OTP/OT
freq mgmt

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON, D.C. 20504

Date: May 20, 1971

Subject: OTP/OT Frequency Management Support Meeting

To: C. T. Whitehead

Attached is a report on the most recent subject meeting.

In summary, the report shows that progress is being made in the following areas:

A. Electromagnetic Compatibility Analysis -- OT now in steady contact with ECAC to determine what "tools" can be applied to the OTP support area.

B. Data Base -- Planning is under way as to those data elements required for EMC analysis and spectrum management.

C. Automatic Data Processing -- Determination of Time-Sharing contractor expected momentarily.

D. Monitoring -- OTP and OT commenting on draft final report from SRI.

E. Specific Action Items --

1. Interference Prediction Model for FAA in connection with Air/Ground Communications.

2. FAA Project Regarding Emission Susceptibility Simulation and Testing.

3. Compatibility Analysis of Digital and Voice Communication in the VHF/UHF Bands.

4. Altimeters vs. CAS (1535-1660 MHz).

5. Tropo vs. Space -- ITS contribution for Space WARC preparatory work received and incorporated into U.S. Position Papers.

6. EMC of Proposed New Space Systems -- Means of accomplishment being explored.

7. Compatibility of 7/8 GHz area -- First "major" project to be undertaken by ITS. Problem definition completed.

F. Standards -- Department of Commerce proposed course of action in Standards area in support of frequency management under review.

G. Noise -- OT supporting OTP in this effort with JTAC and AMA.

H. Receivers -- Close contact being maintained with FCC who have thus far codified land mobile area and commenced work with respect to TV.

I. EMC Education -- Reference data passed to Dr. Newburn Smith at Boulder for development of proposed curriculum inputs.

J. Equipment Characteristics -- OT Contract with Sachs/Freeman signed May 13, 1971.

K. Program/Project Administration -- Shaking down satisfactorily on the basis of experience.

W. Dean, Jr.

Attachment

CC: Dr. Mansur
Mr. Hinchman

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON, D.C. 20504

Date: May 13, 1971

Subject: OTP/OT Frequency Management Support Meeting

To: For the Record

The following attended subject meeting on May 12, 1971 in Room 283, 1325 G Street NW:

Name	Organization	Telephone
Stanley Cohn	OT-DC	967-3591
Anthony Corrado	"	967-5012
D. D. Crombie	OT-Boulder	303-447-3816
W. Dean, Jr., Convener	OTP	395-5623
William Gamble	OT-DC	967-5012
George Garber	"	"
Lyman G. Hailey	OTP	395-5623
George W. Haydon	OT-Boulder	303-447-3583
Bruce Higgins	OT-DC	967-5012
Donald Jansky	OTP	395-5692
Robert Powell	OT-DC	967-3908
Harvey Lance	"	967-3603
George Stelzenmuller	"	967-3591

Minutes also sent to:

Buss
Barghausen
Hatfield
Kirkwold
Kandoian

The discussion followed the agenda distributed as Attachment 7 to Minutes of April 14, 1971.

1. Electromagnetic Compatibility

a. Analysis Capability

Mr. Cohn's work on development of a list of the types of data necessary for analyzing systems before frequency assignment applications are submitted was continued as a pending item.

In connection with the development of a follow-on paper to Mr. Cohn's "Notes on Analysis Capability" (Attachment 2, Minutes of April 14, 1971), Mr. Haydon submitted "Considerations in the Development of an EMC Analysis Service" (see Attachment 1). Recognizing that more thought would be required, the paper was adopted as a point of departure on which to build. All participants were requested to review the paper and submit comments to Mr. Haydon with a copy to Mr. Cohn. Mr. Haydon will develop the paper further based on comments received.

Mr. Cohn reported that ECAC will complete in about six months an EMC degradation handbook which will have considerably more data than the chart on degradation in JTAC's "Spectrum Engineering - Key to Progress." He will initiate a review of the JTAC chart to determine the priorities, as we see them, of the cases of modulation in which we are most interested. These will be reviewed with ECAC to validate any questionable entries.

The Convener and Mr. Cohn noted that coordination with ECAC by OT is proceeding well.

The Convener reported that the VERSAR efforts have been completed and the final report turned over to OT for use as appropriate.

b. Data Base

Using as a basis the document "Spectrum Management Data Base" (Attachment 2 to 11/10/70 memo Dean to Kandoian), Mr. Crombie reported on his efforts to develop a rationale as to where and how data should be obtained. After reviewing Appendix C to the above Attachment and the Sachs/Freeman report, he prepared Suggestions for Additions to Appendix C of Data Base Study (see Attachment 2) and A List of Data Required for Notification of Receiving Stations Requiring Protection from Unwanted Signals (see Attachment 3). The

latter relates, alternatively, to the equipment file being developed. It was noted that some of the suggested data items are presently required on frequency applications, some may be required only on a case-by-case basis, and others (economic) may not be obtainable. All participants were requested to review Attachments 2 & 3 and submit comments to Mr. Crombie, with a copy to Mr. Cohn, who will prepare revisions. Messrs. Cohn and Crombie were requested to determine "where we go from here" in connection with a frequency management data base, and Mr. Higgins was requested to assist on matters relating to format. It was also note that we must determine which data items come from the user and which from other sources.

c. Automated Data Processing

In connection with the proposed Time-Sharing contract, Mr. Hailey reported that the 22 bids received had been narrowed to two by the Contract Evaluation Board and that based on further review by the Board Mr. Garber is preparing a written rationale for selection of one of the two.

Mr. Hailey reported that the contract with HRB-Singer was signed on April 14, 1971. It will provide programming necessary to change the unique identifier of assignment records and will provide one-half man-year of system maintenance, the latter being to allow for transition pending the availability of OT programmers.

Mr. Powell reported that efforts are still underway to transfer a Boulder programmer to Washington. Messrs. Higgins and Hailey emphasized the need for early action in this regard, noting that current programming requirements are being held in abeyance.

In response to the Convener's re-emphasis of the need for a computer program to evaluate proposals for international conferences, Mr. Corrado reported that the item is included in the draft FY73 OT budget.

Mr. Cohn reported he is still working on the OEP request that the transfer of $415K from OT's FY72 budget be in one lump sum, the purpose being to preclude a GAO requirement that the funds be parcelled out on a job-by-job basis. Mr. Cohn reported that OEP/NRAC had indicated to him that they may not be able to provide computer support after FY72 and that initial thinking was being given to a dedicated OT computer. The Convener urged that computer support be developed in-house in order to increase flexibility of use, and noted that the OEP/NRAC position heightens the need for the early provision of OT programmers.

Mr. Garber submitted a memo to Mr. Dean (see Attachment 4) on his survey of the availability of a facsimile machine for OTP which would be compatible with those used by OT-Boulder and OT-Washington. Mr. Jansky was requested to pursue the matter with Mr. Urbany, OTP.

d. Monitoring

Mr. Jansky reported that the draft final SRI report had been reviewed in detail; suggested changes had been given to SRI; Mr. Barghhausen had particularly considered the equipment aspects; a meeting with SRI was scheduled for 3:30 PM May 12; and that he was optimistic that by the end of May we would have the final product. The Convener stated that upon receipt of the final product OT-Boulder should begin to "put the meat" on it and develop a firm program. Thereafter, OTP would inform the Government agencies directly of plans in the monitoring area. As a related matter, Mr. Cohn reported that the draft FY73 OT budget includes $500K for OT-only monitoring projects.

The following efforts are still underway in connection with the noise measurement program of the Urban Mass Transportation Administration (UMTA)of the DOT:

-- Mr. Jansky will ask Mr. Klien of UMTA to document UMTA's noise measurement capability. (Mr. Gamble assisting).

-- Mr. Crombie will then evaluate the stated capability to determine how it might be responsive to OTP/OT needs.

-- After consideration of the foregoing, OTP might decide to ask DOT for use of the capability.

2. Status of Action Items

a. Propagation

In connection with efforts to get the HF prop model to run on the OEP computer, Mr. Haydon reported that an existing deck of cards is being obtained from the Offutt AFB Exec 8, and that he is optimistic that they will run on the OEP computer after 300 or 400 of the 4000 to 5000 cards are changed.

Messrs. Crombie and Haydon are still working on the list of ITS routines that may be useful to frequency managers.

Mr. Crombie reported that by the end of June 1971 Messrs. Utlaut and Wait will have prepared a report on the duplication of prop research among Government agencies. They are also working on a means to coordinate and centralize prop research, which, the Convener stated, should logically come under ITS.

b. Specific Items

(1) Interference Prediction Model for Air/Ground Communications (formerly called VHF Follow-on Aircraft Study for FAA) (1ST PRIORITY)

Mr. Hailey reported that this had been formally accepted as an ITS project (see Attachment 5), and that necessary coordination had been effected with ECAC. Mr. Crombie reported the cost as $60K and the target date for a draft report as December 1, 1971.

(2) Emission Susceptibility Simulation & Testing(6TH PRIORITY)

Mr. Hailey reported that this is a proposed project from FAA (see Attachment 6) presently under consideration by OT-Boulder. Their comments on the feasibility of it being undertaken will be furnished OTP via Mr. Cohn.

(3) Compatibility Analysis of Digital & Voice Communication in the VHF/UHF Aeronautical Mobile Communications Bands (4TH PRIORITY)

Same as (2) above (see Attachment 7).

(4) GE Computer Program re Orbital Satellites (NO PRIORITY)

Appears to be executing on the Boulder computer. Being pursued to eliminate any bugs.

(5) Altimeters vs CAS 1535-1660 MHz (3RD PRIORITY)

Messrs. Hatfield and Adams are preparing a report on the McDonald-Douglas tests; McDonald-Douglas is producing CAS equipment; FAA is having more measurements made at Ft. Huachuca; IRAC is awaiting an FAA report on the McDonald-Douglas tests.

(6) Tropo vs Space

Project has been completed and Mr. Crombie is preparing a report and a math appendix which will be distributed to the IRAC and the U. S. Delegation to the Space WARC. The Convener expressed his appreciation for the excellence of the work and the expeditious manner in which it was handled

(7) EMC of Proposed New Space Systems (2ND PRIORITY)

Mr. Crombie has furnished IRAC with a document suggesting two additional areas that need looking into in connection with the U. S. proposals for the Space WARC (see Attachment 8). The work is continuing and any output developed before the Space WARC adjourns will be mailed to Mr. Dean, Hotel California, Geneva. The convener requested that Messrs. Cohn and Crombie each be furnished with a complete package of the U.S. documents on the WARC (Mr. Kirkevold, action) and a copy of the SJM Report (Mr. Jansky, action).

(8) EMC of Satellite Systems for Mobile Services in the 1535-1660 MHz Band (7TH PRIORITY)

No progress due to pressure of other work. Project continuing.

(9) Compatibility of 7/8 GHz Systems (5TH PRIORITY)

Mr. Higgins' paper "Frequency Management in the Band 7125-8400 MHz" (Attachment 1 to Minutes of 4/14/71) was adopted as the broad terms of reference under which sub-tasks will be developed for attacking the overall problem. After a brief discussion of the sub-tasks, Mr. Higgins was requested to undertake the coordination and development of a paper which will identify the sub-tasks and outline a plan of action for their execution.

(10) Problem Definition

In order to provide a time-scheduling feature for Mr. Buss' format for defining a problem (see Attachment 9, Minutes of 3/16/71), Mr. Cohn is developing a Gant chart and a modified PERT chart.

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In connection with the workload involved in the foregoing projects, Mr. Crombie stated it involves one-third of the capacity of his Group and about one-tenth of the capacity of ITS as a whole.

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c. Standards

Mr. Stelzenmuller's report is in Attachment 9.

Mr. Lance submitted a document entitled Facilitating the Operational & Commercial Utilization of Telecommunications Technology (see Attachment 10) which deals with what Commerce should be doing in the telecommunications standards area. More specifically, it deals with a) characterization of telecommunications systems and their performance, b) measurement methods and measuring instruments, c) standards of practice, and d) international standardization. Budgeting would not involve frequency management funds. The meeting expressed endorsement in principle of the concept of the Government taking positive actions in this area, and the participants were requested to review the document and provide comments to Mr. Lance, to whom appreciation was expressed for his efforts.

Mr. Crombie submitted Notes on Chapter 5, Technical Standards, Requirements, and Objectives of the OTP Frequency Management Manual (see Attachment 11). Participants were requested to review the document and to furnish comments to Mr. Crombie with a copy to Mr. Cohn.

3. Noise

The Convener reported he had referred to Mr. Cohn a request from the Automobile Manufacturers Association for support in the noise area. Mr. Cohn stated an OT representative will participate in AMA's radio committee in Detroit.

Mr. Gamble referred to the UMTA project (see Monitoring on page 4 of these Minutes).

The Convener reported he had referred to Mr. Cohn for comment a copy of DoD's Program Analysis EMC Standardization Program (see Attachment 12).

4. Receivers

At the request of the Convener, Mr. Hailey called Mr. Dixon, FCC, on May 13 to determine the status of the FCC's efforts to codify its receiver standards. Mr. Dixon stated that the land mobile area is on schedule with a target date of June; some work has been started in the TV area and will require two to three more months; no work has been done at HF (as had been thought); and that no areas other than land mobile and TV have been scheduled as yet.

5. EMC Education

Mr. Gamble will send Newburn Smith copies of mil-standards and the Armour Research lecture series, referencing the Boulder meeting in March 1971 with Mr. Dean. He is continuing to try to obtain pertinent Air Force and Navy publications for Smith.

6. Equipment Characteristic - Sachs/Freeman Work Statement

The OT contract with Sachs/Freeman is to be signed on May 13, 1971.

7. Program/Project Administration

The Convener reported he had given Mr. Cohn copies of the OTP Program X entitled Program Plan for Spectrum Management (see Attachment 13). Participants were requested to review it in detail and to furnish comments to Mr. Cohn, particularly for those items affecting OT.

