and measurement techniques if the Commission's rules were amended. They also point out that adjustments of antenna arrays to establish the correct horizontal pattern in accordance with our rules may, inadvertently, cause the vertical pattern to depart from predicted values and cause unintended nighttime interference. The Commission's efforts when it restructured and improved the AM Service in Docket 87-267 could prove ineffective, petitioners argue, unless accurate measures are in place to assure that AM antennas are adjusted properly.[2]

3. Comments on the petition were filed by the following parties: duTreil, Lundin & Rackley, Inc.: Hatfield & Dawson: Lahm, Suffa & Cavell, Inc.: Moffet, Larson & Johnson, Inc.: CBS Inc.: Jules Cohen & Associates, P.C.: The National Association of Broadcasters (NAB): Capital Cities/ABC Inc.: and William G. Ball, P.E. Reply Comments were filed by Lahm, Suffa & Cavell, Inc. All commenters supported a Commission proceeding to examine the issues raised in the petition. Hatfield & Dawson, one of the petitioners originally requesting issuance of a Notice of Inquiry, stated in its comments that it now preferred a Notice of Proposed Rulemaking (NPRM), indicating that an Inquiry is unnecessary. A conference or forum of interested parties was suggested as a vehicle for developing specific rule changes for an NPRM. In their Reply Comments, Lahm, Suffa & Cavell, Inc., argued that the issuance now of an NPRM would probably not be wise and could lead to exactly the sort of delays Hatfield & Dawson were seeking to avoid. Lahm, Suffa & Cavell, Inc. argued that this is the time for a "more comprehensive proceeding that addresses all important philosophical, as well as mechanical, matters in the subject area."

BACKGROUND

4. As petitioners note, many of the current rules and policies governing AM directional antenna systems were adopted as part of the Commission's former *Standards of Good Engineering Practice* in 1939. Since that time, the rules have been amended many times, but the entire framework has never been comprehensively reexamined. A listing of the rule sections which are pertinent to this issue includes the following:

[1] An AM directional antenna array typically consists of 2 or more antenna towers, each of which receives power from the AM station transmitter. The power is fed to the antenna towers through "phasing networks", the purpose of which is to precisely determine the amount of power fed to each tower and the relative phase angles of the currents in each tower. This is done in order to control the direction(s) in which the antenna array radiates power. Directional arrays are used to provide strong signals in desired directions or to minimize interference to other stations, or both.

[2] The parameters of a directional antenna system, such as individual antenna currents or field strengths, may change over time and actual measurements on an operating antenna system can differ from the authorized or permitted values of those parameters. Therefore, the Commission requires that AM station licensees 'prove' the performance of their systems by making tests and measurements specified in Part 73 of the rules. These tests, and any subsequent adjustments to the array they indicate as necessary, are intended to assure that the antenna system is in full conformance with the terms and conditions of the station's license and the provisions of the Commission's rules. As an AM array increases in size, the complexity of these tests increases commensurately, and the time and costs involved in a proof of performance analysis can be significant.

73.14	Definitions: Antenna current; Critical Directional Antenna: Nominal Power; and Proof of Performance
73.33	Antenna systems: showing required
73.45	AM transmission system emission limitations
73.51	Determining operating power
73.53	Requirements for authorization of antenna monitors
73.54	Antenna resistance and reactance measurements
73.57	Remote reading antenna and common point ammeters
73.58	Indicating instruments
73.61	AM directional antenna field strength measurements
73.62	Directional antenna system tolerances
73.68	Sampling systems for antenna monitors
73.69	Antenna monitors
73.151	Field strength measurements to establish performance of directional antennas
73.152	Modification of directional antenna data
73.153	Field strength measurements in support of applications or evidence at hearings
73.154	AM directional partial proof of performance measurements
73.158	Directional antenna monitoring points
73.189	Minimum antenna heights or field strength requirements

5. The purpose of these rules is to set out the Commission's regulatory framework for assuring that AM directional arrays will be properly designed, constructed, tested, monitored and maintained. This is necessary because a misadjusted array could cause interference to cochannel and adjacent channel stations both locally, via groundwave signals, and at great distances, via skywave signals. Misadjustment of an array can arise from many causes, including faulty measurement equipment and faulty measurement procedures. It is often difficult to reconcile theoretical calculations of array performance with actual field measurements of an array's performance. Several sophisticated antenna array modeling programs are now available for use on computers which can predict patterns for very complex combinations of power and phase. It is difficult with these programs, however, to take into account the collateral effects of obstructions, such as buildings and nonresonant wires (e.g. power and telephone lines), which are proximate to the array being analyzed. As petitioners note, the formidable task of verifying actual array performance has put a significant financial burden on AM licensees.

6. In Docket 87-267, the Commission adopted a sweeping restructuring of the AM broadcast service in order to reduce the current level of interference in the band, and to make available new AM broadcast frequencies directly above the current band edge.[3] As commenters in that proceeding noted, misadjustment of AM directional arrays was a major contributing cause of high interference levels in the current band, and proper adjustment of any directional arrays licensed in the new band would be very important in controlling interference in that band. For this reason, and because the Commission's regulations have not been comprehensively evaluated in light of much of the new technology affecting array design and measurement, we believe it would now be appropriate to initiate a *Notice of Inquiry* into this matter.[4]

THE INQUIRY

7. In the broadest sense, this inquiry seeks to identify those portions of the current rules affecting AM directional arrays which ought to be the subject of a *Notice of Proposed Rulemaking*. We ask interested parties to review each of the rules listed in paragraph 4, *supra*, and any others which they find relevant, and evaluate which of these, in whole or part, ought to be amended or deleted. Criteria which may be of use in such evaluations include, but are not limited to, the following:

(a) What types of instrumentation are appropriate at the AM broadcast station for measuring antenna operating parameters? Where, physically and electrically, should this instrumentation be placed? Within what bounds of variation should parameters be maintained? What instrumentation error tolerance is acceptable? How frequently should the instrumentation readings be examined? How frequently should the instrumentation itself be calibrated, and to what standard? What type and extent of documentation of instrument readings should be generated and maintained? What information should be submitted to the Commission, and in what time frame(s)?

(b) What routine should be followed in taking measurements in the field? What parameters should be measured? What instrumentation is appropriate? At what distances should readings be taken? What should be the criteria for selecting sites for field measurements? To what degree should there be repeatability for readings from the same site?

(c) To what extent should theoretical, rather than measured, parameters be acceptable? Which theoretical computational routines are acceptable for use in lieu of measurements, and which are not? How is the difference between calculated and measured parameters to be resolved when the results differ? What magnitude of difference is acceptable, and what is too large?

[3] *See Notice of Proposed Rule Making*, MM Docket No. 87-267, 5 FCC Rcd 4381 (1990) and *Report and Order*, MM Docket No. 87-267, 6 FCC Rcd 6273 (1991).

[4] We can understand Hatfield & Dawson's desire to proceed as rapidly as possible on this matter, but we agree with Lahm, Suffa & Cavell, Inc. that the number of issues involved, and their impact on the service, is of such a magnitude that a full record should be established first in an Inquiry, rather than proceeding immediately to a Notice of Proposed Rulemaking.

(d) To what degree is it practical or necessary to take into account other structures in the vicinity of the array? Which structures should be considered and which ignored? Can this ever be done theoretically, or must this effect always be measured in the field? Should the effect be remeasured/recalculated when new structures are added, or existing structures significantly modified or removed?

8. Our goal is to formulate a set of proposed rules which will ensure that array evaluations are done thoroughly and accurately, and to the degree necessary to meet the interference criteria put in place as a result of Docket 87-267. We wish to eliminate any redundant, outmoded or unnecessary rules, as well as any rules which impose a significant burden on licensees, without sacrificing the benefits of interference control. We will focus our efforts here, as we did in Docket 87-267 and related rulemakings, on formulating rules which promote the long term viability and quality of the AM Service.

PROCEDURAL MATTERS

9. This Notice of Inquiry is issued pursuant to authority contained in Sections 4(i), 303 and 403 of the Communications Act of 1934, as amended. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, 47 CFR 1.415 and 1.419, interested parties may file comments on or before **August 20, 1993**, and reply comments on or before **September 7, 1993**. All relevant and timely filed comments will be considered by the Commission before taking further action in this proceeding. To file formally in this proceeding, participants must file an original and four copies of all comments, reply comments and supporting documents. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Offices of the Secretary, Federal Communications Commission, Washington, D.C., 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference Room (Room 239) of the Federal Communications Commission, 1919 M Street N.W., Washington D.C., 20554. For further information, contact Joseph M. Johnson, Engineering Policy Branch, Policy and Rules Division, Mass Media Bureau, (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

William F. Caton
Acting Secretary

14.

USING ELEVATED RADIALS IN CONJUNCTION WITH DETERIORATED BURIED-RADIAL GROUND SYSTEMS

by

Al Christman
Grove City College
100 Campus Drive
Grove City, PA 16127-2104

R. Paul Zeineddin
ECE Department
Ohio University
Athens, OH 45701-2979

with

Roger Radcliff
ECE Department
Ohio University
Athens, OH 45701-2979

Jim Breakall
Pennsylvania State University
EE Department
306 EE East
University Park, PA 16802

Abstract

In the US, medium-wave broadcast stations utilize ground-mounted vertical monopole antennas with extensive buried-radial ground systems. Over a period of time, these radials may deteriorate, leading to a decrease in the radiated field strength of the antenna. Computer modeling studies indicate that, in such a situation, the addition of four elevated radials can restore performance to a level which is equal to or better than the original installation. Several different configurations for the elevated radials were investigated, including variations in their orientation, length, and height above ground. The computer software used for this work was the Numerical Electromagnetics Code (NEC) [1].

Background

Previous computer-modeling exercises have shown that an elevated vertical monopole antenna with four elevated radials can perform as well as a conventional ground-mounted tower with 120 buried radials [2]. Also, other studies reveal that a ground-mounted tower may be used with four elevated radials (and no buried radials) to produce radiated field intensities which are equivalent to that of a standard buried-radial system [3]. The integrity of a ground screen composed of buried radial wires may be compromised in a variety of ways, but the damage will be manifested as a decrease in the magnitude of the radiated field strength and a change in the driving-point impedance. This study examines the feasibility of adding elevated radials to a pre-existing conventional AM broadcast antenna in an effort to counteract the loss in field intensity caused by a deteriorating buried-radial ground system.

As in our earlier papers, a classic ground-mounted series-fed tower with 120 buried radials was modeled initially, to serve as a standard reference [4]. An operating frequency of 1 MHz was selected, and the radii of all conductors were set at 3 millimeters. In the NEC model, the tower is made of aluminum and rests upon a two-meter-long buried steel ground rod. All radials are copper and are buried to a depth of six inches in "average" soil with a conductivity of 0.004 Siemens per meter and a dielectric constant of 15. The tower and the radials are all 90° in length, which is equal to 75 meters at 1 MHz. A drawing of this antenna is shown in Figure 1, which illustrates all of the metallic conductors in the system and the segmentation that was utilized in the computer model. NEC predicts an input impedance of 40.52 + j 23.40 Ohms for this antenna, with a field strength of 267.91 millivolts per meter. This is the magnitude of the "theta" component of the radiated electric field intensity (E_θ), monitored at a distance of 1 kilometer from the antenna, at a height of 50 inches (1.27 meters) above the ground, when the input power is 1000 watts.

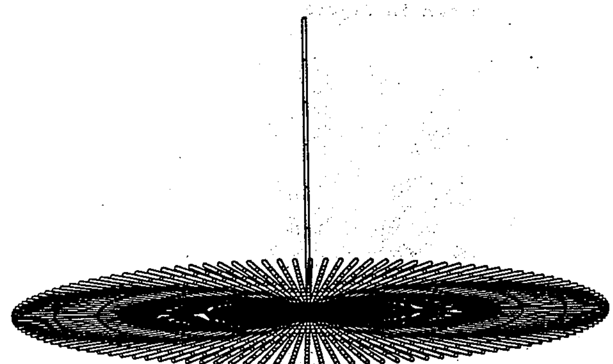

Figure 1. A conventional ground-mounted tower with 120 buried radials.

In order to ascertain the minimum field-strength values which could be expected, a similar antenna with only four buried radials was also examined. This computer-modeled antenna produced a field intensity of 225.56 mV/m, which is a reduction of almost 15% (about 1.5 dB) from the 120-radial reference level. As a result, one would expect that conventional antennas with deteriorating ground systems should yield field-strength values between 225 and 267 mV/m/kW at 1 km. (A note of interest at this point: with only a two-meter-long ground rod and no radials at all, the predicted field intensity is 125.57 mV/m, which is about 6.6 dB below the reference.)

Deterioriated Ground Systems

It was decided that a "typical" group of deteriorated radials would appear as depicted in Figure 2. Here we see a top view of five adjacent radials, all of which were originally 90° in length. The first radial is completely intact and remains bonded to the central ground rod at the tower base, which is located at the top of this figure. The second radial is still connected to the grounding node, but its outer portion is gone. The third (middle) radial is missing entirely. Neither the fourth nor fifth radials are joined to the ground node, and various portions of their inner sections have disappeared.

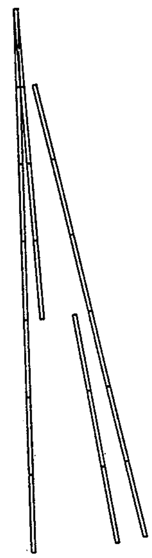

Figure 2. Top view of a "typical" group of five "deteriorated" radials.

This group of five radials, as described above, was then rotated 24 times about the tower axis (5 X 24 = 120) in order to produce the "deteriorated ground system model" shown in Figure 3.

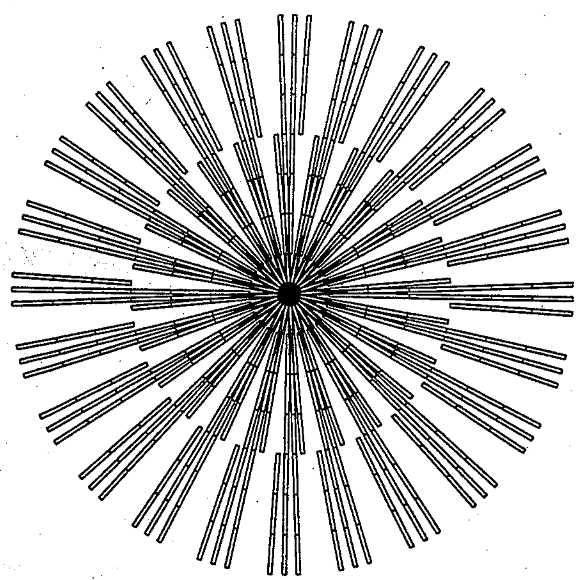

Figure 3. Top view of the "deteriorated ground system model."

In addition, a "very deteriorated ground system model" was constructed, and is illustrated in Figure 4. Here, the "typical" five-radial group which was shown earlier is spaced evenly at 120-degree intervals around the base of the tower. This particular model could represent a worst-case scenario.

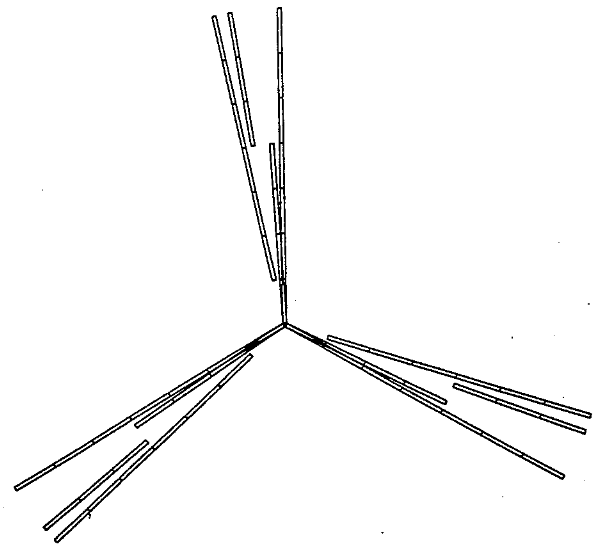

Figure 4. Top view of the "very deteriorated ground system model."

Elevated-Radial Configurations

After designing two separate "damaged" buried-radial ground systems, the next step was to add four elevated radials to each of these pre-existing structures and take note of the effects. A large number of different test configurations for the elevated radials were modeled. In order to minimize confusion, an abbreviated symbol was adopted for each of these permutations, which are explained below:

- **455** – quarter-wave (75 m) radials which slope upward from the base of the tower at a 45-degree angle until reaching a height of five meters above ground; the remaining portion of each radial is horizontal
- **455E** – same as above, except the radial lengths are extended from 75 meters to 80 meters, so that each radial has a total length of .25λ plus its height above ground
- **4510** – quarter-wave (75 m) radials which slope upward from the base of the tower at a 45-degree angle until reaching a height of ten meters above ground; the remaining portion of each radial is horizontal; (see Figure 5)

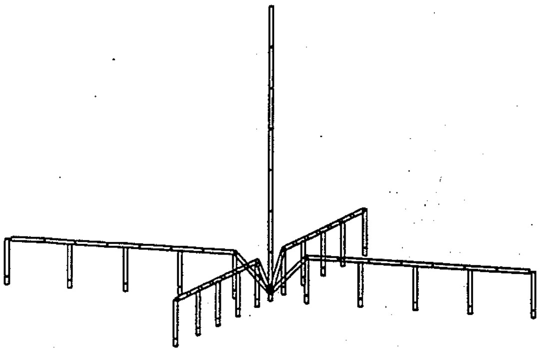

Figure 5. This is configuration "4510" as described in the text. The 4 elevated radials slope upward from the tower base at a 45° angle to a height of 10 meters, and then extend horizontally outward. They are supported atop metallic masts set on steel ground rods. All buried radials are omitted for clarity.

4510E – same as above, except the radial lengths are extended from 75 meters to 85 meters, so that each radial has a total length of .25λ plus its height above ground

S5 – quarter-wave (75 m) radials which slope steeply upward from the base of the tower until reaching a height of five meters above ground; at this height, the radial is displaced laterally from the tower by only one-half meter; the remaining portion of each radial is horizontal

S5E – same as above, except the radial lengths are extended from 75 meters to 80 meters, so that each radial has a total length of .25λ plus its height above ground

S10 – quarter-wave (75 m) radials which slope steeply upward from the base of the tower until reaching a height of ten meters above ground; at this height, the radial is displaced laterally from the tower by only one-half meter; the remaining portion of each radial is horizontal; (see Figure 6)

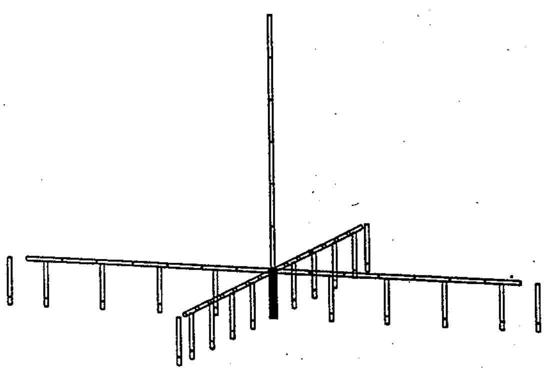

Figure 6. This is configuration "S10" as described in the text. The 4 elevated radials slope steeply upward from the tower base to a height of 10 meters, and then extend horizontally outward. They are supported atop metallic masts set on steel ground rods. All buried radials are omitted for clarity.

S10E – same as above, except the radial lengths are extended from 75 meters to 85 meters, so that each radial has a total length of .25λ plus its height above ground

H5 – quarter-wave (75 m) radials which are completely horizontal; the tower is fed against these four radials at a height of five meters above ground; note that the tower is now being fed above its base; for this configuration, the base of the tower was raised one-half meter above the ground to isolate it from the buried radials

H10 – same as above, except the radials are located at a height of ten meters above ground (see Figure 7)

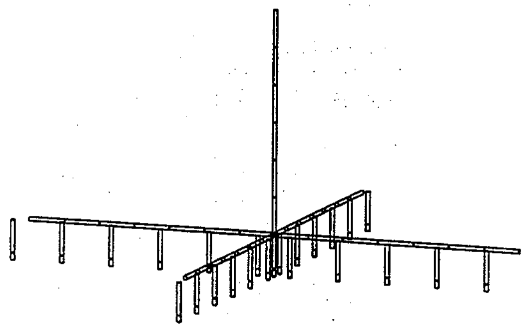

Figure 7. This is configuration "H10" as described in the text. The 4 elevated radials extend outward horizontally from the tower at a height of 10 meters. They are supported atop metallic masts set on steel ground rods. The tower base is 1/2 meter above the ground. All buried radials are omitted for clarity.

In addition, each of the ten configurations listed above was modeled using either metallic or non-metallic masts to support the elevated radials. When metallic (steel) masts are used, these rest upon two-meter-long buried steel ground rods, and extend to within one-half meter of the height of the radial. The outer-most masts are the same height as the elevated radials, but are laterally displaced from them by a short distance. In every case, the elevated radials are positioned at the four cardinal points of the compass, where $\phi = 0°, 90°, 180°$, and $270°$.

Results

Table I includes all of the differing values of radiated field strength which are predicted by NEC, when various arrangements of elevated radials are added to a "deteriorated" buried-radial ground system. The first two data entries reveal that, even though 35 to 40 percent of the buried copper has been removed from the radial ground system, the field intensity drops only by about 2%, from 268 to 262 mV/m (roughly 0.2 dB).

An examination of the remainder of the table indicates that some of the elevated-radial configurations actually lead to a decrease in the radiated field intensity, so that "more is less" in these instances. Other configurations produce values of field strength which are well above the standard reference, and the five best performers are numbered in their order of precedence. Notice that all five of these structures utilize radials which are elevated to a height of ten meters above ground.

If the buried-radial ground screen is "very deteriorated," then the addition of different configurations of elevated radials will produce the results displayed in Table II. Here, NEC indicates that the removal of nearly all of the buried radials will cause the transmitted field strength to drop almost 14%, from 268 to 231 mV/m, a loss of about 1.3 dB.

A review of the other data in Table II shows that, as before, some elevated-radial structures do more harm than good, and thus should be avoided. However, several of the configurations allow the antenna system to perform "better than new", and the top five are again indicated numerically.

Comparing the results from both tables, one can see that the same five configurations came out in the "top five" in both cases. In fact, "number one" and "number two" were identical in both instances, while the next three positions were interchanged among the remaining trio of contenders.

All of the data in both tables indicates that the radiation patterns have excellent circularity in every instance, even when most of the buried radials have been removed.

The information contained in Tables I and II is also presented pictorially in Figures 8 and 9 respectively. These bar charts show very clearly the relative field-strength amplitudes for each of the elevated-radial structures, as well as the standard reference antenna. The consistent first- and second-place finishers both stand out "head-and-shoulders" above the crowd. The computer modeling indicates that, whether metallic or non-metallic masts are used, extended radials which slope steeply upward to a height of ten meters above the ground always provided the best performance.

Table I. Radiated Field Intensity for a Vertical Monopole Antenna when Various Configurations of Elevated Radials are added to a "Deteriorated" Buried-Radial Ground System (see Figure 3).

Ground System		E_θ (mV/m @ 1 km for 1 kW)	
		$\phi = 0°$	$\phi = 45°$
Reference Standard		267.91	267.91
"Deteriorated"		262.19	262.19
455 (met)		254.26	254.15
(non-met)		246.86	246.65
455E (met)		270.84	270.77
(non-met)		265.39	265.33
4510 (met)		187.06	186.41
(non-met)		216.74	216.47
4510E (met)	5	279.67	279.65
(non-met)		267.98	267.98
S5 (met)		203.40	203.26
(non-met)		215.82	215.69
S5E (met)		220.46	220.37
(non-met)		225.32	225.27
S10 (met)		275.64	275.41
(non-met)	3	294.25	294.14
S10E (met)	1	312.24	312.09
(non-met)	2	308.88	308.82
H5 (met)		254.18	254.03
(non-met)		267.82	267.68
H10 (met)	4	293.21	292.96
(non-met)		269.85	269.68

$\phi = 0°$ corresponds to a point located directly off the end of an elevated radial, while $\phi = 45°$ is midway between two elevated radials; met = metallic masts used to support the elevated radials, and non-met = non-metallic support masts

Table II. Radiated Field Intensity for a Vertical Monopole Antenna when Various Configurations of Elevated Radials are added to a "Very Deteriorated" Buried-Radial Ground System (see Figure 4).

Ground System		E_θ (mV/m @ 1 km for 1 kW) $\phi = 0°$	$\phi = 45°$
Reference Standard		267.91	267.91
"Very Deteriorated"		231.12	231.49
455 (met)		250.42	250.60
(non-met)		247.20	247.63
455E (met)		264.48	264.69
(non-met)		260.34	260.66
4510 (met)		216.26	215.68
(non-met)		226.54	226.28
4510E (met)	4	277.10	277.40
(non-met)		263.64	264.00
S5 (met)		193.26	193.80
(non-met)		196.83	197.56
S5E (met)		216.24	216.44
(non-met)		220.78	221.00
S10 (met)		269.47	269.24
(non-met)	5	270.11	270.42
S10E (met)	1	308.42	308.61
(non-met)	2	304.60	304.91
H5 (met)		249.39	249.55
(non-met)		263.07	263.48
H10 (met)	3	289.78	289.87
(non-met)		266.44	266.79

$\phi = 0°$ corresponds to a point located directly off the end of an elevated radial, while $\phi = 45°$ is midway between two elevated radials; met = metallic masts used to support the elevated radials, and non-met = non-metallic support masts

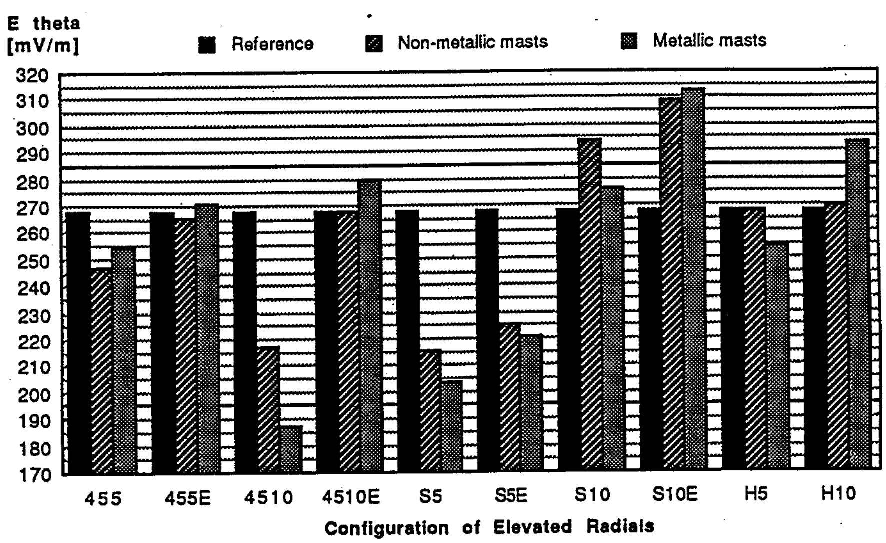

Figure 8. Radiated electric field intensity for all elevated-radial configurations when installed above a "deteriorated" conventional ground system. In each case, the performance of the reference-standard buried-radial ground system is shown for comparison (267.91 mV/m at 1 km for 1 kW).

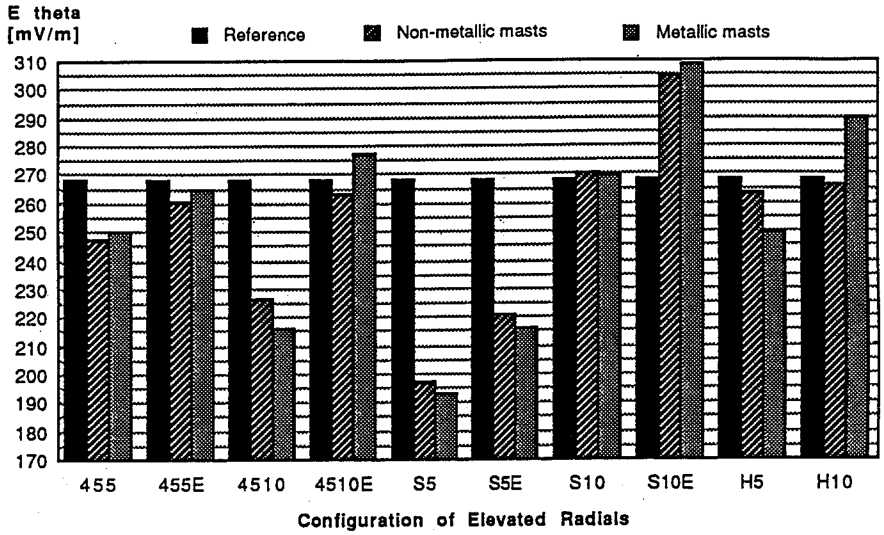

Figure 9. Radiated electric field intensity for all elevated-radial configurations when installed above a "very deteriorated" conventional ground system. In each case, the performance of the reference-standard buried-radial ground system is shown for comparison (267.91 mV/m at 1 km for 1 kW).

Conclusions

Computer-modeling exercises indicate that it is possible to add a group of four elevated radials to a pre-existing conventional AM-broadcast vertical monopole antenna system in order to restore performance to its original level (or better) in situations where the buried-radial ground system has been damaged. A wide variety of different configurations for the elevated radials have been examined, and clear-cut winners were determined. As always, extensive outdoor testing should be performed in order to verify these computer predictions.

The choice of whether to replace those radials which are damaged with new buried radials, or to add elevated radials, must be made by the station's management personnel, and would depend upon the particular circumstances at each individual installation.

Acknowledgements

The authors would like to express their appreciation to Al Resnick for providing important technical information [5], and to Suzanne Vazzano for her expert word processing of this report. Thanks go also to Richard Piccard and Karen Hostetler of Ohio University's Computing and Technology Services for assisting with software implementation.

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MEASURING PEAK/AVERAGE POWER RATIO OF THE ZENITH/AT&T DSC-HDTV SIGNAL WITH A VECTOR SIGNAL ANALYZER

Gary Sgrignoli
Zenith Electronics Corporation
1000 Milwaukee Ave.
Glenview, IL 60025

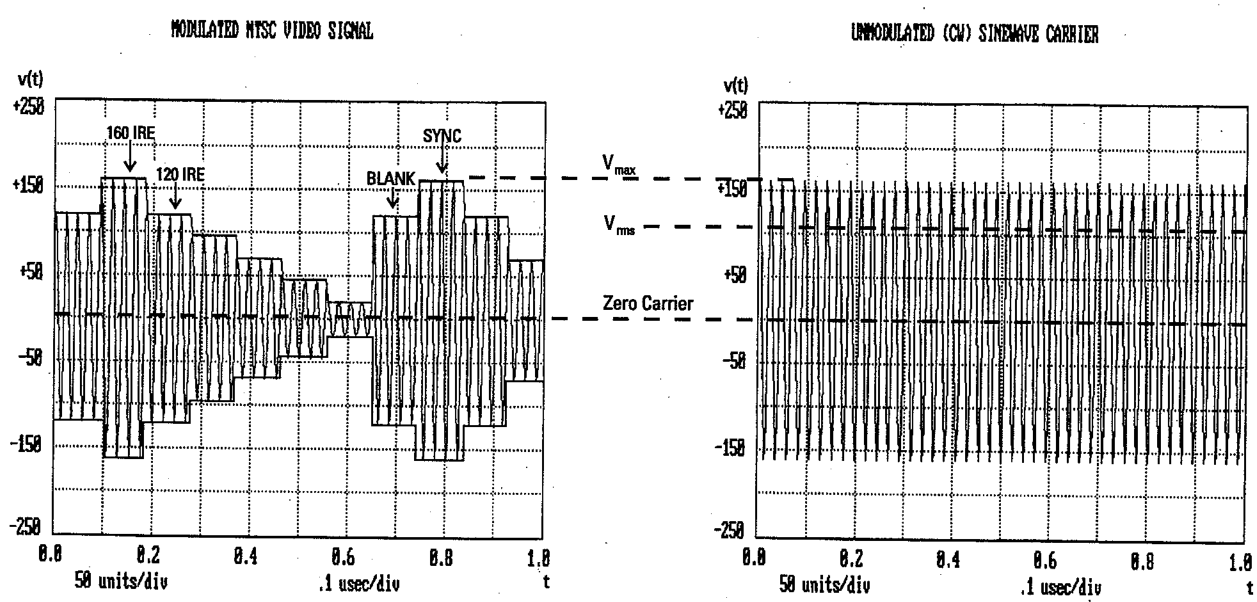
Abstract: The characterization of digital high definition television (HDTV) signal power is becoming very important in light of the current selection process underway for a new television broadcast standard in the United States. Characterizing and measuring the power of this new type of television transmission system is much different than that of the current NTSC transmission standard. Therefore, new measurement techniques and instruments must be developed. This paper describes the different power measurement techniques used for NTSC (peak envelope power) and HDTV (average power and peak-to-average power ratio). A brief description of a digital data transmission system is included to show why the HDTV signal is noise-like in nature and how it can be measured. A new type of RF analyzer with the ability to statistically measure peak-to-average power ratio is described. The Zenith/AT&T Digital Spectrum Compatible High Definition Television (DSC-HDTV) data transmission system is currently one of the systems being evaluated for consideration as a new U.S. broadcast standard. Signal measurement examples of this system are provided.

Introduction

Zenith/AT&T's Digital Spectrum Compatible High Definition Television (DSC-HDTV) system is a sophisticated and complex data transmission system for broadcast television. Accurately measuring the average power and peak power in a transmitted digital HDTV signal is an important task for both the broadcaster and the system designer. The broadcaster is concerned with power ratings and breakdown voltages of transmitter output devices, while system designers are concerned with data error rates for a given service coverage area and interference into other services (e.g. NTSC).

Characterizing the random digital data signal power is different than characterizing an NTSC signal. This is due to the fact that digital HDTV signals do NOT have the large horizontal and vertical synchronizing pulses. HDTV data signal levels vary at random so that statistics must be used to determine both the peak and average power.

Figure 1. NTSC Peak Power Definition



V_{max} ≡ Peak Instantaneous Voltage

V_{rms} ≡ Root Mean Square Voltage $= \frac{V_{max}}{\sqrt{2}}$

P_{pk} ≡ Peak Instantaneous Power $= \frac{V_{max}^2}{R}$

P_{env} ≡ Peak Envelope Power $= \frac{V_{rms}^2}{R} = \frac{V_{max}^2}{2R}$

Comparison of NTSC and DSC-HDTV Power Measurements

NTSC Power Measurement: NTSC signal power is characterized by its peak power, as measured during the horizontal and vertical sync intervals. However, it must be noted that the parameter used to describe the NTSC signal power is the average power Pavg (V_{rms}^2/R) of a CW sine wave signal whose voltage peaks equal the voltage peaks of the RF carrier during the sync intervals. This is formally called Peak Envelope Power (PEP), but is usually referred to as "peak power." This is illustrated in Figure 1. Note that "peak power" is NOT meant to be peak instantaneous power (i.e.V_{pk}^2/R). Thus, the ratio of the peak envelope power to the average power of a CW signal is 0 dB, that is, the "peak-to-average" power ratio is 0 dB. While peak power in an NTSC signal is very consistent (syncs are always the same height), its average power is not. Instead, average power is highly dependent on the video signal content (i.e. average luminance level) and, therefore, is not used to describe NTSC RF signals.

