NRSC REPORT

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-R52

Report of the Field Test Task Group; Field Test Data Presentation

Working Group B "Testing" of the CEMA-DAR Subcommittee

December 1996

Part I - Report

NAB: 1771 N Street, N.W.
Washington, DC 20036
Tel: (202) 429-5356 Fax: (202) 775-4981

CEA: 1919 South Eads Street
Arlington, VA 22202
Tel: (703) 907-7660 Fax: (703) 907-8113

Co-sponsored by the Consumer Electronics Association and the National Association of Broadcasters
http://www.nrscstandards.org

NOTICE

Published by
CONSUMER ELECTRONICS ASSOCIATION
Technology & Standards Department
1919 S. Eads St.
Arlington, VA 22202

NATIONAL ASSOCIATION OF BROADCASTERS
Science and Technology Department
1771 N Street, NW
Washington, DC 20036

FOREWORD

NRSC-R52, Report of the Field Test Task Group; Field Test Data Presentation Working Group B "Testing" of the CEMA-DAR Subcommittee, documents the results of the digital radio field test program conducted in the 1995-96 time frame by the Digital Audio Radio (DAR) Subcommittee of the Electronic Industries Association (EIA) Consumer Electronics Manufacturers Association (CEMA, precursor to the Consumer Electronics Association).

The NRSC is jointly sponsored by the Consumer Electronics Association and the National Association of Broadcasters. It serves as an industry-wide standards-setting body for technical aspects of terrestrial over-the-air radio broadcasting systems in the United States.

REPORT OF THE FIELD TEST TASK GROUP; FIELD TEST DATA PRESENTATION

December, 1996

Working Group B "Testing" of the CEMA - DAR Subcommittee

Prepared by
Lohnes and Culver Washington, D.C.
Robert D. Culver, P.E.

(submitted with data to FCC 2/97)

ADDENDA AND ERRATA PAGES;
REPORT OF THE FIELD TEST TASK GROUP

underline indicates changed item

INDEX PAGE, Contents page numbers; revised page attached

TEST ROUTE DATA, NOTE AND COMMENTS; new page attached

TEST ROUTE DATA, PATH OBSERVATION SUMMARIES; corrected below

Route "D";				
EU-147	64,070	63,759(99.5)	97(0.2)	214(0.3)
SEU-147	70,054	69,751(99.6)	164(0.2)	139(0.2)
AT&T	68,777	63,704(92.6)	779(1.1)	4294(6.2)
Route "P";				
no changes				
Route "N:;				
EU-147	87,997	67,250(76.4)	3,972(4.5)	16,775(19.1)
AT&T	85,669	55,859(65.2)	383(0.4)	29,427(34.4)
Route "E";				
EU-147	97,932	66,711(68.1)	2,717(2.8)	28,504(29.1)
SEU-147	76,822	36,433(47.4)	1,140(1.5)	39,249(51.1)
AT&T	88,991	49,333(55.4)	605(0.7)	39,053(43.9)
Route "S";				
AT&T	71,795	19,726(27.5)	4,894(6.8)	47,175(65.7)
Route "W";				
AT&T	76,968	28,701(37.3)	779(1.0)	47,458(61.7)
VOA-JPL	71,416	59,492(83.3)	1262(1.8)	10,662(14.9)

APPENDIX F-4, TRANSMISSION SITE LOGS; new page attached

REPORT OF THE FIELD TEST TASK GROUP;
FIELD TEST DATA COLLECTION AND PRESENTATION

CONTENTS

TEST ROUTE DATA

APPENDICES

REPORT OF THE FIELD TEST TASK GROUP; FIELD TEST DATA COLLECTION AND PRESENTATION

Robert D. Culver, Lohnes and Culver, Co-Chairman
Bert Goldman, Shamrock Broadcasting, Co-Chairman
EIA-DAR Field Test Task Group
December, 1996