Mr. Cohn furnished copies of two documents, one on projects approved for FY71 for OT-Washington (see Attachment 14) and one on projects approved for FY71 for OT-Boulder (see Attachment 15).

8. Other Business

In connection with his recent visit to ECAC, Mr. Cohn reported he is attempting to determine the availability of computer models that might be of use in meeting the needs of OTP/OT in the frequency management area. In this connection, the Convener cautioned that care must be exercised to ensure that national frequency management remains at the National level, i.e. under the control of OTP. It was also noted that the policy had already been established, in coordination with DoD, that a separate capability should be provided to meet non-DoD needs in the EMC analysis area. He outlined the proper procedure as: a) select models for possible applicability; b) conduct tests, as necessary, at ECAC on simulated data; c) if the models are useful, obtain them; and d) add the models obtained to the in-house OTP/OT capability for use in the satisfaction of actual requirements. In summary, OTP/OT should not become an ECAC customer. He also stated that requests for data from ECAC files must be made on a selective rather than a "shotgun" basis, and that all such requests should be made through OTP. Mr. Hailey noted that this would also apply to the current need for data on military use of frequencies for HF and space communications outside US&P, a project under the cognizance of Mr. Garber.

* * * * * *

The next meeting was scheduled for Wednesday, June 30, at 9AM in Room 283, 1325 G Street N. W., with agenda as given in Attachment 16.

The meeting was adjourned at 3PM.

W. Dean, Jr.
Director
Frequency Management

ATTACHMENT 1 - MINUTES OF 5/12/71

U.S. DEPARTMENT OF COMMERCE
Office of Telecommunications
INSTITUTE FOR TELECOMMUNICATION SCIENCES
Boulder, Colorado 80302

Date: May 10, 1971

Reply to Attn of: OT/ITS/GWH

Subject: Considerations in the development of an EMC Analysis Service

To: Addressees below

At the March 16 meeting of the OTP/OT staff in the Spectrum Management area, the convenor identified the following four items for consideration in development of an Analysis Capability:

(1) An understanding of what interference is

(2) The probability of interference happening

(3) The validity of the requirement for quality of service, and

(4) EMC Measures

The attached draft material prepared in a staff study format discusses the interrelationships between the above items in the development of an EMC Analysis Service. It is hoped this staff study will provoke further discussion so the EMC Analysis Service will be truly responsive to the needs of OTP/OT and the IRAC.

George W. Haydon

George W. Haydon, Program Leader
EMC Services & Radio Systems
Predictions

copy for: Leo A. Buss
Stanley Cohn
Anthony Corrado
D. D. Crombie
W. Dean, Jr.
William Gamble
George Garber
Lyman G. Hailey
Bruce Higgins
Donald Jansky
C. R. Kirkevold
Harvey Lance
Robert Powell
George V. Stelzenmuller

RADIO INTERFERENCE

1. Statement of the Problem

The following have been identified for consideration in the development of an analysis capability.

(1) What is interference?

(2) What is the probability of interference?

(3) What is the validity of quality of service requirements?

(4) EMC Measures

How will the EMC Analysis Services apply in these areas?

2. Assumptions

2.1 In this staff study signals from the transmitter of the victim circuit will not be considered as interference even though self interference through multipath may be involved.

2.2 Only radiated electromagnetic energy from relatively distant sources is considered in this study recognizing that interference may also take place through conduction or inductive or capacative coupling especially at close distances.

3. Facts Bearing on the Problem

3.1 Radio links fail to faithfully transfer intelligence from the transmitter to the receiver for two basic reasons:

(a) The radio signal changes in character during the propagation process, i.e., it becomes weaker and possibly distorted through different propagation times for the signal element, more than a single propagation path, etc.

(b) The radio signal must compete with other electromagnetic energy at the receiver location, this energy includes intended (other transmitters) and unintended radiations (noise from natural causes, e.g., atmospheric and unintended man-made radiations such as those associated with auto ignition).

3.2 It is generally agreed that those competing signals at the receiver which change the character of the desired signal at the receiver output can be considered interfering signals. There is less agreement on what constitutes harmful interference.

3.3 The ability of the desired signal to compete with the interference depends not only upon its magnitude but also upon its other characteristics such as modulation and how these characteristics have been affected during the propagation process.

3.4 The competition offered by undesired signals depends not only upon their magnitude, but also upon their other characteristics and how these characteristics have been affected during the propagation process.

3.5 The magnitude of the desired signal may be expressed as the median power at the receiver input during some specified time period. The character of the desired signal in addition to its bandwidth and modulation (e.g., type and percentage) may also be described by its short term fading characteristics, e.g., rayleigh, gaussian or chi-squared.

3.6 The magnitude of the competing signals may also be expressed as the median power at the receiver input during some specified time period and may be additionally described in terms of its amplitude probability distribution during some time period. The amplitude probability distribution may also be used to describe the composite of several interference sources.

3.7 A concept of Grade of Service, Time Availability and Service Probability together with their interrelationships has been extensively used to describe radio circuit or system performance in the absence of unwanted intended radiations.

3.8 The concept of a "Grade of Service" has been used to describe the quality of the received signal during some specified unit of time, e.g., one hour. For digital systems such as teletype this quality may be rather well defined as average character error rate within the hour,

average binary error rate, etc. for other systems such as analog voice, or radar quality is less well defined and the "Grade of Service" must be expressed rather subjectively such as percent intelligibility of "unrelated" words as received by a "skilled" operator, the likelihood of missing a "standard" target on an individual radar scan, etc.

In the absence of interfering signals, the "Grade of Service" is often associated with available signal to noise ratio and a minimum signal-to-noise ratio is required as an input in the estimation of circuit performance in terms of time availability.

3.9 A concept of "Time Availability" has been used with "Grade of Service" to express overall circuit performance in terms of the percentage of time a circuit was or is expected to be of a given quality. It involves a history of the percentage of time (normally hours) within some longer time period that a specified "Grade of Service" was available or for prediction purposes the percentage of time a specified "Grade of Service" is expected to be available. "Time Availability" and "Grade of Service" are interdependent as illustrated in Figure 1.

3.10 When prediction of "Time Availability" for some specified "Grade of Service" or "Grade of Service" for some specified "Time Availability" are made it is realistic to include an estimate of the likelihood that Grade of Service will be at least that good for at least that percentage of time. This likelihood has been expressed as a "Service Probability" and may be viewed as an estimate of the distribution of circuit performance which may be expected when all the parameters used in the predictions were identical. A failure to know these parameters in greater detail and to properly assess this variability together with the interaction can be expected to result in distribution of actual circuit performance about the predicted performance. When "Service Probability" is not expressed and Time Availability or Grade of Service are predicted as illustrated in Figure 1, these are best estimates and a Service Probability of 50% is implied. Figure 2, an expansion of Figure 1, illustrates

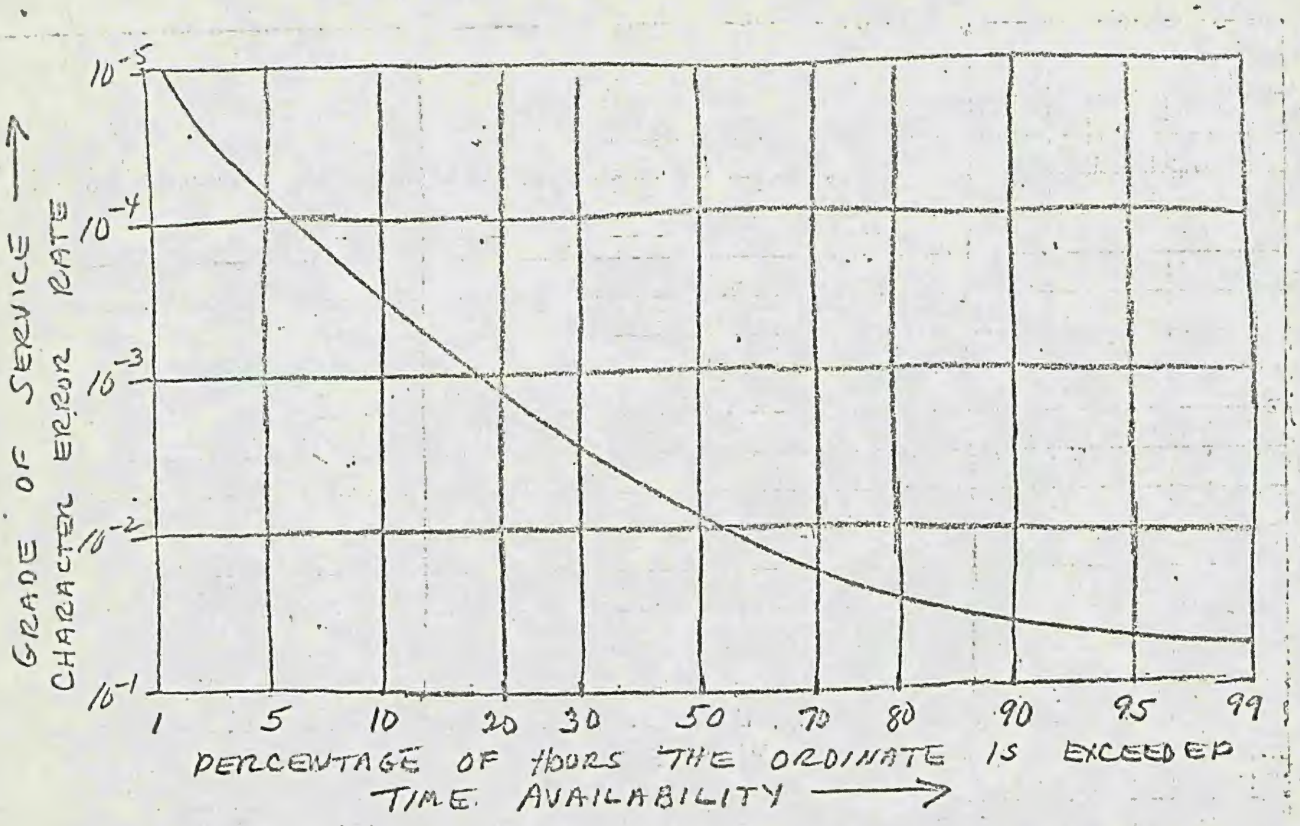


FIGURE - 1

the interrelationship between Quality of Service, Time Availability and Service Probability.

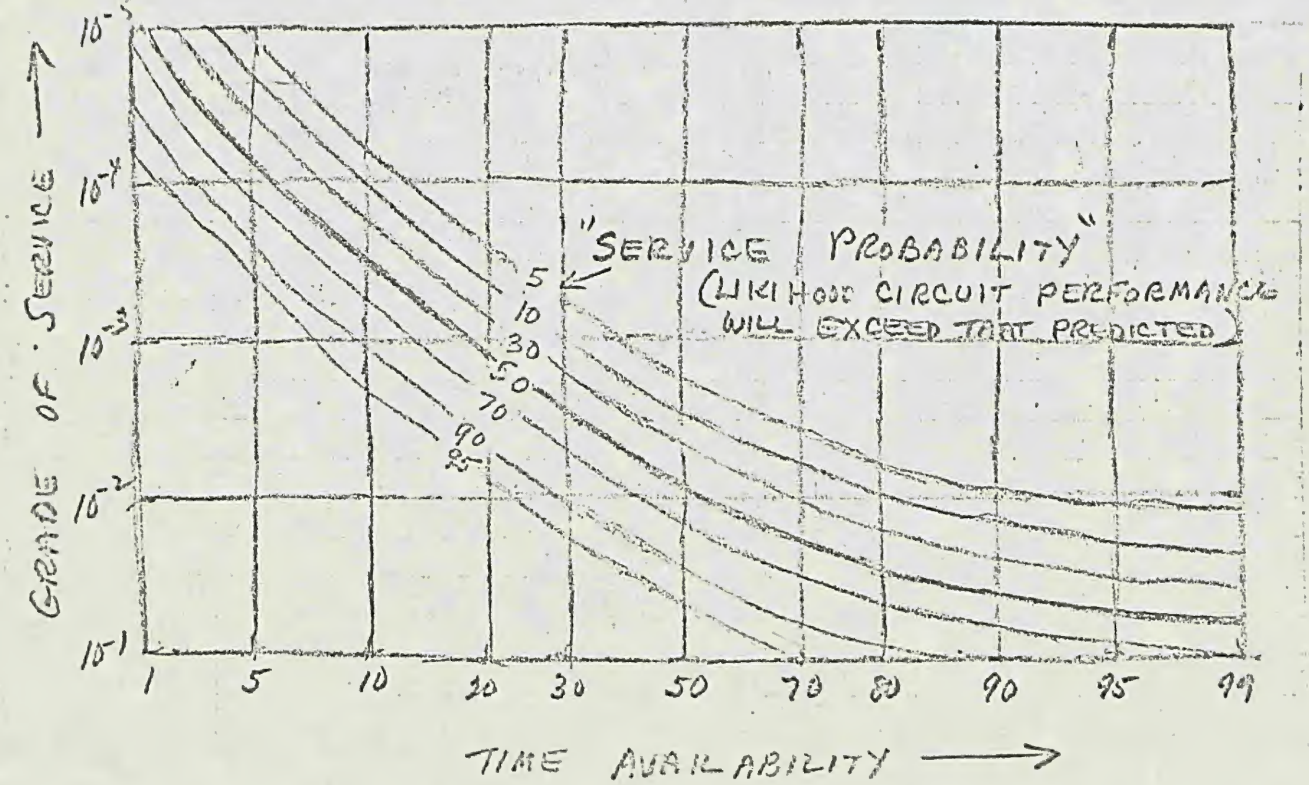


FIGURE - 2

4. Discussion

The definitions of interference, harmful interference, probability of interference, etc. are subject to wide and divergent interpretations. For this study, it is assumed that all unwanted electromagnetic energy at the receiver which produces a change in the desired signal at the receiver output can be considered to create interference and the emphasis of this study is in what constitutes harmful interference and in the manner predictions of harmful interference might be made and presented to be useful in frequency management.