In general, NTSC RF peak power can be measured on the traditional swept-frequency spectrum analyzer by looking at the picture carrier and widening the bandwidth so that the sync peaks are seen rolling through. The power measured at these peaks is the NTSC peak power. Another way to perform the same measurement is to center the picture carrier in the center of the spectrum analyzer screen, and then to put the analyzer into the zero span mode of operation. With the resolution and video bandwidths on 1 MHz or wider, the syncs can be easily seen and measured. In both measurement methods, since the spectrum analyzer is already calibrated in terms of average power that is read for a CW sine wave signal (for its given input impedance), the value that is read off the screen is exactly the desired "peak NTSC power" reading.

FCC rules specify that power measurements of transmitted NTSC RF signals are to be referenced to peak sync. During NTSC broadcast transmitter calibration, this peak signal power is measured indirectly by using average power measurements. A special NTSC test signal that consists of only composite syncs and blank level is sent through the transmitter. The average power of this special test signal ("Composite Syncs Only") is measured very accurately by using a dummy load calorimeter (in place of the antenna) to dissipate the output power. Since the peak-to-average power ratio for this special test signal is easily calculated and generally known to be 2.25 dB (linear power ratio of 1.68), this correction value can be mathematically applied to the calorimetrically measured average power to obtain an accurate peak envelope power value. This accurate calorimetric power measurement is then used to calibrate any through-line average power meters for subsequent power measurements of the "Composite Syncs Only" test signal. Daily use of the through-line power meters avoids repeating this time consuming calorimetric measurement. The dummy load power as measured can also be used to calibrate other power-measuring equipment (e.g. spectrum analyzer) at low-power sampling points on the transmitter output and antenna feed.

DSC-HDTV Power Measurement: The digital HDTV signal is different from the NTSC signal in that the HDTV average power (V_{rms}^2/R) is very consistent if averaged over sufficient time since the transmitted data is random in nature. However, the peaks of the RF envelope of the HDTV signal are statistically determined by the combination of random data patterns and the channel filtering. Therefore, the peaks must be described as a statistical distribution, indicating not only how high the peaks are, but how often they occur (i.e. what percentage of time).

Average power for the noise-like, flat-spectrum DSC-HDTV signal is measured over a 6 MHz channel bandwidth by integrating the squared linear magnitude function of the signal spectrum. Since the data is random, the average power should remain consistent for all types of video signals.

The peak envelope power (PEP) of a DSC-HDTV signal is defined in a manner similar to that of the NTSC signal. The RF data signal peaks, which occur randomly and are statistical in nature, are identified and equated with a CW sine wave whose voltage peaks equal the voltage peaks of the RF data signal. The average power of this CW signal is then said to be the peak power of the DSC-HDTV signal. Figure 2 illustrates this definition.

The average power of the HDTV signal becomes important for transmitter power dissipation and temperature considerations, while the peak power is important for non-linear considerations such as compression in output devices and voltage breakdown in transmission lines.

Before describing the statistical nature of the HDTV signal, it may help to briefly describe the fundamentals of the data transmission system and show how the discrete data levels are converted into finite rise-time analog signals which exhibit variable amounts of peaking.

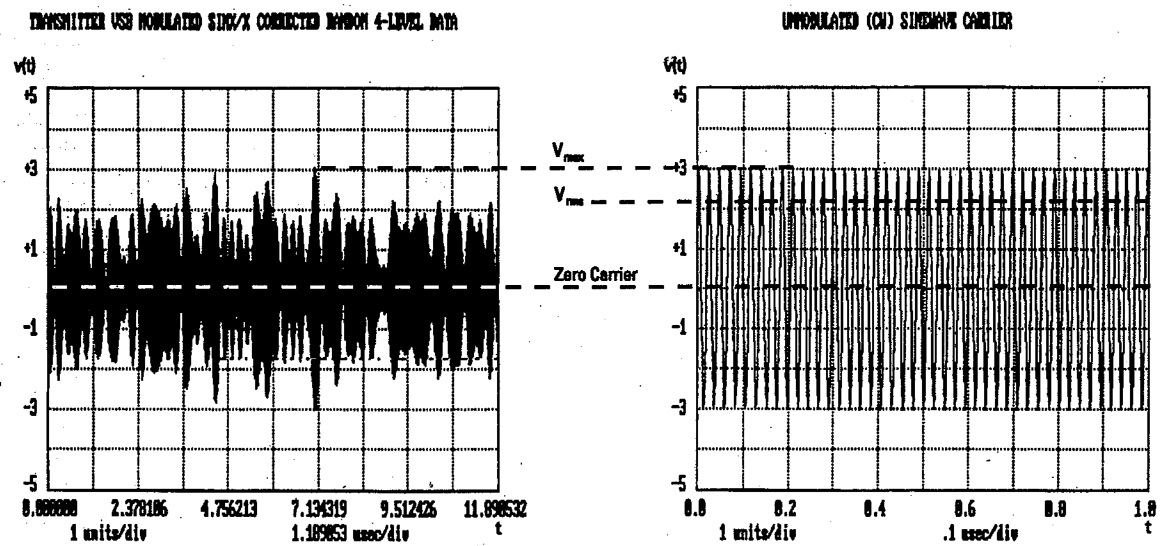
Data Transmission Theory

High spectral efficiency is very important in the transmission of digital HDTV signals. Since the FCC requires the new HDTV transmission system to use the same channel allocations as NTSC, transmitting as much data as possible in the allotted 6 MHz television channels is critical for the highly compressed video and audio signals. At the same time, energy spillage into adjacent channels must be tightly controlled. One way of achieving these goals is to use a flat passband filter nearly one channel wide with steep but well-controlled transition bands, or skirts. The wide filter bandwidth is necessary for passing large amounts of data (high data rates), and the steep skirts are necessary for channel energy containment. However, these steep filter skirts cause data signal ringing. This ringing causes one data symbol to ring into other data symbols, a phenomenon called intersymbol interference (ISI). Also, random data passing through this filter is converted from discrete amplitude levels to continuous levels since the rise times are now finite.

To overcome the problem of ISI, the shape of the overall data channel transfer function (and thus impulse response) can be selected such that any ringing caused by one pulse will travel through zero at every subsequent symbol-sampling instant, and thus cause no interference. In order to achieve this, the system impulse response must have a constant ring frequency equal to one half the data symbol rate. One filter that accomplishes this feat is the linear phase, "raised cosine" filter, as illustrated in Figure 3. It should be noted that, strictly speaking, this filter is not exactly realizable (finite frequency response always leads to an infinite impulse response). It is, however, relatively easy to approximate. The channel filter response, as considered at baseband on a linear frequency and amplitude scale, must have a skirt that has odd symmetry around the half-data rate frequency ($F_s/2$), i.e. the Nyquist frequency. This type of filter transition requirement is called a Nyquist slope. The actual slope can be any reasonably monotonic function (linear, quadratic, raised cosine, etc.) as long as it has linearly odd symmetry around the Nyquist frequency. The most commonly-used transition function is the raised cosine. Any noise-like random data, when filtered by such a Nyquist filter for bandwidth reduction, has a continuous amplitude distribution, and causes the RF envelope between data symbols to add up to values often greater than the original data levels. Since the data is random with a quantized amplitude only at sampling instants and random amplitude in between, the instantaneous power must be described statistically.

In determining the maximum data rate that can be passed through a data system, channel bandwidth allotment and practical

Figure 2. DSC-HDTV Peak Power Definition



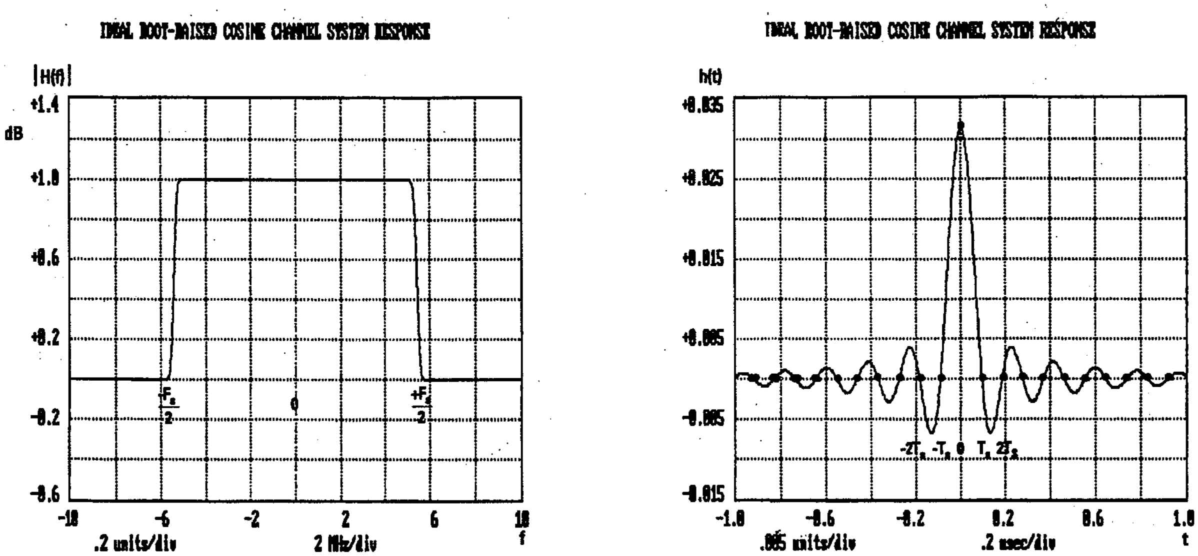
V_{max} = Peak Instantaneous Voltage

V_{rms} = Root Mean Square Voltage $= \frac{V_{max}}{\sqrt{2}}$

P_{pk} = Peak Instantaneous Power $= \frac{V_{max}^2}{R}$

P_{env} = Peak Envelope Power $= \frac{V_{rms}^2}{R} = \frac{V_{max}^2}{2R}$

Figure 3. Ideal Data Channel System Response



F_s = Sampling Frequency

$\frac{F_s}{2}$ = Nyquist Frequency

T_s = Sampling Rate

$f_s = \frac{1}{T_s}$

Figure 4a. DSC-HDTV Nominal Channel Definition

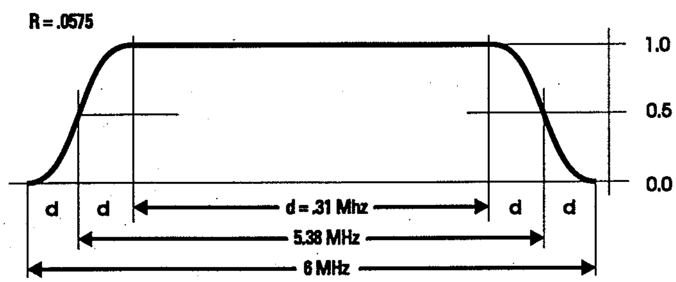
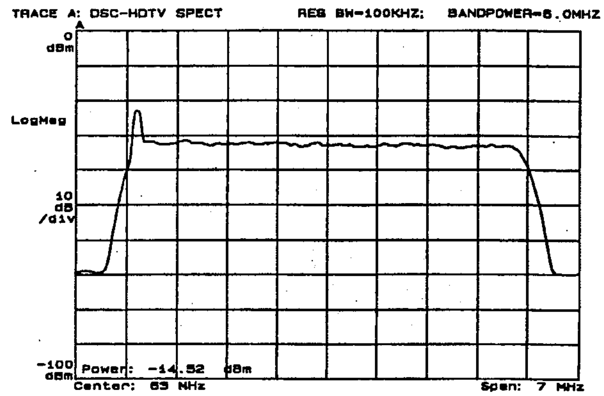


Figure 4b. DSC-HDTV Transmitted Spectrum



transmitter and receiver filter implementation must be taken into account. The filter transition region can be made very wide (easier to implement) with much excess channel bandwidth (inefficient spectral usage, low data rate, but small overshoots), or very narrow (harder to implement) with little excess bandwidth (efficient spectral usage, high data rate, but large overshoots).

In the DSC-HDTV system, four-level data symbols are transmitted vestigial sideband (4-VSB) at a symbol clock rate of 10.762 MHz. The two Nyquist frequencies are 5.380 MHz apart, with 620 kHz transition regions. The total data channel fits within the allotted 6 MHz band width, as shown in Fig 4a. Note that the Nyquist slope requirement is for the OVERALL system response. The filtering between the HDTV transmitter and receiver must be partitioned. In the DSC-HDTV system, equal partitioning is used, that is, the transmitter and receiver magnitude responses are square roots of the overall system magnitude response. This provides for optimum noise performance in the receiver. The shape of the transmitter and receiver filter skirts are now referred to as "root-raised cosines." When measuring the HDTV transmitter output signal, it should be noted that the signal has only been processed by one of the two system filters. Thus the transmitter output signal has slightly different characteristics from the overall system response described above. Fig 4b illustrates the noise-like DSC-HDTV flat transmitted spectrum as measured on a vector signal analyzer with the aid of power bandwidth markers and signal averaging. Note that a pilot exists at the low end of the DSC-HDTV spectrum. This pilot, which aids in the synchronous detection process, appears to be more dominant than it really is since the spectrum analyzer resolution bandwidth is set to 100 kHz, displaying the CW pilot at full strength while bandlimiting the noise-like data signal.

Statistical Power Measurment of DSC-HDTV Signals

Since the transmitted data is random (nondeterministic), a statistical approach is needed to characterize the RF signal. Therefore, the concept of probability is used to determine the relative frequency of occurrence of transmitter RF signal power levels. Estimation of random processes becomes more accurate for larger amounts of data, according to the "empirical law of large numbers."

If enough time samples of the RF envelope of the HDTV signal could be measured, and collected into "power bins," a statistically accurate histogram could be derived. A histogram is a tabulation of the frequency of occurrence of a random variable within adjacent ranges (or bins). The total number of samples in all the bins is the total number of power measurements made. If the power bins are narrow enough, and the number of occurrences of each bin is divided by the total number of samples taken, the histogram can accurately approximate a probability density function (PDF). Each bin will have associated with it a percentage number indicating what proportion of the total number of power samples resides in that particular bin. (See sidebar "Probability Theory")

The desired result is to find the percentage of the time during which an HDTV RF signal envelope rises ABOVE a particular power level. Therefore, once a PDF has been determined, a form of the cumulative distribution function (CDF) can be obtained by integrating over all the power levels, starting from the maximum power level found and working down to zero power. As each bin's frequency of occurrence is added, a percentage number is obtained for how often the HDTV signal envelope power exceeded that power (bin) level. As more and more bins are added (integrated), the number will rise toward 100% at zero power level. In other words, 100% of the measured RF envelope power samples are greater than zero power level. It should be noted that the histogram could have been integrated from zero power to maximum power, creating the standard CDF. Then the value found in each power bin would represent the percentage of time the HDTV RF signal is BELOW that particular power level.

Rather than using only the statistical CDF of the absolute power samples, the statistical CDF of the RATIO of "peak power" to average power gives a good normalized signal description of an DSC-HDTV signal. This is easily achieved by dividing each bin's power value by the average power (a constant) of the HDTV signal. As mentioned previously, the average power is defined as the power contained in a 6 MHz bandwidth.

Given that the CDF is the most useful means of statistically describing peak-to-average power of an HDTV signal, all that remains is to find an instrument that measures: 1) the average power over the desired 6 MHz bandwidth, and 2) a long-term statistical CDF of the envelope power of an RF signal. It is desirable to have wideband sampling (> 6 MHz information bandwidth), high accuracy amplitude measuring capability (for voltage and power), a variable heterodyning front end that covers the VHF and UHF spectrum, flexible signal processing, and the ability to accumulate and process a large quantity of data over time. Currently, swept-frequency spectrum analyzers are used for most of the traditional RF signal power measurements. However, another type of analyzer, the HP89440A Vector Signal Analyzer, appears to do in one unit all the traditional power measurement functions as well as all of the necessary special functions (band power measurements, time domain RF envelope display, programming capability, etc.).

Sidebar: Tutorial Probability

In probability theory, the probability of occurrence of an event p is a positive number within the range 0 and 1. An event that is NOT possible has a probability of p = 0 while an event that is certain has a probability of p = 1. The concept of random variables is used to describe possible outcomes of an experiment by signifying a rule (or mapping) by which a real number (e.g. 0 or 1) is assigned to each possible outcome of an experiment (e.g. heads or tails in a coin flip). This allows the use of the familiar structure of real numbers and enables the making of numerical graphs of probability versus events for a given experiment. Note that in defining the random variable, a measure (frequency of occurrence) of each outcome has NOT been as signed. The roles of probability and random variables are distinctly different. In the case at hand, the desired random variable is the set of instantaneous power samples of the RF signal envelope where a one-to-one correspondence (= mapping) exists between each power sample value and the random variable itself. It should also be noted that random variables can be either discrete (finite number of distinct values) or continuous.

As mentioned above, it is of special interest in this analysis to determine the frequency of occurrence for various transmitted RF power levels, and obtain a plot of the outcome probabilities (frequency of occurrence) versus the random variable (power samples). Of particular importance is a plot of the standard cumulative distribution function (CDF), F(x), which is a statistical function indicating the frequency of occurrence of all the signal power sample values BELOW a given power level. It is cumulative because it adds up all the occurrences of power levels below the plotted value. Generally, a cumulative distribution function, which is associated with a random variable, is based on the concept of probability, and has the following properties:

$$0 \le F(x) \le 1$$

$$F(x1) \le F(x2) \quad \text{if} \quad x1 < x2$$

$$F(-\infty) = 0$$

$$F(+\infty) = 1$$

The CDF function F(x) is always non-negative and between 0 and 1 since it is a probability. F(x) has a positive, monotonic slope because F(x2) includes as many or more of the possible outcomes as does F(x1). F(x) is zero at minus infinity since it includes NO possible events while F(x) is one at plus infinity since it includes ALL possible events. If the frequency of occurrence of the signal power values ABOVE a given power level are desired, the normal CDF values can be subtracted from 100% to obtain these values. For example, if 99% of the samples are BELOW a given power level, then 1% are ABOVE this level.

The problem at hand is one of determining the CDF. The probability density function (PDF), f(x), is often used in probability theory to describe the relative frequency of occurrence and statistical averages (mean, mean square, variance, etc.) of a random process. This function, which is the derivative of the cumulative density function, has the property that the area under its curve is the probability of occurrence. Its properties are:

$$f(x) \ge 0$$

$$\int_{-\infty}^{+\infty} f(x)dx = 1$$

$$f(x) = \frac{d}{dx}F(x)$$

$$F(x) = \int_{-\infty}^{x} f(x)dx$$

The function f(x) is always positive since the CDF is monotonically increasing, which indicates that as x increases, more outcomes are included in the probability of occurrence. The integral from minus infinity to plus infinity (total area under the PDF) must equal one, which indicates total certainty of occurrence. The last two equations are the defining equations of the PDF and its differential relationship to the CDF. The probability of occurrence of a value LESS than x is the integral of the PDF curve between minus infinity and x. In the search for the peak-to-average power ratio of an RF-modulated data signal, the PDF is NOT known deterministically. However, a way exists to approximate the PDF and, consequently, the CDF.

Measured samples of the random variable (RF signal envelope power) can be used to create a histogram for estimation of the PDF. Once the PDF is estimated, the CDF can be obtained by integrating the histogram (PDF). A histogram is a tabulation of the frequency of occurrence of a random variable within adjacent ranges (or bins). The total number of samples in all the bins is the total number of samples available. The best histograms (close approximation of PDF) result from narrow bins and tabulation of a large number of data samples.

Description of Hewlett-Packard's New Vector Signal Analyzers

The HP 89440A is a new Vector Signal Analyzer of the category known as "Real Time Spectrum Analyzers," or "FFT Analyzers." Their architecture is quite different from that of swept analyzers, and provides the measurement capability needed for the statistical power measurements already mentioned. The most fundamental difference between this type of instrument and swept analyzers is that the vector signal analyzer's input signal is sampled for a short period of time, giving a data block that is then transformed to the frequency domain with a Fast Fourier Transform (FFT). This yields a spectrum with high frequency resolution in one quick operation, with all parts of the signal record being represented simultaneously in the resulting spectrum.

This duality—of a time domain measurement corresponding to its frequency domain counterpart, with no information lost—offers several immediate advantages:

The time domain and frequency spectrum of a signal can be studied simultaneously, formatted as upper and lower traces if desired. The analyzer's full color display is especially useful for superimposing up to four distinct traces without confusion.

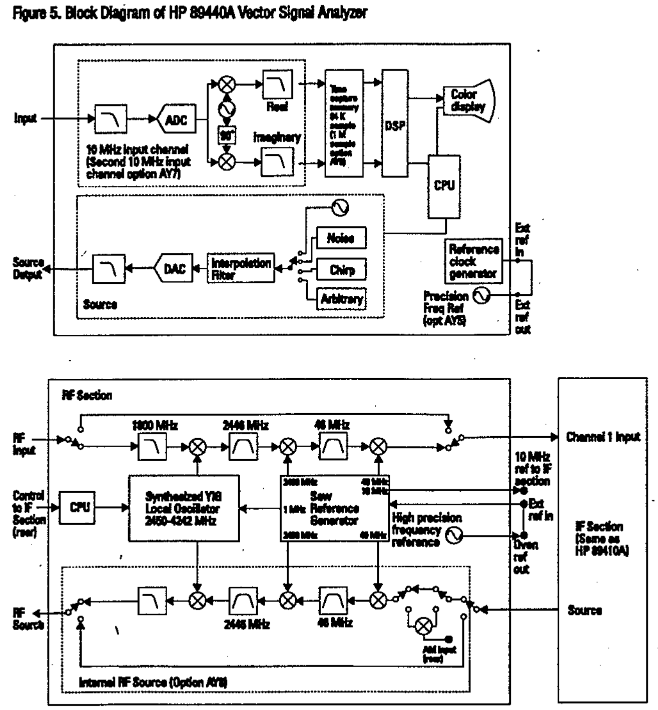
Accuracies of measurements in the frequency and time domains are equivalent: 1.0 dB and 12%, respectively. This is an overall specification, guaranteed to cover worst cases, and applies when the internal auto calibration and time domain corrections are enabled. Much better accuracies are obtained when relative measurements are made, such as the peak-to-average power ratio, or when an external transfer standard is used.

The phase spectrum is preserved—increasingly important for today's signals containing phase coded information, and for two channel measurements such as transfer function.

The measurement is based on a particular time segment that is captured; for example, a color bar of an NTSC signal, or a complete HDTV video frame.

Once captured, the measurement can be the basis for further analysis: for example, the placement of band markers constraining a power measurement exactly to a video channel; or, with marker controls, measuring the power in any portion of the spectrum the user desires.

Figure 5. Block Diagram of HP 89440A Vector Signal Analyzer



The IF unit of the 89440A hardware covers a 0 to 10 MHz frequency range and can be used separately, but it is usually combined with heterodyning hardware that extends measurement capability to 1800 MHz. The complete, combined vector signal analyzer system is shown in Figure 5. An accessory downconverter (HP 89411A) is available that accepts IF signals at 21.4 MHz from higher frequency spectrum analyzers for coverage above 1800 MHz.

For the statistical measurement of power on a DSC-HDTV signal, several capabilities of the hardware are important:

- Wide information bandwidth: 10 MHz at baseband, 7 MHz at all VHF and UHF channels. ("Information bandwidth" is the widest frequency spectrum that can be generated from contiguous samples, determined in the 89440A by its 25.6 MHz sample rate.)
- High accuracy in both time and frequency domains, provided by automatic, internal calibrations.
- Measurement speed up to 60 display updates/second, to support good statistical estimates quickly.

Measurement accuracy, dynamic range, and other performance specifications are determined mainly by the hardware, but the flexibility of many different measurement types is achieved in the instrument's resident software. Many measurement types are supported by the architecture in Figure 5, including autocorrelation, cross power spectrum, and transfer function. A particularly useful display format for view ing a DSC-HDTV video signal in the time domain is "linear magnitude," that shows the envelope of an AM modulated carrier. This is the format Zenith/AT&T uses to derive the peak envelope power distribution function.

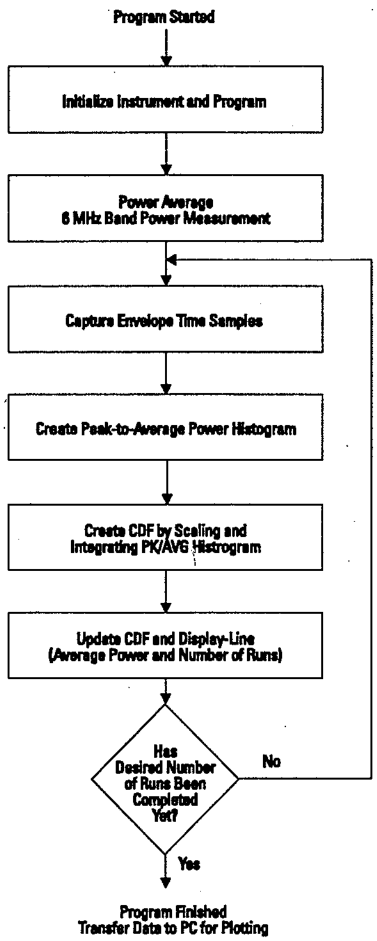
Another valuable measurement result generated by the instrument's software is the demodulation of phase noise. (AM and FM demodulation are also available; and the architecture of a vector signal analyzer is an attractive environment for digital demodulation and analysis.) Demodulation yields a display of phase deviation vs. time—very useful as a time function to see transient and drift behaviors, and also to derive statistical information: probability of L.O. or data carrier phase deviation exceeding a system limit, for example. How this could be done is illustrated in the next section—not for this specific phase deviation example, but for deriving power distributions.

Synthesizing Statistical Measurements with BASIC Programming

The flexible time and frequency domain measurements made by the described vector signal analyzer are a useful resource for further processing, and Instrument BASIC programming is an excellent environment for this extension. Instrument BASIC programs can be developed and run in the instrument's 68030 CPU, using the resident editor, debugger, and programming utilities. A PC compatible keyboard can be attached and used to save typing time for all but very short programs. Another way to simplify program development is to use "keystroke recording," that captures measurement sequences as they are performed, and results in an executable program with little or no editing. A 3.5 inch floppy drive is integrated into the instrument, which is useful for saving programs and trace data in DOS format for use within the instrument or personal computer environments.

The following is a brief description of the peak-to-average power ratio software program written in HP's Instrument BASIC for the 89440A. Figure 6 contains a block diagram of the program flow. While the CDF is not a resident function in the signal analyzer, the Instrument BASIC program controls the instrument over the internal HP-IB bus for taking data, calculating the CDF function, and display-

Figure 6. Peak-to-Average Power Ratio HP Instrument Basic Program Flowchart



ing it. This is all done within the instrument itself. For most accurate results, a single self-calibration should be executed before running the program. Also, the input range should be selected so that the input signal uses as much of the dynamic range as possible without overdriving the analyzer.

1) Declaration and Utilization of Variables
Program variables are defined as integer or real, and arrays are dimensioned. Also, those parameters that remain constant throughout the program are given their initial values.

The peak-to-average power ratio histogram (and subsequently, the CDF) covers a 50 dB range (-30 dB to +20 dB) using 449 "bins" of constant dB width. This means that each bin is about 0.11 dB wide, providing a smooth, accurate representation of the CDF curve.

2) Analyzer Initialization
The analyzer is preset to its power-on default parameters. After an opening program description screen, the user is prompted to enter the center frequency of the modulated RF or IF data signal, and to specify the number of captured data blocks ("runs") to process via the softkeys displayed along the right side of the CRT.

The vector signal analyzer is initialized by this program as follows:

Trace 1: Captured Time Block of Signal Envelope Power Samples
X-axis: Time record (RF envelope): 0 - 221 μsec
Time sampling period = 111.6 nsec; 2048 sampled points
Y-axis: Log magnitude mode: 10*log ($Re^2 + Im^2$); autoscaled dBm

Trace 2: CDF Curve
X-axis: Time record (peak-to-average power ratio): -30 to +20 dB
Bin width = 0.11 dB; 449 data points (bins)
Y-axis: Linear magnitude (CDF percentage): 0 - 100 %

The analyzer is set for a 7 MHz span, thus passing the entire 6 MHz RF data signal without any distortion. The analyzer's time domain correction capability is enabled also, giving maximum accuracy. Since the analyzer is nonsynchronously sampling the RF envelope of the signal over long periods of time, a good statistical power measurement is obtained.

3) Histogram Trace Setup
Trace 2 is initialized for later display of the CDF by saving a specific time trace into it that has the required number of data points (bins) and appropriate axis scaling. This will remain intact when new data (histogram/CDF) is later created and displayed. It should be noted that the x-axis will be labeled as time (usec) instead of peak/average power ratio (dB), and the y-axis will be labeled as voltage (Vpk) instead of percentage (%). This is a result of using the vector signal analyzer screen to display nonstandard output data. The X-axis and Y-axis units displayed on the plots can be corrected at a later time with external plotting software (data transfer via a 3.5" floppy disk). However, it should be noted that the CDF data on the analyzer display can still be easily interpreted by reading the marker readout (when the instrument has been paused) and using a very simple conversion scheme:

1) Read the Y-axis marker values directly as percent (not Vpk).
2) Read the X-axis marker values directly as dB (not μsec) and subtract 30.

4) Average Power Measurement
The signal under test is measured for average power. This is done by using the band power markers set to a 6.0 MHz bandwidth centered around the center frequency. A long term measurement is performed in which the signal is RMS-averaged for 100 blocks in order to get a good estimate of the average power. After this, the 6 MHz band power marker value (in dBm) is displayed and used in later computations.

5) Peak Envelope Power Distribution Function
The analyzer is set up for a single sweep measurement that will be retriggered each time the program loops through this section of code. Trace 1, which is autoscaled before entering the loop, contains the time-captured RF envelope of the signal.

After the loop is initialized, data gathering begins with a single sweep measurement. The RF envelope time samples are placed in an array for statistical processing. Each power sample is ratioed to the average power before being placed in the appropriate peak-to-average power ratio bin. Each power bin is associated with a count of how many RF envelope power samples have been placed into it. While many time blocks are captured, bin counts continue to accumulate, forming a histogram.

A peak-to-average power ratio histogram is created that ranges from -30 dB to +20 dB. The maximum level of +20 dB has more than enough overhead for the DSC-HDTV signal so that all peak-to-average power ratio measurements/calculations will fall well below this value. Having a +20 dB maximum limit on peak-to-average ratio also allows other types of signals (analog or digital) to be measured accurately.

The histogram is scaled (normalized to 100%), and then integrated from the maximum peak-to-average power ratio (+20 dB) down to the minimum value (-30 dB) to create the envelope power CDF. This provides a CDF whose values in each bin represent the percent of power envelope samples that are ABOVE the average power by the dB amount represented by the bin pointer. The CDF is now ready for display.

The final portion of the loop stores the CDF data and displays it on trace 2, where the marker can be used (after pausing the program) to read out the x-axis (power ratio, in dB) and y-axis (CDF, in %), as described above. Also displayed, at the top of the screen, are the average power (in dBm) and the current decrementing loop counter value.

The program then loops back for another block of envelope power samples. The process continues until the number of user-determined passes has been reached or the user pauses or terminates the program. The display line indicates the number of captured data blocks ("runs") that have been processed, the center frequency used in the measurement, and the measured average power over a 6 MHz band. The lower portion of the screen displays the CDF curve. The marker can be used to accurately read off any desired values. The top half of the screen prints selected values of the CDF (every 0.5 dB from 0 through 10 dB). Softkeys provide the ability to save the CDF trace to disk, continue with more CDF runs, or exit the program.

Peak-To-Average Power Measurement Examples

The 89440A can be used to measure the statistical peak-to-average power ratio CDF of many kinds of electronic signals, including both NTSC video and HDTV data signals. In order to verify that the peak-to-average power ratio measurement is valid, a simple CW test signal was applied to the analyzer RF input and the Instrument BASIC program was run. Figure 7 illustrates the results. Note that the peak-to-average power ratio is about zero dB as predicted from the theory, thus verifying the accuracy of both hardware and software. The number of captured and processed data blocks ("runs") for all the CDF curves shown in this paper is 100. With 2048 samples per captured block, over 200,000 non-synchronous power samples are processed for each CDF curve, giving good statistical results. The time to acquire and process all these samples is less than 10 minutes.

Of course, there are more interesting signals to be measured. The previously mentioned NTSC test signal called "syncs only," used by NTSC broadcasters to calibrate their high-power transmitter outputs, can be measured. This signal only has two envelope levels: sync level (maximum RF power) and blank level (2.5 dB below peak sync power level). Figure 8 shows that the measured peak-to-average power ratio of this special test signal is indeed close to the 2.25 dB theoretical number. Notice that this CDF is not as steep as the CW signal's CDF. This is due to the fact there are two RF levels (blank and sync) and the transitions between the two are bandlimited (finite rise time), causing the CDF to spread out. Also, the absolute maximum peak-to-average power ratio is seen to be about 3.25 dB instead of precisely 2.25 dB. This is because the modulated NTSC signal has preshoots and overshoots from the sharp IF (SAW) filters used to bandlimit the signal to 4.2 MHz and predistort the group delay beyond 3 MHz. This additional peaking is reflected in the slightly higher peak-to-average power ratio measurement.

Figure 7. Peak-to-Average Power Ratio CDF of CW Test Signal

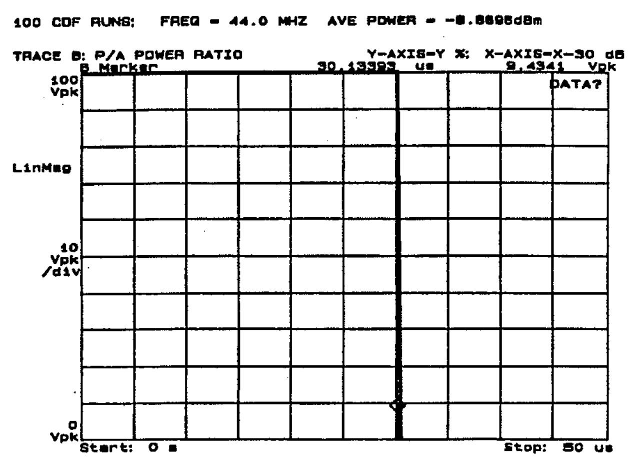


Figure 8. Peak-to-Average Power Ratio CDF of NTSC "Composite Syncs Only" Test Signal

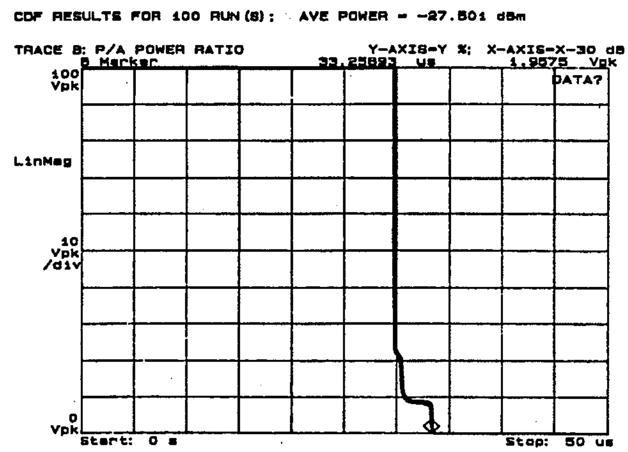
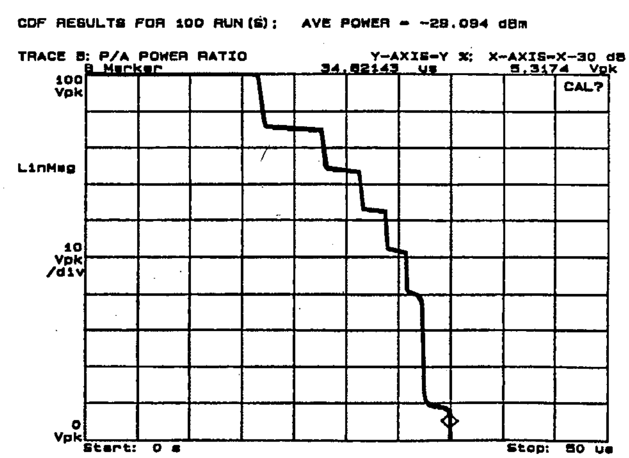


Figure 9. Peak-to-Average Power Ratio CDF of NTSC Stairstep Test Signal



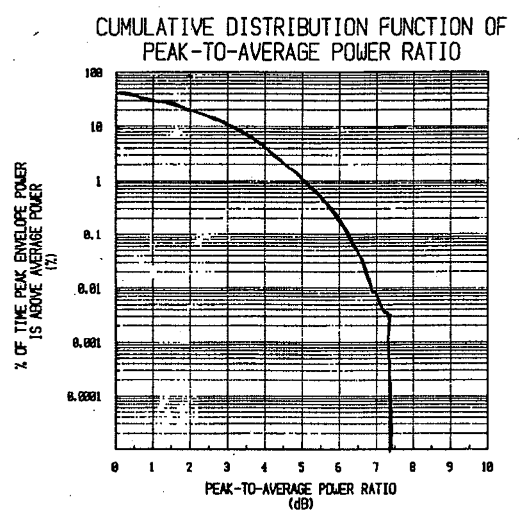
Another common NTSC test signal familiar to NTSC engineers is "stairstep." This signal has five constant-level steps that linearly increase (at baseband) across one horizontal line (63.556 usec). Since the five step levels, each one about 8 usec in duration, cause the RF envelope to occur at these distinct values for a good percentage of the time, the CDF curve should be stepped, as seen in Figure 9.