FIELD TEST TASK GROUP, MEMBERS AND PARTICIPANTS

Robert D. Culver, P.E., Lohnes and Culver, Co-Chairman
Bert Goldman, Shamrock Broadcasting, Co-Chairman

Bud Aiello, National Public Radio
Jeffrey Andrew/Alan Parnau, USADR - CBS Radio
Talmage Ball, Bonniville International
John Bingham, Amati Communication Corp.
Randall Brunts, Delco Electronics
Ed Chen/Carl-Erik Sundberg/Nickil Jayant, AT&T Bell Laboratories
Michael Chrysochoos/Richard Zerod, Ford Motor Company
L. Claudy/J. Marino/D. Layer/D. Wilson, NAB Washington, D.C.
Almon Clegg, CCI/Denon
Robert Finger, Matsushita Elect. Corp. of America
Ann Gallagher/Dr. H. Donald Messer, VOA
Ralph Justus, EIA-CEG DAR Subcommittee
Tom Keller, EIA-DAR WG-B, Lab Test Manager
Andrew Laird, Heritage Media Corporation
Dave Londa, EIA-DAR test laboratory manager
Anthony Masiello, USADR - CBS Radio
Charles Morgan, Susquehanna Radio Corp.
Clint Pinkham, EU-147 - Thomson Consumer Electronics
Robert Reymond, Nationwide Communications, Inc.
Dave Ritchie, SEIKO Telecommunications Systems, Inc.
William Ruck, KFOG/KNBR
Stanley Salek, Hammett and Eddison
Brian Sawyer, DRRI - CBC Engineering
Milford Smith, Greater Media
Bernee Strom, USA Digital Radio
Arv Vaisnys, Jet Propulsion Laboratories
A. J. Vigil, USADR
Ed Williams, PBS, Alexandria, Virginia

The EIA-DAR Subcommittee acknowledges the valuable support and contributions of the above Task Group members and additional support of Companies who participated in this project, specifically; AT&T Lucent Technologies, BEST Power Products, Bird Electric, Brown Broadcasting, Cablewave, CBS, Chancellor Broadcasting, Delco Electronics, Denon America, Dielectric, ERI, Family Stations, Ford Motor Company, Harris, Philip Kane, Lexicon, NASA-Ames Research Center, NASA-Lewis Research Center, NPR - Bud Aiello, Shamrock Broadcasting, Shively Labs, Thomsen Consumer Electronics, Susquehanna Broadcasting - Bill Ruck, US-NPS - Presidio, and a host of others.

Prepared by
Lohnes and Culver Washington, D.C.
December, 1996

REPORT OF THE FIELD TEST TASK GROUP; FIELD TEST DATA PRESENTATION

INTRODUCTION

This report was prepared for the Electronic Industries Association - Consumer Electronics Manufacturers Association (EIA-CEMA) DAR Subcommittee and presents the DAR Field Test Data. This report has been formatted in the anticipated form of the final report and most sections are complete. However, some sections will be revised and augmented as required with future versions of this report. Various Appendices are attached after the presented data. Most appendices are complete, however several larger or previously supplied items are represented only by cover pages with the full appendix available on request.

The purpose of this report is to present the field test data in a form sufficient for review and analysis for preparation of positions relating to the DAR systems. Questions and comments relating to the data content and the methods of collection and reporting should be referred to the EIA-DAR subcommittee. This data is "reported" directly from the measured data of the field test program without further comment or analysis. Some data, such as the vehicle velocity, have been "calculated" from the measured data, from the distance and time information, and presented as an adjunct and demonstration of other useful data which may be extracted in future revisions. No "analysis" or "results of performance" of the systems under test is made within this report. Any items which may be considered to be analytical are presented only to illustrate the type, method and sufficiency of the data collected and reported.

The author of this report is Robert Culver, a partner at the engineering firm of Lohnes and Culver. He was retained by CEMA as the Field Test Design Engineer and charged with preparation of a field test Plan. Participants in the interpretation of the plan to build the field test hardware and software included him, Tom Keller, Dave Londa and Robert McCutcheon from the EIA-DAR test laboratory and Michael Grimes of Lohnes and Culver. Stanley Salek and Daniel Mansergh, both of the engineering firm of Hammett and Edison were responsible for assembling the field test transmission systems and conducting the actual test measurements.