Whether interference is harmful or not obviously depends not only upon the degree of signal degradation but also upon the length of time this degradation has been present or is expected to be present. The degree and duration of interference which may be considered harmful will differ for the various telecommunication services.

It appears that a complex of interrelated factors must be considered in the prediction of harmful interference:

(a) A degree of signal degradation which depends not only upon relative signal and interference levels but also upon the modulation and short term fading character of the signal and the interference,

(b) A tolerable level of signal degradation which varies widely between services,

(c) The percentage of time a signal degradation will take place which depends not only upon the variation of signal and interference magnitudes within a relatively long time period but also upon the variations in other characteristics of both the signal and noise within short time periods,

(d) A tolerable percentage of time which varies widely between services,

(e) The risk that the actual interference (signal degradation for some specified percentage of time) will depart from the predicted interference

(f) A possible wide variation in this risk that the various services may be willing to accept.

If the concepts of "Grade of Service" "Time Availability" and "Service Probability" as used to express radio system performance as a desired signal competes with radio noise could be extended to include intended radiations as a part of the competition these concepts may prove applicable in the analysis and description of electromagnetic compatibility.

It is common practice to associate grade of service with a required signal to noise ratio to achieve this grade of service. As a first approximation, the ratio of the hourly median signal power in the necessary bandwidth relative to the hourly median noise level in a reference bandwidth (usually one hertz) is often used with some assumption concerning the signal and noise distributions within the hour (often a rayleigh fading signal and gaussian distributed noise). It is recognized that the short term signal variations may not be well represented by a rayleigh distribution, e. g., at the higher frequencies for high noise terrestrial locations above 100 MHz where the sharp pulses of auto ignition may dominate.

It appears, therefore, that as radio system performance predictions are extended to a wide range of frequencies encompassing many propagation mechanisms and involving many noise types, it will become increasingly important to consider signal and noise distributions as well as the median levels both in the estimate of available signal to noise ratios and in the determination of required signal to noise ratios.

If some descriptors for the short term signal and noise distribution were used, e. g., ratio of r. m. s to median noise (Vd) or a chi squared or Rice distribution for the signal, it may become increasingly practical to combine an unwanted signal (or signals) of specific levels and modulations with multiple noise sources to obtain a single estimate of the overall competition (interference) to which the desired signal is subjected. As the first part of our prediction process, we would then have a predicted

S/I ratio (median signal level within some short time period relative to median interference level (noises plus all unwanted signals) during this same time period plus some description of the short term distribution of both signal and noise during the time period.

Second, we have a distribution of these S/I ratios within the time period for which time availability would be expressed.

Third, we would require a determination of the required Grade of Service (S/I ratios)

Fourth, an estimate of the percentage of time the Grade of Service would be exceeded (Time Availability)

Fifth, an expression of the tolerable likelihood that the circuit must be satisfactory (Service Probability)

Sixth, a determination of the likelihood that the actual circuit performance will equal or exceed that predicted.

In summary if the likelihood that the actual circuit performance exceeds the tolerable likelihood as associated with the service under consideration, the circuit can be expected to be free from harmful interference.

As appropriate, the above steps may be reduced by taking best single estimates, i.e., Service Probability or Time Availability equal to 50%.

5. Conclusions.

(1) An understanding of what interference is depends primarily upon the user of a radio service. It probably will involve at least a specification of the minimum quality of service in terms of permissible error rate, etc. within some relatively short time period and the ~~minimum~~ maximum percentage of time (time periods) this degradation can be tolerated. When planning is involved and predictions are required, it may be desirable to augment the above two parameters by an estimate of the likelihood the circuit will perform as predicted.

(2) The probability of interference happening can be considered as a part of interference. In the proposed EMC Analysis service, this probability is planned as a part of the prediction. New parameters will need to be considered, e.g., the probability an interfering transmitter will be operating, and in some cases the probability of its location, the probability of its antenna gain in the direction of the victim receiver, etc.

(3) The validity of the requirement for quality of service should be a responsibility of the user. It should prove useful, however, to predict the expected performance on a relatively large sample of operational circuits which are known to be satisfactory and use some quasi minimum of the predicted performance as guidance as to what constitutes satisfactory performance as determined by predictions (predictions are normally much more useful in the determination of relative circuit performance rather than absolute performance). This prediction effort should be augmented by a measurement program of interference and signal levels and characteristics at the receiver site.

(4) EMC Measures - EMC measures can probably best be taken by the users involved since often a modification of operational procedures is the most effective approach. The EMC analysis service hopes to be able to surface the opportunities for sharing, predict expected performance and otherwise highlight alternatives for consideration either by the user in his initial planning or later within the IRAC or the OTP.

A List of Data Required for Notification of Receiving Stations Requiring Protection from Unwanted Signals

1. Location
2. Type of service.
3. Frequency and bandwidth of wanted signal(s).
4. Modulation of wanted signal.
5. Expected levels of wanted signal (median and deciles, etc.).
6. Hours of operation and percentage of time to be free from intolerable interference.

Receiving Antenna

7. Type of receiving antenna.
8. Gain in direction of wanted signal source.
9. Pattern or beamwidth and sidelobe levels.
10. Azimuth and elevation of main beam.
11. Variation of impedance with frequency.
12. Variation of sidelobe level with frequency.
13. Variation of main lobe gain with frequency.

Receiver

14. Bandwidth up to first active element (- 3, - 6, - 20, - 60, - 120 dB, - 140 dB).
15. Input impedance and its variation with frequency over the above range and at high signal levels.
16. Nominal bandwidth (3 dB) and slope of single frequency selectivity curve.
17. IF frequency(s), local oscillator(s) frequency(s) relative to signal frequency.
18. Single frequency selectivity, IF and image rejection, and sub-harmonic rejection.
19. Two-signal and multiple-signal performance.
20. Suppression of periodic impulsive noise.

D. D. Crombie
5/11/71

ATTACHMENT 4 - MINUTES OF 5/12/71

U.S. DEPARTMENT OF COMMERCE
Office of Telecommunications
Washington, D.C. 20230

Date: May 11, 1971

To: Mr. W. Dean, Jr.
Office of Telecommunications Policy

From: George W. Garber GWG

Subject: OTP/OT Facsimile

Reference: Item c, Page 5, April 20, 1971 Memo Re: OTP/OT Staff Meeting

A Xerox 400 Telecopier duplicating those installed in the Office of Telecommunications/Department of Commerce offices in Washington and Boulder and compatible with each is available from:

Xerox
Mr. R. Sydney Kolls
1901 N. Fort Myer Drive
Arlington, Va. 22209

This equipment will send/receive at a rate of one 8½"x11" sheet every four minutes. The costs associated with this equipment are:

$38 Month
$10 Installation
$10 Starter Kit (Paper and minor accessories)
$7.38 Box of paper (150 sheets) as needed.

cc: D.M.Jansky, OTP

ATTACHMENT 5 - MINUTES OF 5/12/71

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON, D.C. 20504

Date: 4/29/71

Subject: Interference Prediction Model for Air/Ground Communications

To: Mr. Stanley I. Cohn (OT/DOC)

Pursuant to decisions made at the April 14, 1971 OT/OTP staff meeting and the April 16, 1971 FAA/OT/OTP meeting, it is requested that the subject project, as contained in the attached Work Statement, be assigned to ITS-Boulder.

Information is also requested as to the estimated completion date of the project.

W. Dean, Jr.
Director
Frequency Management

Attachment

cc - Mr. Hawthorne, FAA
- Mr. Kirkevold (for Info distribution)
- Mr. Jansky
FM Reading

FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
FREQUENCY MANAGEMENT DIVISION
SPECTRUM PLANS AND PROGRAMS BRANCH

WORK STATEMENT

TITLE: INTERFERENCE PREDICTION MODEL FOR AIR/GROUND COMMUNICATIONS (Develop a frequency assignment criteria based on the probability of interference related to communications intelligibility.)

PURPOSE: To provide a parameter for consideration in an automated frequency selection program for air/ground communications. The criteria should be based on channel loading, location of aircraft, types of air traffic and number of aircraft a controller can manage under varying categories of control environment.

BACKGROUND: The rapid growth of aircraft traffic in the United States is placing unprecedented demands upon the Federal Aviation Administration air traffic control facilities. FAA spectrum managers are finding it increasingly difficult within the frequency spectrum resources available and necessary assignment constraints to provide the frequency assignments required to meet the rapidly growing operational needs for air traffic control. A manual study made by the FAA consumed thirty-six man weeks to determine that, using present methods, it was not possible to

satisfy operational requirements for the next two years with the existing allocation of 253 VHF air traffic control channels spaced 50 kHz apart. It became apparent that a method is needed to evaluate quickly for the present, and to anticipate for the future, the congestion situation in the air traffic control air/ground communications frequency bands. In order to accomplish this a contract has been let to the Electromagnetic Compatibility Analysis Center (ECAC) at Annapolis, Maryland for development of an automated data processing program to provide assignment plans for "optimum" *utilization of available 50 kHz spaced channels and plans for deployment of 25 kHz spaced channels when they are introduced into the air traffic system. This program is to provide the FAA with a tool that will select channel assignments according to an easily changeable set of requirements, criteria and constraints, starting with automation of present methods.

At the present time, the criteria for air/ground communications frequency assignments are based upon a certain protection of the desired signal from an undesired or

*This term has not been precisely defined pending results of tradeoff studies; however, using the absolute minimum number of channels required has historically been considered "optimum."

interfering co-channel or adjacent channel signal under the worst-case condition. This protection ratio is attained by providing adequate frequency and geographical separation of the ground stations. The worst-case condition is normally encountered when two aircraft which are in different service volumes and are communicating with different ground stations on the same or adjacent channels, are located at the vertical and horizontal extremities of their respective service volumes in such a manner that they are as far apart as possible from the ground stations with which they are communicating, and are at the same time as near as possible to each other. At these points, they receive the weakest desired signals from their ground stations and the strongest undesired signals from each other. If a ground station is located far from the center of its service volume, it is possible that the worst-case condition would occur at a ground, rather than an airborne receiver. Frequency assignments are now made so that the weakest desired signal received at any point within a service volume will be at least a standard dB level stronger than the strongest undesired co-channel signal and no weaker than a standard dB level relative to the strongest adjacent-channel signal received at that point from a transmitter in another service volume.

In accordance with the ICAO standard, in order to avoid noticeable interference, the desired-to-undesired co-channel signal field strength ratio should be at least +20 dB. In actual practice, it has not been possible to provide this full +20 dB margin of protection for the worst-case condition. There are so comparatively few channels available, with such a large demand, that the FAA has been forced to assign frequencies to stations not sufficiently far separated to meet this requirement. As the demand has increased, the separation criteria have been progressively relaxed, so that recently assignments have been made providing less than 6 dB protection. Despite the fact that assignments are being made with increasingly less physical separation between ground stations, service has remained generally satisfactory, with the occurrence of interference still not intolerably frequent. Because of this fact, it is apparent that whether or not there will be a serious interference problem in a location is dependent not only upon physical separation of ground stations calculated on the worst-case basis, but additionally upon factors not now taken into consideration--relative positions of aircraft within their service volumes when they are communicating, frequency of occurrence and duration of contacts, etc.

Because of the difficulty now experienced in finding frequencies suitable for assignment, and because this difficulty is expected to become even greater in the next several years, it will be

necessary to utilize the available spectrum more efficiently by employing a method of frequency selection which will be based upon as many of the significant criteria as possible, rather than upon station-to-station separation alone.

Thus, automation of present methods must be further supplemented with methods which take into account this intermittent (in the time domain) quality of the system.

The Proposed ITS Effort

The priority goal of the ITS effort will be to develop a method of handling probability considerations to integrate with the ECAC effort involving the development of an automatic technique for making optimum frequency assignments. This could take any of several forms, but the one which appears to be most promising is a computer program or mathematical model which will give a probability of occurrence of interference by statistically analyzing the communications traffic density. Inputs would include those factors which make up the air/ground communications environment, such as:

1. Aircraft statistics (quantity, velocity, user class and flight phase, etc.).
2. Pertinent dimensions of the service volumes of the facility in question and of the other facilities in the area with which it might cause interference.

3. Physical separation from, and frequency assignments of, certain other facilities in the area.
4. Predicted utilization of the new channel.
5. Utilization of the other channels in operation in the area.
6. Utilization of the selected channel at those co-channel locations close enough to cause possible interference.

Channel Utilization Considerations

There are two problems involved in obtaining channel utilization values for inputs to the interference program or model. One is to predict the loading (percent of a time period during which a channel is utilized) on the new channel to be established, the other is to determine the loading on the already-established channels with which the new channel may cause co-channel or adjacent-channel interference. At present, there are no really satisfactory methods for calculating and predicting channel loading. Among several methods which can be used, one is to analyze in detail the tape recordings of ATC communications, summing the times of all the individual contacts made on a channel and dividing by the time of the observation period. This procedure, which is laborious and time consuming, is accurate, but it cannot be used to predict the loading which would exist on a channel before its establishment. Another method is to make use of mathematical models by developing empirical equations relating the channel loading to various combinations of aircraft statistics (aircraft type, flight phase, quantity, time in sector, etc.).

A major consideration in determining channel loading is the length of the time period for which it is expressed. The percent of a 24-hour period that a channel is utilized may be quite low, yet there may be a number of relatively short periods of time in the 24 hours during which the channel is saturated. Obviously then, an expression for percent of time a channel is loaded during a very long period is of little or no value because it provides so little information about the loading during the critical peak periods, which is the reality significant information. At the opposite extreme, an expression for channel loading during a very short period of time is equally meaningless. During a one-second interval, for example, channel loading is usually either 0% or 100%. To be practical the time interval should be of some length that is intermediate between the long and short extremes. The optimum length of time is not known. Intuitively, it would seem to be on the order of several minutes.