An HDTV "IF" signal can be measured for the purpose of determining its statistical peak-to-average power ratio. Of particular interest to HDTV engineers is the statistical spread of power near the top (right hand side) of the CDF curve. How frequently these high peak power levels occur is very important to broadcasters and transmitter manufacturers. To more accurately display these values, the CDF plot was converted to a Y-axis log plot. This was accomplished by storing the CDF plot on the internal 3.5" floppy disk (DOS-compatible) and then converting it to ASCII format on a PC-compatible computer using HP utilities software. The data was then read into a stand-alone graphics software package for subsequent log plotting. Figure 10 illustrates the log version of the CDF curve for the DSC-HDTV IF signal. The trace marker was used to read off the following CDF values:

% OF TIME DSC-HDTV "IF" SIGNAL SPENT ABOVE P/A VALUE	MEASURED P/A VALUE
.01 %	6.76 dB
.05 %	6.32 dB
.10 %	6.09 dB
.50 %	5.42 dB
1.00 %	4.98 dB
42.20 %	0.00 dB

Note that most of the of the DSC-HDTV signal power samples (99.9%) are less than 6.1 dB above average power.

Figure 10. Peak-to-Average Power Ratio CDF

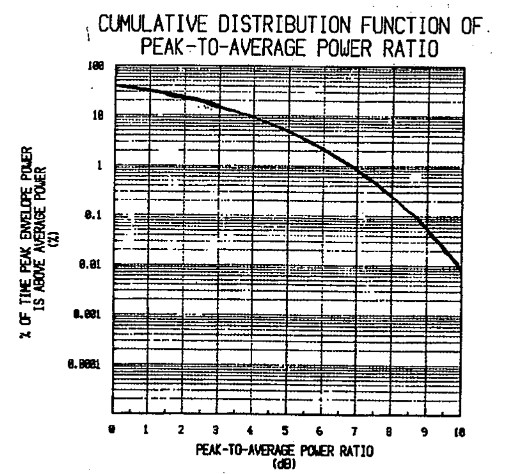


Digital HDTV signals are often described as "noise-like" since they consist of random data and exhibit flat spectra. Another way of comparing these data signals to white noise is to compare their respective peak-to-average power ratios. Figure 11 illustrates the CDF curve for 5.38 MHz bandlimited white noise. This noise is bandlimited to the same 5.38 MHz bandwidth as the DSC-HDTV signal. Note that the shape of the white noise CDF curve is similar to that of the digital HDTV data signal at the lower peak-to-average values; however, the peak-to-average ratio of white noise is statistically larger than that of the HDTV signal for large values of peak-to-average power ratios. This can be seen by comparing the following chart with the previous one:

% OF TIME WHITE NOISE SIGNAL SPENT ABOVE P/A VALUE	MEASURED P/A VALUE
.01 %	9.84 dB
.05 %	9.06 dB
.10 %	8.61 dB
.50 %	7.50 dB
1.00 %	6.83 dB
38.40 %	0.00 dB

On one hand there is a noticeable difference in that 1% of the white noise power samples are 6.83 dB or more above its average power as compared to 4.98 dB for the DSC-HDTV signal. On the other hand, a similarity can be seen in that white noise and the DSC-HDTV signal have about the same percentage of power samples (38.4% vs. 42.2%) above their respective average powers.

Figure 11. Peak-to-Average Power Ratio CDF of Band-limited white noise signal

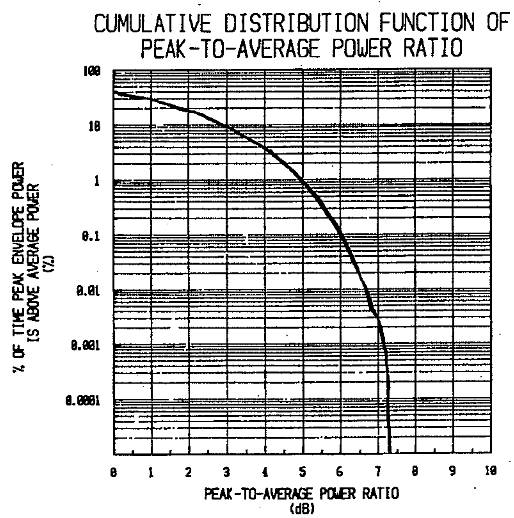


Finally, an HDTV signal, as measured at the output of a real UHF transmitter, can be easily characterized. Figure 12 is the CDF curve of a Harris Multiple Stage Depressed Collector (MSDC) UHF transmitter (WNVT CH 53) located in Independent Hill, Virginia. Data was taken during a recent (February 1-5, 1993) over-the-air broadcast of the DSC-HDTV signal 29 miles to downtown Washington, D.C. The transmitter average power output being fed to the antenna during this measurement was 6.6 KW, 12 dB below the typical full power NTSC peak envelope power of 105 KW. The vector signal analyzer marker was used again to obtain the following CDF data:

% OF TIME DSC-HDTV "RF" SIGNAL SPENT ABOVE P/A VALUE	MEASURED P/A VALUE
.01 %	6.65 dB
.05 %	6.21 dB
.10 %	5.98 dB
.50 %	5.31 dB
1.00 %	4.87 dB
40.90 %	0.00 dB

Note how this data is very similar to that measured on the HDTV "IF" signal, indicating that the nonlinearities associated with high-power UHF transmitters were adequately linearized so that the peak-to-average power ratio was relatively unchanged. The very slight decrease in peak-to-average power ratio (0.1 dB) of the high-power transmitter output signal may have been due to "soft clipping" of the Klystron tube.

Figure 12. Peak-to-Average Power Ratio CDF DSC-HDtv "RF" Signal.



Conclusion

When the HDTV standard is selected for the United States and digital HDTV broadcasting becomes a reality, new methods of describing and measuring "video & audio" RF signals must be developed. The ability to statistically define HDTV signals in terms of average power and peak-to-average power ratio will be necessary. This article has described procedures that serve these needs, and has illustrated how existing instrumentation can perform the measurements. The ease and speed with which these measurements can be obtained will be a benefit for the engineers who will be characterizing the HDTV RF signals of the future.

Acknowledgments

Thanks to Doug Wagner of Hewlett Packard for the initial version of the HP Instrument BASIC program and to Larry Nielsen of Zenith Electronics for further program developments. Also, thanks to Larry Whatley from Hewlett Packard for his description of the vector signal analyzer, and to Leif Otto from Zenith for creating the CDF plots.

Biography

Gary Sgrignoli received his bachelor and master of science degrees from the University of Illinois, Champaign in 1975 and 1977, respectively. He joined Zenith Electronics Corporation in January 1977, and is currently a senior project engineer in the Electronic Systems, Research and Development Department. Mr. Sgrignoli has worked on television ghost canceling, cable TV scrambling, cable TV two-way data systems, and digital high definition transmission systems. He has published several technical papers and holds 15 patents with 5 patents pending.

STATIONS IN THE NEWS

NEW TELEVISION REBROADCASTERS PLANNED
The CRTC has approved a rebroadcaster at Courtenay, B.C., for **CKVU-TV Vancouver**. It will operate on ch. 5, 9.8 kW ERP. In Ontario, **CFMT-TV Toronto** has applied for channel 60 in Ottawa, with 573 kW ERP. **CHEX-TV Peterborough** has filed for new parameters, channel 22, 2445 watts ERP, for an Oshawa rebroadcaster approved last year.

TWO AMs SEEK MOVE TO FM: Standard Radio has applied for 106.9 MHz, 84 kW ERP, in Ottawa. The FM would replace CJSB on 540 AM and overcome "severe technical problems". At Port-Cartier, Québec, CIPC — now 1 kW on 710 — would move to 7.4 kW on 99.1... *Other radio action at the CRTC:* Transfer of **CFNB Fredericton** has been approved from Radio Atlantic to John F. Eddy. VP/GM for the past 3-1/2 years, Eddy remains president of Radio Atlantic, which also owns stations in Bathurst and Truro. CFNB is currently marking "70 years of great radio" — 1923 to 1993... Hearings are scheduled for June 16 and July 7 in Hull. Upcoming applications: CHUM Limited for purchase of **CKKW/CFCA-FM Kitchener**; London Communications (Jack Schoone, Irving Zucker) for purchase of **CKOC/CKLH-FM Hamilton** and **CJBK/CJBX-FM London**... After a brief fling as CKMO, 'Oldies 1150' is again CKOC. Except for the past year or so, it was CKOC since 1922 and listeners wanted the historic call letters back!... Local investors want to buy **CKLY Lindsay**, ON. It's been in receivership for a year... In Ottawa, Don Crockford (Algonquin College) has applied for a low-power campus instructional FM on 96.9... A tourist information FM has been approved, 8w on 91.9, originating at **CJRN Niagara Falls.** CJRN was also permitted to continue programming its sister station, **CKEY-FM Fort Erie** from Niagara Falls; plans to build new studios at Fort Erie have been folded.

Health Concerns at CBC Toronto Broadcast Centre: The Globe and Mail has reported unexplained sickness is affecting some employees in the new CBC building in Toronto. Three non-CBC workers have applied for disability assistance after doing installation work in the $380 million project, and many CBC staff have complained of fatigue and other ailments. The prime suspect is carpeting which emits 10 chemicals. About 2000 employees have been moved into the centre, with another 1000 still to come from other locations... *Speaking of CBC:* The Radio network now has a 15-minute news report at 10pm M-F. A lot more changes will come by fall...

History of CFRC Kingston: A new book by Professor Arthur E. Zimmerman documents the history of radio at Queen's University. The focus is on 71-year-old CFRC, "the first C-call in Eastern Ontario, a pioneer campus station, tenth oldest surviving station in the country... The first documented broadcast from the Queen's campus was on April 28, 1902." *In the Shadow of the Shield* is available from 204-670 Sir John A. Macdonald Blvd., Kingston, ON, K7M 1A3, tel. (613) 542-1789.

CKGL/CHYM-FM Kitchener had the grand opening of its renovated studios on May 17; Key Radio says they're among "the most technically advanced broadcasting facilities in North America." *(See story page 9.)*... Shaw Radio's **CHAY-FM Barrie** is in brand new facilities, where its 'Open House Wednesdays' attracted 1500 visitors... *(Watch for story in BT!)*

16

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	MM Docket No. 87-267
Review of the Technical	)	
Assignment Criteria for the	)	
AM Broadcast Service	)	

PETITION FOR MIGRATION

Submitted: May 28, 1993

On behalf of Olmstead County Broadcasting Company (Olmstead), licensee of AM radio station KOLM, 1520 kHz, Rochester, Minnesota, the Federal Communications Commission is hereby requested to authorize radio station KOLM to migrate to the AM expanded band (1605-1705 kHz). The present facilities are described as follows:

KOLM ROCHESTER, MN 1520 KHZ BL800813AJ
10 KW ND-D-D (DA DURING CRITICAL HOURS)

It is Olmstead's intent to operate its facility in the expanded band employing AM stereo transmissions.

Olmstead County Broadcasting Company

Howard G. Bill
President

17

May 21, 1993

Ms. Donna Searcy, Secretary
Federal Communications Commission
Attn: AM Branch
1919 M Street, NW
Washington, DC 20554

Re: Petition requesting migration to the expanded band, 1605-1705 kHz

Dear Ms. Searcy:

Forwarded herewith is a petition requesting migration of radio station KOLM, Rochester, Minnesota to the expanded band.

If there are any questions, please let us know.

Sincerely yours,

Howard G. Bill

Enclosure

Can we ditch some of this?

18

RECEIVED
APR 21 1993
COHEN, DIPPELL AND EVERIST, P.C.
WASHINGTON, D.C.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In re **Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard**	**ET Docket No. 92-298** **Reply Comments of** **<u>Leonard R. Kahn</u>**

Leonard R. Kahn, as the developer of one of the two AM Stereo systems that is competing in the free marketplace, wishes to offer reply comments opposing the subject NPRM, because it is based on false assumptions, will mandate the use of a fatally flawed system and violates the Federal Communications Act, 47 United States Code. Moreover, the Commission's staff, acting under severe political pressure was unwilling to even permit a ten-day delay,[1] so that broadcasters would have time to voice their opinions regarding a decision that threatens the very survival of AM radio broadcasting.

In summary, Kahn replies to Motorola that its system was rejected by broadcasters and now it must be rejected by the Commission, because of its technically fatal flaws that make its

[1]The undersigned has received telephone calls from irate broadcasters from all over the country asking why the FCC has set such an unreasonable schedule for replies to probably the most important proceeding the Commission has ever authorized. The instant reply was rushed to a point that Kahn believes that he has been denied a reasonable opportunity to present his case.

use inconsistent with the Commission's policy favoring improving, not the destroying, the AM broadcast service, and because its anticompetitive behavior in the marketplace in violation of the law disqualifies its system from being selected by the Commission pursuant to The Federal Communications Act.

COMMENTS

Leonard R. Kahn ("Kahn")[2] opposes the adoption of the Motorola system for stereophonic AM broadcast service in view of the system's serious deficiencies and because its adoption would violate the rules of the Commission.

As the Commission will note, Motorola's comments are singularly free of any attempt at arguing its system's technical merits, but rather repeats its unfounded claims to the number of **users** of its system.[3] The confidential section of this reply will further address the real reasons for Motorola having **any**

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[2]For Kahn's professional qualifications to comment on this NPRM, please see page two of his Comments filed on April 5, 1993. In view of certain statements in the instant Reply he wishes to point out that he appeared as a witness at the Senate subcommittee hearing that led to this NPRM and that he is a Patent Agent, licensed to practice before The United States Trademark and Patent Office on patent matters since 1973.

He is President and CEO of Kahn Communications, Inc., the first recipient of FCC type acceptance of an AM Stereo Exciter.

[3]Each FCC decision maker should pick up a phone and spot check stations in areas where Motorola claims it still has **users** of its stereo system....and check if any leaves it on at night?

stations at all using its flawed system.[4] Thus, most of the following reply comments will be directed to the comments by broadcasters who address the real issues in selecting a technical standard,[5] i.e., how each candidate system's performance will impact on broadcast service. Clearly, the replies should make even lay Commission staff members realize that they need impartial, high-level, engineering advice, something they cannot expect from individuals who are paid for their lobbying efforts.

RESPONSES TO THE NPRM WERE UNFAVORABLE TO MOTOROLA BUT MOST FAVORABLE TO THE SELECTION OF ISB AM STEREO

The clear majority of the comments oppose the Commission's

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[4]The Commission has a substantial amount of data on file that proves the "fatal flaws" of the Motorola system. For example, in 1980, Mr. David Hershberger, of Harris, Mr. Robert Streeter, of Phillips/Magnavox and the undersigned all filed reports to the Commission (based on measurements and mathematical analysis), proving that the Motorola system creates severe interference, in violation of FCC rules. This bandwidth problem will dead-end AM radio, as it will deny AM radio the opportunity to introduce new and advanced narrowband technology. Besides the inherent bandwidth flaw, the Motorola system has the overwhelming disadvantage of being a phase separation system which creates "platform motion" making its use inappropriate for night time operation for most stations.

[5]Unfortunately, there is insufficient time to properly comment on the a number of important statements by broadcasters and FCC consultants. These are important statements and one can only hope the staff will take time to digest their contents. The undersigned wishes to list (alphabetically) the specific submissions of engineers that he wished he had been given sufficient time to discuss in his Reply;

1. Capital Cities/ABC
2. Cohen, Dippell & Everist
3. Communications Technology
4. James Dorrence
5. Philip E. Galasso
6. Christopher Hays
7. David L. Hershberger
8. Peter Kraushar
9. Lee Sutherland Parr
10. Burt Sherwood
11. David H. Solinske
12. John J. Tibilietti

first quick response to the mandate to select a system. Actually, not only do they request the Commission to try again, but the system of preference is the so-called Kahn ISB system. This result is most impressive in view of the biased wording of NPRM and in view of Motorola's all time most expensive marketing effort directed at the broadcast industry.[6]

Clearly, the majority favors the Commission's selecting a system on merit, not questionable success in the marketplace where Motorola has destroyed free competition by making certain that radios that receive other types of stereo signals are excluded.

Most of the commentors have pointed out that:

a) Motorola is not the industry's favorite, and

b) they want the "best" system, not the politically right system.

Selection of a system whose technical deficiencies preclude many stations' use of AM Stereo will only further injure AM broadcasting.

REPLY TO JUST TWO COMMENTS

Even the inventor of the "Harris Linear System" Favors ISB Sideband Stereo:

Capitol Cities/ABC, correctly opposes the Motorola system.

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[6] The response is especially gratifying in view of the staff's uncritical use of Motorola's incredible station "usage" statistics. **In its final count, the Commissioners should consider that most broadcasters and FCC consultants lack the courage to publicly oppose Motorola.** To learn just how strong the opposition is to Motorola, the Commission should take a secret poll of broadcasters as did the Department of Commerce in 1987. **By now, even more stations have abandoned Motorola's system.**

Its engineers know something is wrong, because they can hear it and see it on their spectrum analyzers all over the country. Amusingly, ABC selected the system that the Harris Corporation abandoned,[7],[8] but more importantly, the system's developer and original proponent, Mr. David Hershberger, also abandoned it, but for the correct engineering reasons. He discarded the QUAM system because it is a "phase" perturbation-sensitive system i.e., a "phase separation" system, that makes the system subject to platform motion, i.e., the very reason the undersigned originally developed the favored ISB system.

WHICH SYSTEM IS BETTER, LINEAR ISB OR KAHN ISB?

Linear ISB is best. But not now. If we could somehow destroy the hundreds of millions of AM radios now in use, almost every single one of them using some sort of "envelope" demodulator, there is no doubt that the linear system would

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[7]The Commission's staff is referred to the Confidential section filed with Kahn's April 5, 1993 Comments.

[8]The main reason ABC supports the old Harris system is that its linearity permits the use of "synchronous detection." They should note that the "synchronous detector" (product demodulator) was originally developed for SSB and ISB operation and actually provides better performance with such systems. So they cannot only enjoy the use of synchronous detectors, but they will not subject ABC listeners to "platform motion" and therefore will not have to switch on and off the stereo mode, whenever phase perturbations start rolling in.

Thus, selection of the Kahn ISB AM Stereo system will lead to the equipping of the public with radio receivers that are compatible with linear ISB transmission and start the change over to the ultimate stereo broadcast system, linear ISB.

provide the best performance.[9] However, in the iterim, i.e., for at least the next twenty years, the so-called Kahn ISB system is superior, because it does not produce an envelope with a cusp for negative modulation that restricts effective modulation. See Exh. 1, an early publication by the undersigned analyzing the envelope of a linear SSB wave and also cited earlier papers.

In Mr. David Hershberger's carefully thought out submission, he details the reasons why Motorola system could not be used; including, the "platform motion," and then proposed a linear independent sideband system.

The undersigned fully supports a linear independent sideband system. He has been involved in the development of linear SSB systems for some 40 years and, indeed, invented the system that was used by Harris to provide linear quadrature modulation and the system that would be used to implement linear SSB. However, unfortunately, the existence of literally hundreds of millions of conventional AM receivers with envelope detectors precludes the use of such a system by the vast majority of stations who would never willingly restrict their modulation and curtail service to a significant number of their listeners.

The problem is the "cusp" like nature of the envelope function of a linear SSB system. (see Exh. 1)

However, the undersigned believes that the linear system is

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[9]The undersigned must hedge a little, because a transmitter for the linear ISB system is somewhat more difficult to design. Kahn Communications is presently engaged in the development of high-efficiency, high-powered (up to 1 megawatt) transmitters for AM, linear SSB, AM Stereo and POWER-side. (Exh. 2)

the ultimate system by allowing broadcasters to use the present system that has been thoroughly tested and which is still effectively competing in the marketplace because of its capability of full modulation +125% and -100%.

With the selection of the Kahn ISB system, receiver manufacturers will be able to immediately switch over from Motorola ICs designed for its system to ICs already designed for Kahn operation.[10] They will also be able to start design of receivers using product demodulators (sometimes called synchronous detectors) as such receivers improve reception for the Kahn ISB system and are the optimum type receiver for linear ISB stereo reception.

[Such receivers cannot be implemented with the Motorola system because of excessive odd harmonic distortion. Whereas with the Kahn ISB system only even order distortion, which is the natural distortion, of the human ear and which, as proven in numerous tests by Kahn and also Harris, is not disturbing to the listeners. Indeed, such "distortion" is used in recording and broadcasting to enhance sound.]

IS THERE A WAY TO MAKE ALL BROADCASTERS HAPPY?

There is a way to make all broadcasters who have invested in AM stereo happy. If the Commission selects the Kahn ISB system, AM stereo receiver manufacturers will be able to make receivers

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[10]Indeed, the undersigned has designed inexpensive circuits that permit Ics (chips) designed for Motorola radios to continue to be used when production is switched to Kahn-type reception.

that operate in stereo all of the time, night and day, under good listening conditions or under the worst. **They will be able to make radios without stereo/mono automatic mode switchers or blenders.** The only reason Motorola and Harris needed receivers that switched to mono was "**platform motion.**" **No platform motion...full time stereo.** And since platform motion disappears when a Kahn ISB demodulator is used, **even listeners to Motorola stations will enjoy a tremendous improvement!**

<u>But what will Motorola stations penalties be</u>?

a) Their stereo imaging will be degraded, but most listeners will find the sound much better than stereo with platform motion and the stereo switching on and off; and

b) They will still suffer from loss of mono coverage due to the excessive bandwidth of the Motorola signal.

Thus, Motorola-equipped stations will actually be better off then they are now and many will probably turn their equipment back on.

<u>How will the Harris-equipped stations find the switch</u>?

a) Their stereo imaging will be degraded, but their listeners will also still find the sound better, absent "plat-mo."

b) They too will still suffer from loss of coverage, not due to excessive bandwidth (Harris' bandwidth was excellent), but rather due to poor negative modulation characteristics.

<u>And how will Kahn ISB equipped stations like the switch</u>?

a) Great

b) Just great.

But why shouldn't there be an advantage for stations who listen to their engineers and invest in superior technology?

For the few hundred Motorola users (and those 500 or so owners of such equipment) who wish to enjoy, full-time, platform-free operation, the (b)-item loss of coverage will induce them to switch over to full Kahn ISB system operation. This will not only allow them to serve more of their listeners, but it will allow their adjacent channel neighbors to get relief from their excessive splatter, letting these innocent parties serve more listeners.

[The necessary equipment to convert their equipment will be substantially less than the original investment the Motorola stations made in stereo, and Kahn Communications, Inc. will offer conversion kits to such stations and, indeed, provide other manufacturers design licenses to market such kits.]

Thus, all AM stations,[11] not only AM Stereo stations, should be happy.

<u>But what about those people who bought Motorola only receivers</u>?

That is a problem. But not for the reason one might think. Those people are not tuning to AM stereo stations because they are operating in stereo. If they were there would have been a mad rush to buy (not accept no-cost packages) Motorola system exciters.

In any case, if the Commission picks the Kahn ISB system,

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[11]Including stations with "problem" antennas that cannot be used with the Motorola system. Such stations are generally low on the dial with severe protection requirements that cannot be "broadbanded" by conventional means without losing significant amounts of effective radiated power. Kahn Communications' "Flatterer" can be used to ease such problems, but it is not an inexpensive device and only equipment has been designed for use with mono, Kahn ISB stereo and POWER-side signals. (Exh. 2)

Kahn stations can, in the matter of minutes, switch their pilot tones from 15 Hz to 25 Hz. (Indeed, some stations using the Kahn ISB system conducted experiments with a Motorola pilot, but when they heard the results they quickly switched back.)

The problem with that is, although the listeners heard stereo, they also heard **platform motion!!!! And the radios popped in and out of stereo!!! A true disaster.**

But even though it may offend those in the Congress who think broadcasters, unlike radio receiver manufacturers,[12] cannot be trusted to make their own decisions, the undersigned wishes to make a marketplace decision. Allow any broadcaster, Kahn or Motorola, the choice of using 15 or 25 Hz pilots. If he picks 25 Hz and he uses the Motorola system, everything will be "normal," but he will have platform motion and on-and-off stereo. If he values his reputation he probably rejected that situation. However, if he just serves a small town and he is a daytimer, he (or she) may accept the situation.

On the other hand, if the station uses Kahn ISB it generally serves larger areas and he will find it best to wait for the new radios that will meet the new FCC standards. However, that will be their choice and they will have freedom to switch at any time. Indeed he might switch at sundown each day, as may Motorola

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[12]It is interesting to read EIA's comments. They favor the Commission forcing broadcasters to use the Motorola system, but they are suddenly in favor of free enterprise when it comes to allowing receiver manufacturers to make mono only radios with 2.8 Khz frequency response that have been destroying the reputation of AM for the last two decades.

stations.[13]

The danger of trusting broadcasters with such freedom, (can one imagine such a discussion between Americans), is that if they don't make the correct choice, their listeners will come to the conclusion that AM Stereo is a form of low-fidelity torture.

But, out of the few stations that have bought Motorola equipment and still use it, many turn off stereo operation at night on their own. Thus, one can expect the vast majority of stations that have rejected the Motorola system, will, if the Commission selects the Kahn ISB system, install Kahn type ISB stereo exciters and eschew the freedom to use a Motorola pilot.

RECOMMENDATIONS

[The undersigned, after (hurriedly) studying the comments to this NPRM believes that the vast majority of the comments confirm his original recommendations which he now repeats.]

Kahn respectfully requests the Commission to carefully and deliberately reevaluate its NPRM. AM radio should not be considered a minor matter to the Commission while it ponders what it perceives is more newsworthy subject matter. More people rely on the 1 Mhz of spectrum devoted to AM radio than any other service, and those listeners deserve a full hearing. He further respectfully requests the Commission to seek advice from the National Institute of Standards and Technology ("NIST") in the

[13] In case someone is concerned about patents, Kahn was granted the original patent on the pilot and, of course, while he staked out 15 Hz because of its low frequency and harmonic relationship to 60 Hz, the claims are not that narrow.

selection of a system that will allow AM stations to make use of the best technology available to compete in their all important marketplace competition with FM, cable, cassettes, etc., etc.

AM radio deserves the best technology available...its very survival depends upon it.

Dated: April 19, 1993

Respectfully yours,

Leonard R. Kahn,
c/o Kahn Communications, Inc.
222 Westbury Avenue,
Carle Place, New York, 11514
(516) 222-2221

Of Counsel:

William Malone, Esq.
Miller & Holbrooke
1225 19th Street, NW
Suite 400
Washington, D.C. 20036
(202) 785-0600

19.

COHEN, DIPPELL AND EVERIST, P. C.
CONSULTING ENGINEERS
RADIO-TELEVISION
1300 L STREET, N. W.
SUITE 1100
WASHINGTON, D. C. 20005

JULIUS COHEN
RALPH E. DIPPELL, JR.
DONALD G. EVERIST
SUDHIR K. KHANNA
WARREN M. POWIS
JOHN R. URAM, JR.
ROBERT W. GUILL
WILSON A. LA FOLLETTE

TELEPHONE
(202) 898-0111
TELECOPIER
(202) 898-0895

April 20, 1993

Ms. Donna Searcy
Secretary
Federal Communications Commission
1919 M Street, NW
Washington, DC 20554

Re: Reply Comments on Notice of Proposed Rule Making, ET Docket No. 92-298

Dear Ms. Searcy:

Enclosed herewith are five copies (original and four) of the comments and audio tape (one for each copy of the comments) by this firm in the Notice of Proposed Rule Making, "Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard".

The audio tape provides recorded observations of AM stereo "platform motion" using a Potomac Instruments synthesized monitor receiver model SMR-11, Serial No. 293 with AMS-II C-Quam(r) stereo decoder and ANT-II tunable ferrite rod antenna.

If there are any questions, please do not hesitate to contact this office.

Sincerely,

Warren M. Powis

Warren M. Powis
Vice-President

WP:cc
Encl.

20.

AM

PUBLIC NOTICE

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET N.W.
WASHINGTON, D.C. 20554

News media information 202/632-5050. Recorded listing of releases and texts 202/632-0002.

April 15, 1993

FEDERAL COMMUNICATIONS COMMISSION TO OPEN "FILING WINDOW" ON AM EXPANDED BAND APPLICATIONS

The Federal Communications Commission will begin to accept petitions for migration to the new AM expanded band (1605 -1705 kHz) on May 3, 1993. The filing window will close June 30, 1993. Initial eligibility for expanded band allotments will be limited to existing AM licensees. The petition for migration need only include:

1. An opening statement requesting migration;
2. An accurate description of the existing band station (call sign, community of license and operating frequency) seeking to migrate;
3. A statement as to whether the petitioner intends to use AM stereo.

Those few stations that are eligible to take advantage of the opportunity offered by the recent amendment to Section 331(b) of the Communications Act of 1934, as amended, Pub. L. 102-243, Sec. 4, 105 Stat. 2394, 2402 (codified as amended at 47 U.S.C. Sec. 331(b) (1991)), and wish to do so, should so specify.

More detailed information regarding the methods to be used to calculate the ranking factors and allotments can be found in Review of the Technical Assignment Criteria for the AM Broadcast Service, 6 FCC Rcd 6273 (MM. Docket 87-267, released October 25, 1991), recon. granted in part and denied in part, FCC 93-198, adopted April 13, 1993. The complete text of this document may be purchased from the Commission's duplicating contractor, International Transcription Service, 2100 M Street, N.W., Suite 140, Washington, D.C., 20037 (telephone 202-857-3800).

The Commission will utilize two computer programs, one written in the Fortran language to calculate the ranking factors, and one written in the "C" language to calculate the allotments of frequencies. The Commission will release the Fortran source code and the "C" source code either in hard copy format or machine readable format through NTIS, 5285 Port Royal Road, Springfield, Virginia, 22151; (703) 487-4650. Documentation of the programs and instructions for their use on a PC or PC compatible systems or work stations are included with the programs. To minimize program size and file access, the ground conductives of Alaska and Puerto Rico, which were available only in the Region 2 Conductivity Database (R2RAN), have been transferred to the format of the US Conductivity Database (M3RAN). These additional conductivities (not available in the present M3 database), along with an addition for the Great Salt Lake, will be included in machine-readable format with the material made available.

The Commission will use AM Engineering Database Number 941, updated as of June 30, 1993, in the computation of ranking factors for stations desiring to migrate to the expanded band. Copies of this database will be available from the U.S. Department of Commerce, National Technical Information Service (NTIS), 5288 Port Royal Road, Springfield, Virginia 22161.

Several agencies of the Federal government operate travelers' information stations on 1610 kHz. They will continue operating on that channel on a co-primary basis until they can be reaccommodated in an orderly fashion on an alternative frequency to be determined in a future proceeding. Potential allotment conflicts with those Federal stations will be addressed on a case-by-case basis.

There is no fee required and the petition should be filed with:

Ms. Donna R. Searcy, Secretary
Federal Communications Commission
Attn: AM Branch
1919 M. Street, N.W.
Washington, D. C. 20554

For more information, contact Jim Burtle at (202) 632-7010.

21.

Warren

NEWS

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET, N.W.
WASHINGTON, D.C. 20554

News media information 202 / 632-5050
Recorded listing of releases and texts
202 / 632-0002

32722

Report No. DC-2388 | ACTION IN DOCKET CASE | April 15, 1993

COMMISSION ADDRESSES VARIOUS PETITIONS FOR RECONSIDERATION OF ORDER CONCERNING REVIEW OF THE TECHNICAL ASSIGNMENT CRITERIA FOR THE AM BROADCAST SERVICE (MM DOCKET 87-267)

The Commission has addressed various petitions for reconsideration of its Report and Order (R&O) concerning the review of the technical assignment criteria for the AM broadcast service.

The R&O took major steps to improve technical standards; to reduce the level of interference in the existing AM band; to encourage certain existing licensees to move into the expanded portion of the AM band; and to consolidate existing broadcasting facilities in order to further reduce congestion and interference in the existing band. The R&O also addressed, among other things, the issues of AM stereo and receiver standards as means of making the AM service more competitive and relaxed the rules pertaining to Travelers Information Stations (which are licensed under Part 90 in the Local Government Radio Service) to allow for the authorization, on a secondary basis, of such stations on any assignable frequency in the AM band.

On reconsideration, petitioners sought clarification or revision of specific rules or policy decisions relating to the new technical standards, the migration of existing licensees to the expanded band, the matter of AM receiver standards, Travelers' Information Stations (TIS), and other miscellaneous matters.

Except for minor modifications to the technical standards and a reordering of the priorities governing migration to the expanded band, the decisions made in the R&O were affirmed and the petitions denied.

After the close of the comment period in this proceeding, Congress amended Section 331 of the Communications Act to add Section 331(b). Section 331(b) requires that, if technically feasible, the Commission must find a means to enable current daytime-only stations located in communities of more than 100,000 and within a Class I station primary service area to provide service to those communities 24 hours a day, if these licensees notify the Commission that they seek to provide fulltime service. In order to comply with this statutory directive, the Commission amended its rules to provide that stations defined in Section 331(b) of the Communications Act would be given the first priority for migration to the expanded band. The few stations that fall in this special category will not impede the Commission's main policy objective of interference and congestion reduction in the existing AM band.

(over)

Also, in response to concerns expressed regarding public reliance on TIS, the Commission said that in a future proceeding, it will reexamine the status of TIS and explore the feasibility of a primary allocation for TIS on 1710 kHz. Travelers' information facilities operated by agencies of the Federal government that are presently on 1610 kHz will remain on that channel on a co-primary basis until they can be reaccommodated in an orderly fashion on an alternative frequency.

Action by the Commission April 13, 1993, by Memorandum Opinion and Order (FCC 93-198). Chairman Quello, Commissioners Marshall and Duggan, with Commissioner Barrett concurring in the result and issuing a separate statement.

-FCC-

News Media contact: Patricia A. Chew at (202) 632-5050.
Mass Media Bureau contact: Larry Olson at (202) 254-3394.