6

PROPONENT SYSTEM TESTING

The early CEMA-DAR testing plans called for both laboratory and field testing to be conducted on all the proponent systems submitted for testing. As many as four proponents with nine systems or variations were to be submitted for field testing and the plan (and test vehicle) was to accommodate them all. The DAB Subcommittee - Field Test Task Group, adopted a statement of "Objectives and Goals" for field testing which were incorporated into the early drafts of the test plan in 1995. The final plan was adopted by both the NRSC DAB Subcommittee and the CEMA DAR Subcommittee in June, 1995. A copy of the adopted plan (final version 5.0 dated May 30, 1995), with its attachments, is included with this report as Appendix A. Three proponents with four systems or variations were submitted and tested in the field.

FIELD TEST PLAN

The plan describes test transmission facilities to be implemented in the San Francisco area with mobile testing to be conducted in the surrounding area. The major portion of testing was conducted over long mobile paths. Those paths were chosen in advance and included areas representative of various propagation conditions. The final routes are presented in this report attached as Appendix B. Other tests were anticipated in the plan, such as short paths and measurements inside building. However, such tests were conducted only as time and events allowed as described later in this report.

ROUTES AND DISTANCE REFERENCES

Each of the six long routes were defined by starting and ending landmarks and intermediate landmarks along each route. The routes contained from 14 to 22 landmarks with the distance between sequential landmarks from several hundred meters to several kilometers. The landmarks were assigned by the field test crew at the beginning of the test process during a "pre-scripting" process to lay out the precise path along each route. Minor modifications of the actual path along portions of some of the routes were necessary because of traffic and driving restrictions. The resulting landmarks, which define the final routes and paths, were coded into the computer system used for testing. They were extracted from the computer files when all testing was completed and are presented on the cover pages for the collected data graphs.

The same landmarks were used for each proponent along each route. They are intended to form a uniform basis for comparison to determine position along a route. Linear position between landmarks was precisely determined by the use of a shaft encoder attached to the drive wheels of the test van. The shaft encoder delivered 200 pulses, or distance "Tic Marks" for each revolution of the vehicle wheels. The precise distance traveled by the van for a given number of wheel revolutions was measured and the shaft encoder distance constant was established as listed in the table below;

DISTANCE	TIC MARKS
1.171 CM	1.0
0.461 IN	1.0
1 METER	85.4
1 FOOT	26.0
1 KILOMETER	85,394
1 MILE	137,430

The short distance tic marks were used to trigger the repetitive collection of data, to precisely mark distance along a path and, together with other data (time) to calculate additional data (velocity).

DATA COLLECTED - COMPUTER DATA

The data to be collected is outlined in the test plan in Appendix A. The data presented in this report is as follows;

R.F. SIGNAL LEVEL - The R.F. signal voltage was measured at a convenient location in the mobile test bed. The method and location of R.F. voltage measurement is generally indicated in the overall field test system Block Diagram attached to this report as Appendix C. That overall Block Diagram also shows the Audio, Computer and ancillary items in the test bed. Also included in Appendix C is a detailed Block Diagram of the final configuration of the R.F. sub-section of the test bed components. Included with that Block Diagram is a tabulation of the gain and loss for each of the components in the test bed. The R.F. voltage was measured and recorded at each tic mark supplied by the shaft encoder, at each 1.171 cm (0.461 inch) of distance traveled. This R.F. data was collected at the shortest possible sample distance as determined by the shaft encoder and the vehicle wheel circumference (and at the fastest rate depending on vehicle velocity) of any of the data. Other data, as described below, was collected regularly but less frequently.