Since it is unlikely that an accurate method of predicting the utilization of a non-yet-established channel will be found, what may have to be used in the interference program or model is a statistically determined maximum loading obtainable for the particular ATC function to be served by the channel.

For example, if it is desired to establish a departure control channel and it is known that departure control channels are never

loaded more than X%, then X% would be used as the predicted loading. Results would then be suitable for all probable degrees of loading for the new channel. Previous work has indicated that the maximum communications capacity of a channel may actually be limited by the nature of the workload and the ability of the controller using the channel (this maximum capacity varies with ATC function, being comparatively low for an ARTCC sector controller, and much higher for a local controller). An ATC controller must perform various duties in addition to communicating on his channel, and it is felt that as his workload increases, a point is reached where, because of his other duties, he is no longer able to increase the amount of his communications. It is believed that this point is measurably lower than the actual maximum capacity of the channel itself, which is the capacity that would be observed if the controller were able to devote his full time to communicating on the channel. Values for the maximum amount that each kind of channel can be loaded are not known, but it should be possible to determine them by analysis of data taken at representative facilities during the busiest hours. Good judgment must be applied to the use of maximum values of loading in the probability-of-interference calculations. Considerable work has been done in characterizing

air traffic communications channels by FAA and this would be made available.

Some Preliminary Conditions

In order to limit the number of variables to a manageable quantity and prevent the problem from becoming impossibly complicated, it will be important at the outset to state certain assumptions and conditions upon which the work will be based. Some of these are:

1. Before an adequate expression for the probability of interference can be developed, a realistic standard for what shall be called "interference" will be needed. At a desired-to-undesired signal ratio of 35 dB, for instance, the undesired signal is interfering with the desired signal, but to such a small extent that for ATC communications purposes, "interference" is not occurring.

   An expression merely giving probability of interference, therefore, would not be meaningful. To be meaningful, it would have to be related to a definite desired-to-undesired signal ratio. A 14 dB desired-to-undesired signal ratio has been determined empirically as the level below which the interference can be seriously objectionable.

2. There are circumstances (final approach, etc.) under which no interference at all can be tolerated.

3. Interference, protection ratios, etc., will be expressed in terms of signal-in-space field strengths of the desired and the undesired signals without regard to the orientation of the antenna, or to its position on the aircraft. Results will be derived independently of the characteristics of the airborne receiving equipment, which varies considerably between aircraft.

4. The programs or models will also be derived independently of any unusual propagation conditions which may occur, due to such things as mountains, atmospheric conditions, etc.

5. Although weather is a very important factor that cannot be ignored, the already-complicated problem of developing a probability of interference problem or model would be further complicated if all the many different weather conditions were singled out as variables. Weather will be incorporated, however, both through the short and long term variability considerations associated with signal ratio predictions and its strong effect upon the amount and nature of channel utilization. The weather, as reflected in certain conditions of channel utilization, will be taken into consideration without being treated as a separate entity.

6. The radiated power of airborne transmitters varies from less than one watt to twenty-five watts or more. Since the occurrence of interference is directly dependent upon

the strength of the signals, certain assumptions about the power of airborne transmitters will have to be made.

7. It will be assumed that receiver selectivity is such that adjacent-channels are attenuated 60 dB.

8. Norminal 1/ service volume dimensions by function are as follows:

		Service Altitude (Feet)	Service Range (Nautical Miles)
Precision Approach Radar		*5,000	25
Helicopter Control		*5,000	30
Local Control and VFR Radar Advisory		**10,000	30
Approach Control (Radar or Manual) & ATIS		**25,000	60
Departure Control (Radar or Manual)		**20,000	60
Low Altitude Enroute		**18,000 2/	60
High Altitude Enroute	(VHF)	***45,000	150
	(UHF)	75,000	200

*Above terrain
**Above MSL
***Altimeter standard pressure setting (29.92)

1/ Actual volumes are right polyhedra of varying dimensions

2/ Service is provided to 24,000 feet at regional discretion on case-by-case basis.

Desired Output

A set of algorithms which can be added to the computer program developed by ECAC which will indicate by percentage the probable number of messages which will be interfered with by an undesired co-channel signal at a level higher than 14 dB below the desired signal level.

Schedule

This sub-program should be available for use by 1 January 1972. However, because of the internally dictated requirements of the FAA for early receipt of substantial portions of the work indicated in this description, (primarily the automated frequency assignment program using fixed D/U ratios) no assurance can be given ITS that the FAA will not make arrangements with other organizations for the accomplishment of similiar work.

EMISSION/SUSCEPTIBILITY SIMULATION & TESTING

The FAA Air Traffic Control (ATC) radio frequency bands receive interference from a multitude of Industrial Scientific Medical (ISM), low power devices, and improperly operating transmitters with out-of-band emissions. The variety of emission characteristics poses a complex measurement/description problem in assessing the electromagnetic compatibility (EMC) of these sources. In the case of ISM dielectric heaters, period, repetition rate, frequency drift during pulse, etc. change from day to day according to length of leads and type of work. A combination of time and frequency domains with visual and audio responses may be required to simulate, measure, and describe specific emissions.

This project would study and develop, techniques for computer emission simulation and receiver transfer functions/susceptibility to evaluate EMC situations for specific FAA ATC systems equipments and interference.

Phase I: Develop and apply computer emission/susceptibility simulation/response for typical interference sources covered in FCC Rules and Regulations Parts 15 and 18 using TD-100 or other techniques.

Phase II: Catalog the interference descriptions applicable to the ATC frequency bands and the associated FAA equipment susceptibilities/responses.

Phase III: Develop standard measurement techniques and validate the theoretical procedures and displays in Phases I & II.

Phase IV: Develop interference decision displays and measurement descriptions suitable for modifying FCC Rules and Regulations Parts 15 and 18 to provide safe emission limits in the ATC environment.

ATTACHMENT 7 - MINUTES OF 5/12/71

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON, D.C. 20504

Date: May 5, 1971

Subject: Draft FAA Work Statement on "Compatibility Analysis of Digital and Voice Communication in the VHF/UHF Aeronautical Mobile Communications Bands

To: Mr. Douglass D Crombie (OT-ITS)

Pursuant to your April 29, 1971 telephone discussions with Messrs. Jansky/Hailey (OTP) and Kadi (FAA), the subject work statement is forwarded.

It is requested that this office be informed whether this work can be undertaken by ITS and, if so, your estimate of the probable starting and ending dates.

W. Dunn, Jr.
Director
Frequency Management

Enclosure

cc - Mr. Jansky (w/o encl.)
Mr. Cohn, OT (w/o encl.)
Mr. Hawthorne, FAA (w/o encl.)

FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
FREQUENCY MANAGEMENT DIVISION
SPECTRUM PLANS AND PROGRAMS BRANCH

WORK STATEMENT

TITLE: COMPATIBILITY ANALYSIS OF DIGITAL AND VOICE COMMUNICATION IN THE VHF/UHF AERONAUTICAL MOBILE COMMUNICATIONS BANDS

PURPOSE: To determine the mutual effects on each mode of operation of the use of digital and voice communication under the following circumstances:

1. Both transmitting an adjacent 25 kHz channels using present separation criteria.
2. Both transmitting on the same channel using present separation criteria.
3. Both operating in a multiplex mode on the same channel.

BACKGROUND: The air-ground-air traffic control communication system in use today is overloaded under peak traffic conditions in many areas of the country. There is a good possibility that it will break down under loading conditions predicted for the future. In order to avert such a breakdown and to improve the condition of the existing system, the FAA is proposing three courses of action which offer the promise of substantial relief. The first is doubling the number of available channels by reducing spacing between channels

from 50 kHz to 25 kHz, the second is to make use of digital techniques in the transmission of data, and the third concerns novel approaches to changes in the protection criteria.

The advantage in the use of digital data or data link is that it transmits information at a vastly improved rate over voice with the same bandwidth. This offers the capability of relieving the severe congestion now experienced at high activity locations.

Spokesmen for various user groups of the air traffic control system have voiced a need for continuation of voice capability even after the advert of data link. Therefore, we anticipate a requirement to use both data link and voice communication in the same frequency bands in the future as well as during the introduction of data link into the air traffic control system. This requirement makes it imperative that we ascertain the compatibility of the two methods of data transmissions.

Aeronautical Radio, Inc. (ARINC) has petitioned the Federal Communications Commission to permit use of 25 kHz channel spacing and grant authorization of 6A9 Emission in the Band 128.825 - 132.025 MHz for the use of data link. The FAA supports ARINC and has asked the FCC to extend the rule making to cover the complete band 117.975 - 136.0 MHz. The FCC intends to permit the use of 25 kHz spaced channels but will withhold authorization of 6A9 Emission until an evaluation can be made of the feasibility

of 6A9 emission in this band and the extent to which interference may be caused to voice communications on these frequencies which are allocated internationally for aeronautical safety purposes. Final judgement on the part of the FCC will await the outcome of this analysis.

PROPOSED ITS EFFORT

In order to achieve maximum flexibility in assignment of frequencies it will be necessary to use any channel interchangeably for either voice or digital data. The ITS effort should incorporate measurements made in a real or simulated environment. Voice communication will use 6A3 emission with an effective radiated power of 25 watts. Appendix 1 is a description of the various techniques that are being seriously considered for the transmission of digital data.

The compatibility of both systems is to be determined using our present spacing criteria. In the event they prove incompatible with the present criteria investigation should be made to determine an acceptable criteria.

The effect of digital transmissions on voice can be measured using Articulation Index and Intelligibility, the effect on digital data can be measured using error rate, garbling and any other means that may be applicable.

DESIRED OUTPUT

1. A determination of whether or not digital data and voice transmissions can be made an adjacent-channel and co-channel frequencies without further restriction in the Aeronautical Mobile Communications Bands (117.975 - 136.0 MHz and 225.0 to 400.0 MHz) using present separation criteria.

2. In the event the present criteria does not permit satisfactory operation, an additional dB protection factor that will permit operation equivalent to Voice/Voice (6A3/6A3) shall be established. A voice/voice D/U of 14dB is now considered minimum for acceptable operation.

SCHEDULE

Since the FCC is waiting for the results of this investigation to complete action on the ARINC/FAA petition, we request completion of this EMC project at the earliest possible date in order for the aeronautical communication data link program to proceed on schedule.

Mr. Bernard Sulsky, Communications Engineering Specialist, is the FAA project engineer for this effort. He may be reached on 202-426-3996 or addressed FAA, Spectrum Plans and Programs Branch, RD-510, Washington, D. C. 20590.

APPENDIX

II. MODULATION

Radio system requirements are being developed for two operational environments:

- High signal-to-noise ratio environment typically encountered in U.S. domestic and other over-land operations.
- Low signal-to-noise ratio environment encountered in over-ocean operations served by the extended-range VHF radio systems.

Voice bandwidth compatible modulation techniques now under consideration for the synchronous transmission of data include:

- Audio phase shift keying
- Audio frequency shift keying
- Carrier phase shift keying
- Carrier frequency shift keying

The system is being designed to operate at a data rate of 2400 bps. Several schemes of bit encoding are under consideration, each relating to the signal characteristic(s) (phase, frequency, or both) varied by the mark-space data bits and detected at the receiving demodulator to reconstruct the data bits.

A. MINIMUM SHIFT KEY (MSK)

The "Minimum Shift Key" (MSK) technique operates at 2400 bps in a (300 - 2500Hz) voice bandwidth. With the assignment of phase polarity conventions, it can be expanded from its basic two signatures to a four-signature scheme. This provides design latitude for escalation of the data rate (to 4800 bps) or more redundant encoding to enhance the error performance of the link if operational experience indicates that such steps are in order in the future. The following excerpts from a technical description explain the technique.

The 1200/2400 bps data rate is frequency shift keyed, using 1200Hz as the space frequency, and 2400Hz as the mark frequency. This corresponds to FSK with an 1800Hz carrier and modulation index of 1 or 1/2. The modulation is easily accomplished by sending a half-cycle or full cycle of 2400Hz clock for each bit. Correctly implemented, this also ensures phase continuity at the data transitions. The data signal waveform is shown in Figure 2.

It is shown below that this FSK signal is equivalent to a PSK signal with shaped pulses. The PSK equivalent is an 1800Hz carrier modulated with cosine shaping and phase reversal encoding. Two such signals delayed with respect to each other by one bit interval and added make up the FSK signal transmitted. This equivalence to PSK is significant, since it will be used in the detection process to provide effective 2400 bps demodulation. It is well known that a 2-channel (4-phase) PSK can provide 2400 bps in a voice bandwidth whereas FSK is usually limited to 1200 bps.

Figure 3 shows a block diagram of a system capable of generating frequency shift keying. The associated waveforms shows the nature of the equivalent 2-channel PSK system. Each channel (X and Y) consists of cosine shaped "footballs" which are modulated by phase reversals at their zero crossings. A phase reversal on either channel causes a frequency shift on the combined output. It can be shown that the upper shift frequency results when the data on each of the two channels is different while the lower shift frequency results from the same data on each channel. Since each channel is keyed at 1200 bps and the channels are overlapped, the effective FSK rate is 2400 bps.

The ADCS modem receiver is matched to the configuration of Figure 3. The input signal is multiplied by unmodulated cosine "footballs" corresponding to each channel and the products are integrated for the "football" interval and tested for sign. Data from each channel are compared; if the signs are the same, a space is output, if different, a mark. The result is a 2400 bps data stream.

To implement the receiver, it is necessary to derive synchronism and phase lock on each of the two shift frequencies. This is accomplished by phase lock loops which follow a square law device (frequency doubler) which removes the randomness of the data. It is still necessary that the signal contain a mixture of marks and spaces to allow synchronization. This is ensured by a data randomizer and decoder contained in the transmitter and receiver.