April 9, 1993

Concurring Statement of
Commissioner Andrew C. Barrett

RE: Review of Technical Assignment Criteria for the AM Broadcast Service

At the time of our Report and Order in this proceeding, I concurred in this item because of its failure to adequately address my concerns regarding the impact on small radio station businesses, including those who are minority owned.[1] I felt the decision was inequitable then with respect to these entities. I continue to believe that is the case in this subsequent order. It is not surprising to me that the Commission finds equitable reasons, as a matter of law or policy, to modify our prior Order and allow certain entities priority status in the expanded band where: 1. AM daytime-only stations in communities of more than 100,000 and within a Class I station primary service area seek to provide full-time, 24-hour service[2]; and 2. Travelers Information Stations seek to operate on a primary status within the AM expanded band[3]. The Order finds that such actions are likely to have a deminimis impact on our goal of reducing interference. It also acknowledges that other public interest concerns can be considered beyond interference reduction with respect to expanded band allotments. Thus, I am surprised that this Order selectively carves out these concerns while rejecting others with similar merit. Our decision to deny opportunities for Class C licensees to migrate to the expanded band is inequitable. Our decision to reject some type of priority allocation for all AM daytime only stations and minority-owned AM stations[4] in a portion of the expanded band also continues to be inequitable. I believe that arguments on reconsideration justify granting these various entities equal priority in the reallocation of at least a portion of the AM expanded band. To selectively support public interest concerns for certain entities in the expanded band, yet

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[1] See, Concurring Statement of Commissioner Andrew C. Barrett, Report and Order, Sept. 26, 1991.

[2] See Order at 12.

[3] See order at 16.

[4] An NTIA study during the past year shows that minority ownership statistics in broadcasting continue to be abysmal. Our efforts to address minority ownership issues in the context of the revised radio rules also have not yielded significant improvements in minority ownership. If anything, small broadcasters, including most minorities, appear to be struggling to compete with the consolidation among larger group owners. Thus, in the context of trends over the last decade, minority ownership in broadcasting is continuing to decline, not improve.

reject small business and minority ownership concerns despite statistical evidence that supports more equitable treatment, is an arbitrary exercise in regulatory linedrawing. Thus, I concur.

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COHEN, DIPPELL AND EVERIST, P.C.
CONSULTING ENGINEERS
RADIO-TELEVISION
1300 L STREET, N.W.
SUITE 1100
WASHINGTON, D.C. 20005

JULIUS COHEN
RALPH E. DIPPELL, JR.
DONALD G. EVERIST
SUDHIR K. KHANNA
WARREN M. POWIS
JOHN R. URAM, JR.
ROBERT W. GUILL
WILSON A. LA FOLLETTE

TELEPHONE
(202) 898-0111
TELECOPIER
(202) 898-0895

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APR 5 '93
OFFICE OF THE SECRETARY

April 5, 1993

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
Room 222
1919 M Street, N.W.
Washington, D.C. 20554

Re: Comments on Notice of Proposed Rule Making, ET Docket No. 92-298

Dear Ms. Searcy:

Enclosed herewith are five copies (original and four) of the comments and audio tape (one for each copy of the comments) by this firm in the Notice of Proposed Rule Making, "Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard".

The audio tape provides recorded observations of AM stereo reception using three different receivers (Potomac Instruments, Sony, and the Denon "Super Tuner"). The observations were taken in various locations to simulate actual conditions experienced by the typical AM radio listener.

If there are any questions, please do not hesitate to contact this office.

Sincerely,

COHEN, DIPPELL AND EVERIST, P.C.

Donald G. Everist
President

DGE:mcw
Enclosure

ENGINEERING STATEMENT
ON BEHALF OF
COHEN, DIPPELL AND EVERIST, P.C.
REPLY COMMENTS
RE NOTICE OF PROPOSED RULE MAKING
ET DOCKET 92-298; FCC 92-546

APRIL 1993

COHEN, DIPPELL AND EVERIST, P.C.
CONSULTING ENGINEERS
RADIO AND TELEVISION
WASHINGTON, D.C.

COHEN, DIPPELL AND EVERIST, P. C.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Establishment of a Stereophonic	)	
Transmitting Standard in the	)	ET Docket No. 92-298
Radio Broadcasting Service	)	FCC 92-546

Reply Comments By
Cohen, Dippell and Everist, P.C
to Notice of Proposed Rule Making

Introduction

These comments are submitted by Cohen, Dippell and Everist, P.C. ("CDE"), Consulting Engineers, in response to comments filed in the above-captioned proceeding. CDE and its predecessors have practiced and represented the broadcast industry before the FCC since 1937. CDE has reviewed the numerous comments filed in this docket which seeks to adopt a single AM stereo standard, and submits its reply comments with a view to the Commission's selection of the superior system.

CDE is a professional consulting engineering firm. Its principals are registered professional engineers with memberships in the National Society of Professional Engineers (NSPE) and the Association of Federal Communications Consulting Engineers (AFCCE). CDE fully subscribes to the Canons of Ethics of these organizations. As such, it does not represent any manufacturers or their agents. CDE is concerned that the FCC does not prematurely adopt an inferior AM stereo system that could act as a millstone around the neck of an ailing AM broadcast industry. The technical superiority of the best system must outweigh other interests.

Alfred E. Resnick, P.E., of Capital Cities/ABC, Inc. stated:

"The competition for listeners that AM radio faces is not only FM, but CD and high quality cassette. The time has come to choose an AM stereo system on technical merits."

Listening Tests

CDE agrees with comments by Capital Cities/ABC, Inc. that there are serious unanswered questions concerning the quality and superiority of the Motorola system.

CDE also filed comments in this docket and included cassette tapes of C-Quam AM stereo monitoring tests taken at five locations. Listening tests[1/] taken on Station WFMD, 930 kHz, Frederick, Maryland from approximately 2 minutes before sunset until 10 minutes after sunset exhibited a very annoying effect in the AM stereo mode. These tests were made at Site No. 1 described in the Comments previously filed by this office. A stereo cassette tape has been included with this filing which demonstrates the observed effect, also described by various commenters as "platform motion".[2/] [The listener may wish to use stereo headphones to properly hear the impact of this effect.] The measured daytime field strength of WFMD at Site Number 1 was approximately 5 mV/m and the postsunset field strength was approximately 2.5 mV/m at the time of the recordings taken in Fall, 1991.

[1/] Observations were made using a Potomac Instruments synthesized monitor receiver Model SMR-11, Serial No. 293 with AMS-11 C-Quam(r) stereo decoder and ANT-11 tunable ferrite rod antenna.

[2/] See for example comments by Communications Technology, Paragraph 21.

CDE agrees with various commentors that the choice of the AM stereo standard should be based on technological decisions. A quality AM stereo system must be technically robust against undesired effects including platform motion, undesired gating between monophonic and stereophonic modes, no added (or minimally added) noise when operating in the stereo versus mono mode, and be free from distortion effects in the stereo mode.[3/]

Receivers

CDE supports the commentors who observed that adjacent channel rejection of AM receivers has been attained at the expense of strictly limiting the desired channel bandwidth and thus severely restricting the audio fidelity (bandwidth). It is no wonder that the public dislikes the muffled signals which are created from within the AM portion of their receivers. A major comparability problem between AM and FM lies squarely within most commercially available receivers.

Conclusion

CDE suggests that the appropriate forum to determine a true comparison between the two AM stereo systems is independent, objective laboratory tests of the systems under a wide range of test conditions. Such tests could be carried out by the National Bureau of Standards where

[3/]Various commentors observed high levels of stereo distortion in the C-Quam system. See, for example, comments by Capital Cities/ABC, Inc., Appendix 1, fifth paragraph.

various test measurements, and "aural" evaluations[4/] can be made by expert listeners using music, speech, audio tones, etc.

Over 10 years have passed since the Commission adopted its decision for a marketplace selection of an AM stereo standard. Broadcast technology has advanced tremendously since that time. CDE urges the Commission to provide a window of opportunity for proponents to improve and/or replace their systems prior to thorough engineering testing and evaluation by an independent laboratory. Following system tests, the Commission should adopt the technically superior system as the AM stereo standard. To do otherwise will be a disservice to the American (and ultimately the worldwide) public.

CDE also urges the Commission to adopt recommended stereo AM receiver standards which include minimum bandwidths capable of fully receiving the transmitted signals.

Respectfully Submitted,

Warren M. Powis

Warren M. Powis, P.E.
Vice-President

DATE: April 20, 1993

[4/] Including but not limited to carrier offset susceptibilities, variable skywave interference effects, and adaptability of existing stereo exciters to the Kahn or other systems.

ENGINEERING STATEMENT
ON BEHALF OF
COHEN, DIPPELL AND EVERIST, P.C.
RE NOTICE OF PROPOSED RULE MAKING
ET DOCKET 92-298; FCC 92-546
APRIL 1993

COHEN, DIPPELL AND EVERIST, P.C.
CONSULTING ENGINEERS
RADIO AND TELEVISION
WASHINGTON, D.C.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Establishment of a Sterephonic Transmitting Standard in the Radio Broadcasting Service	)))	ET Docket No. 92-298 FCC 92-546

COMMENTS BY COHEN, DIPPELL AND EVERIST, P.C. OF NOTICE OF PROPOSED RULE MAKING

Introduction

The comments are submitted by Cohen, Dippell and Everist, P.C. Consulting Engineers ("CDE") in response to the above captioned proceeding ("NPRM")[1/]. CDE and its predecessors have practiced and have represented the broadcast industry before the Federal Comunications Commission ("Commission") for more than fifty (50) years.

CDE has carefully reviewed the Commission's NPRM which seeks to adopt a stereophonic standard. The Commission is to be further commended for its efforts to improve the AM service. We believe that stereophonic operation can be an important tool in its effort to achieve "parity" with the FM aural broadcasting service.

[1/]The proposed rule making was adopted December 10, 1992 and released January 6, 1993 and published in the *Federal Register* January 21, 1993 on Page 5320.

Last year, CDE filed information regarding stereophonic operations. An audio recording was offered in the Petition for Reconsideration MM Docket 87-267 ("Petition") which provided examples of typical environmental conditions encountered when the consumer listens to this service in a rural home environment from three AM stations at different signal levels in both monophonic and stereophonic modes. In addition, a recording was provided at three AM signal levels in three rural locations which compares AM stereo (normal and wideband) with FM stereo.[2/] These tapes are being resubmitted for convenience. In addition, these observations have been supplemented in 1993 by selecting a site whose environment is subject to greater man-made noise. We believe this tape recording offers strong evidence that AM sterephonic operation can be comparable to FM stereophonic transmissions and that based upon these limited observations[3/] that a higher signal strength is required to provide that quality.

Daytime Service Contour Class B Station

Now the Commission has raised an important factor in the consideration of adopting a stereo standard. CDE believes that the Commission by adopting a standard, it must also consider the signal strength necessary to provide quality stereo reception. In the Petition, CDE submitted that an analogous example was FM stereo reception at the once-recognized 0.050 mV/m monophonic contour was not practical. Subsequently, the FCC deleted that contour as a pertinent contour. So too, for different reasons, the 0.5 mV/m groundwave contour for

[2/]For this comparison, WMZQ AM and FM (simulcast programming) have been selected and observations recorded on a digital audio tape recorder.

[3/]Observations were made over a 2 to 3 month period and under different environmental conditions.

daytime service for the Class B stations[4/] is impractical in delivering technical AM stereo quality competitive with FM stereo now that an AM stereo standard is to be adopted. Selection of a higher daytime service contour for the Class B[5/] station will balance and complement the new stricter interference ratio with an enhanced service concept.

Also in the Petition, CDE performed daytime listening tests in the home using the Potomac Instrument SMR-11[6/] stereo monitor. It was observed that the AM stereo signal, having a value around 0.5 mV/m for the regional station is susceptible not only to receiver mixer noise, but to electronic devices indigenous to the home, not common twenty years ago. These devices include light dimmers, fluorescent high efficiency light bulbs, computers, etc. It was further observed that noise is exacerbated when trying to receive in the stereo mode. Recordings[7/] were made to demonstrate these conditions and were a part of that Petition. In addition, recordings of an AM stereo station at three signal levels (0.61, 1.15 and 2.15 mV/m) were performed in normal and wideband stereo modes. In 1993, recordings of AM signals in

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[4/] CDE believes this opportunity only exists for Class B stations since by birthright Class A and Class C stations historically filled a different role in delivering AM service. It is noted that over 40% of the broadcast stations population are Class B stations.

[5/] It is noted that the Petition for Reconsideration for Docket 87-267 is still awaiting Commission action.

[6/] Special acknowledgement is made to Potomac Instruments for providing the AM stereo monitor.

[7/] Special acknowledgement to stations Chase Broadcasting, former licensee of WTOP and Greater Media, licensee of WWRC for providing professional quality recording and transcribing equipment and other support.

a business (downtown) environment at two signal levels 1 mV/m and 2 mV/m) were also performed in the narrow and wideband stereo modes.

Therefore, based upon these observations, at relatively rural locations and from downtown Washington, DC, we believe it prudent that the Commission adopt a higher signal level[8/] for both the existing band as well as the expanded band.[9/] A convergence of desired receiver field strengths for satisfactory AM stereo reception on three different receivers requires signal levels well in excess of the current 0.5 mV/m standard. We are providing this tape as a part of this submission. The reason is quite simple as demonstrated by the tape, AM is technically competitive with FM when a sufficient AM signal is delivered to operate in the wideband stereo mode. CDE believes based upon these observations that AM signal must be 1.0 mV/m or greater.

To correlate those observations with a typical Class B allocation situation additional studies are being performed. On the existing band, a study has been performed on 1260 kHz. Stations surrounding WWDC, Washington, DC and WNRK, Newark, Delaware on 1260 kHz and their first adjacent channels, 1250 kHz and 1270 kHz have been studied. WWDC is licensed to a city with more than 500,000 persons and WNRK is licensed to a community with less than 30,000 persons. Figures 1 through 10 provide a summary of those allocation studies.

[8/]Time only permitting observing stations using the C-Quam system, however, we believe that the conclusions would be substantially the same if the Kahn system was subject to similar scrutiny.

[9/]This is not unrealistic since the station loading will be determined by nighttime consideration.

Figure 1 shows the co-channel allocation situation based on existing powers and the groundwave contours of 0.5 mV/m and the interfering 0.025 mV/m contours.

Figure 2 shows the same stations at the same power level; however, the 1.0 mV/m and interfering 0.050 mV/m contours are shown.

Figure 3 depicts the daytime first-adjacent 0.5 and 0.25 mV/m contours.

Figure 4 shows the first-adjacent channel relationship of the 1.0 and 0.5 mV/m contours.

Figure 5 shows the daytime co-channel allocation situation based upon a fifty (50%) percent increase in power for all stations and the resultant 1.0 and 0.050 mV/m groundwave contours.

Figure 6 shows the first-adjacent channel allocation based on a fifty percent (50%) increase in power for all stations utilizing the 1.0 and 0.5 mV/m contours.

Figure 7 provides the co-channel allocation situation based on all stations increasing power by one hundred percent (100%) and utilizing the 0.050 and 1.0 mV/m contours.

Figure 8 shows the daytime first-adjacent channel situation with all stations operating with a power increase of one hundred percent (100%) using the 1.0 and 0.5 mV/m contours.

Figure 9 shows the multitude of FM service in the area.

Figure 10 provides an article from the *Washington Post* which details a report on the population shift from rural to the urbanized areas.

By increasing the daytime power and selecting the 1.0 mV/m (or greater) contour rather than 0.5 mV/m contour as the protected contour and using the protection ratios adopted in the R&O, the resultant population gain based upon the 1990 Census is as follows:

STATION	POWER	1990 POPULATION	1 MV/M POPULATION GAIN REFERENCED TO LICENSED
WWDC	LICENSED (5 KW)	3,045,601	—
WNRK	LICENSED (1 KW)	393,943	—
WWDC	7.5 KW	3,326,782	281,181 (9.2% GAIN)
WNRK	1.5 KW	454,588	60,645 (15.4% GAIN)
WWDC	10.0 KW	3,534,340	444,739 (16.0% GAIN)
WNRK	2.0 KW	501,688	107,745 (27.4% GAIN)
Population Count Includes Urban Areas and Towns of 25,000 or Greater Outside the 2 mV/m Contour			

As seen from the above example, a dramatic population increase of a high quality stereo AM signal can result when the 1.0 mV/m contour is used as the protected contour.

Figure 10 concludes that based on the 1990 Census over 50 percent of the population of the United States is located in metropolitan areas.[10/] The article further notes that in 1950 that figure was less than 30 percent. This dramatic population shift demonstrates the need for the Class B AM stations to serve these expanded metropolitan population areas.

CDE believes that the Commission has adopted a very appropriate step in MM Docket No. 88-375 adopted July 13, 1989 concerning Class A FM operations. In Paragraph 52, it says in part, **"In this regard, we wish to extend authority to increase power where possible, so long as it does not interfere with other stations."** In that paragraph it then continues to provide the circumstances under which stations seeking **mutual** increases in facilities are permitted to do so. It also indicates unilateral increases will be permitted if a station has

[10/] As required by the Commission, urbanized areas or communities in excess of 2500 persons require 2.0 mV/m or greater signal.

obtained the consent of all stations which may be affected and the increase is consistent with the public interest. The FCC has reaffirmed that decision in the *Memorandum, Opinion and Order* adopted April 15, 1991. **CDE believes that a similar approach would be constructive and benefit AM stations seeking to achieve mutual improvements in their facilities.**

CDE believes that for Class B stations in the expanded and existing bands one aspect for the prescription for competitive technical quality is a redefined daytime service contour of 1.0 mV/m or greater[11/] with the interference ratios provided in the *Order* for existing stations.

<u>Model 1 and Model 2 Carrier Frequency Tolerance</u>

The Commission has left unaltered the frequency tolerance if stereophonic operation is adopted. CDE has received numerous reports that false stereo receiver indications can be a problem in certain conditions. One of those conditions appear to be traced to any two stations operating with a frequency difference that produce combinations at or near the pilot frequency. The receiver stereo pilot indicator reacts to this frequency difference such that it indicates the presence of stereo operation. This inadvertently triggers that portion of the receiver circuitry and thereby results in the introduction of wideband noise in certain receivers. The Commission should study whether the 20 Hz tolerance is contributing to this phenomena and if so whether the AM carrier frequency should be maintained to within 10 Hz. Therefore, the Commission is urged to adopt an appropriate carrier frequency tolerance.

[11/] A new broadcast station (transmission facility) would still be assigned based upon protection to the 0.5 mV/m contour.

In Docket 87-267 the Commission allowed Travelers Information Stations (TIS) to be licensed for the first time, co-channel to AM broadcast operations. Since the carrier frequency tolerance of TIS operations is 100 Hertz as required under Section 90.242(b)(2), CDE requests the Commission to adopt the same carrier tolerance that it applies to AM broadcast stations.

Summary

Stereo observations have been performed in a rural environment, in and around, a community with a population of greater than 2500 and in downtown Washington in a high-rise building. The receivers have ranged from a Potomac monitor, Sony portable receiver and a Technics "Super Receiver". In all cases, it is interesting to note that observations find that reception of the AM stereo signal is significantly improved when the field strength is in excess of 1 mV/m. It is in that context that with the adoption of an AM stereo standard, that we urge that at least for Class B stations that a new minimum protected signal contour in lieu of the 0.5 mV/m be selected. We note that Commission action on the Petition for Reconsideration in MM Docket No. 87-267 is still outstanding. We urge the Commission to take these stereo observations into account as part of its on-going effort to make AM comparable to FM reception.

Respectfully Submitted,

By: [signature]
Donald G. Everist

DATE: April 5, 1993

APPENDIX I

FIGURES 1 THROUGH 10

JANUARY 1992

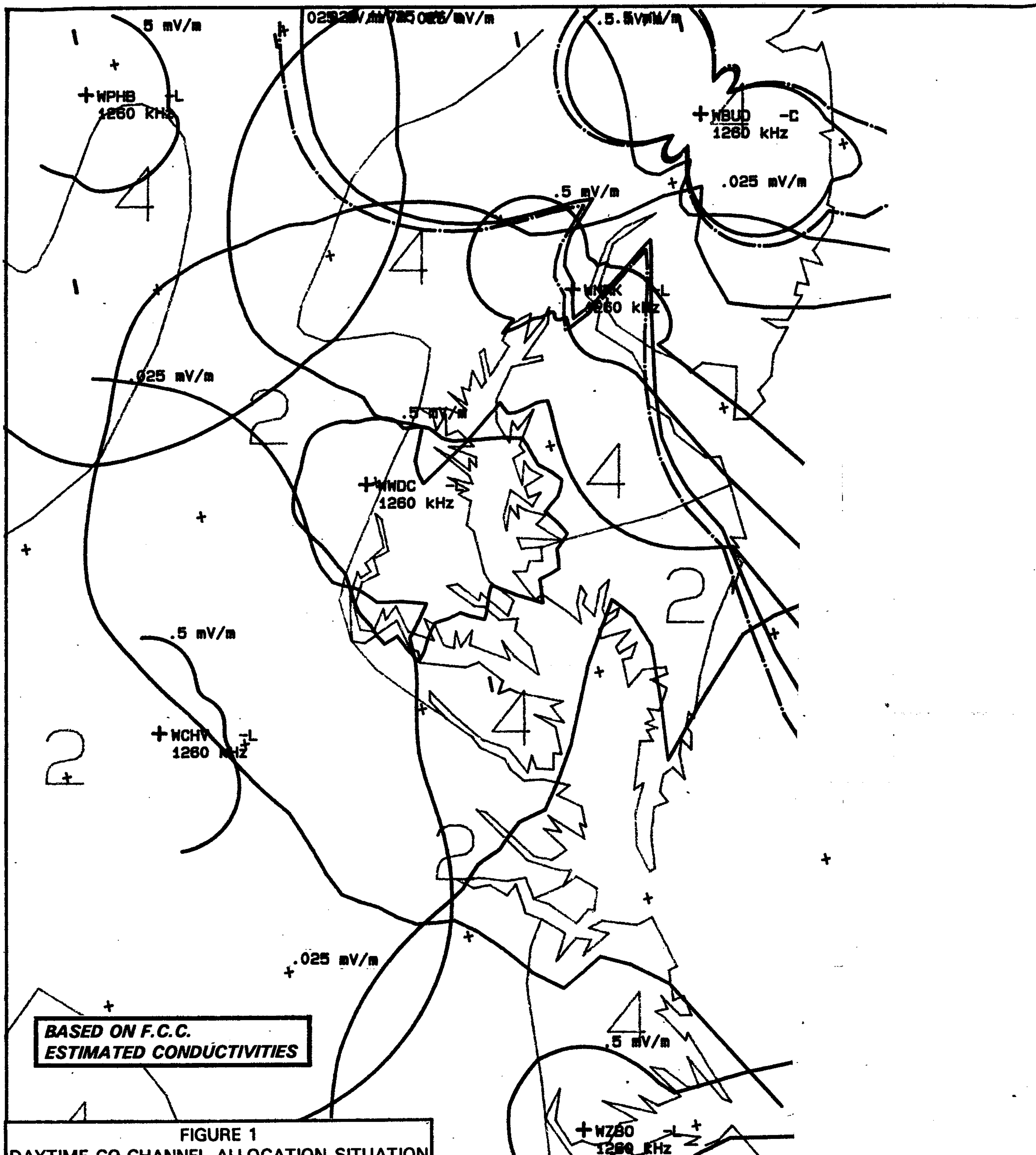


FIGURE 1
DAYTIME CO-CHANNEL ALLOCATION SITUATION
BASED ON EXISTING POWER FOR
WWDC, WASHINGTON, D.C
WNRK, NEWARK, DELAWARE
AND ALL OTHER STATIONS
SHOWING THE 0.025 AND 0.5 mV/m CONTOURS
JANUARY 1992

REFERENCE POINT COORDS:			
LATITUDE:	36	30	0
LONGITUDE:	85	30	0

MAP PROJECTION-Albers

TIC MARK INTERVAL: 1.0 °

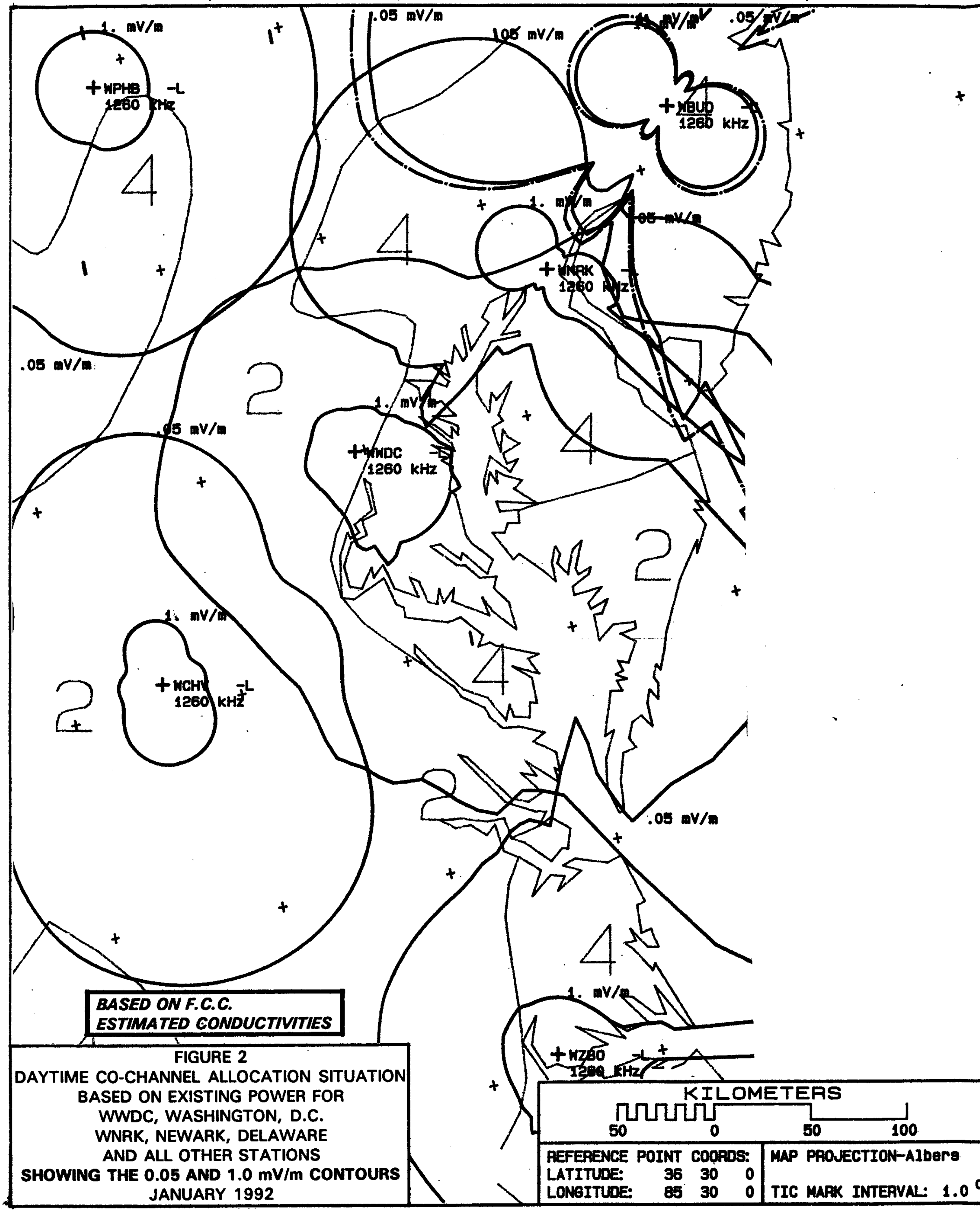


FIGURE 2
DAYTIME CO-CHANNEL ALLOCATION SITUATION
BASED ON EXISTING POWER FOR
WWDC, WASHINGTON, D.C.
WNRK, NEWARK, DELAWARE
AND ALL OTHER STATIONS
SHOWING THE 0.05 AND 1.0 mV/m CONTOURS
JANUARY 1992

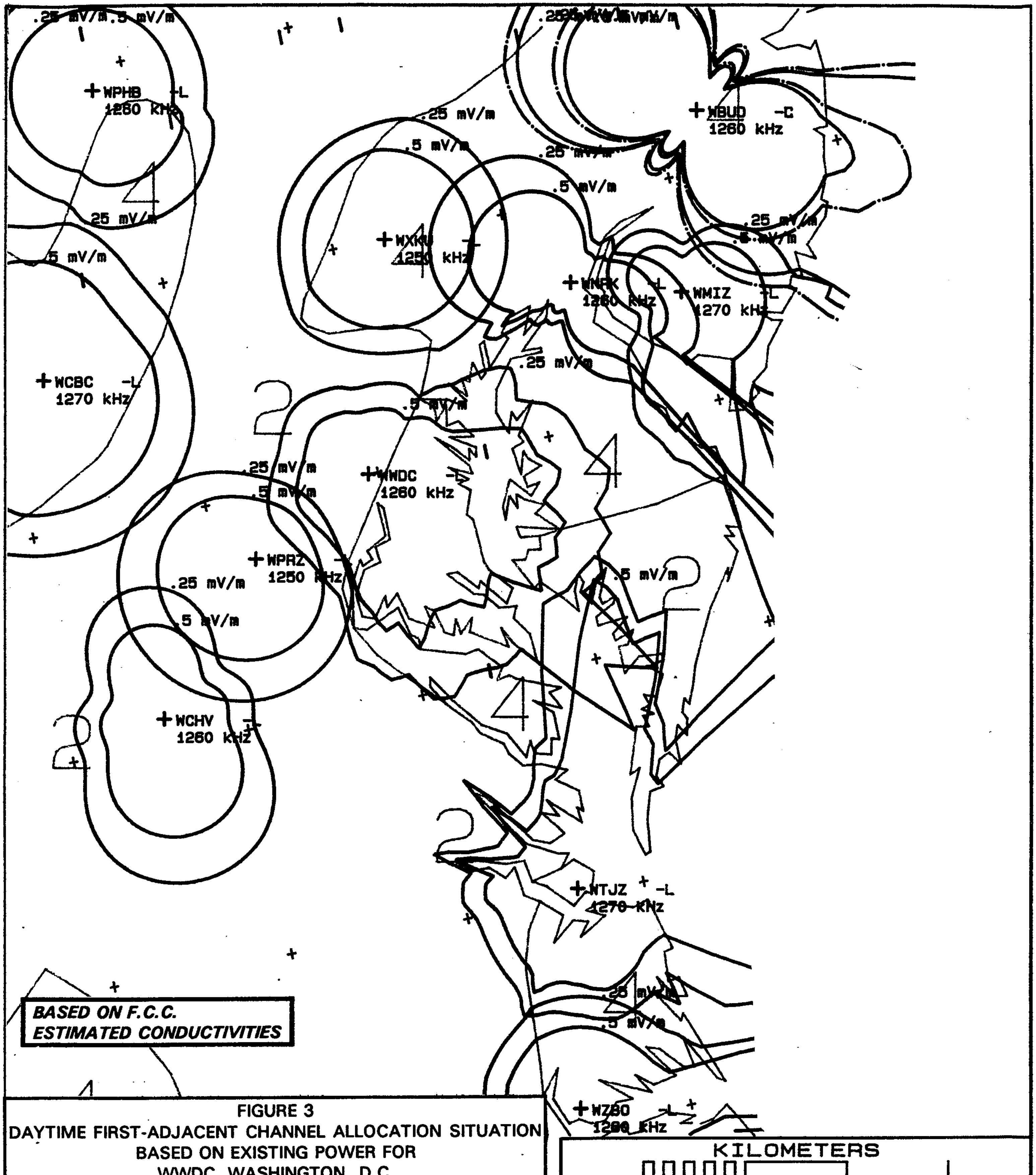


FIGURE 3
DAYTIME FIRST-ADJACENT CHANNEL ALLOCATION SITUATION
BASED ON EXISTING POWER FOR
WWDC, WASHINGTON, D.C.
WNRK, NEWARK, DELAWARE
AND ALL OTHER STATIONS
SHOWING THE 0.5 AND 0.25 mV/m CONTOURS
JANUARY 1992

REFERENCE POINT COORDS:				MAP PROJECTION-Albers
LATITUDE:	36	30	0	
LONGITUDE:	85	30	0	TIC MARK INTERVAL: 1.0 °

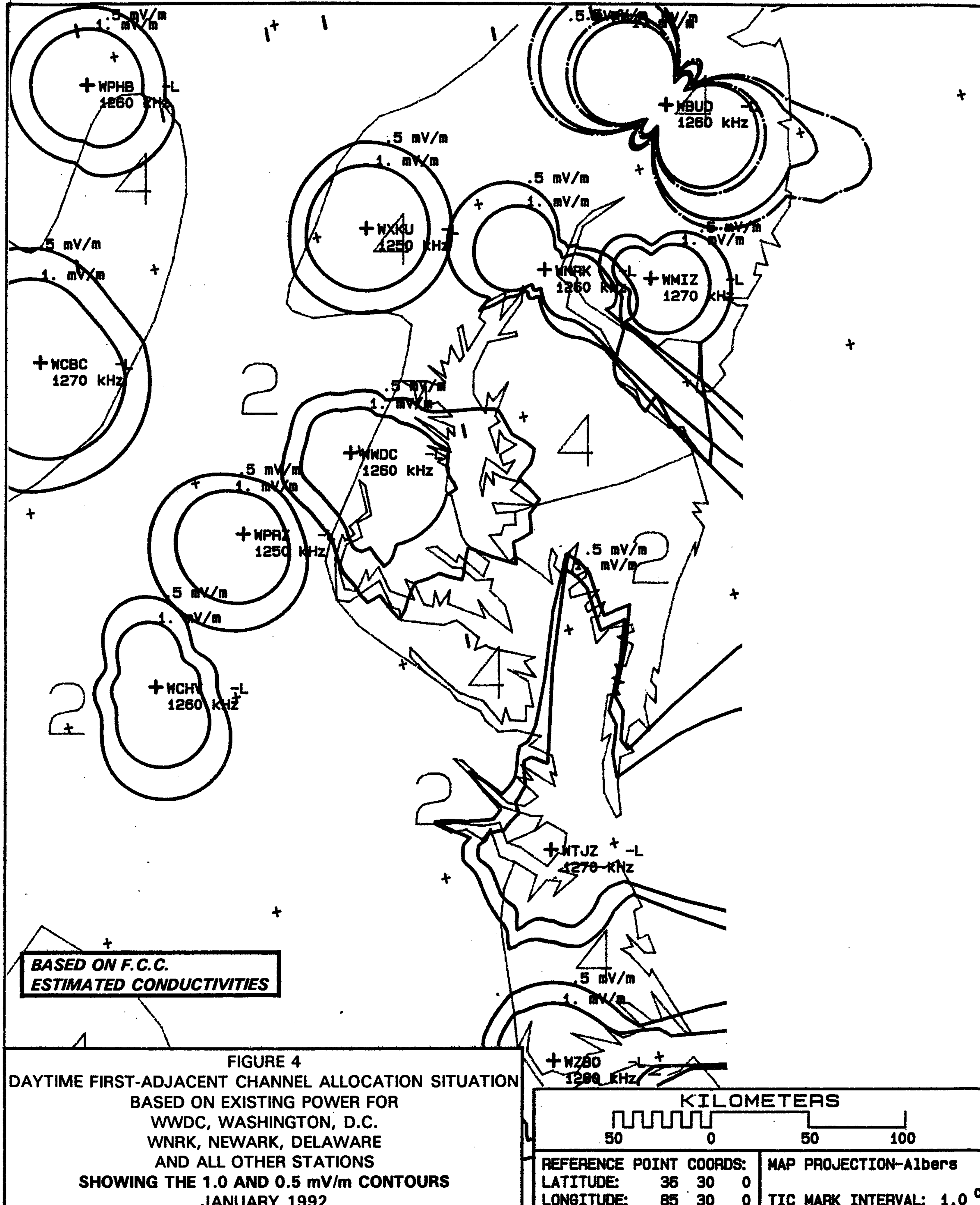


FIGURE 4
DAYTIME FIRST-ADJACENT CHANNEL ALLOCATION SITUATION
BASED ON EXISTING POWER FOR
WWDC, WASHINGTON, D.C.
WNRK, NEWARK, DELAWARE
AND ALL OTHER STATIONS
SHOWING THE 1.0 AND 0.5 mV/m CONTOURS
JANUARY 1992