AUDIO EVENTS - Attached as Appendix D is a description of the audio events to be monitored and a transcript of the observer training script, further describing two audio "conditions". Those conditions became the audio events which were observed and marked. The two audio conditions, and the resulting marked events, were discussed and defined in the DAR Subcommittee. The audio events can loosely be described as when the audio becomes totally muted or only impaired.

It was the task of two observers in the van to listen by headphones and monitor the received DAR audio, for each of the systems over each path, and to respond by marking an "event" when either of the two audio conditions existed. Their actions were guided by the written training instructions, the verbal instructions of the test operator in the van and their interpretation of these instructions. The observers practiced for this activity by listening to a lengthy sample of previously recorded DAR audio containing a wide variety of audio conditions. By this process, all observers were thoroughly trained to be able to mark the computer files when the required audio conditions were detected. The actual observer action was to press and hold either of two buttons when the corresponding audio conditions were detected.

OTHER DATA - COMPUTER DATA RECORD STRUCTURE - Each tic mark initiated the collection of data with the sampling of the R.F. values. At each tic mark the R.F. values were digitized and stored in temporary memory. At the same time a software timing loop was started to collect additional data. Each data record contains at least the R.F. data, with the additional data being written to create a full record as each timing loop is completed. The full data records are thus interspersed at a more or less uniform spacing among the R.F. only records, with the spacing depending on the velocity of the vehicle. As computer memory was filled, the data was regularly written to disc storage.

The additional data in a full record includes the observations of audio events, described above, and other factors associated with the path being measured such as environmental and physical conditions, landmark position and SMPTE Time Code from other data collection instruments. The timing loop required approximately 30 to 50 ms to complete, depending on other computer activity. From one to several distance tic marks, with only R.F. values recorded, could pass before a full data record was written.

DATA COLLECTION - NON COMPUTER DATA

Various "analog" data was recorded in synchronization with the computer data and recorded on other media. That data is not directly presented in this report but has been used in part to extract and present the data in this report. All such additional data will be made available for further analysis and use as necessary. The basis for synchronization of the data is SMPTE Time Code. That time code was pre-striped, as relative time from 0:00:00 to the end of the recording tapes, on both the video and digital audio tapes, and also passed to the computer during video recording. The video sub system, seen in the full system block diagram in Appendix C, served as the master time code reference and to record video based information. The video consisted of two color camera views out of the test vehicle, left and right views comprising a forward panorama, and two video representations of spectrum analyzer displays. The four video views were fed to a four scene video combiner for recording onto one video tape. The recorded video also had the timecode super-imposed on it while the audio tracks contained time code information.

Two 8-track Digital Audio Tape recorders (DAT's) were operated simultaneously and in parallel to record incoming audio, creating simultaneous master and backup tapes. The audio recording DAT's were slaved to the video time code so that synchronized playback is possible. The audio that was transmitted by the proponent systems came from a standard Compact Disc (CD) and player. The audio samples were selected from items submitted to the DAR Committee and previewed and selected by committee members. The total audio play time was just over 60 minutes, comprising all or portions of 25 selections with two identification announcements. A listing of the test audio is attached at Appendix A. The test CD or a DAT tape copy can be made available as necessary. The audio that was received and recorded in the van is listed in the table on the following page.

TRACK	CONTENTS
1-2	DAR Device Under Test digital to analog audio (stereo)
3-4	Analog FM receiver No.1 off-air broadcast (stereo)
5-6	Analog FM receiver No.2 off-air broadcast (stereo)
7	not used
8	"Cockpit Audio" comments by the test crew in the van

Two spectrum analyzers were active in the test bed and each had true composite video outputs of their front screen displays. The video outputs were routed to the four scene video splitter to supply two of the video images recorded on tape. One analyzer was operated in a "wide-band" mode, covering the spectrum well beyond the spectrum occupied by the system being tested and sampling the spectrum approximately every 200 ms. This spectrum, recorded on video tape, serves to indicate the general test signal spectrum and extraneous signals which may be present near the test signal. The second analyzer was operated in the "zero-span" mode at the fastest possible sample rate of 200 microseconds per sample. This analyzer followed the voltage of the tested system R.F. signal almost instantaneously. including the fastest level variations due to modulation artifacts as well as null signal periods, as well as the slower short term multipath and the slowest long term obstruction fades.