The spectrum of the data signal is shown in Figure 4. The spectrum may be approximately derived as the transform of a 1/2

cosine pulse centered on 1800Hz. At 2400 bps, the spectrum contains no CW. At 1200 bps, the spectrum contains 1/4 its power in each of the two shift frequencies. This corresponds to one unmodulated "football" channel in Figure 3. This spectrum is shown compared to conventional 1200 bps PSK. Its central portion is wider but the lobes attenuate more rapidly. When transmitted through a voice band, the ADCS modem signal is relatively unaffected and maintains its constant level. The PSK signal will, however, contain ripple at the phase transitions due to the phase discontinuity. The wider spectral lobes reflect this fact in the frequency domain.

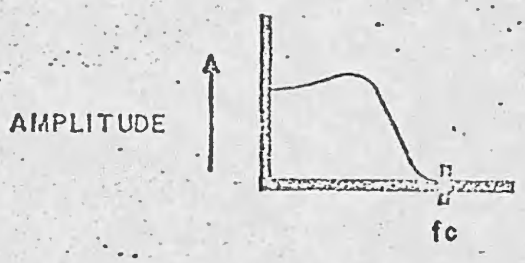
B: PULSE DURATION MODULATION (PDM)

In addition to the aforedescribed voice bandwidth compatible techniques, Pulse Duration Modulation (PDM) is being considered for the low signal-to-noise ratio environments. This technique provides the capability for handling non-simultaneous voice and data information with the same modulation scheme. The generic description of this technique is phase shift keying of the radio frequency carrier in terms of radio system characteristics. The technique is named from the method used to impress analogue voice signals into the clocked pulse stream. While for all practical purposes, the technique may be considered purely digital, it is truly analogue when used for voice. The use of a clocked pulse stream for conveying mark-space data is, of course, fundamental to the operation of all synchronous modulation techniques.

The clock rate of the pulse stream (thus the occupied radio frequency bandwidth) is a function of the bandwidth of the analogue signal being transmitted. In the case of a voice bandwidth (300 - 2500 Hz), the minimum theoretical clock rate is 5kHz. However, experience has shown that the rate must be slightly higher than the theoretical minimum and would approach 6.25kHz.

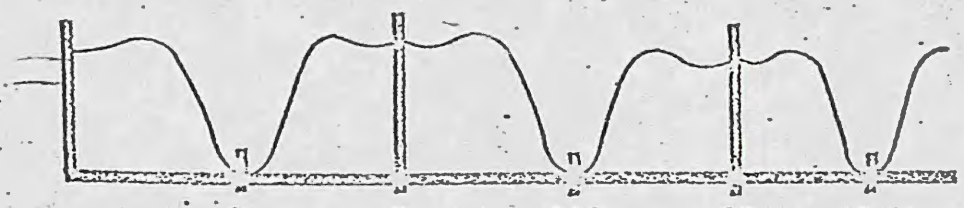
This technique offers the system gain margin inherent in direct carrier modulation. Since it is a digital technique at the radio frequency carrier, it can be regenerated, translated, repeated, or otherwise handled through non-linear amplifying elements. The following excerpts from a complete technical description explain the principals employed in this technique.

Sampling techniques permit transformation of analog signals which are inherently two-dimensional variables, amplitude and time (frequency), into signals of one fixed dimension (sampling rate) and one variable (containing the amplitude information). The minimum sampling rate that permits perfect reconstruction of the analog signal (the Nyquist rate) is twice the highest frequency component of the analog signal. As an illustration, consider an analog spectrum extending to f_c as shown:



ANALOG SPECTRUM

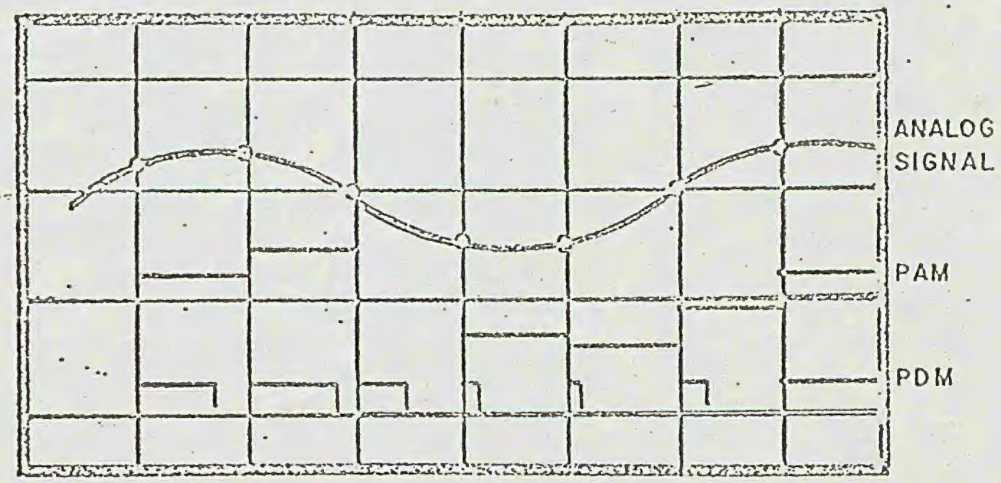
If this signal is sampled by multiplying it by unit impulses at a rate of $F = 2\ f_c$, the resulting spectrum is as shown:



CLOCKED ANALOG SPECTRUM

It is easily seen that $f_c > F/2$, the upper and lower sidebands around n x F overlap producing an irresoluble ambiguity.

There are two basic modulation schemes associated with sampled information: One varies a pulse amplitude to represent the sampled analog amplitude, and the other varies pulse timing to represent the analog amplitude. These are as shown:



TWO TYPES OF MODULATION FOR SAMPLED INFORMATION

The first scheme is called Pulse Amplitude Modulation (PAM) and is the most rudimentary. The PAM receiver is a low-pass filter. Since pulse amplitudes must be preserved in the RF receivers, PAM is identical to AM. It finds application in power limited, pulsed transmitters. The PAM samples are made narrow and large, and thus tower above the background noise during the "on" time. To realize the advantage, the receiver must be gated coherently.

The second scheme is called Pulse Time Modulation (PTM). One type of PTM is Pulse Duration Modulation (PDM) or Pulse Width Modulation (PWM). Here the pulse width represents the analog amplitude. It is suited to constant power transmission techniques such as PSK or FSK transmission. Signal recovery is optimized by an I and D filter following a hard limiter.

Any type of PTM requires a coherent clock. PDM usually uses the leading edge to transmit the clock and the trailing edge the analog information. An inefficient way to receive PDM is to detect the crossovers. However, a more efficient way is to phase lock a local oscillator to the leading (clock) edge of the samples and recover the samples by an I and D filter. The technique as developed goes one step further and has a very efficient transmission and recovery technique. The

clock crossovers are deleted at the transmitter and are reinserted, essentially noiseless, at the receiver by means of a VCO loop. This halves the bandwidth of the principal sidebands of the transmitted signal, thereby allowing a 3dB improvement in the tracking of the Costas loop in the modem.

C. OTHER TECHNIQUES

The other techniques being considered are in general variations of the generic forms for synchronous transmission of data. One other technique, a parallel four-tone audio frequency scheme, is being considered for asynchronous data transmission. While the technique may be useful in certain cases, present emphasis is being directed toward developing synchronous techniques for application in the VHF band.

III. BANDWIDTH CONSIDERATIONS

The modulation techniques now being considered for application in the high signal-to-noise ratio environments are voice bandwidth equivalent. In the case of audio shift keying, an audio frequency carrier in the voice band (300 - 2500Hz) is phase or frequency modulated by the mark-space data. This makes it possible to transmit data over facilities through which voice can be conveyed. At 2400 bps, the phase characteristics and stability of the voice facility are important parameters and must be recognized and reconciled to achieve optimum data performance. These factors are well known and have received much attention among various activities dealing with point-to-point voice facilities typical of those provided by the communications common carriers.

In the application of audio techniques in the VHF band, the audio frequency carrier will amplitude modulate the radio frequency carrier through the audio input (but not necessarily the microphone input) of the VHF radio transmitter. The bandwidth occupied at the radio frequency will be essentially that required for voice; 6kHz. The distribution of sideband energy within this bandwidth is a function of the encoding techniques used on the audio sub-carrier; but in any case does not differ from that of a typical voice signal. The audio frequency bandwidth is generally controlled by filtering at the transmitter audio input to prevent the generation of extraneous energy outside the 300 - 2500Hz band.

These techniques are compatible with and interchangeable with voice. They can be used with existing transmitting and receiving equipment now in the aeronautical service. In its simplest form, the radio system may be considered a circuit having a bandwidth of 300 - 2500Hz over which either voice or data can be conveyed.

In considering the other data modulation techniques and the use of offset carrier networks for the provision of voice communications, the occupied (transmitted) bandwidth is in the order of 13kHz. In the case of multiplexed voice and data, the bandwidth would also approach 13kHz. Where audio frequency division multiplex techniques are considered, the 13kHz re-

sults from the composite of two voice bandwidth basebands (300 - 2500Hz), one translated to a higher frequency audio sub-carrier, double sideband modulating the radio frequency carrier. In the case of PDM/PSK as described, the 13kHz results from the clock rate necessary in sampling the analogue voice signal, the transmitted bandwidth being twice the clock rate.