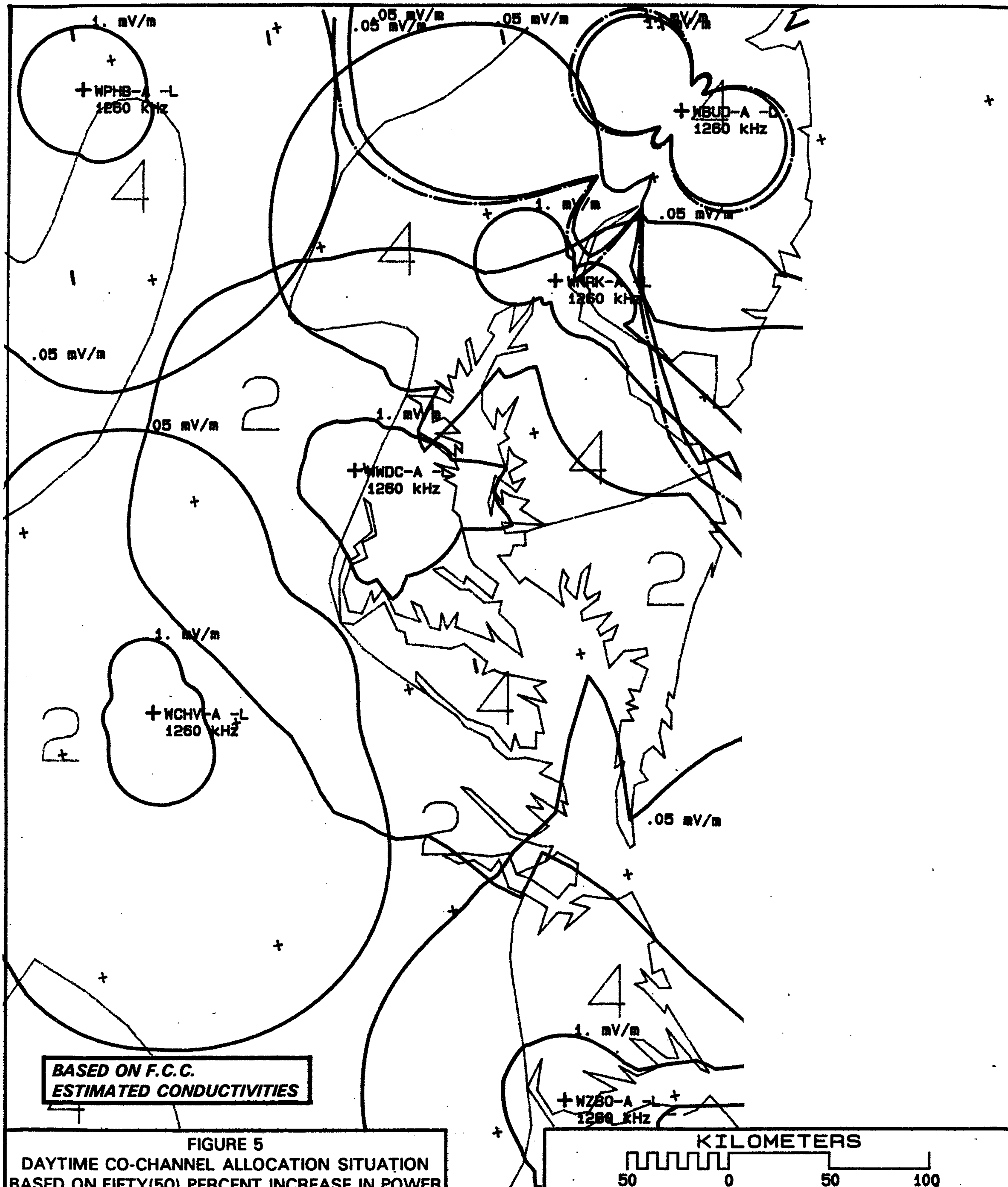


FIGURE 5
DAYTIME CO-CHANNEL ALLOCATION SITUATION
BASED ON FIFTY(50) PERCENT INCREASE IN POWER
FOR ALL STATIONS
UTILIZING THE 0.050 AND 1.0 mV/m CONTOURS
JANUARY 1992

REFERENCE POINT COORDS:
LATITUDE: 36 30 0
LONGITUDE: 85 30 0

MAP PROJECTION-Albers
TIC MARK INTERVAL: 1.0 °

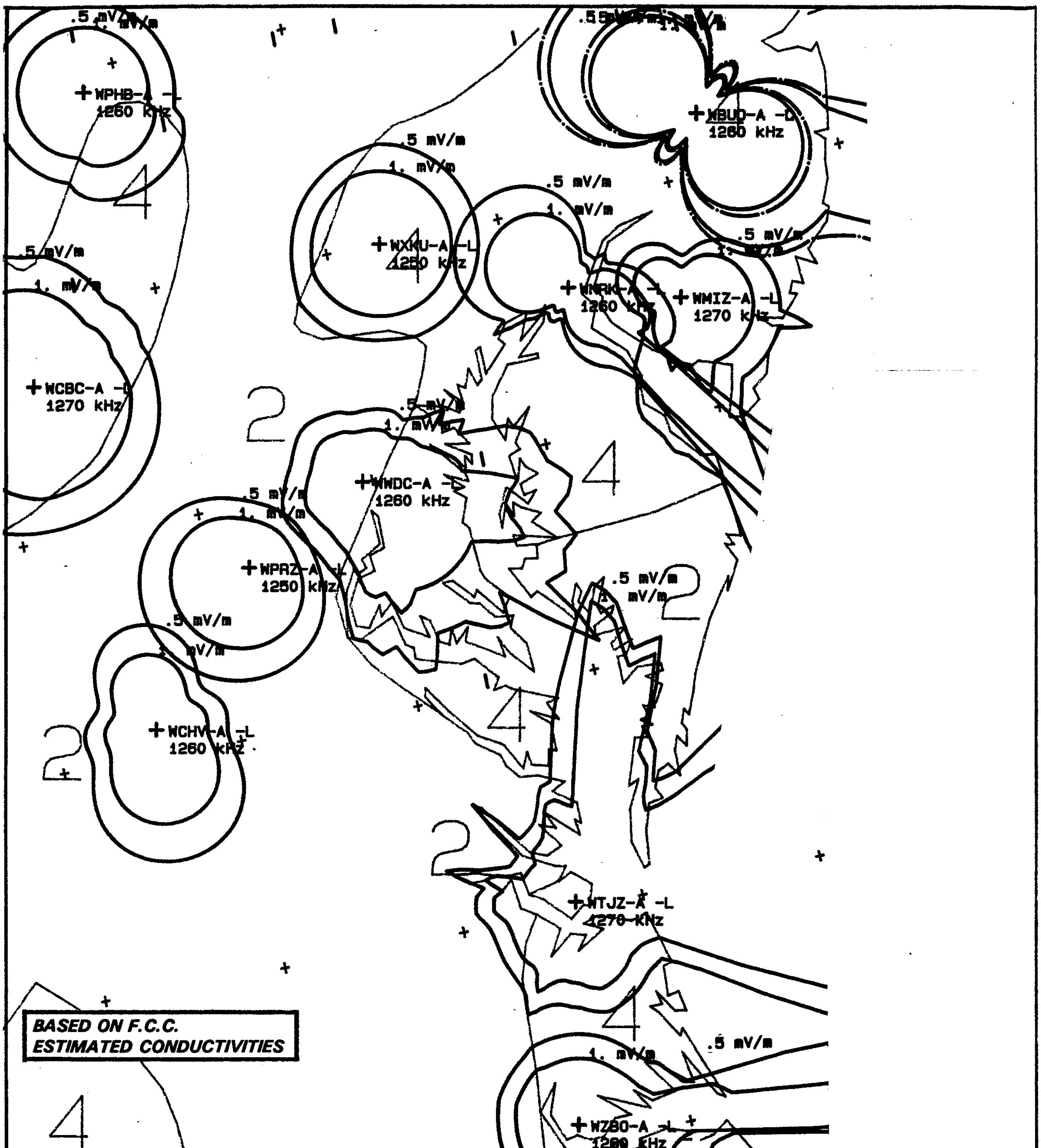


FIGURE 6
DAYTIME FIRST-ADJACENT CHANNEL ALLOCATION SITUATION
BASED ON FIFTY(50) PERCENT INCREASE IN POWER
FOR ALL STATIONS
UTILIZING THE 1.0 AND 0.5 mV/m CONTOURS
JANUARY 1992

COHEN, DIPPELL AND EVERIST, P.C. CONSULTING ENGINEERS WASHINGTON, D.C.

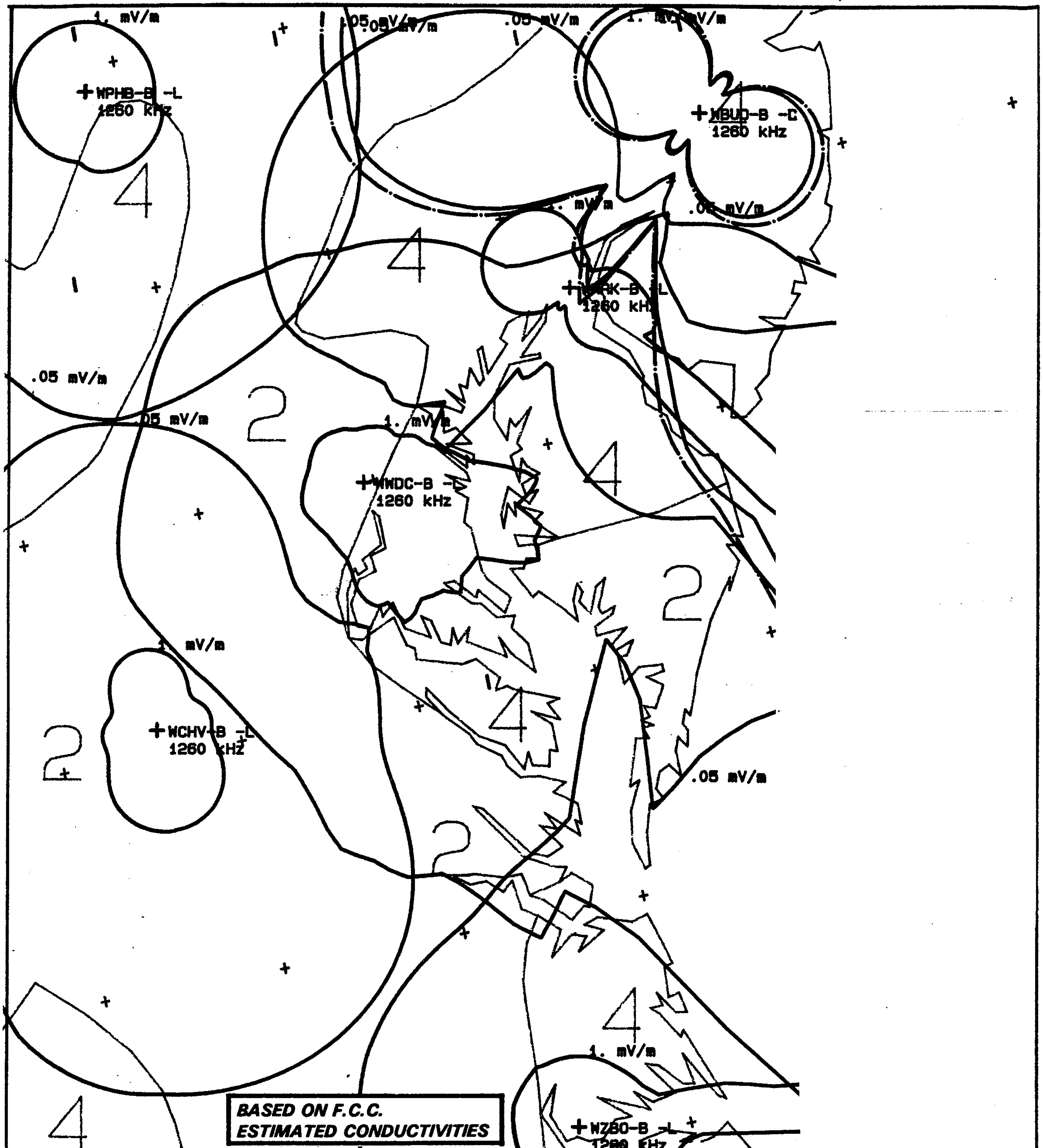


FIGURE 7
DAYTIME CO-CHANNEL ALLOCATION SITUATION
BASED ON ONE-HUNDRED(100) PERCENT INCREASE IN POWER
FOR ALL STATIONS
UTILIZING THE 0.050 AND 1.0 mV/m CONTOURS
JANAURY 1992

KILOMETERS
50 0 50 100

REFERENCE POINT COORDS:				MAP PROJECTION-Albers
LATITUDE:	36	30	0	
LONGITUDE:	85	30	0	TIC MARK INTERVAL: 1.0 °

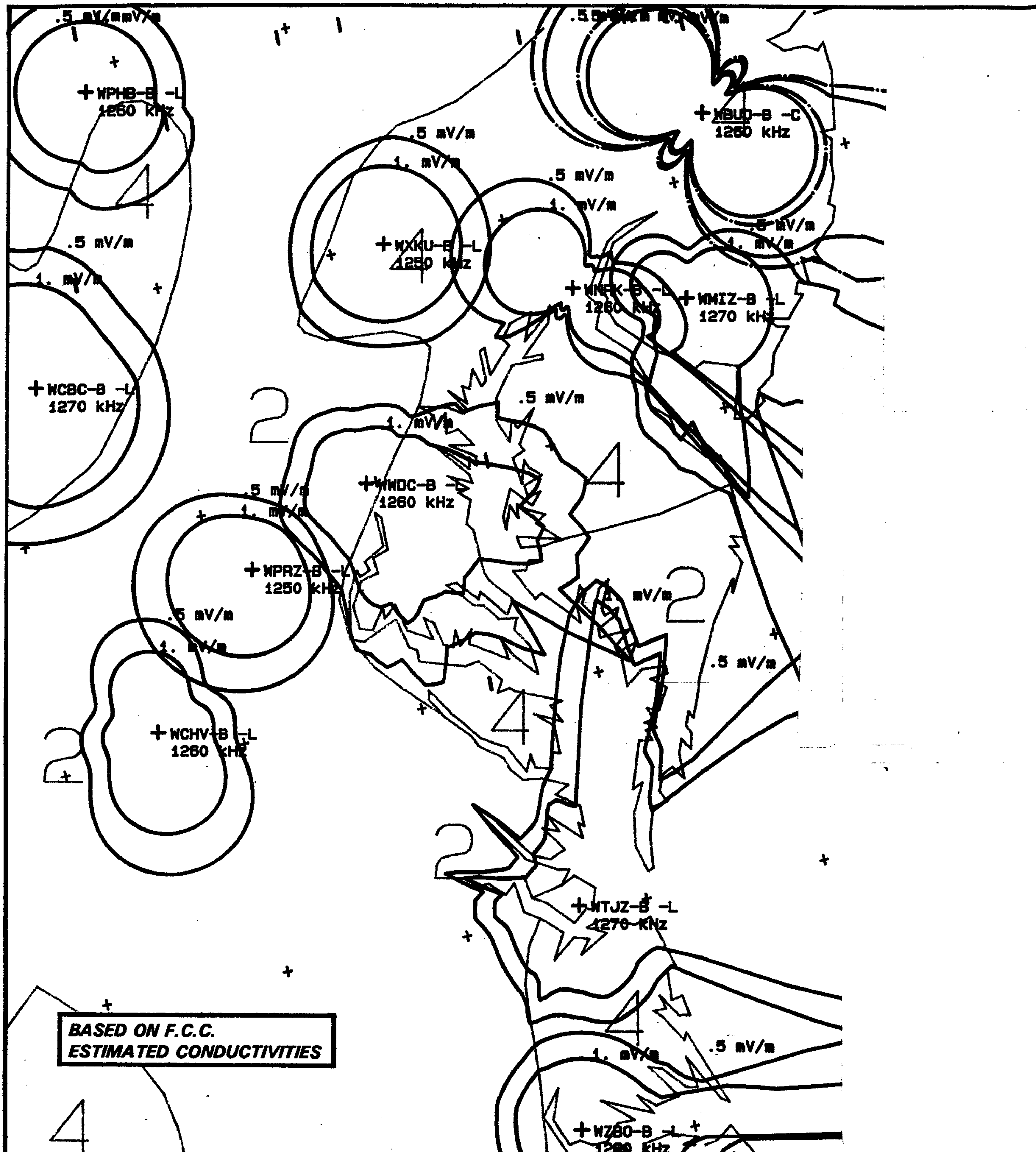


FIGURE 8
DAYTIME FIRST-ADJACENT CHANNEL ALLOCATION SITUATION
BASED ON ONE-HUNDRED(100) PERCENT INCREASE IN POWER
FOR ALL STATIONS
UTILIZING THE 1.0 AND 0.5 mV/m CONTOURS
JANUARY 1992

KILOMETERS
50 0 50 100

REFERENCE POINT COORDS:
LATITUDE: 36 30 0
LONGITUDE: 85 30 0

MAP PROJECTION-Albers

TIC MARK INTERVAL: 1.0°

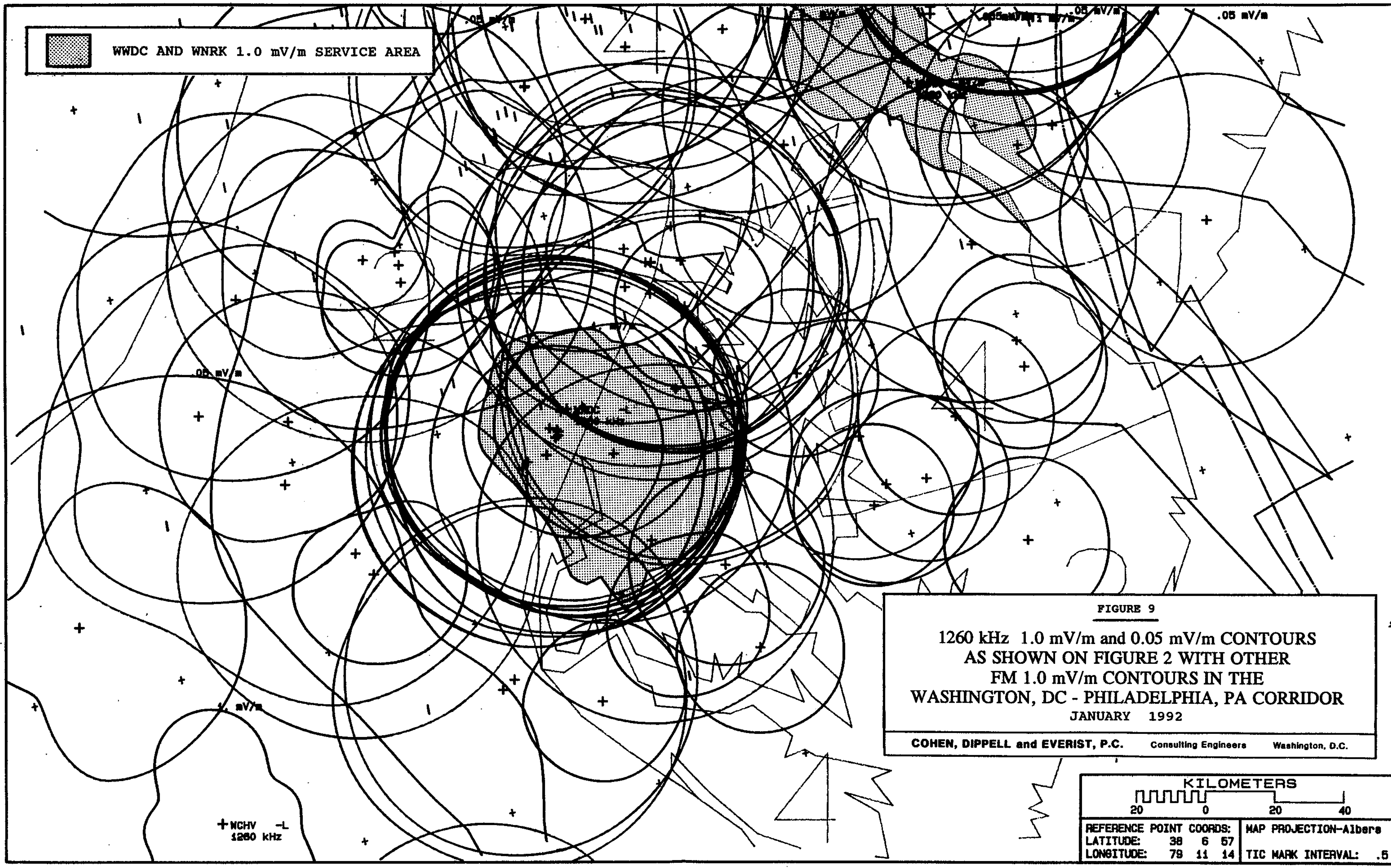


FIGURE 9

1260 kHz 1.0 mV/m and 0.05 mV/m CONTOURS
AS SHOWN ON FIGURE 2 WITH OTHER
FM 1.0 mV/m CONTOURS IN THE
WASHINGTON, DC - PHILADELPHIA, PA CORRIDOR
JANUARY 1992

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, D.C.

The Washington Post FINAL

114th Year .... No. 78 THURSDAY, FEBRUARY 21, 1991 25¢

Half of Population Lives in Urban Areas

Census Says People Drawn to Metropolises of 1 Million or More

By Barbara Vobejda
Washington Post Staff Writer

For the first time, more than half of the nation's population lives in big metropolitan areas, capping decades of American movement from small towns and farms to urban centers and the suburbs that have sprouted around them.

Figures from the 1990 census released yesterday showed that the fastest growing metropolises were in Florida—nine of the top 12—and the Southwest.

While metropolitan areas along the southern Atlantic and Pacific seaboards grew the fastest, the new figures also indicate that northern metro areas fared much better in the 1980s than they had in the previous decade.

"It's certainly different than the 1970s when there was a wholesale population loss . . . in the Snow Belt," said William Frey, a demographer at the University of Michigan. Despite the common prediction that the northern industrial areas would continue to suffer population declines, he said, "these figures show these large metro areas are making somewhat of a comeback."

Overall, the data confirm what demographers and earlier census results have shown: a dramatic shift in population from the Northeast and Midwest to the South and West. The figures on metropolitan areas point to another, simultaneous phenomenon: the concentration of more of the population into urban areas of at least a million population.

While less than 30 percent of the nation's residents lived in such metro areas in 1950, that number has grown steadily, moving from about 46 percent in 1980 to just more than 50 percent today.

See CENSUS, A12, Col. 1

POPULATION SHIFT

1950	LESS THAN 30% IN URBAN AREAS
1990	MORE THAN 50% IN URBAN AREAS

FIGURE 10
THE WASHINGTON POST ARTICLE
OF FEBRUARY 21, 1991
REGARDING POPULATION IN URBAN AREAS
JANUARY 1992

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, D.C.

Florida Home to 9 of 12 Fastest Growing Cities

CENSUS, From A1

"It's a significant threshold," said Richard Forstall, chief of the population distribution branch of the Census Bureau.

The trend reflects not only the consolidation of available jobs around urban areas, he said, but the momentum that continues to attract people to a growing community.

There were four newcomers in the group of areas with more than 1 million people: Charlotte, N.C., Salt Lake City, Orlando, Fla., and Rochester, N.Y. In some cases—Charlotte, for example—the population growth was at least partially because of the annexation of suburban territory.

The population of the Washington metropolitan area grew by 21 percent during the 1980s to 3.9 million people. It remains the eighth largest metro region in the country.

Among the most striking patterns revealed in the new figures was the extraordinary concentration of metropolitan growth in Florida, in communities dotting both of the state's coasts as well as two inland areas. To a large extent, experts said, this growth was fueled by retirees.

Florida's fast-growing metro areas include: Naples, which grew by 77 percent, Fort Pierce, 66 percent, Fort Myers, 63 percent, Ocala, 59 percent, Orlando, 53 percent, West Palm Beach, 50 percent, Melbourne-Titusville, 46 percent, Daytona Beach, 43 percent, and Bradenton, 43 percent.

Also among the fastest-growing areas in the nation were Las Vegas, at 60 percent, Austin, Tex., 46 percent and Las Cruces, N.M., at 41 percent.

The New York metropolitan area gained nearly 548,000 people, or 3 percent, remaining the largest in the country with 18 million. The second largest, Los Angeles, gained more than 26 percent, to 14.5 million.

The pattern of growth around Los Angeles reflected what demographers said was the significant expansion of suburban and "exurban" growth, the movement of residents farther outside a central city.

While the central city of Los Angeles grew by about 19 percent, it was far outpaced by its surburban communities, including Riverside-San Bernardino, up 66 percent.

"The spread of metropolitan areas well beyond the central cities has set up metropolitan systems," said Carl Haub, a demographer at the population reference bureau. "The cultural, social and economic effect can reach out far beyond the obvious."

These are the 39 metropolitan areas with 1 million people or more, according to 1990 Census Bureau figures released yesterday:

City	1980 Total	1990 Total	Percent Change
New York	17,539,532	18,087,251	3.1
Los Angeles	11,497,549	14,531,529	26.4
Chicago	7,937,290	8,065,633	1.6
San Francisco	5,367,900	6,253,311	16.5
Philadelphia	5,680,509	5,899,345	3.9
Detroit	4,752,764	4,665,236	-1.8
Boston	3,971,792	4,171,643	5.0
Washington	3,250,921	3,923,574	20.7
Dallas	2,930,568	3,885,415	32.6
Houston	3,099,942	3,711,043	19.7
Miami	2,643,766	3,192,582	20.8
Atlanta	2,138,136	2,833,511	32.5
Cleveland	2,834,062	2,759,823	-2.6
Seattle	2,093,285	2,559,164	22.3
San Diego	1,861,846	2,498,016	34.2
Minneapolis	2,137,133	2,464,124	15.3
St. Louis	2,376,968	2,444,099	2.8
Baltimore	2,199,497	2,382,172	8.3
Pittsburgh	2,423,311	2,242,798	-7.4
Phoenix	1,509,175	2,122,101	40.6
Tampa	1,613,600	2,067,959	28.2
Denver	1,618,461	1,848,319	14.2
Cincinnati	1,660,257	1,744,124	5.1
Milwaukee	1,570,152	1,607,183	2.4
Kansas City	1,433,464	1,566,280	9.3
Sacramento	1,099,814	1,481,102	34.7
Portland, Ore.	1,297,977	1,477,895	13.9
Norfolk	1,160,311	1,396,107	20.3
Columbus	1,243,827	1,377,419	10.7
San Antonio	1,072,125	1,302,099	21.5
Indianapolis	1,166,575	1,249,822	7.1
New Orleans	1,256,668	1,238,816	-1.4
Buffalo, N.Y.	1,242,826	1,189,288	-4.3
Charlotte,N.C.	971,447	1,162,093	19.6
Providence,R.I.	1,083,139	1,141,510	5.4
Hartford, Conn.	1,013,508	1,085,837	7.1
Orlando, Fla.	699,904	1,072,748	53.3
Salt Lake City	910,222	1,072,227	17.8
Rochester,N.Y.	971,230	1,002,410	3.2

APPENDIX II

SELECTED LISTENING TESTS

JANUARY 1992

AND

APRIL 1993

SELECTED TAPE RECORDINGS OF LISTENING TESTS

Tape recordings of AM radio station reception were taken during daylight hours[1/] at a rural location near Lucketts, Loudoun County, Virginia (Site No. 1 on the attached map) using a Potomac Instruments, Type SMR-11 stereo receiver which meets NRSC voluntary receiver standards and a Tascam, Type 122 professional cassette tape recorder.

The attached tape recordings were taken on Class B radio stations WGMS, 570 kHz, WFMD, 930 kHz; and WMZQ, 1390 kHz. WGMS and WFMD monitoring was performed on November 30, 1991 and WMZQ monitoring was performed on December 7, 1991. During the taping, various electrical items were turned on as follows:

Tone Code	Electrical Item
-	Video Cassette Recorder
--	TV Receiver
---	Compact Fluorescent Lights
----	Standard Fluorescent Lights
-----	SCR Dimmed Light

Field strength measurements were taken of each station at the time of program recording using a Potomac Instruments, Type FIM-41 field strength meter. Field strength measurements of pertinent adjacent-channel stations were also taken with the field meter oriented toward the station being recorded. Since the Potomac Instruments receiver utilizes an amplified ferrite rod antenna, field strength values measured as described will approximate the adjacent channel signal station at the receiver. Measured field strength are as follows:

[1/]During the period two hours after sunrise until two hours before sunset.

Relative Frequency	MEASURED FIELD STRENGTHS		
	WGMS	WFMD	WMZQ
	mV/m	mV/m	mV/m
-3 adjacent	0.045 to 0.105	0.033	0.16
-2 adjacent	0.110	0.06 to 0.10	0.021
-1 adjacent	0.185	Unmeasurable	0.14
co-channel	1.45	5.6	0.51
+1 adjacent	0.09 to 0.10	0.06	0.16
+2 adjacent	0.19 to 0.21	1.2	0.10
+3 adjacent	0.075	0.10 to 0.12	0.02 to 0.04

Additional tape recordings were taken on WMZQ (AM and FM) at three locations from the Cohen, Dippell and Everist, P.C. field truck in Loudoun County adjacent to Virginia Route 7 on January 11, 1992, using a Sony portable FM/AM stereo receiver, Type SRF-A100 and a Radio Systems Inc., Type RS-1000 professional DAT machine. Associated field strength measurements of pertinent frequencies were taken using Potomac field strength meters, Type FIM-21 and FIM-71 at the following sites:

Site	Description
2. Hamilton	Opposite gray barn, Route 704 and Irene Avenue
3. Leesburg	Parking lot in front of Giant supermarket, north side of Route 7
4. Ashburn	Ashburn Village Boulevard, 200 feet south of Route 7.

At each site, recordings were made in the following sequence:

Song Number One

(a)	WMZQ AM	Mono	Wideband
(b)	WMZQ AM	Stereo	Wideband
(c)	WMZQ FM	Stereo	---

Song Number Two

(d)	WMZQ FM	Stereo	---
(e)	WMZQ AM	Stereo	Normal Bandwidth
(f)	WMZQ AM	Mono	Normal Bandwidth

Field strength values were taken at each site. The average of probing of FM field strength readings taken at seven feet above ground level were computed in accordance with the manufacturers instructions. A constant 3.0 was assumed in converting from 7 feet to 30 feet above ground level. All AM field strength measurements were taken with the field strength meter oriented towards WMZQ-AM.

SITE	FREQUENCY (kHz)	FIELD STRENGTH (mV/m)
2	1360	0.12
	1390	0.60 to 0.62
	1400	0.38 to 0.40
	98.7 MHz	1.1 (at 30 feet)
3	1360	0.14 to 0.15
	1390	1.15
	1400	0.24 to 0.26
	98.7 MHz	2.6 (at 30 feet)
4	1360	0.22 to 24
	1390	2.15
	1400	0.22
	98.7 MHz	5.6 (at 30 feet)

Other Information

At Site Number 1, tape recordings were also taken on AM Stations, WHP, 580 kHz; WMAL, 630 kHz; WCBM, 680 kHz; WCPT, 730 kHz; WQSI, 820 kHz; WWRC, 980 kHz; WBAL, 1090 kHz; WMET, 1150 kHz; WPVG, 1160 kHz; WAGE, 1200 kHz; WFAX, 1220 kHz; WWDC, 1260 kHz; WTOP, 1500 kHz; WTRI, 1520 kHz; WXVA, 1550 kHz, and WINX, 1600 kHz. Recordings were generally undertaken in a similar manner to the examples included for WGMS, 570 kHz; WFMD, 930 kHz and WMZQ, 1390 kHz. Copies of the above tapes can be made available to the Commission on request.

Equipment Used for Listening/Measurement Program

RECEIVERS	Potomac Instruments, Inc. Synthesized Monitor Receiver Model SMR-11* Serial No. 293 Sony Portable FM/AM Stereo Receiver Model SRF-A100
FIELD STRENGTH METER	Potomac Instruments, Inc. Type FIM-41 Serial No. 117 Calibration Date, August 15, 1991 Potomac Instruments, Inc. Type FIM-71 Serial No. 258 Calibration Date, June 4, 1986 Potomac Instruments, Inc. Type FIM-21 Serial No. 820 Calibration Date, Jan. 7, 1985

TAPE RECORDER	Tascam (TEAC Corporation) Model No. 122 MKII Serial No. 280190 Realistic Type SCT-28 Model No. 14-641 Serial No. 26013 Tascam (TEAC Corporation) Model No. 122 Serial No. 190037 Radio Systems, Inc. Professional DAT machine Type RS-1000 Serial No. 1038

*With AMS-ll C-QUAM (r) stereo decoder and ANT-ll tunable ferrite rod antenna.