An analog voltage output is also available on the rear panel of the analyzers which delivered a voltage signal, ranging from zero to slightly more than one volt, proportional to the front display trace. The front panel display covered a range of 80 dB and digitizing the analog voltage yielded approximately 0.2 dB resolution over the 80 dB range. The digitized R.F. voltage was passed to the computer system described below. The display, digitization and resulting voltage recording is highly linear over most of the display range and is capable of accurately recording voltages up to about 20 dB above the maximum display range with only minor gain compression. The calibration and demonstration of linearity of this data is shown in material attached in Appendix C. Procedures used during data collection kept the display within the useful recording range of the analyzer and digitizer combination. For the two higher frequency L-Band and S-Band systems, of the three systems under test, the receiver antennas with associated filters and pre-amplifiers were supplied by the proponents. For the VHF system the antenna was built by the crew assembling the test system and consisted of a 1/4 wavelength monopole over a ground

11

plane. All antenna systems were tested and measured at the Audio Systems Engineering department of Ford Motor Company and a full report of those measurements is available as indicated in Appendix C.

FIELD TEST PROCEDURES

The field test procedures are outlined in Appendix A, including the attachments thereto, and also described below. After a test system and route were chosen for a particular measurement run, the test vehicle had been prepared and the test bed had been initialized, the actual data collection proceeded in a highly automated process. Attached as Appendix E is a description of the standard run process. The start of data collection is initiated by the operator selecting and marking the passing of the first landmark in a particular route file. As each subsequent landmark is passed it is marked by the operator and each landmark indicates the absolute position along a run relative to objects such as road junctions, signs, turns and etc. Passing and marking the last landmark indicates the end of data collection along a route. Intermediate relative position, between landmarks, is indicated by the shaft encoder distance tic marks. A run could be disrupted and re-started at any landmark through which the proceeding run segments were complete. Several of the data files presented in this report were collected in such interrupted and segmented runs. The accuracy of position for these segmented and then reconnected files (or any file including continuous runs) is dependent only on the ability of the operator to accurately mark the crossing of a particular landmark which, depending on the landmark chosen, would be within a few meters. Occasional errors in land marking have been discovered and where possible they are corrected using preceding and/or following landmarks for reference. All route segments where such events occur and may have been corrected are marked with an explanatory note. At the end of a run a short data review was made to assure that data was properly recorded. A "Data Integrity Program" was written and available for more detailed data checking. Each data file was labelled and saved to disc. The computer data was then transferred to high capacity cartridge data tape and the analog data was recorded on DAT tapes and video tape for long term storage.

TRANSMISSION FACILITIES

The DAR Field Testing was conducted in the San Francisco area with a main transmission facility at Mount Beacon, near Sausalito, California. The gap filling capability of the EUREKA-147 DAB system was also tested using additional transmission facilities. The attempt to have one of the Mount Beacon licensed FM facilities act as a host for IBOC FM system testing proved futile, hence an IBOC DAR transmission system was not built. The FM IBAC and the L-Band EUREKA-147 experimental transmitter facilities were both built and put into operation. The details of both transmission facilities are contained in copies of FCC applications for Experimental transmission facilities and other pertinent data attached to this report as Appendix F. The Mount Beacon transmission facilities were directly controlled and monitored by the Field Test Engineers, representatives of the EIA-DAR Field Testing process, whenever test transmissions or facility work was being conducted. Samples of the transmission and work logs are also attached in Appendix F. The VOA-JPL S-Band satellite system was up-linked from the JPL laboratory in White Sands, New Mexico to a NASA TDRS Satellite in Geo-synchronous orbit over Hawaii. The only accessible part of that transmission system, the up-link transmitter, was secured so no unauthorized changes could be made.