N. D. Steele, Jr.
September 17, 1970

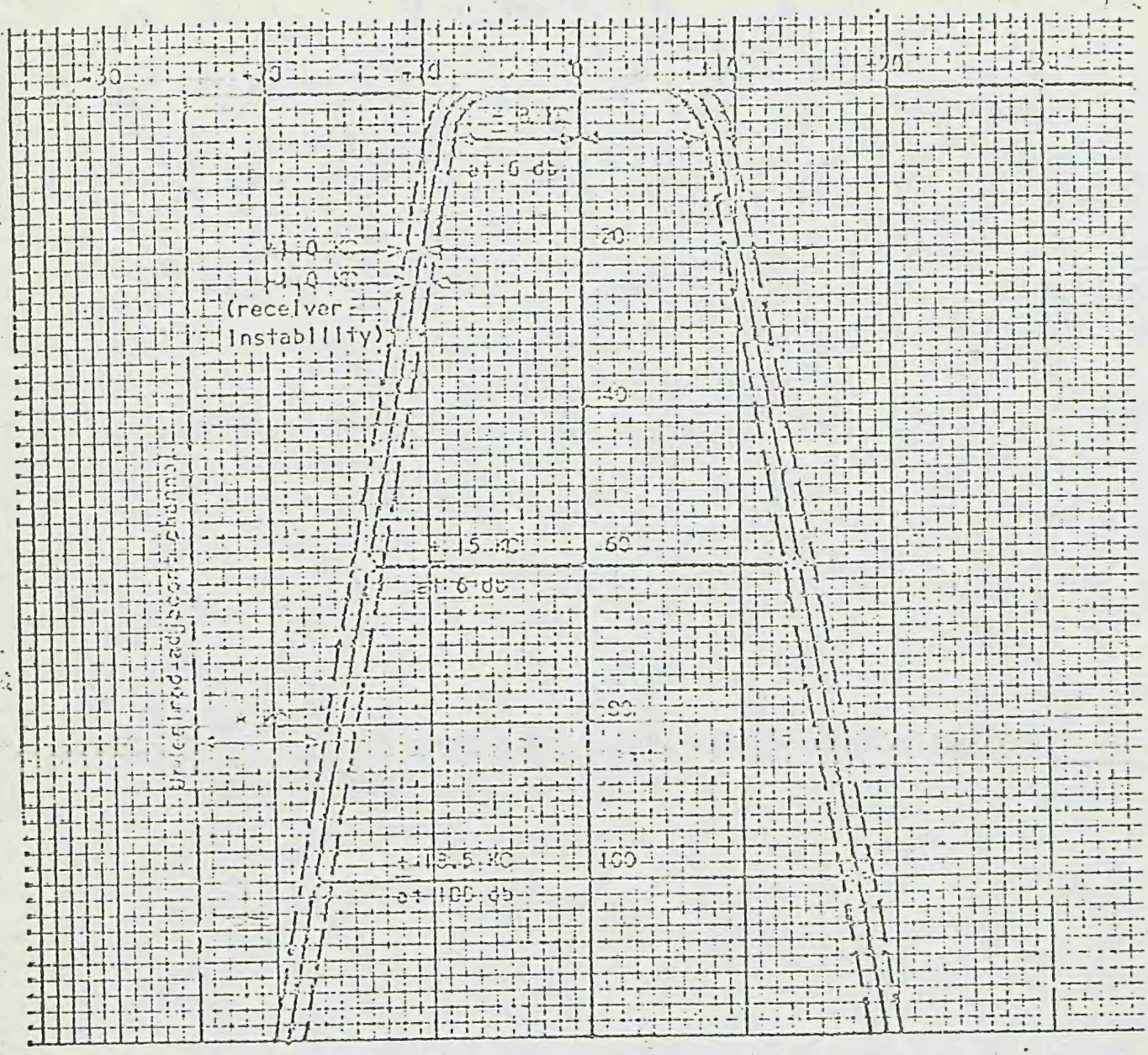


FIGURE 1

TYPICAL AIRCRAFT RECEIVER SELECTIVITY FOR 25kHz CHANNEL SPACING

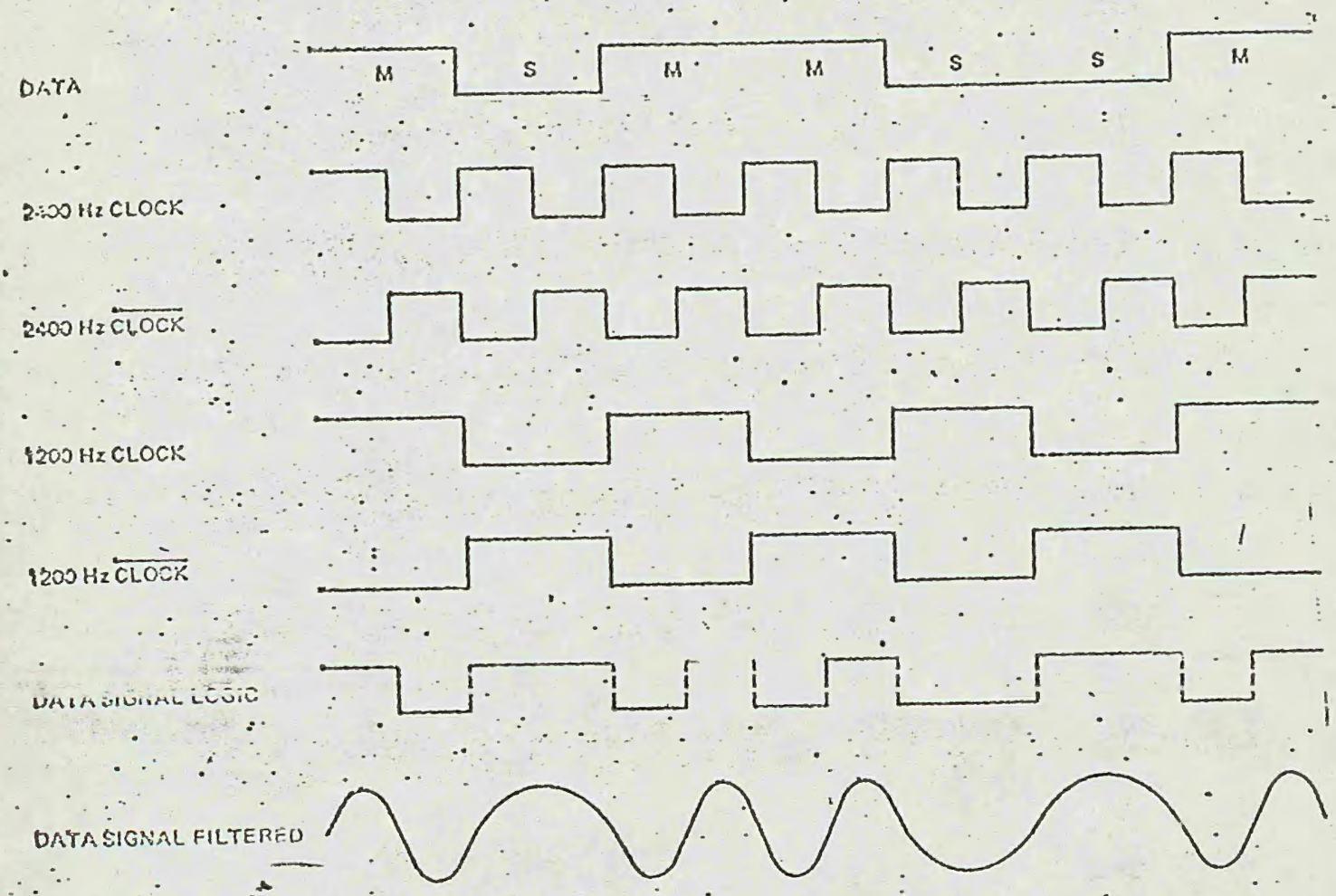


Figure 2. Modulator Waveforms

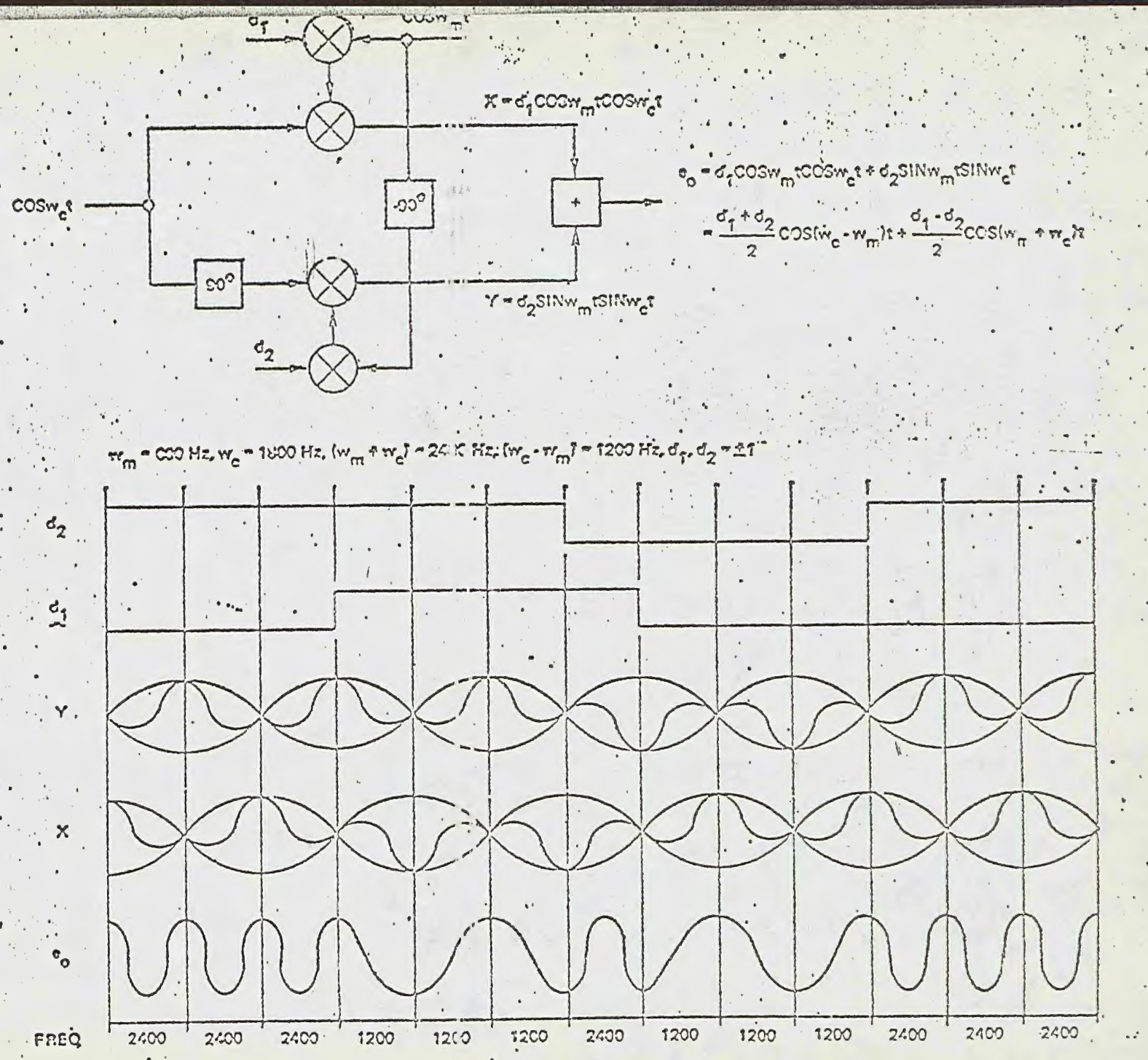


Figure 3. ADCS Modem Modulation Analysis

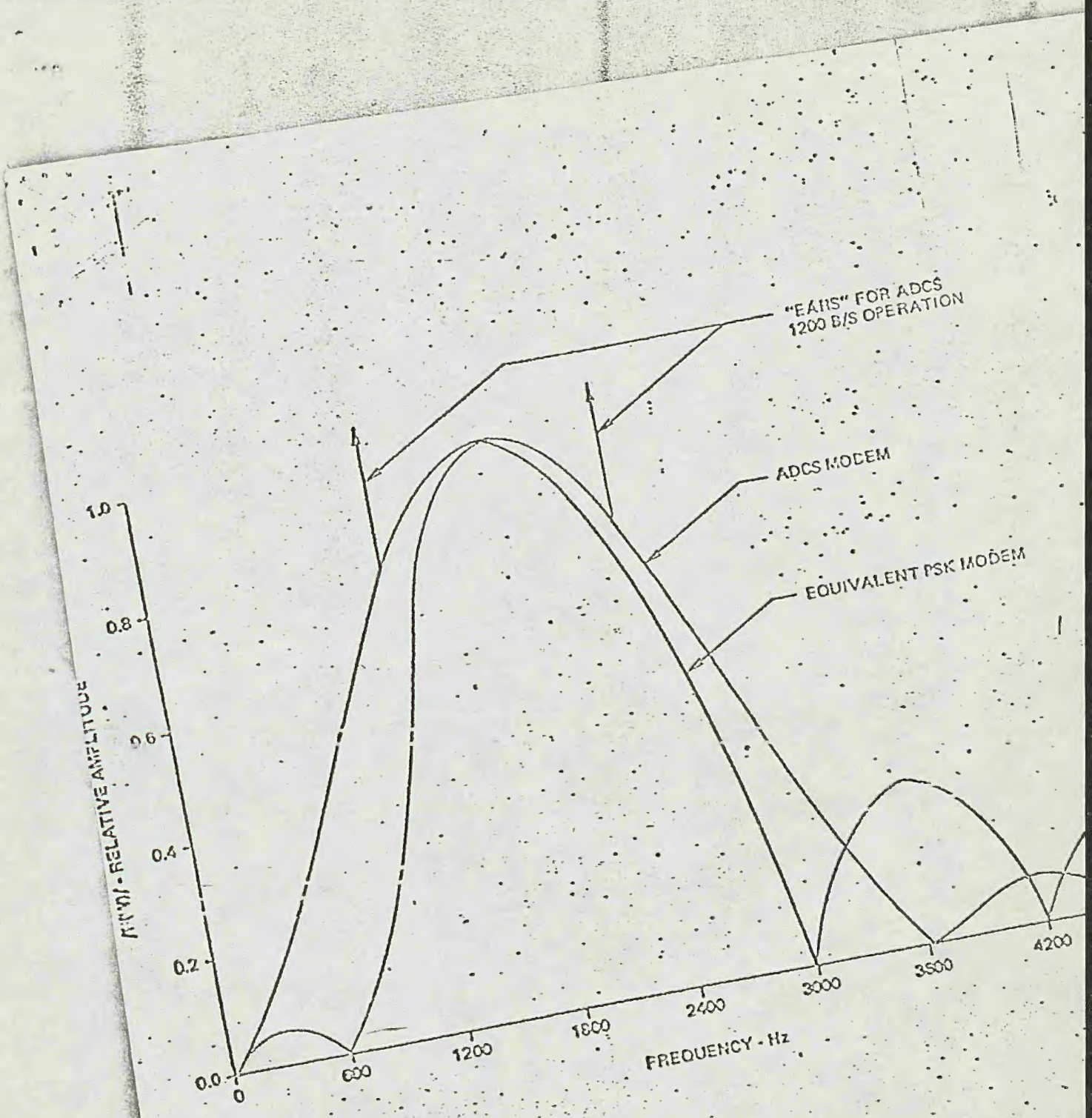


Figure 4. ADCS and PSK Spectra

FCC AGENDA - MAY 11

Doc. 14054 1-3.1.21

ATTACHMENT 8 - MINUTES OF 5/12/71

URGENT

U.S. DEPARTMENT OF COMMERCE
Office of Telecommunications
INSTITUTE FOR TELECOMMUNICATION SCIENCES
Boulder, Colorado 80302

May 7, 1971

D. D. Crombie, OT/ITS

Advance information on proposed Satellite Systems

Mr. Will Dean, IRAC Chairman, at IRAC meeting now in progress at OT.

1). In view of the possible use of reversed frequency bands in the future by nearby satellites it is believed that item 3 on page 140 of the U.S. proposals to WARC be modified to require an indication of the e.i.r.p. in both directions along the geostationary (GS) orbit, for geostationary satellites. It is also likely that this information should be supplied over cones which have apex angles of 60° about the geostationary orbit, since the GS satellites will not necessarily be on the exact G.S. orbit.

This provision is particularly important because of possible use of techniques which can restrict antenna coverage of the earth, at the expense of the pattern in directions away from the earth.

2). With the possibility that G.S. satellites may have to be moved in orbit as new satellites are added, it may be important to ensure that satellites have sufficient fuel stored that they can make arbitrary changes in longitude without sacrificing normal position tolerances. It is suggested that advance information be supplied concerning the number of 1°, 3°, 10°, etc. orbital position changes which will be obtainable, and the time to achieve each change.

ATTACHMENT 9 - MINUTES OF 5/12/71

U.S. DEPARTMENT OF COMMERCE
Office of Telecommunications
Washington, D.C. 20230

Date: May 14, 1971

To: Lyman Hailey

From: George Stelzenmuller

Subject: Report of Standards Activities pertinent to OT/OTP Meeting, 5/12/71.

1. Review of OTP Manual for standards improvements: Crombie is developing a paper on this. Stelzenmuller is preparing recommendations also. This topic may be viewed as the total suggested program for OTP FM standards improvement.

2. Table for Limits of spurious emissions. Material has been received from ITS and reviewed and a proposal is on TSC agenda for May 24. Proposals for extension of table beyond 960 MHz are being considered by Crombie.

3. Radar criteria recently adopted by IRAC are being discussed in DOD; the ECAC points out that if radars don't meet IRAC criteria, they likely don't meet MILSTD 469 either.

   A new TSC working group is beginning consideration of criteria for mobile radars.

   A group for drafting measurement procedures for IRAC radar criteria is being planned; funding will delay till next fiscal year.

4. (a) Land mobile standards project is set aside by common consent because TSC working group cannot make useful progress because of personnel involvement in SPS work.

   (b) A new proposal has arisen in TSC for study of specs to promote more effective use of "splinter" channels.

   (c) A new equipment offered as a catalog listing last week makes available for the first time a multi-channel equipment for 406-420 MHz, meeting IRAC requirements for frequency stability.