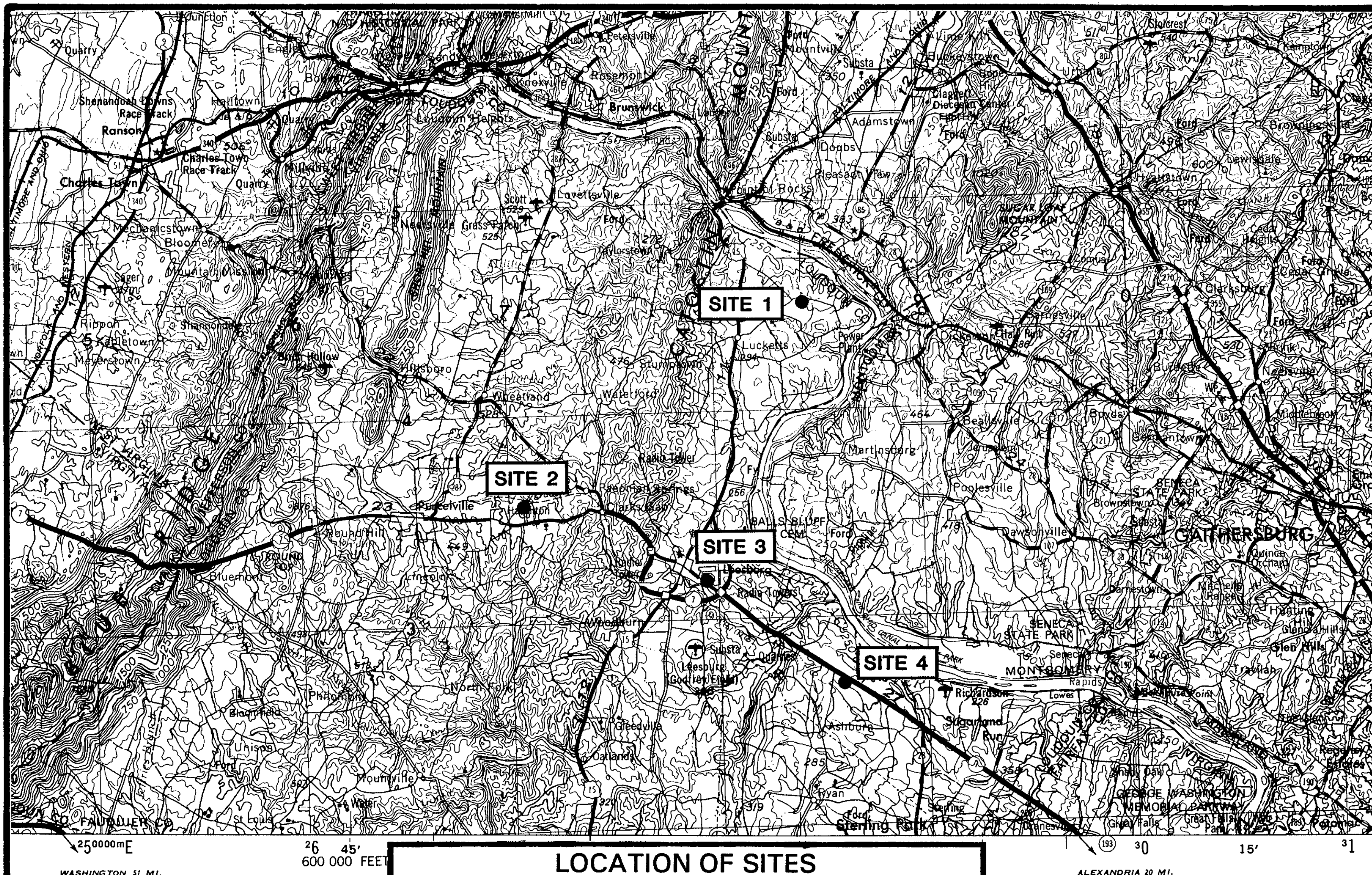
CDE wishes to acknowledge the valuable contributions and assistance and loan of professional equipment from Chase Communications Inc. (WTOP), Greater Media Inc. (WWRC) and Potomac Instruments, Inc.

AM STEREO DOCKET 92-298

Additional observations have been undertaken in downtown Washington, DC at our office on April 1 and April 2, 1993. These observations were performed on the Eleventh Floor on the Northeast Corner of the Building located at 13th and L Streets, N.W., Washington, DC using the Denon "Super Tuner", Type TU-680NAB, Serial No. 2400633. The tuner was connected to a Technics amplifier, Type SU-G90 with two floor sized speakers, Technics, Type SBA52 and two cabinet speakers, Sony, Type SS-U310. Recordings were made using a Technics, Type RS-TR311 tape recorder. Observations were made using the Denon supplied exterior loop antenna oriented in two different positions. The first position achieved a measured field strength of approximately one (1) mV/m and the second position approximately two (2) mV/m. The noise blanketing circuit was switched on and off, however, it did not reduce during the course of these observations the AM background interference.

In addition to the AM stereo recording in the wideband and narrow band position, a recording of the simulcast FM WMZQ signal was also made. These recordings are found at the end of the 1991 and 1992 observations.

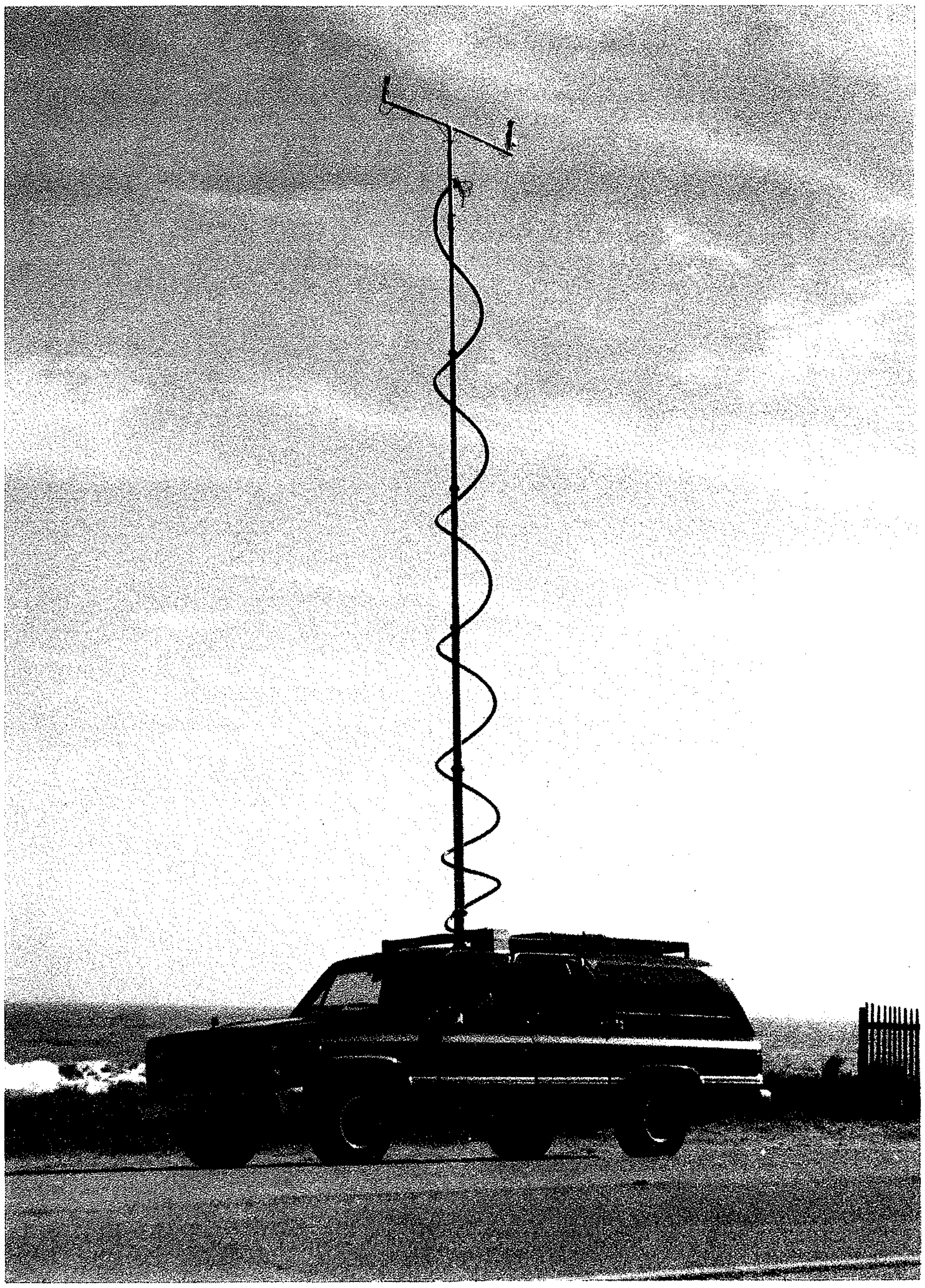
In this business location, the signal observed with 1 mV/m consistently had background noise both in the wideband and narrow band mode. However, under these same noise conditions, 2 mV/m field strength was sufficient to reduce noise such that compatible audio quality to FM was achieved.



LOCATION OF SITES
USED FOR LISTENING TESTS
JANUARY 1992

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, D.C.

5	0	5	10	15	20 Statute Miles	
5	0	5	10	15	20	25	30 Kilometers



COHEN, DIPPELL AND EVERIST, P.C.

FIELD MEASUREMENT VAN

WITH 30 FOOT TELESCOPING MAST

26,

PUBLIC NOTICE
FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET N.W.
WASHINGTON, D.C. 20554

32383

News media information 202/632-5050. Recorded listing of releases and texts 202/632-0002.

March 24, 1993

NATIONAL EFFORT TO BOOST BROADCAST COMPLIANCE

As part of its overall compliance program, the FCC educates licensees about their responsibilities under the FCC rules and regulations. The FCC takes special effort to do this in areas where compliance is found to be lower than desired, as with certain broadcast technical and public inspection file requirements. Specifically, based on inspections of broadcast stations during fiscal year 1992, compliance in the following five areas was found to be in need of improvement:

* AM directional parameters
* AM monitoring points
* power tolerance
* meters
* the public inspection file

In other areas, compliance was generally found to be good.

During the last several months the 35 field offices in the Field Operations Bureau have taken steps to improve compliance in these areas, including:

* mailing over 2100 information letters to licensees and broadcast organizations

* calling over 100 broadcast organizations informing them of these problem areas

* meeting with 11 broadcast organizations

* inspecting over 350 AM, FM, and TV stations between February 8 and February 19, 1993

Later this year, the FCC will again select AM, FM, and TV stations, and inspect them for compliance with the FCC rules. The findings from this sample will guide our education and enforcement efforts next year.

For additional information, please contact Jeffrey Young at (202) 632-7014.

-FCC-

AM 27

OFFICE MEMORANDUM

TO: Bell Atlantic Letter File
WMRF File
OSHA File
All Engineers

FROM: Warren

RE: Tower Climbing Procedures

DATE: March 3, 1993

This office has designed a detuning system for a proposed 180 foot self-supporting 3-leg cellular telephone tower to be located near AM station WIEZ, 670 KHz, Lewistown, Pennsylvania. The detuning skirt consists of three vertical drop wires mounted on insulating rods out from each tower leg. The drop wires will be electrically connected by horizontal wire hoops at 20 foot invervals hoops to be located approximately 2 feet out from the tower face.

We inquired with Bell Atlantic on whether the hoops/insulators would constitute a climbing hazard for tower climbers. Bell Atlantic advised this would not be a problem since each of their towers has an associated unique set of climbing instructions and procedures; and that they are familiar with this type and style of installation.

OFFICE MEMORANDUM

TO: All Engineers and Kent

FROM: Don

TOPIC: AM

DATE: March 31, 1993

Enclosed for your information is another dismissal letter for an AM application.

Attachment

FCC MAIL SECTION

FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

SEP 25 10 35 AM '92

22 SEP 1992

DISTRIBUTED BY

In Reply Refer To:
8910-EAL
Stop Code 1800B2

Group W Radio, Inc. (Hou./Wash.)
400 North Capitol Street, N.W.
Suite 550
Washington, DC 20001-1511

In re: Group W Radio, Inc. (Hou./Wash.)
WCPT, Alexandria, Virginia
ARN-920805AA

Gentlemen:

This is in reference to the above-captioned application for an AM station construction permit.

A preliminary engineering study of your application reveals that the proposed 0.025 mV/m-10% skywave contour overlaps the 0.5 mV/m-50% skywave contour of co-channel Canadian Class A station CKAC, Montreal, Canada, in violation of the U.S/Canadian Agreement. It should be noted that a detailed clipping study of points along the border, in accordance to Section 4.10.2.2 of the U.S/Canadian Agreement, shows that at these points the proposed radiation would raise the RSS nighttime limitation of station CKCA.

Accordingly, pursuant to Section 0.283 of the Commission's Rules your application is unacceptable for filing and is herewith returned. One copy of the application will be retained for reference. A detailed review of the application was not made to determine whether other deficiencies exist which could also preclude its acceptance for filing. In the event your application is mutually exclusive with another application, you will be afforded one opportunity to obtain acceptance *nunc pro tunc* to your original submission date by submitting such a request along with an amended application specifying a minor change within 30 days of the date of this letter. Inasmuch as you will not be afforded a second opportunity to correct any other deficiency, I urge you to carefully review the entire application (See enclosed Public Notice).

Sincerely,

James R. Burtle
Chief, AM Branch
Audio Services Division
Mass Media Bureau

cc
Mr. Glen Clark

OFFICE MEMORANDUM

TO: All Engineers and Kent

FROM: Don

TOPIC: AM

DATE: March 1, 1993

Enclosed for your information is another dismissal letter for an AM application.

Attachment

FCC MAIL SECTION

FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

SEP 25 10 35 AM '92

DISPATCHED BY

22 SEP 1992

In Reply Refer To:
8910-EAL
Stop Code 1800B2

Group W Radio, Inc. (Hou./Wash.)
400 North Capitol Street, N.W.
Suite 550
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WCPT, Alexandria, Virginia
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Gentlemen:

This is in reference to the above-captioned application for an AM station construction permit.

A preliminary engineering study of your application reveals that the proposed 0.025 mV/m-10% skywave contour overlaps the 0.5 mV/m-50% skywave contour of co-channel Canadian Class A station CKAC, Montreal, Canada, in violation of the U.S/Canadian Agreement. It should be noted that a detailed clipping study of points along the border, in accordance to Section 4.10.2.2 of the U.S/Canadian Agreement, shows that at these points the proposed radiation would raise the RSS nighttime limitation of station CKCA.

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Sincerely,

James R. Burtle
Chief, AM Branch
Audio Services Division
Mass Media Bureau

cc
Mr. Glen Clark

A.M. 29

Post-it™ brand **Fax Transmittal Memo** 7672

No. of Pages: 1	Today's Date: 2-10-93	Time: 11:20 a.m.	
To: Bob Guill		From: J. Whitley	
Company: Cohen & Dippell		Company: FCC	
Location:		Location:	Dept. Charge:
Fax #: 898-0895	Telephone #: 898-0111	Fax #:	Telephone #: 632-7010
Comments:		Original Disposition: ☐ Destroy ☐ Return ☐ Call for pickup	

Per your request.

CORRECTIONS TO BE APPLIED TO VALUES OF EFFECTIVE FIELD READ FROM FCC FIGURE 8

120 RADIALS

Average length of radials (wave lengths)	Correction (MV/M)
0.2401-	None
0.2301 -.24	-2
0.2201 -.23	-4
0.2101 -.22	-6
0.2001 - .21	-8
0.1901 -.20	-10
0.1801 -.19	-12
0.1701 -.18	-14
0.1601 -.17	-16
0.1501 - .16	-18

90 RADIALS

Subtract 6 mv/m from curve values. Make further correction in accordance with above table from ground systems having average lengths of less than 0.25 wave lengths. Interpolate as necessary for number of radials between 90 and 120.

For simple vertical antennas over salt water use curve values.

Use minimum permissible radiation figures for antennas with roof top grounds. T and L antennas, and for simple vertical antennas having ground system too small to fall within the range of corrections noted above, as follows:

[redacted]

Class I	225 mv/m
Class II	175 mv/m
Class III	175 mv/m
Class IV	150 mv/m

PER KW / 1 mile

If corrected curve values give effective fields falling below permissible minimums, use these minimums in lieu of such values.

Top loaded antennas, sectionalized antennas, etc., are to be considered on a case-to-case basis.

Radials	Correction MV/M
120	None
110	-2
100	-4
90	-6

187

AM 30

47 CFR Part 73

[ET Docket No. 92-298; FCC 92-546]

Establishment of a Stereophonic Transmitting Standard in the AM Radio Broadcasting Service

AGENCY: Federal Communications Commission.

ACTION: Proposed rule.

SUMMARY: This document proposes to select a transmitting standard for AM stereophonic broadcasting. Specifically, it proposes to adopt the Motorola C-QUAM system as the US standard. This proposal responds to section 214 of the Telecommunications Authorization Act of 1992, which requires the Commission to adopt a single AM stereo broadcasting transmission standard. The effect of the proposed rules would be to eliminate any remaining uncertainty among broadcasters as to the technology they should employ and to foster expansion of the AM stereo service and a corresponding improvement in the overall quality of the AM service.

DATES: Comments must be filed on or before April 5, 1993, and reply comments must be filed on or before April 20, 1993.

ADDRESSES: Federal Communications Commission, Washington, DC 20554.

FOR FURTHER INFORMATION CONTACT: David L. Means, Office of Engineering and Technology, (301) 725-1585, extension 206.

SUPPLEMENTARY INFORMATION: This is a synopsis of the Commission's Notice of Proposed Rulemaking in ET Docket No. 92-298, adopted December 10, 1992, and released January 6, 1993.

The complete text of this Notice of Proposed Rulemaking is available for inspection and copying during normal business hours in the FCC Dockets Branch (room 230), 1919 M Street NW., Washington, DC., and also may be purchased from the Commission's copy contractor, Downtown Copy Center, at (202) 452-1422, 1919 M Street NW., room 246, Washington, DC 20554.

Synopsis of Notice of Proposed Rulemaking

1. By this action, the Commission proposes to adopt a standard for stereophonic AM broadcast radio service, specifically, the Motorola C-Quam system. This proposal responds to section 214 of the Telecommunications Authorization Act of 1992 (Authorization Act), which requires the Commission to adopt a single AM broadcasting stereo transmission standard.

2. Section 214 of the Authorization Act, which was signed into law on October 27, 1992, states that the Commission shall, within 60 days of enactment of the Act, initiate a rulemaking to adopt a single AM radio stereophonic transmitting equipment standard that specifies the composition of the transmitted stereophonic signal; and, within one year of such date of enactment, adopt such a standard.

3. In 1982, the Commission authorized AM stations to offer stereo service, but it declined to select a single standard from among the five competing AM stereo technical systems. Rather, the Commission concluded that it would be more effective and efficient to allow market forces to determine the course of AM stereo development. Shortly afterward, the field narrowed to two systems: Motorola's C-Quam system and the system marketed by Kahn Communications, Inc./Hazeltine Corporation (the Kahn system).

4. Of the approximately 660 US AM broadcasting stations that have converted to stereo, 591 use the Motorola system and an additional 37 use the Harris Corporation C-Quam compatible system. Fewer than 20 stations now employ the Kahn system. Twenty-six receiver manufacturers incorporate the Motorola system in at least one model; none incorporate the Kahn system. There are approximately 24 million C-Quam receivers currently in use by radio listeners. In the mid-1980's, approximately 280,000 receivers were made that could decode both the Motorola and Kahn signals; however, these are no longer produced. The Motorola system has been adopted as the national standard in six foreign countries; none have adopted the Kahn system.

5. In light of the data presented above, and considering our mandate to select a single standard, we believe the public interest would be best served by adopting the Motorola C-Quam system as the US AM stereo standard. Broadcasters, manufacturers and radio purchasers have, directly or indirectly, demonstrated strong preference for the Motorola system. Adoption of the C-Quam system as the AM stereo standard would eliminate the remaining uncertainty with regard to the AM technology broadcasters should employ and thereby serve to promote expansion of AM stereo transmitting equipment and a corresponding improvement in the quality of the AM service.

6. We believe that selection of an alternative to the Motorola system would set back the clock on the implementation of AM stereo service by undercutting the existing investment in C-Quam equipment by both receiver purchasers and broadcasters. Further, we are aware that many AM broadcasters are struggling financially and may not be able to afford replacement stereo transmitting equipment. Selection of an alternative stereo standard thus could conceivably result in discontinuance of the existing stereo service with no replacement. Such a result would be inconsistent with the legislative intent to advance AM stereo service. In light of these factors, proponents of alternative standards would bear a heavy burden to show that the potential benefits of an alternative technology outweigh the likely costs and delays arising from selection of an alternate standard. Nevertheless, we invite comment on alternatives to the proposed standard.

7. We are proposing to incorporate the Motorola C-Quam standard in part 73 of our rules. We are also proposing to require stations that employ alternative AM stereo systems (i.e., the Kahn and Harris systems) to discontinue such operation as of one year from the effective date of these rules. Any stations converting to AM stereo after the effective date of these rules will be required to employee the system adopted by the Commission. We invite comment on the extent of compatibility of the Harris system with the Motorola system and whether we should permit stations currently employing the Harris system to continue to do so indefinitely. Consistent with our general policies towards improvement of the AM broadcasting service, we will continue to encourage the availability of AM receivers, including AM stereo receivers, that meet appropriate quality standards. Finally, we propose to condition the selection of Motorola's system as the AM stereo standard by requiring Motorola to license its patents to other parties under fair and reasonable terms.

Ex Parte Rules—Non-Restricted Proceeding

8. This is a non-restricted notice and comment rule making proceeding. *Ex parte* presentations are permitted, except during the Sunshine Agenda period, provided they are disclosed as provided in the Commission rules. See generally 47 CFR 1.1202, 1.1203 and 1.1206(a).

Comment Information

9. Pursuant to procedures set forth in §§ 1.415 and 1.419 of the Commission's rules, interested parties may file comments on or before April 5, 1993, and reply comments on or before April 20, 1993. Extensions of these time periods are not contemplated. All relevant and timely comments will be

considered by the Commission before final action is taken in this proceeding. To file formally, participants must file an original and four copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original plus nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, DC 20554. Comments and reply comments will be available for public inspection during regular business hours in the FCC Reference Center (room 239) of the Federal Communications Commission, 1919 M Street NW., Washington, DC 20554.

Regulatory Flexibility Act

10. As required by section 603 of the Regulatory Flexibility Act, the FCC has prepared the following Initial Regulatory Flexibility Analysis (IRFA) of the expected impact of these proposed policies and rules on small entities:

Reason for Action. This proceeding is being initiated to select an AM radio stereophonic equipment standard, as required under section 214 of the Telecommunications Authorization Act of 1992.

Objectives. The Commission's goal is to select an AM stereophonic transmission standard.

Legal basis. Authority for this proposed rule making is contained in section 4(i), 4(j) and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 154(j), and 303(r) and section 214 of the Telecommunications Authorization Act of 1992, Public Law 102–538 (1992).

Reporting, Recordkeeping and other Compliance Requirements. AM stereo transmission equipment would require type acceptance by the FCC to demonstrate compliance with the proposed standard.

Federal Rules that Overlap, Duplicate or Conflict with Proposed Rule. None.

Description, Potential Impact, and Number of Small Entities Involved. This action is expected to expand the operation of AM stereo service and sales of AM stereo receivers. The effect of this proposal would be to necessitate conversion to use of the C-Quam transmission system by approximately 50 AM stations currently using the Kahn or Harris systems in order to continue to provide stereo service.

Any Significant Alternatives Minimizing the Impact on Small Entities Consistent with the Stated Objectives. None.

Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the Notice, but they must have a separate and distinct heading designating them as responses to the regulatory flexibility analysis. The Secretary shall cause a copy of the Notice, including the IFRA, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with section 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96–354, 94 Stat. 1164, 50 U.S.C. sections 601 et seq. (1981)).

List of Subjects in 47 CFR Part 73

Radio Broadcasting.

Amendatory Text

Part 73 of the Code of Federal Regulations is proposed to be amended as follows:

PART 73—RADIO BROADCAST SERVICES

1. The authority citation in part 73 continues to read:

Authority: 47 U.S.C. 154, 303.

2. Section 73.128 is proposed to be amended by revising paragraph (a), (b) introductory text and adding paragraph (c) to read as follows:

§ 73.128 AM stereophonic broadcasting.

(a) An AM broadcast station may, without specific authority from the FCC, transmit stereophonic programs upon installation of type accepted stereophonic transmitting equipment and the necessary measuring equipment to determine that the stereophonic transmissions conform to the modulation characteristics specified in paragraphs (b) and (c) of this section.

(b) The following limitations on the transmitted wave must be met to insure compliance with the occupied bandwidth limitations, compatibility with AM receivers using envelope detectors, and any applicable international agreements to which the FCC is a party:

* * * * *

(c) Effective (insert date one year after enactment), stereophonic transmissions shall conform to the following additional modulation characteristics:

(1) The audio response of the main (L+R) channel shall conform to the requirements of the ANSI/EIA–549–1988, NSRC–1 AM Preemphasis/Deemphasis and Broadcast Transmission Bandwidth Specifications (NRSC–1).

(2) The left and right channel audio signals shall conform to frequency response limitations dictated by ANSI/EIA–549–1988.

(3) The stereophonic difference (L–R) information shall be transmitted by varying the phase of the carrier in accordance with the following relationship:

$$\phi_c = \tan^{-1}\left(\frac{m(L(t)-R(t))}{1+m(L(t)+R(t))}\right)$$

where:

L(t) = audio signal left channel,
R(t) = audio signal right channel,
m = modulation factor, and
m_{peak} (L(t) + R(t)) = 1 for 100% amplitude modulation,
m_{peak} (L(t) + R(t)) = 1 for 100% phase modulation,

(4) The carrier phase shall advance in a positive direction when a left channel signal causes the transmitter envelope to be modulated in a positive direction. The carrier phase shall likewise retard (negative phase change) when a right channel signal causes the transmitter envelope to be modulated in a positive direction. The phase modulation shall be symmetrical for the condition of difference (L–R) channel information sent without the presence of envelope modulation.

(5) Maximum angular modulation, which occurs on negative peaks of the left or right channel with no signal present on the opposite channel (L(t) = –0.75, R(t) = 0, or R(t) = –0.75, L(t) = 0) shall not exceed 1.25 radians.

(6) A peak phase modulation of +/–0.785 radians under the condition of difference (L–R) channel modulation and the absence of envelope (L+R) modulation and pilot signal shall represent 100% modulation of the difference channel.

(7) The composite signal shall contain a pilot tone for indication of the presence of stereophonic information. The pilot tone shall consist of 25 Hz tone, with 1% or less total harmonic distortion and a frequency tolerance of +/–0.1 Hz, which modulates the carrier phase +/–0.05 radians peak, corresponding to 5% L–R modulation when no other modulation is present. The injection level shall be 5%, with a tolerance of +1, –0%.

(8) The composite signal shall be described by the following expression:

$$E_c=A_c\left[1+m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t+\phi_{sn})\right]\cos\left[-\omega_c t+\tan^{-1}\frac{m\sum_{n=1}^{\infty} C_{dn}\cos(\omega_{dn}t+\phi_{dn})+.05\sin 50\pi t}{1+m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t+\phi_{sn})}\right]$$

where:
A=the unmodulated carrier voltage
m=the modulation index
C_{sn}=the magnitude of the nth term of the sum signal
C_{dn}=the magnitude of the nth term of the difference signal
ω_{sn}=the nth order angular velocity of the sum signal
ω_{dn}=the nth angular velocity of the difference signal
ω_c=the angular velocity of the carrier

$$\phi_{sn} = \text{the angle of the nth order term} = \tan^{-1}\left[\frac{B_{sn}}{A_{sn}}\right]$$

$$\phi_{dn} = \text{the angle of the nth order term} = \tan^{-1}\left[\frac{B_{dn}}{A_{dn}}\right]$$

A_{sn} and B_{sn} are the n^{th} sine and cosine coefficients of C_{sn}
A_{dn} and B_{dn} are the n^{th} sine and cosine efficients of C_{dn}

Federal Communications Commission.
Donna R. Searcy,
Secretary.
[FR Doc. 93–1294 Filed 1–19–93; 8:45 am]
BILLING CODE 6712-01-M

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47 CFR Part 73

[MM Docket No. 92–313, RM–8140]

Radio Broadcasting Services; Central, NM

AGENCY: Federal Communications Commission.

ACTION: Proposed rule.

SUMMARY: The Commission requests comments on a petition filed by Mel-Mike Enterprises, Inc., seeking the substitution of Channel 237C1 for Channel 237C2 at Central, New Mexico, and the modification of Station KZTT's construction permit to specify the higher class channel. Channel 237C1 can be allotted to Central in compliance with the Commission's minimum distance separation requirements with a site restriction of 18.6 kilometers (11.6 miles) northwest to accommodate petitioner's desired transmitter site and avoid short-spacings to Station KKRK, Channel 237A, Douglas, Arizona, and Station KLAQ, Channel 238C, El Paso, Texas, at coordinates North Latitude 32–52–15 and West Longitude 108–18–57. Mexican concurrence in the allotment is required since Central is located within 320 kilometers (199 miles) of the U.S.-Mexican border.

DATES: Comments must be filed on or before March 5, 1993, and reply comments on or before March 22, 1993.

ADDRESSES: Federal Communications Commission, Washington, DC 20554. In addition to filing comments with the FCC, interested parties should serve the petitioner, or its counsel or consultant, as follows: Richard F. Swift, Esq., Tierney & Swift, 1200 Eighteenth Street NW., suite 210, Washington, DC 20036 (Counsel to petitioner).

FOR FURTHER INFORMATION CONTACT: Leslie K. Shapiro, Mass Media Bureau, (202) 634–6530.

SUPPLEMENTARY INFORMATION: This is a synopsis of the Commission's Notice of Proposed Rule Making, MM Docket No. 92–313, adopted December 17, 1992, and released January 13, 1993. The full text of this Commission decision is available for inspection and copying during normal business hours in the FCC Dockets Branch (room 230), 1919 M Street NW., Washington, DC. The complete text of this decision may also be purchased from the Commission's copy contractor, Downtown Copy Center, (202) 452–1422, 1990 M Street NW., suite 640, Washington, DC 20036.

Provisions of the Regulatory Flexibility Act of 1980 do not apply to this proceeding.

Members of the public should note that from the time a Notice of Proposed Rule Making is issued until the matter is no longer subject to Commission consideration or court review, all *ex parte* contacts are prohibited in Commission proceedings, such as this one, which involve channel allotments. See 47 CFR 1.1204(b) for rules governing permissible *ex parte* contracts.

For information regarding proper filing procedures for comments, see 47 CFR 1.415 and 1.420.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Federal Communications Commission.
Michael C. Ruger,
Chief, Allocations Branch, Policy and Rules Division, Mass Media Bureau.
[FR Doc. 93–1290 Filed 1–19–93; 8:45 am]
BILLING CODE 6712-01-M

AM STEREO 31.

Before the
Federal Communications Commission
Washington, D.C. 20554

ET Docket No. 92-298

In the Matter of

Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard

NOTICE OF PROPOSED RULE MAKING

Adopted: December 10, 1992; Released: January 6, 1993

Comments Due: April 5, 1993
Reply Comments Due: April 20, 1993

By the Commission:

INTRODUCTION

1. By this action, the Commission is proposing to adopt a standard for stereophonic AM broadcast radio service, specifically, the Motorola C-Quam system. This proposal responds to Section 214 of the Telecommunications Authorization Act of 1992 (Authorization Act), which requires the Commission to adopt a single AM broadcasting stereo transmission standard.[1]

BACKGROUND

2. *Telecommunications Authorization Act.* On October 27, 1992, the President signed the Authorization Act into law. Section 214 of the Authorization Act states that the Federal Communications Commission shall -

> (1) within 60 days after the date of enactment of this Act, initiate a rulemaking to adopt a single AM radio stereophonic transmitting equipment standard that specifies the composition of the transmitted stereophonic signal; and
>
> (2) within one year after such date of enactment, adopt such a standard.

3. *AM Broadcasting Stereo Transmission Standards Developments.* In 1982 the Commission authorized AM stations to offer stereo service.[2] The Commission declined to select a single system standard from among the five competing AM stereo technical systems.[3] Rather, the Commission concluded that it would be more effective and efficient to allow market forces to determine the course of AM stereo development. Shortly afterwards, the field narrowed to two systems: Motorola's C-Quam system and the Kahn system.[4]

DISCUSSION

4. Of the approximately 660 US AM broadcasting stations that have converted to AM stereo, 591 use the Motorola system and an additional 37 use the Harris Corporation C-Quam compatible system.[5] Fewer than 20 stations now employ the Kahn system. Twenty-six receiver manufacturers incorporate the Motorola systempin at least one model; none incorporate the Kahn system. There are approximately 24 million Motorola C-Quam receivers currently in use by radio listeners. In the mid-80s, approximately 280,000 receivers were made that could decode both the Motorola and Kahn signals. These multi-mode receivers, however, are no longer produced. The Motorola system has been adopted as the national standard in six foreign countries: Canada, Mexico, Australia, Brazil, South Africa, and Japan. No countries have adopted the Kahn system.

5. The Authorization Act requires that we establish a single AM stereo standard. In light of the data presented above, particularly the figures regarding receiver types, we believe the public interest would be best served by adopting the Motorola C-Quam system as the U.S. AM stereo standard. Broadcasters, manufacturers and radio purchasers have, directly or indirectly, demonstrated strong preference for the Motorola system. Adoption of the C-Quam system as the AM stereo standard would eliminate the remaining uncertainty with regard to the AM technology broadcasters should employ and thereby serve to promote expansion of AM stereo transmitting equipment and a corresponding improvement in the quality of the AM service.

6. We believe that selection of an alternative to the Motorola system would set back the clock on the implementation of AM stereo service, to the substantial detriment of the public and broadcasters. Specifically, the users of the existing 24 million C-Quam receivers would no longer be able to enjoy AM stereo reception through that equipment. Also, existing AM broadcasters would forfeit their investments in C-Quam transmission equipment.

---

[1] *See* Telecommunications Authorization Act of 1992, Pub. L. No. 102-538. This proceeding is limited to issues involved in implementation of Section 214 of the Authorization Act. Other provisions of the Authorization Act are being addressed elsewhere.

[2] *See Report and Order* in Docket No. 21313, adopted March 4, 1982, 47 FR 13152.

[3] The developers of these AM stereo systems were Belar Electronics Corp., Harris Corporation, Kahn Communications, Inc./Hazeltine Corporation (the Kahn system), Magnavox Corporation, and Motorola Corporation.

[4] In 1988, the Commission reaffirmed its earlier decision not to select a standard. In that action, the Commission noted that the market appeared to be working towards establishing a *de facto* standard. *See Memorandum Opinion and Order*, 3 FCC Rcd 403 (1988).

[5] The statistics and other information cited herein are taken from testimony and comments to the Hearing before the Subcommittee on Communications, of the Committee on Commerce, Science, and Transportation, United States Senate, March 11, 1992, S. Hrg. 102-740. Copies of the relevant information is being inserted in the record for this proceeding. *See*, in particular, the Prepared Statement of Bruce Ladd, Vice President of Government Affairs and Government Relations, Motorola, Inc.

Further, we are aware that many AM broadcasters are struggling financially and may not be able to afford replacement stereo transmission equipment. Selection of an alternative stereo standard thus could conceivably result in discontinuance of the existing stereo service with no replacement. Such a result would be inconsistent with the legislative intent to advance AM stereo service. In light of these factors, proponents of alternative standards would bear a heavy burden to show that the potential benefits of an alternative technology outweigh the likely costs and delays of selection of a standard different than the Motorola system. Nevertheless, we invite comment on alternatives to the proposed standard.[6]

7. We are proposing to incorporate the Motorola C-Quam standard in Part 73 of our rules. The proposed standard is presented in Appendix B. We are also proposing to require stations that employ alternative AM stereo systems (*i.e.*, the Kahn and Harris systems) to discontinue such operation as of one year from the effective date of these rules.[7] Any stations converting to AM stereo after the effective date of these rules will be required to employ the system adopted by the Commission. Consistent with our general policies towards improvement of the AM broadcasting service, we will continue to encourage the availability of AM receivers, including AM stereo receivers, that meet appropriate quality standards.[8]

PROCEDURAL MATTERS

8. *Ex Parte Rules - Non-Restricted Proceeding.* This is a non-restricted notice and comment rule making proceeding. *Ex parte* presentations are permitted, except during the Sunshine Agenda period, provided they are disclosed as provided in Commission rules. *See generally* 47 C.F.R. Sections 1.1202, 1.1203 and 1.1206(a).

9. *Comment Information.* Pursuant to procedures set forth in Sections 1.415 and 1.419 of the Commission's rules, interested parties may file comments on or before April 5, 1993, and reply comments on or before April 20, 1993. Extensions of these time periods are not contemplated. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally, participants must file an original and four copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original plus nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, DC 20554. Comments and reply comments will be available for public inspection during regular business hours in the FCC Reference Center (Room 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, DC 20554.

10. *Regulatory Flexibility Act.* As required by Section 603 of the Regulatory Flexibility Act, the FCC has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is set forth in Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the regulatory flexibility analysis. The Secretary shall cause a copy of the *Notice*, including the IRFA, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96-354, 94 Stat. 1164, 50 U.S.C. Sections 601 *et seq.* (1981)).