The audio fed to all of the systems was supplied by a continuously repeating Compact Disc on a standard player at both the Mount Beacon and White Sands sites. No operator intervention was required other than to make sure the CD player was operating.

TEST AND DATA COLLECTION COMPUTER; SOFTWARE AND HARDWARE

The Field test mobile data collection system was structured around a computer system employing National Instruments (NI) hardware and software data collection components. The NI software "LabWindows/CVI" was used to write a custom data collection program for this purpose. The software provided a virtual instrument panel on the computer video display which included selection boxes and switches to configure, run and monitor the proper test. Data monitored by the real time display of that virtual instrument panel included; R.F. voltage, Audio events, time code, landmark selection and marking, manual comments, etc.

The hardware used consisted of a standard PC with a 133 mHz Pentium processor and large amounts of memory and disc capacity and a high speed tape sub-system. A

13

National Instruments data acquisition board was installed and suitable interfaces were constructed to outside instruments. The observer interface push buttons, for marking audio events, consisted of standard PC game pads with color coded buttons.

DATA FORMAT

The data collected in the computer was written in several records using standard PC-computer file formats. The main records were; a main data file consisting of a header followed by a string of data records; a landmark file; and a comment file. The main data file header contained information regarding; the system under test, the route chosen, weather observations, operator identification time, date, etc. The measured data is organized after its header in a repeating 16 Byte string, one for each data point, with the following sequence and contents;

BYTE	CONTENTS
1-2	R.F. level, output from the NI hardware A-D converter.
3-4	Comment, index for text manually entered into the computer.
5-6	Weather, notes to the temperature, sky, wind, etc.
7	Landmark, the number of the next sequential landmark.
8	Event marks, indicating if observer 1 or 2 buttons are pressed.
9-16	Timecode, an 8 Byte ASCII representation of SMPTE timecode.

As described above, each tic mark of the shaft encoder caused one 16 Byte record to be written. Most records contain only the 2 Byte representation of the R.F. voltage level represented by the zero-span spectrum analyzer voltage, with the remaining 14 Bytes being set to zero. Approximately each 30 milliseconds a full 16 Byte data record was written. The timecode associated with each full data record confirms that the time between successive full records usually is one video frame (33 milliseconds) and occasionally two or more frames.

DATA PRESENTATIONS

The National Instruments software was used to create a virtual test instrument in the computer for display on the computer monitor. Some of the data was displayed in real time as it was collected and recorded, to confirm the proper operation of the system. Similar data displays were created to replay the data immediately after it was collected to assure the integrity of the data. This virtual instrument was further expanded to present the data displays that follow.

Each of the six long routes are analyzed and displayed sequentially, from the first to the last landmarked segments, with each of the four systems that were tested being displayed for each route segment. Each of the following displays represents the distance in meters between two consecutive landmarks. Those absolute distances are different between each successive landmark along a route. However, within a particular span of landmarks on a particular route, the absolute distance in meters is identical for each of the four runs over a segment and is reported on the graphs as very nearly equal (where landmarking errors did not occur), as expected. The minor differences in distance, typically within 1% of a particular path, are expected and due to minor variations of the actual marking of a landmark or minor variations in the actual path driven (for example a lane change forced by traffic conditions which would change over the several weeks the four systems were tested). Larger distance anomalies are due to missed or mis-marked landmarks and are noted on graphs where they occur.

The landmarks for each route are listed on an index page attached at the beginning of each of the sets of route data graphs. At each landmark the topography, urbanization and foliage (the "environment") within each route segment is described by a three letter code. The three letter environment codes are decoded and also listed on the landmark index page. Finally, a summary of audio events for each of the systems on a route is listed on the index pages. A detailed map of the particular route also precedes each route data set.