5. Recommend that reprints of Chapter 5 of OTP Manual be made available to industry and manufacturers through appropriate selective contacts and by public notice if feasible. Manufacturers can't meet standards they don't know about. OT can use EIA contacts and can reprint copies. OTP may want to publicize the OTP role vis-a-vis "IRAC standards".

6. Microwave standards input for TSC coordination is expected to result in FY72 from OT program being drafted by Higgins for micro-wave analyses.

7. Telemetry standards and other general technical input will be aided by new NASA cooperation being developed by OT, for FY72.

8. Harmful interference standards relatively inactive.

9. Lance is preparing paper on overall OT standards program for FY72 and beyond.

10. Continuation of most of OTP immediate needs for Chapter 5 standards development is in effect deferred for balance of FY71 because of lack of available resources.

U.S. DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

FACILITATING THE OPERATIONAL AND COMMERCIAL UTILIZATION OF TELECOMMUNICATIONS TECHNOLOGY

May 11, 1971

For Internal Discussion Purposes Only

FACILITATING THE OPERATIONAL AND COMMERCIAL UTILIZATION OF TELECOMMUNICATIONS TECHNOLOGY

CONTENTS

FACILITATING THE OPERATIONAL AND COMMERCIAL UTILIZATION OF TELECOMMUNICATIONS TECHNOLOGY

PROPOSED OT PROGRAM

This paper describes proposed work by the Office of Telecommunications (OT) on telecommunications standards and measurements. The work is intended to facilitate the utilization of telecommunications technology, initially within the federal government, but it will be useful to non-government telecommunications as well. The paper also contains a discussion of the standards and measurements interface between OT and other organizational units of the Department of Commerce (DoC).

Motivation:

Among the major factors which limit the utilization of telecommunications technology are:

o Lack of clear and concise characterization of telecommunications systems, to show what parameters are most important to systems operation, what the values of these parameters should be, and how far they can depart from their optimum values without significant impairment of system performance; lack of adequate standards for characterizing the performance of systems;

o Lack of recognized, evaluated techniques for measuring parameters which significantly affect systems performance;

o Lack of adequate explicit, well-recognized practices for the design and operation of telecommunications systems, to avoid continual "reinvention of the wheel";

o Lack of adequate international coordination of standards; and

o Lack of prompt resolution of problems and policy decisions at top government levels, to guide the telecommunications activities of government and industry.

These limiting factors

o Cause marginal design and performance of telecommunications systems;

o Make equipment and systems more expensive;

o Produce marginal compatibility among systems;

o Inhibit the demand for new equipment and new services and the innovation of such equipment and services;

o Slow the rate of growth of the industry, and

o Reduce U.S. exports.

Many of these limitations could be overcome by the work to be described.

The proposed work will aid in fulfilling the Department's responsibility (Department Organization Order 1-1 and 15 U.S.C. 272) to foster, serve, and promote the Nation's economic development and technological advancement through

o Assuring effective use and growth of the Nation's scientific and technical resources, and

o Strengthening the international economic position of the U.S., by means of the

o Development of standards of measurement and methods for making measurements and testing, and

o Cooperation with other government agencies and with private organizations in the establishment of standard practices.

Objectives:

The objectives of this work are:

o To characterize adequately many types of communication systems, including the equipment and components which make up these systems and also systems of systems as encountered in EMC situations, by means of mathematical analyses, models, experience with practical systems, etc.

o To provide practical methods of determining the parameters that are important in characterizing telecommunications systems; that is, methods of measuring the parameters with sufficient accuracy, using simple and inexpensive techniques.

o To provide other practical methods or practices for use in the design and operation of telecommunications systems.

o To secure recognition of many of these practices as national and international standards.

o To take into account economic (cost/benefit) as well as technical considerations.

o To apply the results primarily to government telecommunications systems but to make them available to all others.

Content:

This work consists of four main activities:

o Characterization of Telecommunications Systems and their performance,

o Measurement Methods and Measuring Instruments,

o Standards of Practice, and

o International Standardization.

The content of these four activities is summarized here. The activities are described in more detail in the Appendix.

Characterization of Telecommunications Systems

Compile, organize, and utilize information on existing performance standards applicable to federal telecommunications equipment and systems. Look at available models for "radio" systems performance to see what can be learned regarding parameters to which system performance is sensitive and regarding the optimum values and allowable tolerances for these parameters. Encourage the development of (or develop) new models, if appropriate. Develop recommended performance standards for each government radio service (or class of equipment), and seek adoption.

Obtain information on the nominal performance of "wire" systems. Determine experimentally and from models, if available, the performance of typical channels, noting problem areas. Catalog and characterize existing techniques and instruments for measuring performance. Keeping in mind government

communications requirements and the efficiency of systems operation, develop recommended standards and suitable measurement methods.

Conduct economic analyses to answer questions concerning the costs and benefits of proposed standardization. Analyze the procedures now in effect for establishing and revising telecommunications performance standards. Identify possible improvements to these procedures, and determine the associated costs and benefits. Recommend the most promising improvements.

Analyze the functioning of the present system of standardization to answer such questions as: Is a mechanism for assuring compliance with the standards necessary or desirable? What likely compliance mechanisms can be conceived? What sort of monitoring would be required? How would the results of monitoring be used to assure compliance? What would a compliance mechanism cost? What would be its benefits?

Provide the chairman for and operate the IRAC Technical Subcommittee.

Measurement Methods and Instruments

Compile information on techniques for measuring the different transmitter parameters and on the performance of available measuring instruments. Identify existing methods and instruments that are adequate. Devise improved methods and instruments where needed, and improved transmitter circuitry and practices where measurement knowledge is particularly

communications requirements and the efficiency of systems operation, develop recommended standards and suitable measurement methods.

Conduct economic analyses to answer questions concerning the costs and benefits of proposed standardization. Analyze the procedures now in effect for establishing and revising telecommunications performance standards. Identify possible improvements to these procedures, and determine the associated costs and benefits. Recommend the most promising improvements.

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Provide the chairman for and operate the IRAC Technical Subcommittee.

Measurement Methods and Instruments

Compile information on techniques for measuring the different transmitter parameters and on the performance of available measuring instruments. Identify existing methods and instruments that are adequate. Devise improved methods and instruments where needed, and improved transmitter circuitry and practices where measurement knowledge is particularly

applicable. Develop a common body of methods for transmitter measurements that will be applicable (with modifications) to transmitters of the various radio services.

For, receivers parallel the work on transmitters but with attention to the specialized methods of receiver measurement.

Compile up-to-date information on antenna measurement methods and equipment; taking into account complexity, available accuracy, and other limitations. Collect information on antenna standards and measurement methods from such sources as IEEE, EIA, and CCIR. Identify methods which appear useful for meeting OT needs. Start work on new or improved methods where necessary. Develop specific programs for reducing the uncertainity of practical antenna gain measurements, for measuring the performance of antennas in their environment, and for measuring the performance of large antennas.

Analyze existing concepts of man-made noise, known measurement methods, and available measuring instruments. Identify methods and instruments that are adequate. Characterize them for accuracy, simplicity, cost, and application. Identify areas in which improved concepts, methods, and instruments are needed. Develop new concepts useful to the engineer in determining the performance of telecommunications systems. Devise improved measuring methods and instruments as needed.

For "wire" systems, assemble information on the channel characteristics nominally provided for various grades and types of

service, analyze the parameters important to communications system performance, determine, if possible, a small set of parameters that will adequately characterize the channel for various types of communication systems, and recommend channel characteristics for different types of service.

Standards of Practice

Collect standard practices from DoD, FCC, CCIR, etc. Add OT recommendations. Do a critical analysis of competing practices. Get additional supporting data, if needed, for the most promising of the practices. Seek wide acceptance of OT recommendations as standards of practice, through OTP, FCC, technical societies, and international organizations. Include standard practices for predicting the characteristics of the propagation medium (path loss, noise maps, prevalence of interference, field strength needed at receiver sites, etc.); for use in system and equipment design (for signal processing -- modulation and demodulation, etc.); and for use in system operation and maintenance (message formats, signal characteristics, test procedures, etc.).

International Standardization

Review existing data and analyses on the sensitivity of U.S. telecommunications exports and imports to standards and measurements. Extend the analysis as required.

Analyse the impact of European certification schemes on U.S. telecommunications. Find out what telecommunications equipment is likely to be involved, what U.S. organizations are affected, and what U.S. response to the European certification arrangements would be appropriate with respect to telecommunications.

Examine the structure and extent of U.S. participation in international standards activities pertinent to telecommunications. Determine and implement appropriate OT participation.

INTERFACES WITH OTHER DOC PROGRAMS UNDER EXISTING DELEGATIONS OF AUTHORITY

The OT standards and measurements program interfaces significantly with the programs of several other organizations of the Department: the Bureau of Domestic Commerce, the Office of Product Standards, and the National Bureau of Standards. These interfaces are analyzed in the following pages.

Because we shall be considering the functions assigned to these organizations and comparing them with the functions of the Office of Telecommunications, we summarize here the functions of the OT that relate to standards and measurements.

Department of Commerce Organization Orders 30-5A and 30-5B, dated September 20, 1970, assign to and within the Office of Telecommunications the following standards and measurements (and related) functions (and other functions not listed.)

Office of Telecommunications

Research and analysis in the telecommunications sciences, including radio propagation, radio systems characteristics, and operating techniques. Related economic research.

a. Telecommunications Analysis Division

Conducts technical and economic research and analysis.

b. Institute for Telecommunications Sciences

Serves as the central federal agency for research on the transmission of radio waves.

Performs research on the

Description and prediction of electromagnetic wave propagation,

Nature of electromagnetic noise and interference, and

Methods for more efficient use of the electromagnetic spectrum.

Conducts research and analysis

In the telecommunications sciences,

On radio systems characteristics, and

On operating techniques.

Develops methods of measurement of system performance.

Develops standards of practice for telecommunications systems.

1. Interface Between the Bureau of Domestic Commerce and the Office of Telecommunications

According to Department Organization Orders 40-1A and B, the Bureau of Domestic Commerce

o Fosters, promotes, and develops the domestic commerce of the U.S.;

o Identifies business-related issues which may affect the domestic business economy;

o Recommends policies and program objectives to stimulate balanced growth of U.S. industry; and

o Collects, evaluates, and analyzes statistical data both domestic and international, on U.S. industries.

BDC analyses and BDC collection and evaluation of statistical data will provide guidelines that

o Indicate areas where OT attention likely will be fruitful,

o Provide better insight on the sensitivity of U.S. telecommunications exports to standards and measurements, and

o Show the economic impact of OT recommendations that are implemented.

OT standards and measurements work will provide bases for

o Wider entry by domestic manufacturers into telecommunications markets;

o More prompt policy decisions, to facilitate the utilization of telecommunications technology; and

o Growth of U.S. telecommunications exports through international coordination of standards, thus furthering DoC/BDC objectives to promote the domestic commerce of the U.S.

2. Interface Between the Office of Product Standards and the Office of Telecommunications

According to Department Order 16, the purpose of the Office of Product Standards is to strengthen the ability of DoC to contribute to the solution of national and federal policy issues concerning standards for products, including

- o Types of standards to be established,
- o Government responsibility in developing or aiding the development of standards,
- o Forms of participation in the development of standards,
- o Means of U.S. participation in the international aspects of standards, and
- o Adherence to or compliance with standards.

The functions of the Office are to provide staff assistance and advice to the Secretary regarding

- o Policy formulation for product standards;
- o Standards development, adoption, and publication; and
- o Coordination of the DoC standards program and policies with the Executive Office of the President, other agencies, and internationally.

DoC voluntary standards making procedures will be advantageous to OT in the development of standards of practice, and OT work in turn will further OPS goals for an adequate system of voluntary standards.

OT work on the characterization of telecommunications systems, including technical and economic considerations, will form a useful basis for DoC policies and for the development of standards for industrial and consumer telecommunications products.

OT work on international standardization in telecommunications will help OPS to achieve its goal of adequate U.S. participation in the international standards making process.

OT work has policy implications regarding the interface between the government sector and the non-government sector of telecommunications (for example, concerning standards to prevent short-wave receivers in the hands of the public from interfering with air traffic control). OT economic analyses (for example, regarding the sensitivity of telecommunications equipment exports to standards) may have a direct bearing on DoC policies toward the non-government and international sectors.

3. Interface Between the National Bureau of Standards and the Office of Telecommunications

The interface between the Office of Telecommunications and several major portions of the National Bureau of Standards is considered. A similar but less extensive interface exists with several other segments of NBS. Functions within NBS are assigned by Department Organization Order 30-2B. Only those functions directly pertinent to standards and measurements are extracted here.

a. Center for Computer Sciences and Technology

In accordance with Department Order 30-2B, the Center for Computer Sciences and Technology:

Conducts research and development to aid government agencies in the selection, acquisition, and utilization of ADP equipment.

o Serves as the principal focus within the executive branch for the development of federal standards for ADP equipment, techniques, and computer languages.

o Provides leadership and coordination of government efforts in the development of information processing standards at the federal, national, and international levels.

o Operates a specialized information center for computer sciences and technology.

o Provides computer and data conversion services, and supporting services, to NBS and other agencies.

o Conducts research in information sciences and computer programming, develops advanced concepts in the design and implementation of data processing systems, and provides consultative services.

o Conducts research and development on information processing technology and related disciplines.

The Center plans a major new initiative in teleprocessing during the next few years. ("Teleprocessing" is used by the Center to denote computer services using wire or radio.) The proposed teleprocessing program includes the development of

teleprocessing hardware and software, the development of the factual basis and techniques for measuring the performance of teleprocessing systems, and data communication technology. The latter is regarded by CCST as extremely important.