11. *Additional Information.* For further information concerning this proceeding, contact David Means, Engineering Evaluation Branch, Office of Engineering and Technology, (301) 725-1585.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A
INITIAL REGULATORY FLEXIBILITY ANALYSIS

Reason for Action. This proceeding is being initiated to select an AM radio stereophonic equipment standard, as required under Section 214 of the Telecommunications Authorization Act of 1992.

Objectives. The Commission's goal is to select an AM stereophonic transmission standard.

Legal Basis. Authority for this proposed rule making is contained in Section 4(i), 4(j) and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 154(j), and 303(r) and Section 214 of the Telecommunications Authorization Act of 1992, Pub. L. 102-538 (1992).

Reporting, Recordkeeping and other Compliance Requirements. AM stereo transmission equipment would require type acceptance by the FCC to demonstrate compliance with the proposed standard.

Federal Rules the Overlap, Duplicate or Conflict with Proposed Rule. None.

Description, Potential Impact, and Number of Small Entities Involved. This action is expected to expand the operation of AM stereo service & sales of AM stereo receivers. The effect of this proposal would be to necessitate conversion to use of the C-Quam transmission system by approximately 50 AM stations currently using the Kahn or Harris systems in order to continue to provide stereo service.

[6] We recognize that efforts are under way to develop digital broadcasting technologies for the AM broadcast band. The Authorization Act is clearly intended to address an AM stereo standard within the context of the current analog transmission format. Accordingly, AM digital broadcasting technologies are outside the scope of this proceeding.

[7] We understand that the Harris system may be compatible with the Motorola C-Quam system. We invite comment as to the extent of the compatibility and whether we should permit stations currently using the Harris system to continue to do so indefinitely.

[8] We are taking a similar approach with implementation of advanced television (ATV). See Advanced Television Systems, 7 FCC Rcd 3340, 3358 (1992). *Cf.* FCC Public Notice, Revised Patent Procedures of the Federal Communications Commission, Public Notice 13948, December 6, 1961.

Any Significant Alternatives Minimizing the Impact on Small Entities Consistent with the Stated Objectives. None.

APPENDIX B

PROPOSED RULE CHANGES

I. Part 73 of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

PART 73 - RADIO BROADCAST SERVICES

1. The authority citation in Part 73 continues to read:

AUTHORITY: 47 U.S.C. 154, 303.

2. Subpart A is amended by revising section 73.128 to read as follows:

Section 73.128 AM Stereophonic Broadcasting.

(a) An AM broadcast station may, without specific authority from the FCC, transmit stereophonic programs upon installation of type accepted stereophonic transmitting equipment and the necessary measuring equipment to determine that the stereophonic transmissions conform to the modulation characteristics specified in paragraphs (b) and (c) of this section.

(b) The following limitations on the transmitted wave must be met to insure compliance with the occupied bandwidth limitations, compatibility with AM receivers using envelope detectors, and any applicable international agreements to which the FCC is a party:

(1) * * *

(c) Effective (insert date one year after enactment), stereophonic transmissions shall conform to the following additional modulation characteristics:

(1) The audio response of the main (L+R) channel shall conform to the requirements of the ANSI/EIA-549-1988, NSRC-1 AM Preemphasis/Deemphasis and Broadcast Transmission Bandwidth Specifications (NRSC-1).

(2) The left and right channel audio signals shall conform to frequency response limitations dictated by ANSI/EIA-549-1988.

(3) The stereophonic difference (L-R) information shall be transmitted by varying the phase of the carrier in accordance with the following relationship:

$$\phi_c = \tan^{-1}\left(\frac{m(L(t)-R(t))}{1+m(L(t)+R(t))}\right)$$

where:
L(t) = audio signal left channel,
R(t) = audio signal right channel,
m = modulation factor, and
$m_{peak}(L(t) + R(t)) = 1$ for 100% amplitude modulation,
$m_{peak}(L(t) + R(t)) = 1$ for 100% phase modulation

(4) The carrier phase shall advance in a positive direction when a left channel signal causes the transmitter envelope to be modulated in a positive direction. The carrier phase shall likewise retard (negative phase change) when a right channel signal causes the transmitter envelope to be modulated in a positive direction. The phase modulation shall be symmetrical for the condition of difference (L-R) channel information sent without the presence of envelope modulation.

(5) Maximum angular modulation, which occurs on negative peaks of the left or right channel with no signal present on the opposite channel (L(t) = -0.75, R(t) = 0, or R(t) = -0.75, L(t) = 0) shall not exceed 1.25 radians.

(6) A peak phase modulation of +/- 0.785 radians under the condition of difference (L-R) channel modulation and the absence of envelope (L+R) modulation and pilot signal shall represent 100% modulation of the difference channel.

(7) The composite signal shall contain a pilot tone for indication of the presence of stereophonic information. The pilot tone shall consist of a 25 Hz tone, with 1% or less total harmonic distortion and a frequency tolerance of +/- 0.1 Hz, which modulates the carrier phase +/- 0.05 radians peak, corresponding to 5% L-R modulation when no other modulation is present. The injection level shall be 5%, with a tolerance of +1, - 0%.

(8) The composite signal shall be described by the following expression:

where:
A = the unmodulated carrier voltage
m = the modulation index
C_{sn} = the magnitude of the nth term of the sum signal
C_{dn} = the magnitude of the nth term of the difference signal
ω_{sn} = the nth order angular velocity of the sum signal
ω_{dn} = the nth order angular velocity of the difference signal

$$E_c = A_c\left[1 + m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t + \phi_{sn})\right]\cos\left[-\omega_c t + \tan^{-1}\frac{m\sum_{n=1}^{\infty} C_{dn}\cos(\omega_{dn}t + \phi_{dn}) + .05\sin 50\pi t}{1 + m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t + \phi_{sn})}\right]$$

ω_c = the angular velocity of the carrier

ϕ_{sn} = the angle of the nth order term = $\tan^{-1}\left[\frac{B_{sn}}{A_{sn}}\right]$

ϕ_{dn} = the angle of the nth order term = $\tan^{-1}\left[\frac{B_{dn}}{A_{dn}}\right]$

A_{sn} and B_{sn} are the n^{th} sine and cosine coefficients of C_{sn}
A_{dn} and B_{dn} are the n^{th} sine and cosine efficients of C_{dn}

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

FCC 92-546

In the Matter of

Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard) **ET Docket No. 92-298**

NOTICE OF PROPOSED RULE MAKING

Adopted: December 10, 1992 Released: January 6, 1993

Comments Due: April 5, 1993
Reply Comments Due: April 20, 1993

By the Commission:

INTRODUCTION

1. By this action, the Commission is proposing to adopt a standard for stereophonic AM broadcast radio service, specifically, the Motorola C-Quam system. This proposal responds to Section 214 of the Telecommunications Authorization Act of 1992 (Authorization Act), which requires the Commission to adopt a single AM broadcasting stereo transmission standard.[1]

BACKGROUND

2. Telecommunications Authorization Act. On October 27, 1992, the President signed the Authorization Act into law. Section 214 of the Authorization Act states that the Federal Communications Commission shall -

> (1) within 60 days after the date of enactment of this Act, initiate a rulemaking to adopt a single AM radio stereophonic transmitting equipment standard that specifies the composition of the transmitted stereophonic

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[1] See Telecommunications Authorization Act of 1992, Pub. L. No. 102-538. This proceeding is limited to issues involved in implementation of Section 214 of the Authorization Act. Other provisions of the Authorization Act are being addressed elsewhere.

signal; and

(2) within one year after such date of enactment, adopt such a standard.

3. AM Broadcasting Stereo Transmission Standards Developments. In 1982 the Commission authorized AM stations to offer stereo service.[2] The Commission declined to select a single system standard from among the five competing AM stereo technical systems.[3] Rather, the Commission concluded that it would be more effective and efficient to allow market forces to determine the course of AM stereo development. Shortly afterwards, the field narrowed to two systems: Motorola's C-Quam system and the Kahn system.[4]

DISCUSSION

4. Of the approximately 660 US AM broadcasting stations that have converted to AM stereo, 591 use the Motorola system and an additional 37 use the Harris Corporation C-Quam compatible system.[5] Fewer than 20 stations now employ the Kahn system. Twenty-six receiver manufacturers incorporate the Motorola system in at least one model; none incorporate the Kahn system. There are approximately 24 million Motorola C-Quam receivers currently in use by radio listeners. In the mid-80s, approximately 280,000 receivers were made that could decode both the Motorola and Kahn signals. These multi-mode receivers, however, are no longer produced. The Motorola system has been adopted as the national

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[2] See Report and Order in Docket No. 21313, adopted March 4, 1982, 47 FR 13152.

[3] The developers of these AM stereo systems were Belar Electronics Corp., Harris Corporation, Kahn Communications, Inc./Hazeltine Corporation (the Kahn system), Magnavox Corporation, and Motorola Corporation.

[4] In 1988, the Commission reaffirmed its earlier decision not to select a standard. In that action, the Commission noted that the market appeared to be work[illegible]wards establishing a de facto standard. See Memorandum Opini[illegible]der, 3 FCC Rcd 403 (1988).

[5] The statistics and other infor[illegible]ed herein are taken from testimony and comments to the Hear[illegible] the Subcommittee on Communications, of the Committee on [illegible]e, Science, and Transportation, United States Senate, March 11, [illegible]92, S. Hrg. 102-740. Copies of the relevant information is being [illegible]ted in the record for this proceeding. See, in particu[illegible]e Prepared Statement of Bruce Ladd, Vice President of Gover[illegible] Affairs and Government Relations, Motorola, Inc.

standard in six foreign countries: Canada, Mexico, Australia, Brazil, South Africa, and Japan. No countries have adopted the Kahn system.

5. The Authorization Act requires that we establish a single AM stereo standard. In light of the data presented above, particularly the figures regarding receiver types, we believe the public interest would be best served by adopting the Motorola C-Quam system as the U.S. AM stereo standard. Broadcasters, manufacturers and radio purchasers have, directly or indirectly, demonstrated strong preference for the Motorola system. Adoption of the C-Quam system as the AM stereo standard would eliminate the remaining uncertainty with regard to the AM technology broadcasters should employ and thereby serve to promote expansion of AM stereo transmitting equipment and a corresponding improvement in the quality of the AM service.

6. We believe that selection of an alternative to the Motorola system would set back the clock on the implementation of AM stereo service, to the substantial detriment of the public and broadcasters. Specifically, the users of the existing 24 million C-Quam receivers would no longer be able to enjoy AM stereo reception through that equipment. Also, existing AM broadcasters would forfeit their investments in C-Quam transmission equipment. Further, we are aware that many AM broadcasters are struggling financially and may not be able to afford replacement stereo transmission equipment. Selection of an alternative stereo standard thus could conceivably result in discontinuance of the existing stereo service with no replacement. Such a result would be inconsistent with the legislative intent to advance AM stereo service. In light of these factors, proponents of alternative standards would bear a heavy burden to show that the potential benefits of an alternative technology outweigh the likely costs and delays of selection of a standard different than the Motorola system. Nevertheless, we invite comment on alternatives to the proposed standard.[6]

7. We are proposing to incorporate the Motorola C-Quam standard in Part 73 of our rules. The proposed standard is presented in Appendix B. We are also proposing to require stations that employ alternative AM stereo systems (i.e., the Kahn and Harris systems) to discontinue such operation as of one

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6 We recognize that efforts are under way to develop digital broadcasting technologies for the AM broadcast band. The Authorization Act is clearly intended to address an AM stereo standard within the context of the current analog transmission format. Accordingly, AM digital broadcasting technologies are outside the scope of this proceeding.

year from the effective date of these rules.[7] Any stations converting to AM stereo after the effective date of these rules will be required to employ the system adopted by the Commission. Consistent with our general policies towards improvement of the AM broadcasting service, we will continue to encourage the availability of AM receivers, including AM stereo receivers, that meet appropriate quality standards.[8] Finally, we propose to condition the selection of Motorola's system as the AM stereo standard by requiring Motorola to license its patents to other parties under fair and reasonable terms.[9]

PROCEDURAL MATTERS

8. Ex Parte Rules - Non-Restricted Proceeding. This is a non-restricted notice and comment rule making proceeding. Ex parte presentations are permitted, except during the Sunshine Agenda period, provided they are disclosed as provided in Commission rules. See generally 47 C.F.R. Sections 1.1202, 1.1203 and 1.1206(a).

9. Comment Information. Pursuant to procedures set forth in Sections 1.415 and 1.419 of the Commission's rules, interested parties may file comments on or before April 5, 1993, and reply comments on or before April 20, 1993. Extensions of these time periods are not contemplated. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally, participants must file an original and four copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original plus nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications

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[7] We understand that the Harris system may be compatible with the Motorola C-Quam system. We invite comment as to the extent of the compatibility and whether we should permit stations currently using the Harris system to continue to do so indefinitely.

[8] See Report and Order, MM Docket No. 87-267, In the Matter of Review of the Technical Assignment Criteria for the AM Broadcast Service, 6 FCC Rcd 6273 (1991), at paras. 201-9. In this regard, we also note that the Electronic Industries Association and the National Association of Broadcasters have developed standards and certification programs, AMAX and AMAX stereo, for AM receivers.

[9] We are taking a similar approach with implementation of advanced television (ATV). See Advanced Television Systems, 7 FCC Rcd 3340, 3358 (1992). Cf. FCC Public Notice, Revised Patent Procedures of the Federal Communications Commission, Public Notice 13948, December 6, 1961.

Commission, Washington, DC 20554. Comments and reply comments will be available for public inspection during regular business hours in the FCC Reference Center (Room 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, DC 20554.

10. Regulatory Flexibility Act. As required by Section 603 of the Regulatory Flexibility Act, the FCC has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is set forth in Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the Notice, but they must have a separate and distinct heading designating them as responses to the regulatory flexibility analysis. The Secretary shall cause a copy of the Notice, including the IRFA, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96-354, 94 Stat. 1164, 50 U.S.C. Sections 601 et seq. (1981)).

11. Additional Information. For further information concerning this proceeding, contact David Means, Engineering Evaluation Branch, Office of Engineering and Technology, (301) 725-1585.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

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(8) The composite signal shall be described by the following expression:

$$E_c = A_c\left[1 + m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t + \phi_{sn})\right]\cos\left[-\omega_c t + \tan^{-1}\frac{m\sum_{n=1}^{\infty} C_{dn}\cos(\omega_{dn}t + \phi_{dn}) + .05\sin 50\pi t}{1 + m\sum_{n=1}^{\infty} C_{sn}\cos(\omega_{sn}t + \phi_{sn})}\right]$$

where:

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m = the modulation index
C_{sn} = the magnitude of the nth term of the sum signal
C_{dn} = the magnitude of the nth term of the difference signal
ω_{sn} = the nth order angular velocity of the sum signal
ω_{dn} = the nth order angular velocity of the difference signal
ω_c = the angular velocity of the carrier

ϕ_{sn} = the angle of the nth order term $= \tan^{-1}\left[\frac{B_{sn}}{A_{sn}}\right]$

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A_{sn} and B_{sn} are the n^{th} sine and cosine coefficients of C_{sn}
A_{dn} and B_{dn} are the n^{th} sine and cosine efficients of C_{dn}

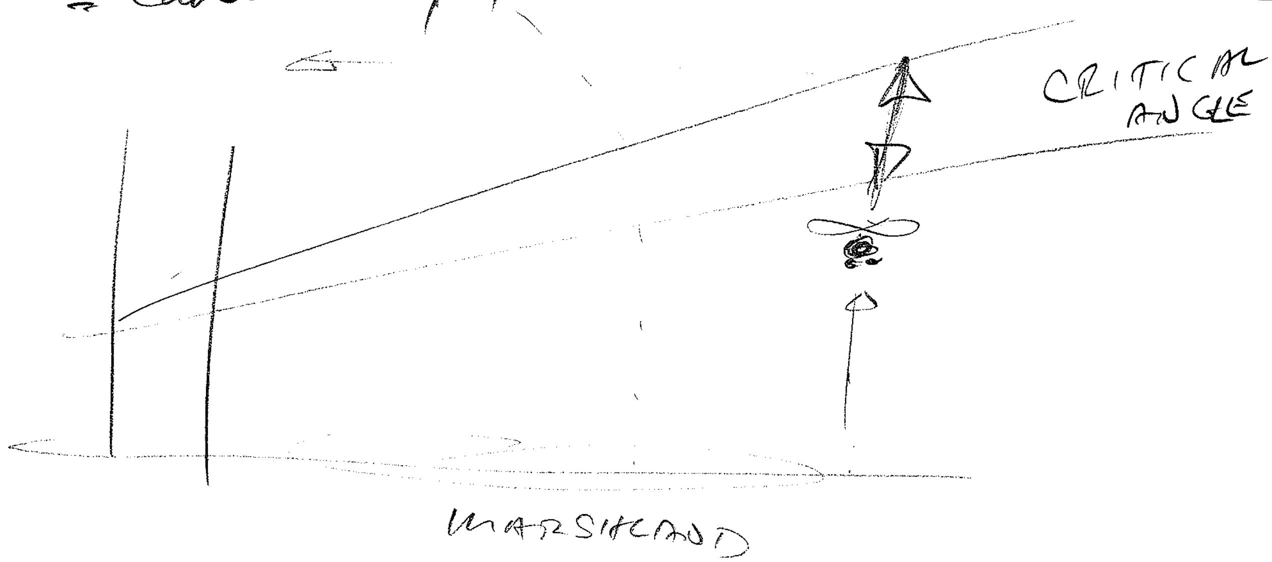
DOCKET COPY → DELTA Tom Wright 33
INC. EXT. → Potomac Inst. Dave Harvey

ED BURKHARDT suggested we send a copy.
∘ Re carrier effects
∘ other items.

(Aware of struggle 2. towers ... seasonal changes DA-1, protecting / stations to north).

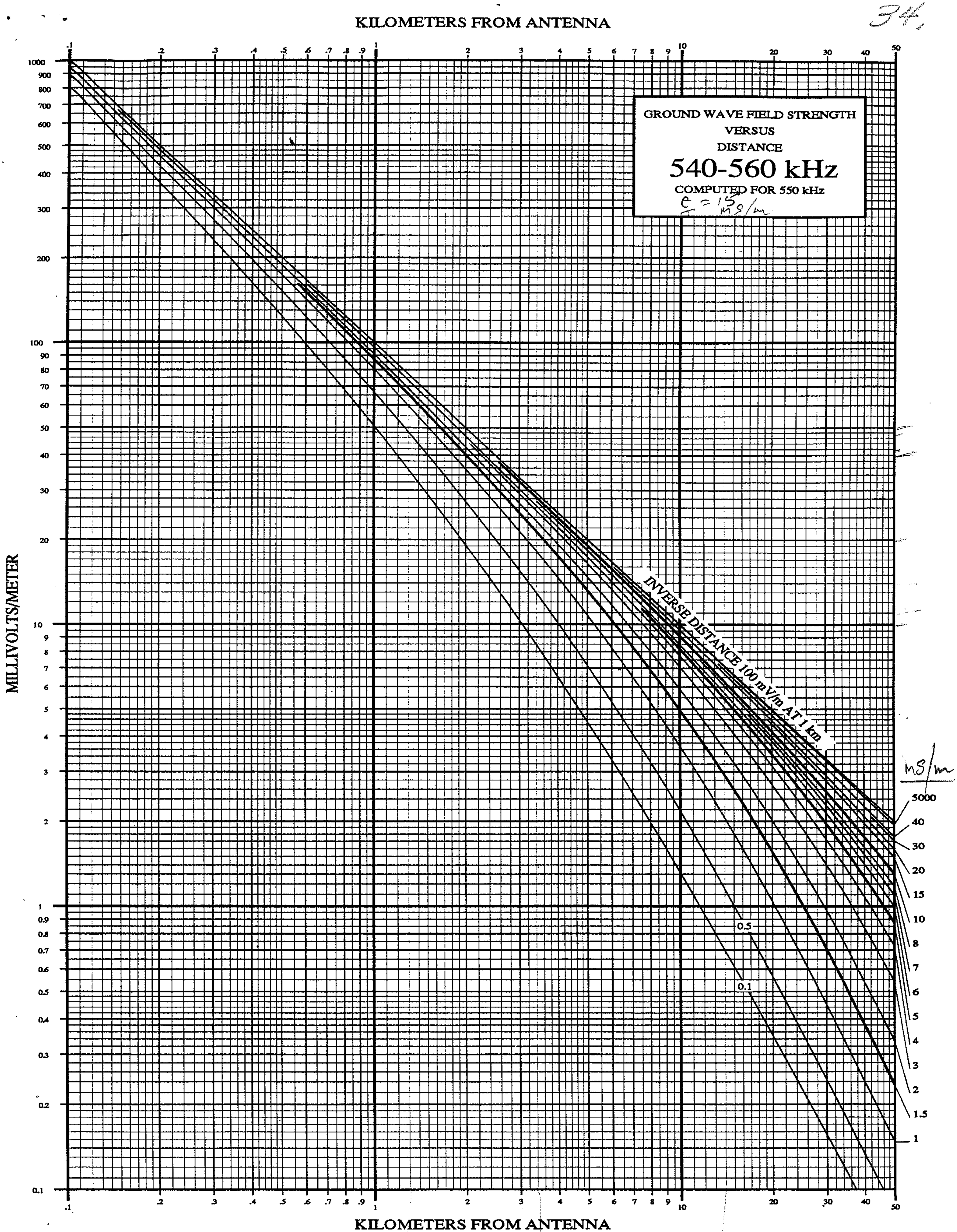
Burkhardt suggests take helicopter meas. to est. M.P.'s (Night time ONLY)

- WRVA - potential ... & others.
- Canada only protection.

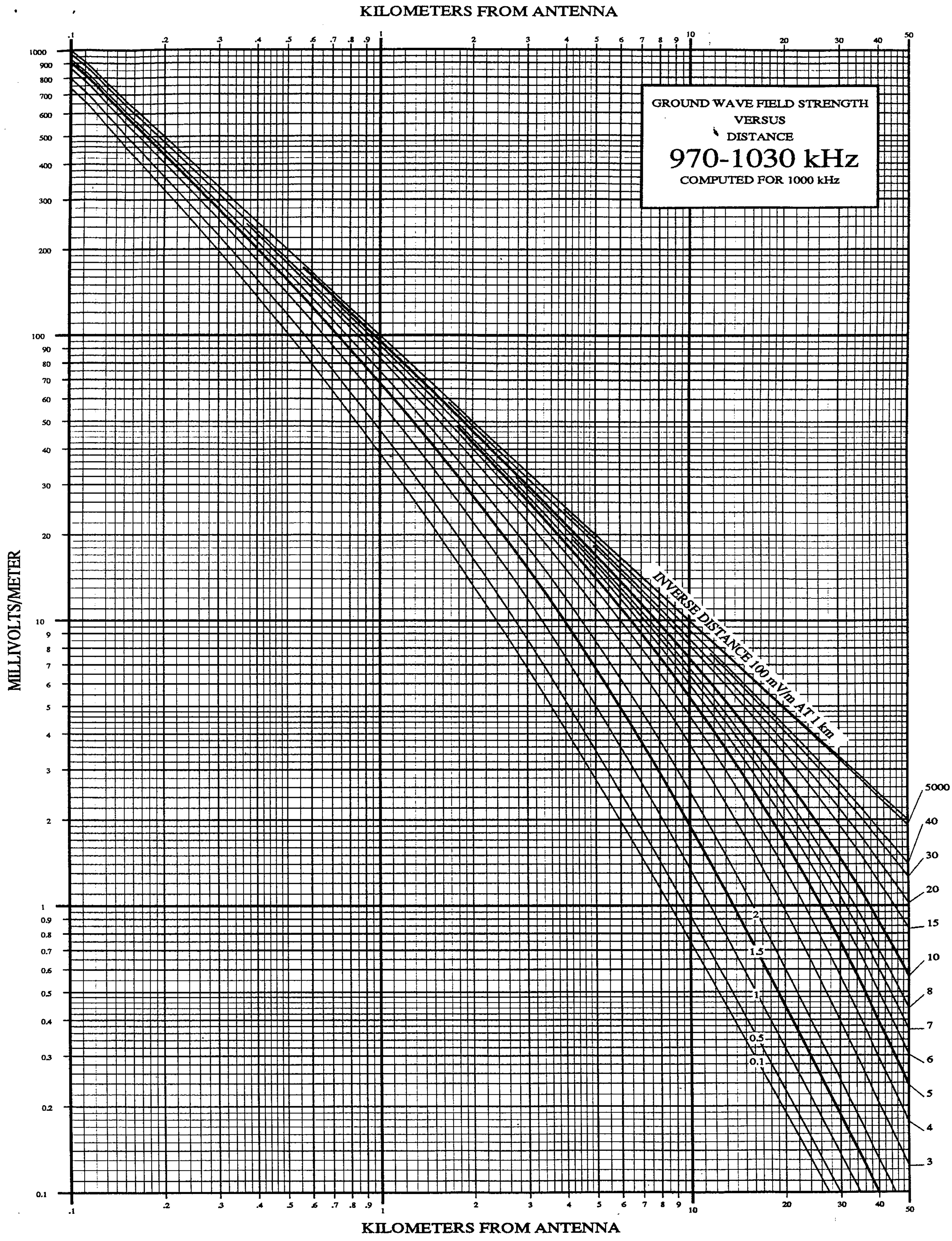


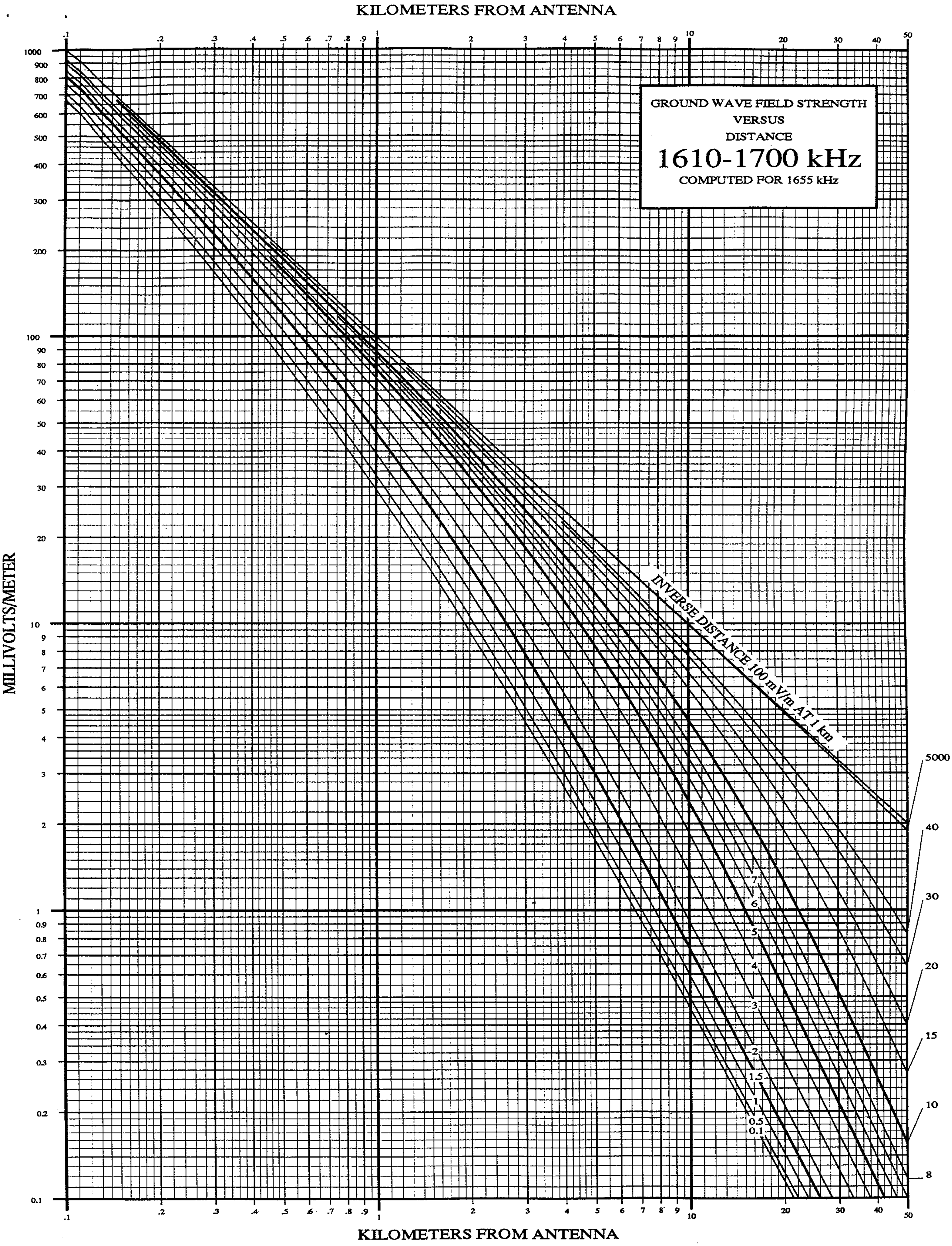
∘ File exceeding C.P.'s seasonally.
∘ Vertical M.P. from helicopter 2x years.
OR
∘ DA / ND ratios

940 WINZ
710 WAQI
Has problems re M.P.'s

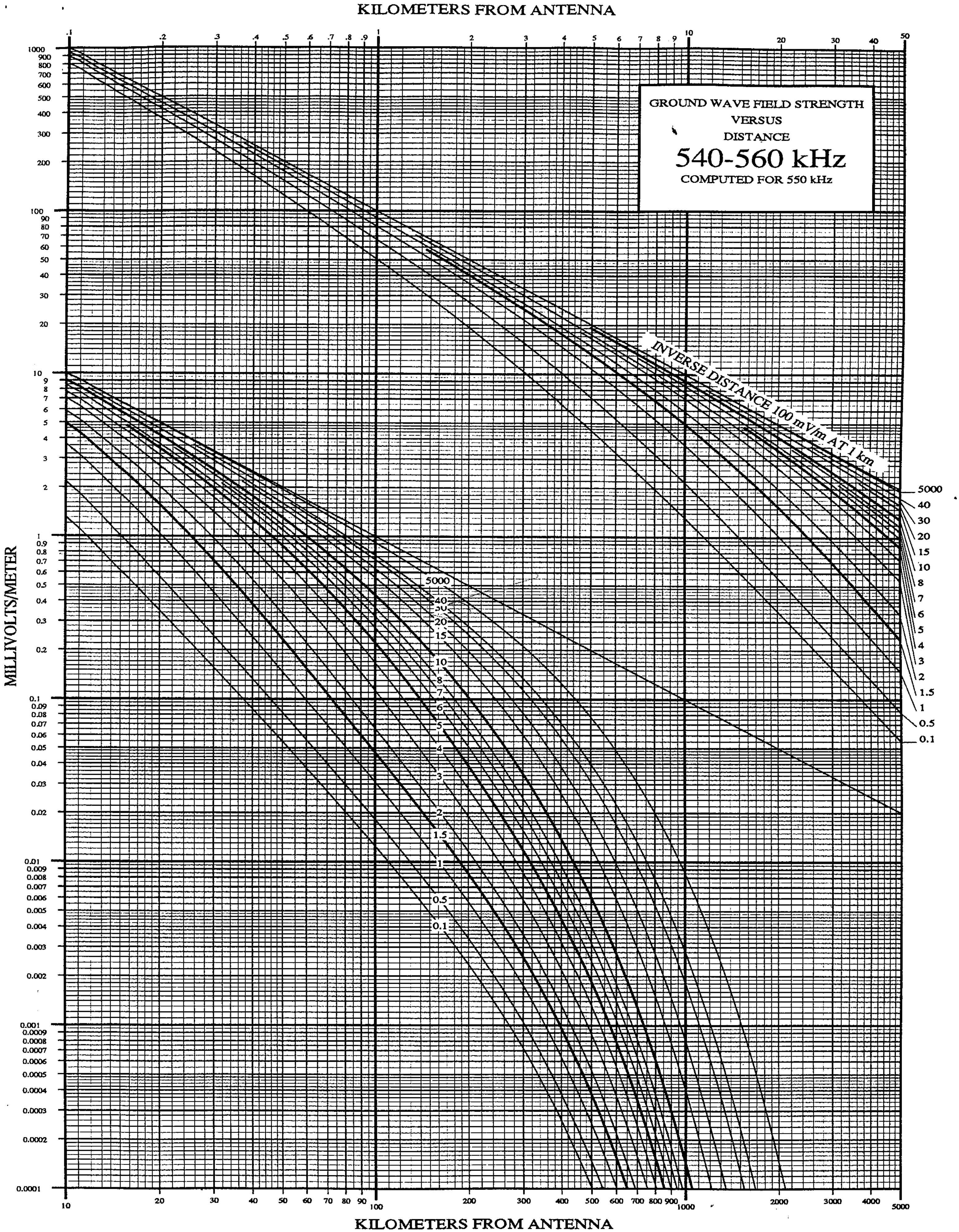

KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
540-560 kHz
COMPUTED FOR 550 kHz
MILLIVOLTS/METER
INVERSE DISTANCE 100 mV/m AT 1 km
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1
KILOMETERS FROM ANTENNA

GRAPH 1 -A


KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
970-1030 kHz
COMPUTED FOR 1000 kHz
MILLIVOLTS/METER
INVERSE DISTANCE 100 mV/m AT 1 km
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1
KILOMETERS FROM ANTENNA
GRAPH 12-A

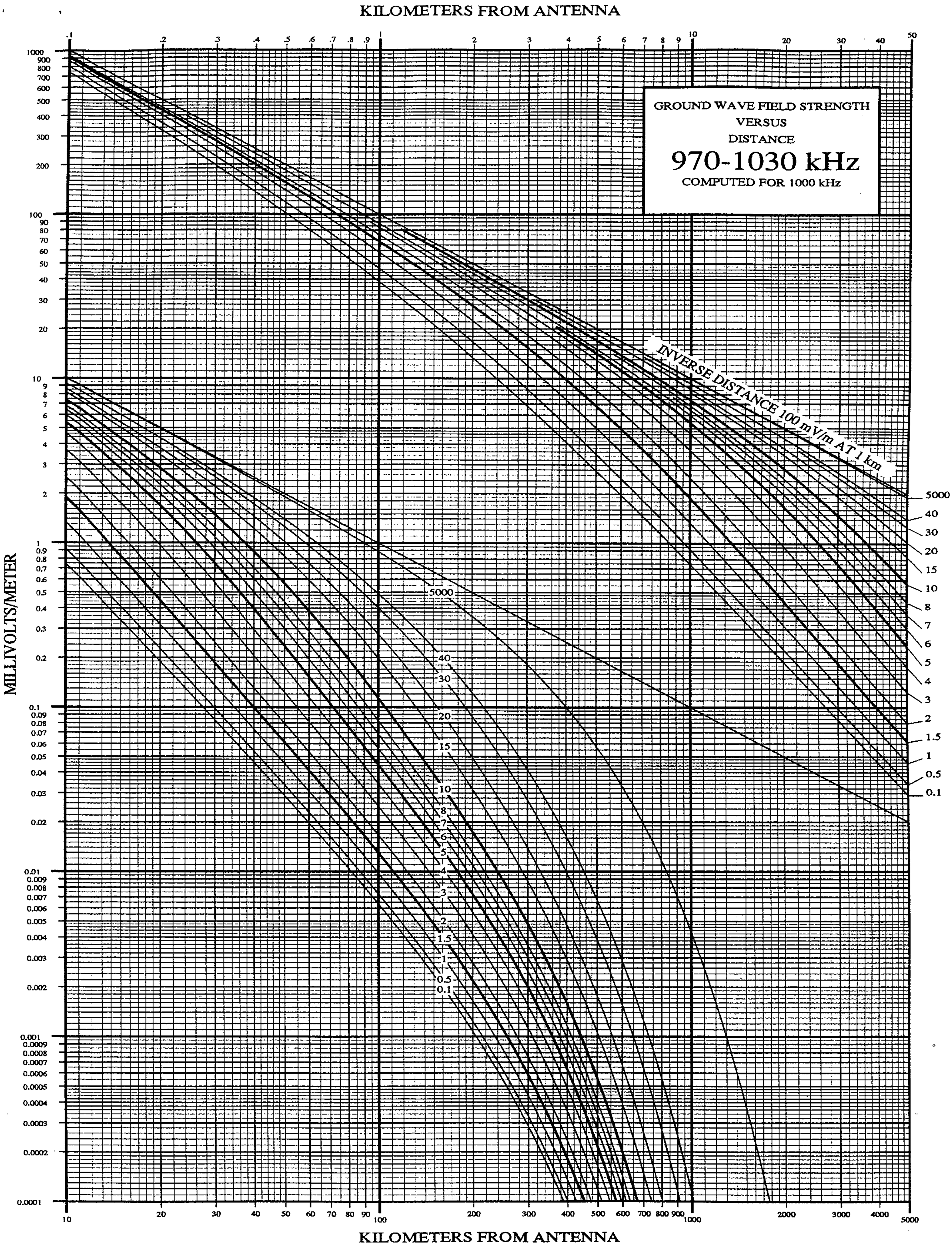

KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1610-1700 kHz
COMPUTED FOR 1655 kHz
MILLIVOLTS/METER
INVERSE DISTANCE 100 mV/m AT 1 km
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1
KILOMETERS FROM ANTENNA