Following the index page are a series of graphs representing the computer data collected along each path. Each two page set of four graphs covers one landmark segment of one route for the four systems under test. The graphs are positioned from top to bottom on the left and right pages in the order in which the systems were tested. Each graph contains a clear title for the system, route and landmark segment. Graphs for route segments which have had landmark data corrected may be marked with beginning and end record numbers rather than landmarks. The top left and right corners of each graph, marked by the landmark number, indicates the landmark position. The three letter environment code, for the segment after the landmark, is printed after each of the landmark numbers. On the top of each graph the velocity of the van has been calculated in Kilometers Per Hour (kph) from the distance and elapsed time. It is plotted along the distance (meters) horizontal axis with divisions marked and labeled at 10% of the total landmark segment length. The velocity is calculated every 20 timecode records, or approximately every second of time. Occasional velocity computation artifacts may be seen where an upward or downward velocity spike is shown. This is due to occasional timecode errors resulting in an incorrect velocity computation.

Below this graph is the main data graph with two major components, the R.F. level and the observer event marks. The vertical axis is plotted in relative dB from 0 to -100 at 10 dB per division with the same horizontal scale distance in meters. The R.F. level is plotted by a small dot for each measured value, approximately every 1.17 cm or 85+ points in each meter. Each graph, which covers from several hundred meters to several kilometers, contains thousands of points. Attached as Appendix G are several graphs showing expanded views of several interesting segments of paths. In these, the structure of the R.F. graphs and other information, for example the presence and severity of multipath propagation, becomes clear.

The various systems under test used passive or active antennas with different loss or gains, the test bed had different configurations and gain or loss for the different systems and some R.F. values were measured differently. For example the S-Band system used an active antenna with approximately 43 dB net gain, and a linear gain block down converter with approximately 40 dB of gain. That system voltage was not measured at S-Band R.F. but at the down converted I.F. frequency of 65 MHz. The I.F. level was therefore, approximately 40 dB higher than the R.F. input because of the I.F. converter gain. The I.F. conversion process in this system is linear, without any automatic gain stages, so the I.F. level is representative of the R.F. level. For this presentation all R.F. values have been shifted by an appropriate "gain" adjustment in the graphing software to place the average R.F. trace near the center to bottom third of the graph. The "attenuation" added with the graphing software is: 40 dB for the L-Band system, 30 dB for the VHF system and 50 dB for the S-Band system. Hence, all R.F. levels are relative, not absolute. Further analysis may be applied to equate the R.F. level to standard reference levels, such as system noise floor or absolute power in watts.

Attached in Appendix C is a block diagram and tabulation of the DAR test system power calibration. From the Appendix C data and the "gain" adjustments listed above the R.F. signal at various points in the testbed can be calculated.

The event marks from the two observers are also indicated on the graphs by the heavy horizontal bands, or dots for short events, in the top two divisions of the graph. The black band indicates the muted event and the gray band indicates the impaired event. As long as an observer pressed an event button a mark was placed in each succeeding record. The computer recorded and displayed event marks are not exclusive, both black and gray can be marked simultaneously and such marks, simultaneous or not, are indicative of the technique used by the observers. It is anticipated that observers using the "two thumb" method to press the two buttons might indicate a transition from one event to the other by momentary simultaneous marks. Observers using a single finger can only indicate one event at a time with a distinct gap between events. The first observer is represented by the top black and gray band pair and observer two by the lower pair. As stated earlier the events are marked only for the full data records so there are usually several, and occasionally dozens of R.F. data points between each event mark. This is illustrated more clearly in the expanded plots in Appendix G.

At the bottom of each graph is a listing of the event summaries. In this count of events if either observer marked an event muted or impaired, it is counted as a muted or impaired event for that record (a logical "OR" operation). The summary for the entire route for all proponents is contained at the beginning of the route graphs on the landmark and environment index pages and is counted in this same way.

OTHER MEASUREMENTS; VHF CO-CHANNEL INTERFERENCE

The experimental VHF FM station KEIA, used for the AT&T IBAC system testing was bracketed by two stations on frequencies two channels above and below its assigned frequency. In addition, other FM stations in outlying areas were operating on Co-Channel frequencies with KEIA. The potential for interference existed where ever the desired KEIA signal was low and the interfering signal was unusually high, for example because of anomalous propagation due to intervening terrain. To investigate the potential for this, measurements were repeated along several of the test routes on the KEIA frequency, but

17

with that transmitter silent, looking for potential Co-Channel interfering signals. The results of those measurements are presented at Appendix H.