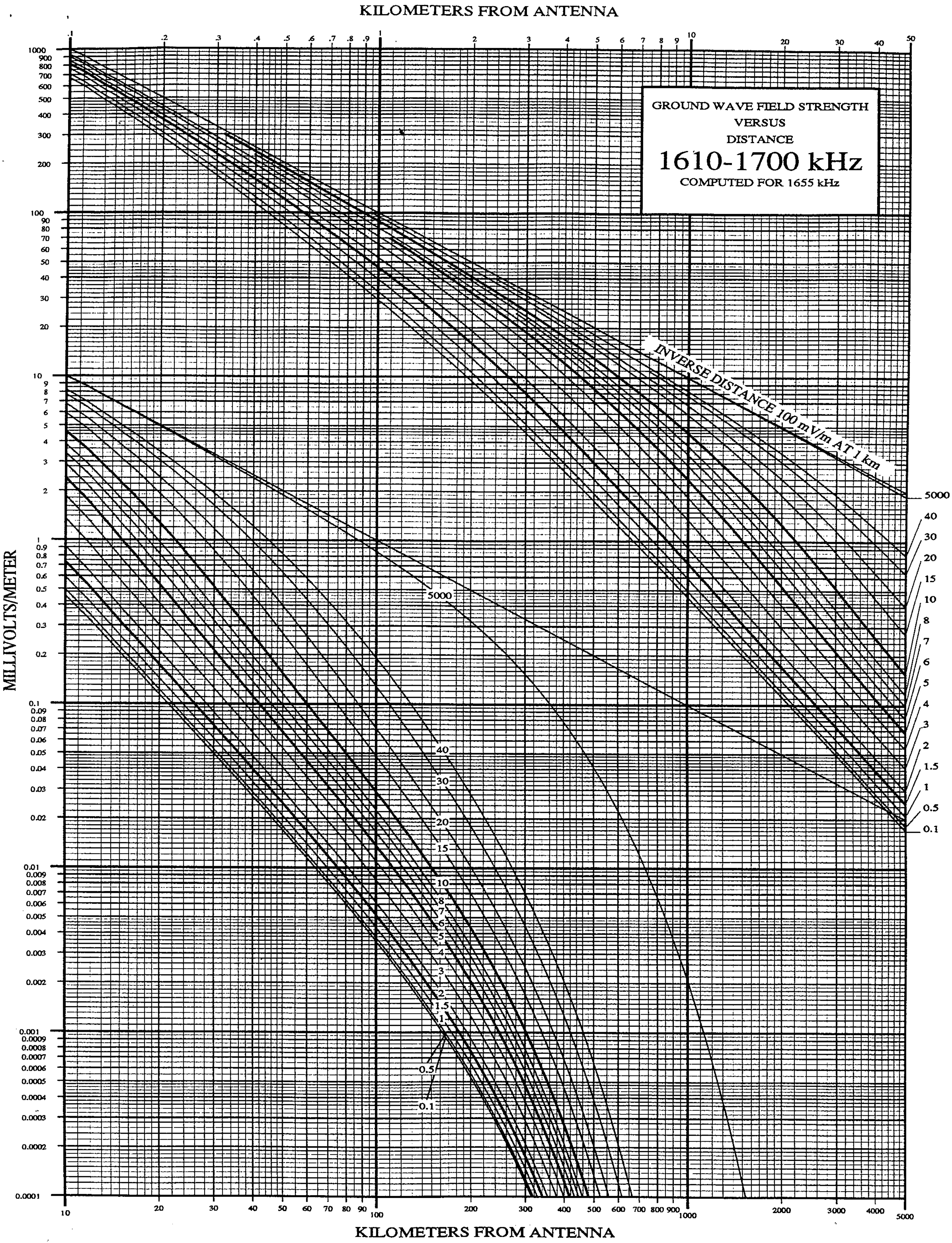
GRAPH 20-A



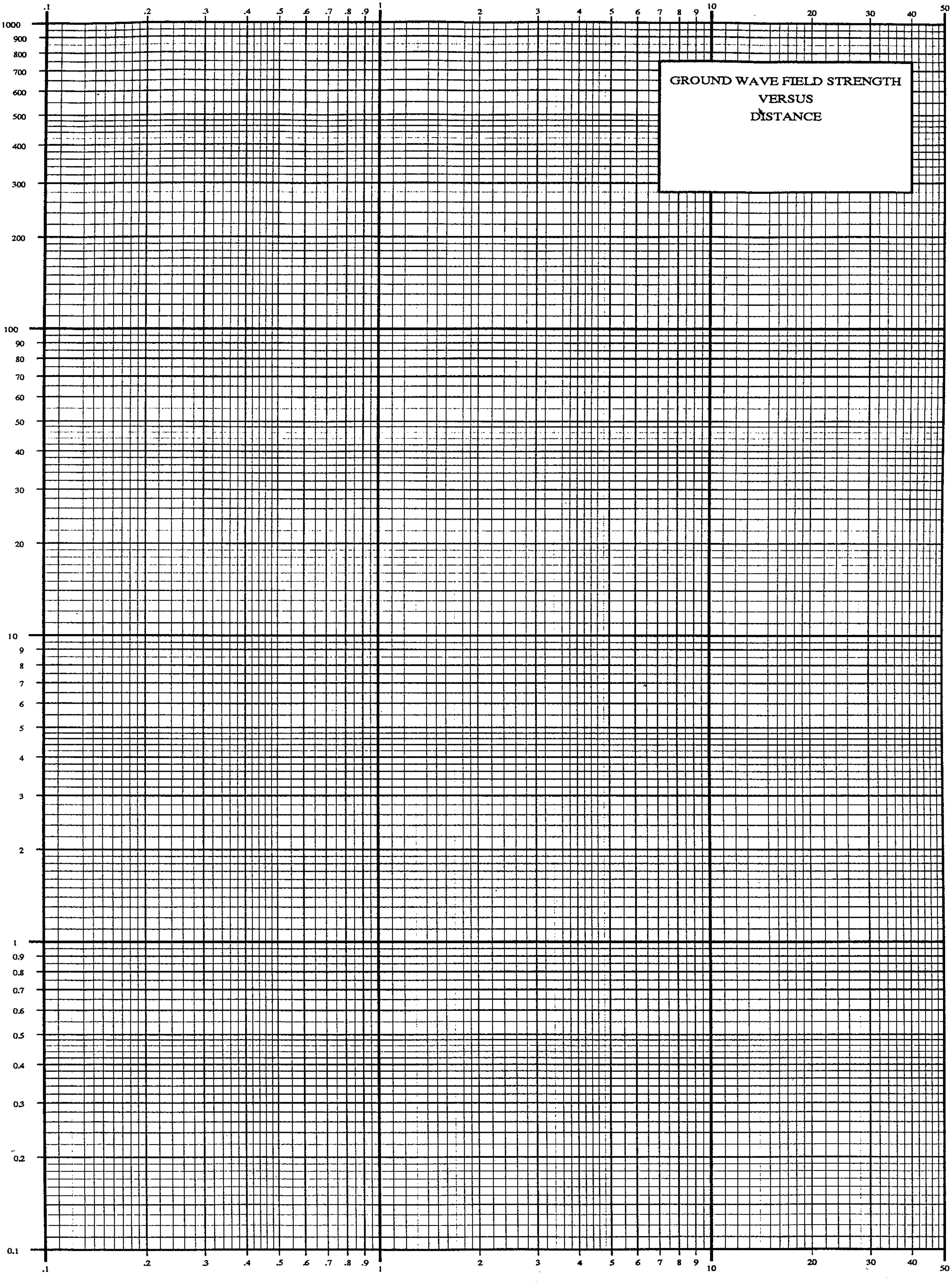
KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
540-560 kHz
COMPUTED FOR 550 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

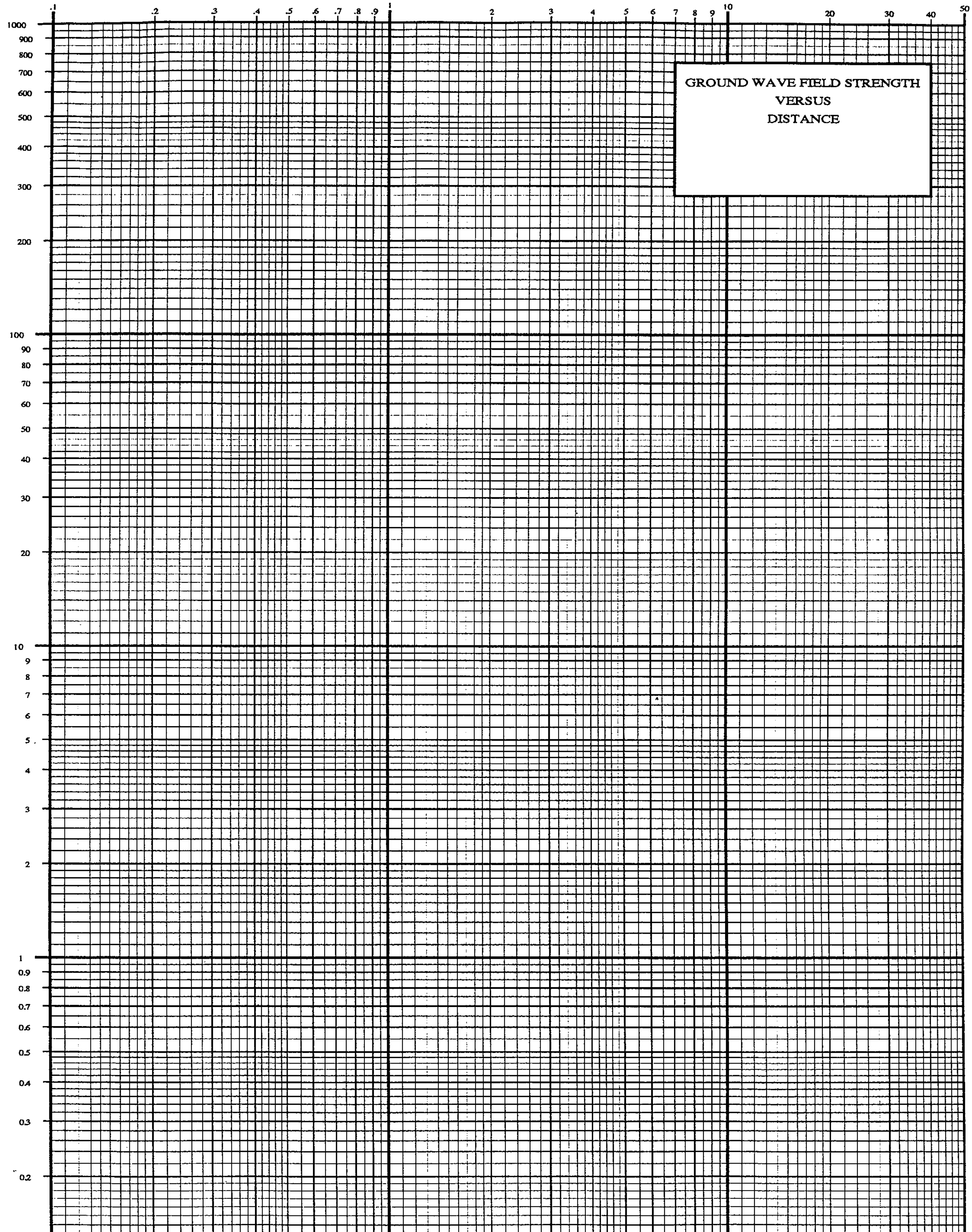
GRAPH 1

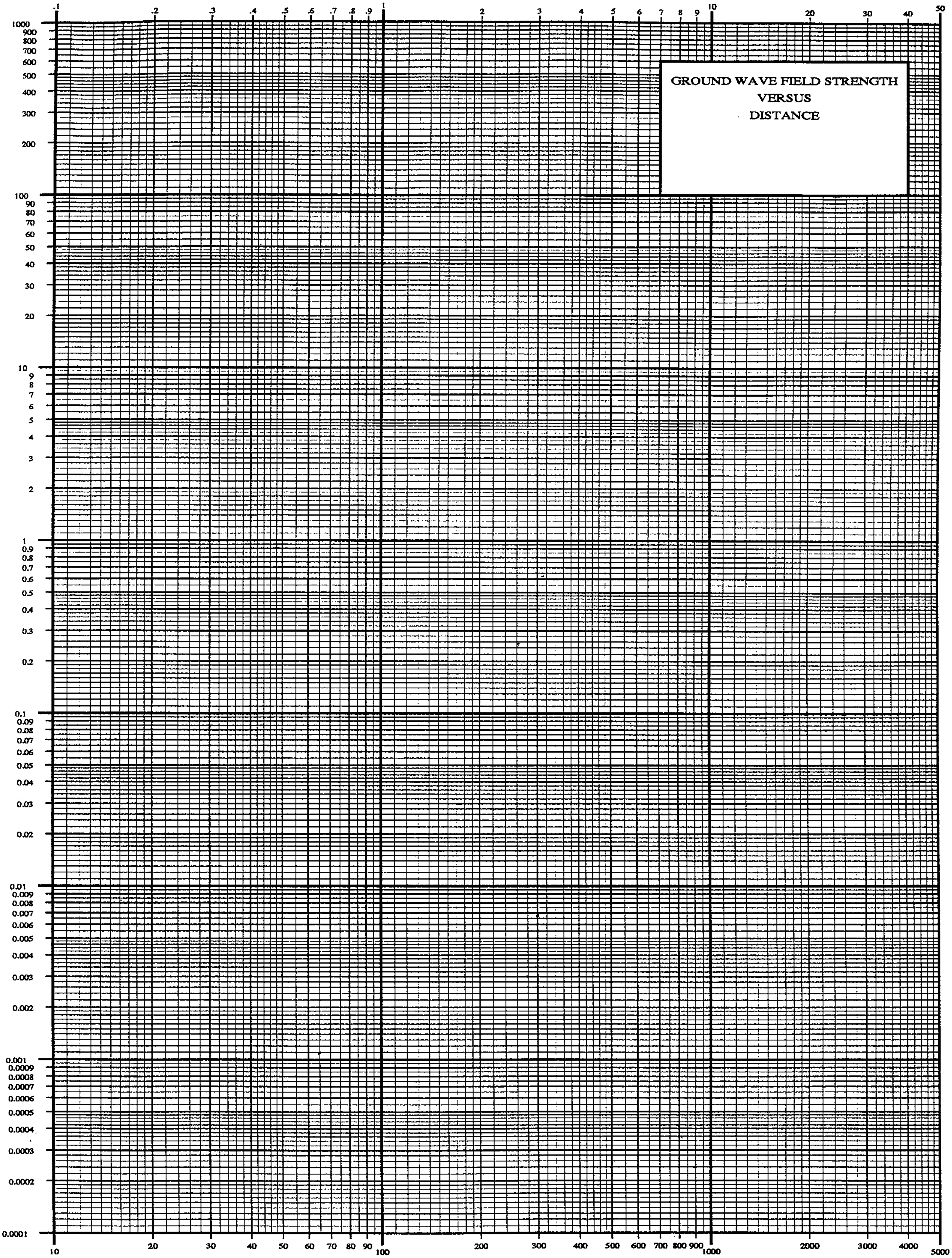

KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
970-1030 kHz
COMPUTED FOR 1000 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA
GRAPH 12


KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1610-1700 kHz
COMPUTED FOR 1655 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1
KILOMETERS FROM ANTENNA

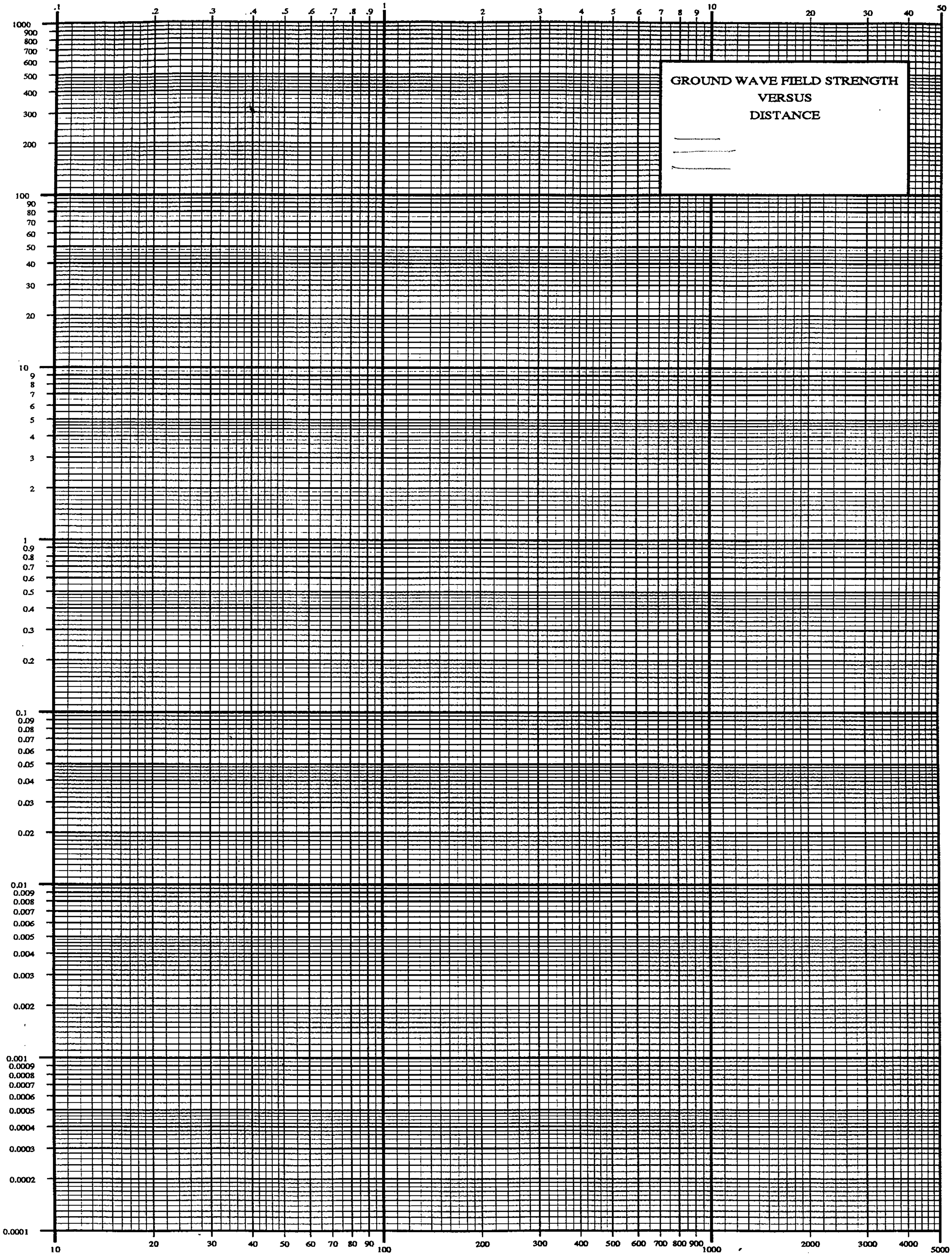
GRAPH 20


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
.1 .2 .3 .4 .5 .6 .7 .8 .9 1 2 3 4 5 6 7 8 9 10 20 30 40 50


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1000 900 800 700 600 500 400 300 200 100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
.1 .2 .3 .4 .5 .6 .7 .8 .9 1 2 3 4 5 6 7 8 9 10 20 30 40 50



GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
.1 .2 .3 .4 .5 .6 .7 .8 .9 1 2 3 4 5 6 7 8 9 10 20 30 40 50
10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000 2000 3000 4000 5000
1000 900 800 700 600 500 400 300 200 100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01 0.009 0.008 0.007 0.006 0.005 0.004 0.003 0.002 0.001 0.0009 0.0008 0.0007 0.0006 0.0005 0.0004 0.0003 0.0002 0.0001



GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE

35.

DRAFT

Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
An Inquiry into the Commission's	)	
Policies and Rules Regarding AM	)	RM-7594
Radio Service Directional Antenna	)	
Performance Verification	)	

Notice of Inquiry

INTRODUCTION

These comments have been prepared by the consulting engineering firm of Cohen, Dippell and Everist, P.C. concerning the Federal Communications Commission ("FCC") Notice of Inquiry, RM-7594 ("Notice"). Cohen, Dippell and Everist, P.C. ("CDE") and its predecessors have practiced before the FCC for over fifty years in broadcast and telecommunications matters.

There are several issues that are concurrent. First the entails petitioners' desire to improve and revise the existing rules and policies pertaining to directional antenna performance and their ability to meet the intent of the FCC Rules adopted in Docket 87-287. The second issue is the FCC's desire to review other attendant rules which may also be improved and revised. In addition, the FCC frames for discussion proposes four (4) broad areas to which the comments are to be directed. We believe the FCC has undertaken a valuable service to the broadcast community in undertaking this review of the FCC Rules. It serves to indicate that the FCC is truly committed to preserving a national asset, that is AM broadcast. We appreciate the FCC efforts in this era of reduced budget and expanded congressional-mandated regulation. We share the FCC's concerns and goals.

The FCC specifically listed eighteen (18) rules which it believes impact the "Notice". These comments reviews the rules listed by the FCC and revisions it believed pertinent; and makes suggestions in other areas not directly indicated in the Notice.

SUGGESTED REVISION OF CURRENT RULES

Section 73.51(f)(2)(i) and (ii) list the factor F for transmitter manufacturer's test report for power level. This table should be updated for the newer transmitters.

SECTION 73.53

SECTION 73.58

Section 73.58(e) provides for indicating instruments for power determination and in the event of failure the alternative in the event a substitute meter is not available. With the advent of the newer transmitters, automatic power control circuit is a useful alternative. The Rules should reflect this alternative.

SECTION 73.68

Section 73.68 details the requirements for sample systems for antenna monitors. We believe Section 73.68(d)(3) should be expanded to include replacement of identical components such as transmission lines etc. in the identical position be exempt from a partial proof-of-performance provided that a showing as outlined in Section 73.69(d) is made.

SECTION 73.88

Section 73.88 lists the responsibilities of broadcast station regarding 1 mV/m contour (blanketing) complaints. Further FCC Form 301 Section V-A Paragraph ___ requires that a showing of less than 300 receives or less than 1% of the population within the 25 mV/m contour be made. As noted in the Notice, many of the sites, once located in rural areas, are surrounded by urban settings. In addition, the FCC has indicated the 25 mV/m contour no longer serves the purpose of establishing signal over segments of the community. Therefore, the Commission should select another contour (such as the 5 mV/m) contour to determine the threshold value. The percentage could be changed. We recommend a percentage of ___% be used. We believe this would be a more realistic number in light of present allocation and environmental factors, strikes a balance and eliminates reliance on a contour the FCC no longer finds ~~useful~~. pertinent

SECTION 73.158

Another area we believe the FCC may wish to visit is the taking of monitor points. In ______, 19__ the FCC after a long and deliberate process made a change which reduced the burden on the FCC and industry by focusing on the operational problems in taking monitor points in changing and varying climate conditions. We continue to subscribe to this policy advanced by this letter. We do believe the FCC should additional consider for the existing or expanded[1/] band permitting monitor point limits established by ratio to the non-directional signal. In this fashion th effects of the environment whether in the winter, summer, wet or dry, etc. the scrutiny of the monitor points of the directional array can be maintained.

OTHER FACTORS WHICH MAY IMPACT THE RULES

Practice and necessity are forcing consideration of using existing sites to move and combine operations. This development is in large part a result of the unavailability of land in which to design and construct the directional arrays. Economic factors also are instrumental in limiting the number of available AM sites.[2/]

Such combinations can result in forshorten ed ground systems[3/]. Other complications can arise on a new site in which land availability is not sufficient for a number of reasons.

Over the years, this office has conducted or supervised a number of proof-of-performances on non-directional and directional arrays in this country as well as on foreign soil. These systems well constructed, universally had to recognize the realities of ground system placement. In a number of instances the ground system length could not be or was not extended out to the normal ninety degrees length about all towers. These variations about each tower have been with different electrical, power, phase, impedance combinations and we can not think

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[1/] We believe that this would be a valuable tool for the expanded band since over the years we believe the changes due to environmental factors is more apparent at the higher frequencies.

[2/] that meet service requirements to the community

[3/] This can result when a lower frequency station proposes to occupy the site of a higher frequency station or the land is limited on which a tower can be constructed.

of one single instance that the null of the pattern or other important areas of the pattern did not develop as a result of the decrease or shortened ground system. In other words, this apparent lack of physical unsymetry did not result in an apparent diminution of pattern performance.

The Notice invites comments on four broad areas ranging from instrumentation, measurement techniques in the field, a comparison of theoretical results over measured and advisability of taking into account other structures in the array. These issues are not only complex but are not easily defined. However, we offer the following comments which we have been developed by experience over the number of years that this firm or its predecessors have been in business.

One of the first issues that we believe that the FCC must foster is a comprehensive and universally system within the FCC[4/]. This will be especially important if the FCC is to achieve its goal in implementing Model 1 parameter for the expanded band as well as existing band. Furthermore, we do not believe it practical nor desirable to provide a litmus test for every obstruction, be it a hill, building, lamp pole or whatever. Nor do we subscribe to detuning trees or other objects found in nature. However, by in large, we believe with a few exceptions, the FCC has through its rules and policies, shown a balance of being achievable and practical.

Rules and policies that we believe the FCC may wish to review its files is the systems built for "critical directional antenna systems" (see Section 73.14 of the FCC Rules) will provide a basis for assessment whether or not, that the present body of knowledge and practice is sufficient to justify reliance on electrical parameters alone. Based upon our experience, we do not believe the sincere effort placed into monitoring and maintaining these arrays have resulted in a procedure that will allow the FCC to revise significantly its current procedures in establishing whether an array is adjusted and operating within its instrument of authorization. Therefore, while we subscribe in large measure to the improvement in monitoring occurring in

[4/]This could include FAA since the FCC and the FAA share common goals. For example, the FAA imposes electromagnetic compatibility on its installations and the FCC should require reciprocal treatment of structures within 0.5 miles of non-directional and 2 miles directional AM operation, similarly the FAA airspace determination of no hazard should include a condition of the proponent's tower if it is changed then the impact on the AM station be assessed.

the last twenty years that continued recognition by the FCC in the taking of proof-of-performances for directional arrays.

Another area we believe the FCC can seek information is its recent emphasis of inspections. The FCC made note of commentors alleged misadjustment of AM directional arrays was a major contributing cause of high-interference levels in the current band. This firm believes this to be unfounded fear and are we aware of a substantive studies which would have yielded that conclusion. We believe the FCC found while improvement can be made and emphasis needs to be placed on antenna system integrity and maintenance, that the directional arrays were found to be in general compliance with the rules.

We have used various computational mechanisms over the intervening years including the method of moments program. We continue to explore new methods of predicting radiation values not only for the AM band as well as other frequencies. This office has yet to find a unique modeling program which can take into account all the factors[5/] in the environment and nor can we advance any special and unique monitoring system which will universally achieve the goals we all share. This firm would be delighted to provide such a system or such a technique but this firm has found any number of instances that the parameters derived from a specially constructed monitoring system has not resulted the desired pattern. We note much improvement in technique as well as equipment in the last fifty years we find the goal of accurately monitoring an array with precision still a formidable task.

SUMMARY

In conclusion, we offer our support to the Notice recognizing the special task of revising policies and rules that have served the industry and FCC well. The FCC is to be commended in its continuing efforts to foster, nurture and improve the AM service.

[5/] If the FCC desires to explore in the NPRM alternate methods, we note that techniques are now available to take into account the conductivity in the area of the transmitter site. This would effect the vertical section of antenna pattern. This approach is ____

____.

If despite all the rhetoric, the AM band remains an integral part of the country's communications fabric and represent the rules and service it provides a benchmark for other emerging countries whose own system has not had the benefit of the FCC's long-term guidance and interest. To this end, this firm plans on being an active participant in the proceeding.

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Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of An Inquiry Into the Commission's Policy and Rules Regarding AM Radio Service Directional Antenna Performance Verification	)))))	MM Docket No. 93-177 RM-7594

Notice of Inquiry

Introduction

These comments have been prepared by the consulting engineering firm of Cohen, Dippell and Everist, P.C. ("CDE") concerning the Commission's Notice of Inquiry ("NOI") in MM Docket No. 93-177; RM-7594.

The Commission initiated the NOI in response to comments and reply comments submitted by several technical consulting firms ("Petitioners") which jointly requested the Commission to initiate an inquiry into the policies and rules pertaining to performance verification methods for AM directional antenna systems.

Petitioners ~~argued~~ observed that the physical environment in which AM stations now operate is significantly changed and that many stations once located in rural areas have been absorbed by expanding suburban and urban areas. Furthermore, it was argued that new buildings and other obstacles affect the magnitudes and phases of the signals from AM antenna arrays. Petitioners ~~further~~ argued ~~argued~~ that computer aided numerical modeling of antenna performance could lead to advances in design and measurement techniques if the current rules are amended.

CDE commends the Commission for issuing the NOI since various aspects of the current rules can be debated in an open forum. However, CDE believes that no significant change should be made to the specific rules listed in the NOI. As noted by the Commission, it is difficult to model buildings non-resonant wires (power and telephone lines, etc.) in the vicinity of an AM array.

Existing Directional Antenna Systems

AM station antenna systems are installed with extensive grounding systems usually extending out to one-quarter wavelength around each tower with additional copper strapping interconnecting the towers and the intersect points where ground radials otherwise intersect. These systems generally operate with vertical electrical tower heights between approximately 80° and 225°. Most installations are inherently stable due to the good engineering practices observed.

Array Adjustment to Theoretical Parameters

CDE experience ~~covering~~ including hundreds of antenna arrays is that all systems adjusted to theoretical parameters[1] do not meet FCC proof-of-performance requirements. The required azimuths of the pattern nulls and/or the depths of the nulls from a theoretically computed pattern require subsequent system adjustments usually by stationing

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[1]With appropriate compensation for sample system variations.

technical staff with calibrated field strength meters with 2-way radio at various reference locations.

In more urbanized areas where localized re-radiation effects from man-made structures can otherwise result in some degree pattern distortion, minor system readjustment based on associated partial proof-of-performance measurement in conjunction with detuning techniques can make such structures "invisible" to the directional antenna system. CDE believes that this is the only reliable method to maintain AM directional antenna systems. CDE is unconvinced that the petitioner's proposal to simply setup a directional array to theoretical (numerical modelled or otherwise) will result in a properly operating system.

If the Commission adopts petitioner's proposals, CDE recommends that additional requirements be placed on antenna system <u>designs</u> and <u>tolerances</u> for all FCC Form 302 applications for license:

- A registered surveyor affidavit demonstrating that the towers are constructed such that all lines of towers are within 0.5° azimuth and tower spacings are within 0.5 meter of specified values. This would pertain to existing and future antenna arrays adjusted and filed with the FCC under the changed rules.
- A tightening of the specified directional antenna tolerances in Section 73.62(a) from ±5%/±3° to ±1%/0.5°.

Field observations by this office indicate that even a 2%/1° ~~a ±5%/±3°~~ variation can drastically change the null radiation areas of a directional antenna pattern.

- In order to ensure stable operation, there should be ~~that~~ no significant reduction in ~~on~~ ground system requirements as specified under Section 73.189(b)(4).

<u>Base Current Meters</u>

CDE submits that base current metering is no longer desirable particularly in light of radio frequency radiation rules which restrict access in the vicinity of these meters due to high magnetic and/or electric fields observed in the vicinity of the tower and tuning components.

- For directional antenna monitoring, sample amplitudes (and the associated ratios) are sufficient for maintenance and monitoring of the system.
- For non-directional operation, indirect power determination methods or use of a line current meter at or near the transmitter output is sufficient.

Revision of Section 73.51 is, therefore, recommended. It is suggested that additional Factor (F) values be incorporated under Section 73.51(f)(2)(ii) to include more modern transmitter types.

<u>Urbanization</u>

As noted by the Commission, many stations once located in rural areas have now been absorbed into expanding suburban and urban areas. These urbanized areas may require an increase in power and/or relocation of AM station facilities. In addition, urbanization can result in greater absorption of the AM station energy creating an effective lower ground conductivity across the community, and hence reduced coverage levels.

CDE finds the current Rule 73.24(g) ~~in~~ is unduly restrictive and mitigates against the Commission's goal of AM improvement.

The one percent cap of population within an AM station 1 volt per meter contour for an application filed with the FCC relates to the population within the previously defined principal community contour of 25 mV/m.[2/] In 1992, the Commission adopted revised AM allocation rules and simultaneously increased the permissible nominal power of regional stations from 5 kW to 50 kW as long as no additional prohibited contour overlap occurred.

In the early days of AM radio, transmitter sites were selected in sparsely populated areas beyond the urbanized city limits of many cities. Such siting along with associated directional antenna systems provided 25 mV/m service across the principal community while resulting 1 V/m contour encompassed very few people.

In succeeding years, urbanization has overtaken most transmitter sites. Many AM transmitter sites are now surrounded by high density residential and/or business areas. This makes it

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[2/]The principal community contour was redefined from 25 mV/m to 5 mV/m in extremely difficult if not impossible to provide any meaningful increase in AM service without violating Section 73.24(g).

CDE, therefore, proposes that the FCC amend its Section 73.24 to enable the power increases and resulting service to the public as envisioned under MM Docket 87-267. To this end, CDE suggests that several options be considered as subjects of discussion in an appropriate rule making. Potential options are:

- Compare population within 1 V/m contour to that within the 5 mV/m contour.
- If 25 mV/m contour retained for reference, increase allowable percentage to a figure such as 4% and 5%.
- Remove Section 73.24(g), delete Paragraph 13 of FCC Form 301, Section V-A and delete Paragraph 13 of FCC Form 340, Section V-A.