DATA PRESENTATION; GENERAL OBSERVATIONS

Two independent observers were monitoring the DAR audio and marking audio events. A general review of the graph of events marked by the observers, showing the general near simultaneous occurrence of events or lack of events, indicate the general agreement of the two independent observers.

FURTHER POTENTIAL PROCESSING AND PRESENTATION

Several options exist for presentation of the DAR Field Test Data. The R.F. values can be equated to a reference level, such as power at the input of the device under test, voltage at the antenna element output terminals, as field strength or power density, etc. The R.F. data points can be averaged over a sliding window to filter out short or longer term variations such as those due to; modulation, multipath or short blockage fades. The measured R.F. can be analyzed for indications of multipath propagation (a recurrent and repetitive fading cycle) and a multipath "rating" can be applied to route sub segments. The various measured and calculated parameters can be compared with each other; such as comparing events to velocity or events to multipath presence and average longer term R.F. level. For the shared VHF band system the background R.F. can be compared to the device under test R.F. to investigate failures due to insufficient C/I ratio.

It is anticipated that all of the test data can be made available to interested parties (in a form represented by the level of processing evident in this report) for their own further analysis.

This data has been presented to the proponents for their review and will be presented to the DAR committee for its deliberations. Further analysis as outlined above can be conducted after committee review, if necessary, to clarify the data and provide a proper interpretation of the results by that committee.

CONCLUSIONS

The DAR field testing program has been completed, to a large extent as described in the original test plan. The long path measurements, the eventual primary goal of the project, has been totally completed. Minor data recording and recovery errors, affecting a small percentage of the total data, have been and are being addressed as described above. The indoor measurements were made but transmission and reception equipment problems resulted in data of limited usefulness. That data will be examined as time permits to attempt to extract useful information and to provide a future presentation. Time did not permit any measurements or investigation of particular areas within the test city by way of the anticipated short path or spot measurements.

The audio events marked on the various long path graphs, together with the R.F. level, give a clear indication of system operation along a path and hence over an area of similar propagation conditions. The presence or absence of audio events is a very good indicator of the expected level of reliable performance of a system under the conditions in which it was operated for this test. It may be possible for proponents to use this information to diagnose causes of system failures or, <u>with care</u>, to extrapolate performance of a system under other operating conditions, for example with different transmitted power.

Respectfully submitted,

by Robert D. Culver

Robert D. Culver, P.E.,
EIA Field Test Design Engineer

NRSC Document Improvement Proposal

If in the review or use of this document a potential change appears needed for safety, health or technical reasons, please fill in the appropriate information below and email, mail or fax to:

National Radio Systems Committee
c/o Consumer Electronics Association
Technology & Standards Department
1919 S. Eads St.
Arlington, VA 22202
FAX: 703-907-4190
Email: standards@ce.org

DOCUMENT NO.	DOCUMENT TITLE:	
SUBMITTER'S NAME: COMPANY:		TEL: FAX: EMAIL:
ADDRESS:		
URGENCY OF CHANGE: _____ Immediate		_____ At next revision
PROBLEM AREA (ATTACH ADDITIONAL SHEETS IF NECESSARY): a. Clause Number and/or Drawing: b. Recommended Changes: c. Reason/Rationale for Recommendation:		
ADDITIONAL REMARKS:		
SIGNATURE:		DATE:

FOR NRSC USE ONLY

Date forwarded to NAB S&T: ______________________________

Responsible Committee: ______________________________

Co-chairmen: ______________________________

Date forwarded to co-chairmen: ______________________________

CEA®
Consumer Electronics Association

NAB™
NATIONAL ASSOCIATION OF BROADCASTERS