Computers and communications have merged to a significant extent. However, in the Department of Commerce, organizational responsibilities for computers and for communications have not merged, as reflected in the Department Orders delegating responsibility to NBS and to OT (Department Orders 30-2 and 30-5). The lack of merger is based on a deliberate policy decision by the Assistant Secretary for Science and Technology. The NBS Center for Computer Sciences and Technology is assigned responsibility for information (data) processing. The Office of Telecommunications is assigned responsibility for telecommunications (often abbreviated to "communications"), essentially without reference to the type of information being communicated.

Keeping in mind the organizational segregation of computer and communications functions, we may describe the interface as follows (Figure 1):

o OT works on telecommunications standards and measurement methods which are independent of the information being transmitted and, in coordination with the Center, on telecommunications standards and measurements that affect the transfer of data to and from computers. This work includes economic (cost/benefit) as well as technical considerations.

o CCST works on computer standards and measurement methods which are independent of the communication system, and in coordination with OT, on computer standards and measurements that impact on communication systems.

OT should be able to advise CCST on likely future requirements for the interconnection of computers by means of telecommunications systems. Such information could have important implications regarding computer main-frame design. Conversely, CCST should be able to advise OT regarding demands on telecommunications facilities (data and error rates, etc.) Such information could be very useful in OT program planning. OT-CCST cooperation should enable DoC to serve the teleprocessing needs of other government agencies more effectively and to make stronger contributions to the solution of federal and national policy issues and to national and international standardization.

b. Institute for Basic Standards

Electromagnetics Division

The Institute for Basic Standards:

o Provides the central basis of a system of physical measurement within the U.S.;

o Coordinates that system with other nations;

o Furnishes essential services leading to accurate and uniform physical measurements.

The Electromagnetics Division (and the other Divisions of the Institute):

o Develop and maintain the national standards for physical measurement, develop appropriate multiples and sub-multiples of prototype standards, and develops transfer standards and standard instruments.

o Conduct studies of fundamental physical phenomena, for improving or creating new measurement methods and standards.

o Conduct research and development on basic measurement techniques and instrumentation.

o Calibrate instruments in terms of the national standards, and provide other measurement services.

o Correlation with other nations the national standards and definitions of the units of measurement.

o Provide advisory services on basic measurement problems.

The appropriated funds of the Division are used primarily for promoting accurate, meaningful, and compatible electromagnetic measurements. (including the international compatibility of measurements), as part of the NBS program for "development, maintenance, and improvement of the standards of physical measurement." A minor part of the Division's appropriated funds is devoted to "promoting more effective use of science and technology" (mainly electronic instrumentation) and to "promoting strength in the economy and equity ...in trade" (mainly participation in domestic and international standards committees on voluntary engineering standards.

This work provides instrumentation and techniques for

measurement, at the highest levels of accuracy, of many parameters of importance to telecommunications. The Division has no appropriated funds allocated to the NBS program, "telecommunications technology," but on the other hand, the Division does a substantial amount of telecommunications work on other agency funds. This work deals primarily with radiated signals and related telecommunications and other electronic equipment. It often is done directly for the standards and calibration branch of an agency, but is intended ultimately to solve specific equipment design, procurement, or operating problems of the sponsor.

Division 272 disseminates the results of its work through a variety of means, including formal calibration services. Work supported by both appropriated and other agency funds provides instrumentation for use in these services. The costs of calibrations are covered by fees.

OT works on the characterization of telecommunications systems, to determine parameters to which systems performance is sensitive, the values of the parameters, and their permissible tolerances, and on the economic (cost/benefit) aspects of these topics. OT also works on methods of measuring these parameters, for both systems and equipment, on other standard methods or practices for systems design and operation and on national and international coordination of standards for telecommunications.

The interface between OT and Division 272 is illustrated by Figure 2. Because the assignment of functions by the DoC is quite clear, there should be no OT-Division 272 duplication of effort in the area of the Division 272 mission, supported by funds directly appropriated to NBS. However, there is a definite area of overlap between Division 272 work supported by other agencies and OT work supported by both directly-appropriated and other-agency funds. Information regarding program planning and execution should flow in both directions across the interface to prevent duplication of effort in the area of overlap.

Division 272 provides physical standards of measurement, measurements to the highest available accuracy, and accurate techniques and instrumentation applicable to telecommunications. The Division is a resource for the further advancement of the state-of-the-art in measurement techniques and equipment for telecommunications support.

OT is more broadly coupled than Division 272 to telecommunications in government and industry. Therefore, OT can assist the Division in applying its results more widely to the nation's telecommunications needs.

c. Institute for Applied Technology

Electronic Technology Division

The Institute for Applied Technology

o Cooperates with public and private organizations in the development of technological standards, codes, and methods

of test;

o Monitors NBS engineering standards activities; and

o Provides liaison between NBS and national and international engineering standards bodies.

The Electronic Technology Division

o Develops criteria for the evaluation of electronic instrumentation products and services;

o Cooperates with public and private organizations in the development of standards, codes, and specifications; and

o Applies electronic instrumentation technology to the development of methods for practical measurement of physical quantities.

One important program in the Division is work to increase the effectiveness of U.S. participation in international standards activities. The objectives are accomplished largely through participation in subcommittees, committees, and commissions of U.S. and international standards organizations, notably the IEEE and the IEC. The subject matter includes subjects such as vocabulary, graphic symbols, cables and waveguides for telecommunications equipment, and electronic instruments. Approximately half of the work is closely related to telecommunications.

Another important program of the Division is the Joint Program on Methods of Measurement for Semiconductor Materials, Process Control, and Devices. The objectives are to enhance the performance, interchangeability, and reliability of discrete semiconductor devices and integrated circuits, through improvement

in measurement methods for specifying materials and devices and for controlling device fabrication processes.

Other Division work is on electronic instrumentation, largely on transducers and not necessarily related to telecommunications.

The Electronic Technology Division can provide improved coupling between OT standardization work and related standardization activities. The Division can further OT understanding regarding the effect on telecommunications of limitations in semiconductor performance and semiconductor measurement technology. OT can provide additional justification for Division work and support for work in closely related program areas. OT-Division cooperation can increase the effectiveness of telecommunications particularly in the civilian sectors of government, in contrast to the defense-aerospace sectors which have received much more attention.

d. Technical Analysis Division

The Technical Analysis Division

o Conducts benefit-cost analyses and other basic studies for the Institute, other DoC programs, and other agencies.

The division, with a staff of about 130, is the strongest group in a civilian agency of the government for the application of operations research or systems analysis. The work of the Division emphasizes the early aspects of the total systems process:

Concept formulation: goals, what should be done, and how to do it.

System definition: analysis of system operation and system parameters, leading up to specifications.

The work is a mixture of technical analysis and economic impact studies. It supports primarily the needs of other government agencies; for example, through studies of transportation systems and systems for electronic handling of the mail. An important TAD function is to assist these agencies in developing their own competence in operations research/systems analysis techniques. Only a small fraction of the Division's work is done in support of the Institute.

The OT-Division interface is illustrated in Figure 3. There is no present subject-matter overlap, but there is an overlap in methodology and interests. OT can provide to the Division support in telecommunications systems analysis, policy, technology, and resource utilization. The Division can provide to OT a multidisciplinary competence in operations research/systems analysis. It is a source of competence which may be directly applicable to OT problems and is a potential resource for filling gaps in telecommunications systems analysis. OT will wish to use the available Division competence rather than duplicate it.

COMPUTER-COMMUNICATIONS INTERFACES

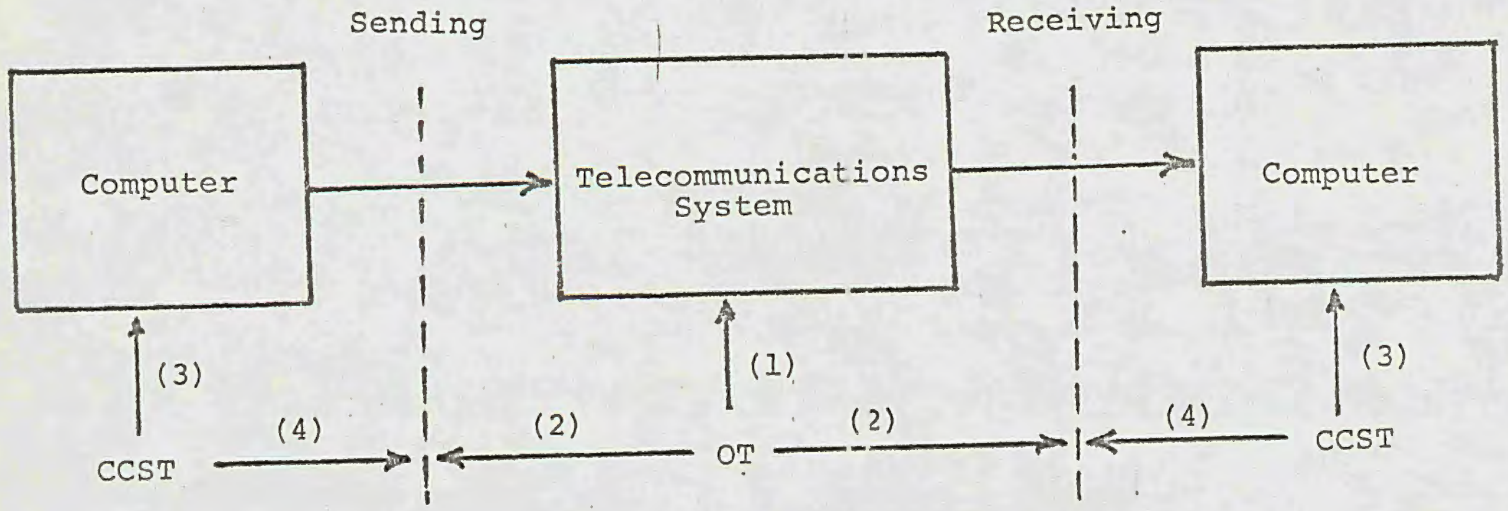

Figure 1 INTERFACE BETWEEN OT AND CCST

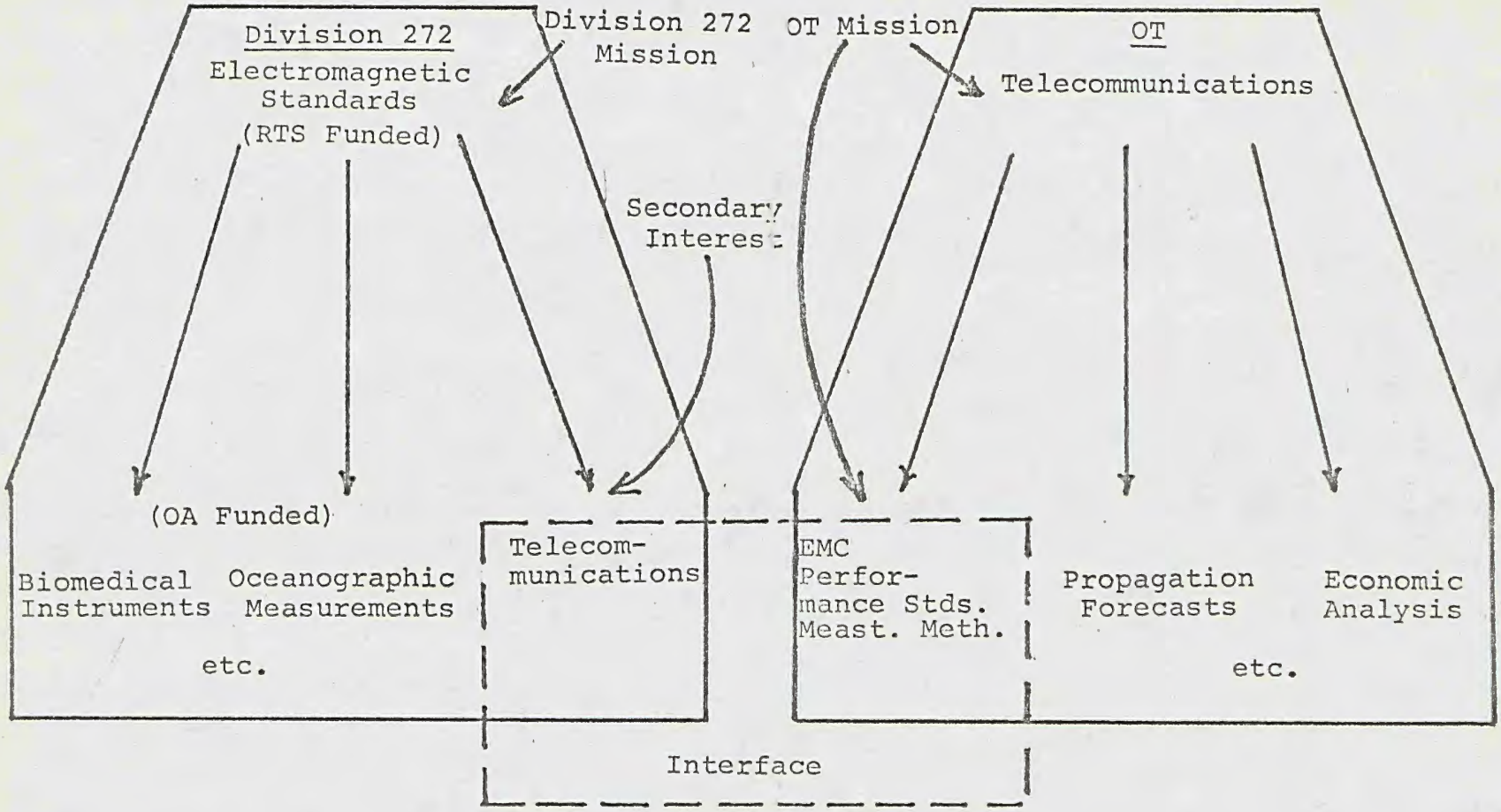

Figure 2 INTERFACE BETWEEN OT AND DIVISION 272

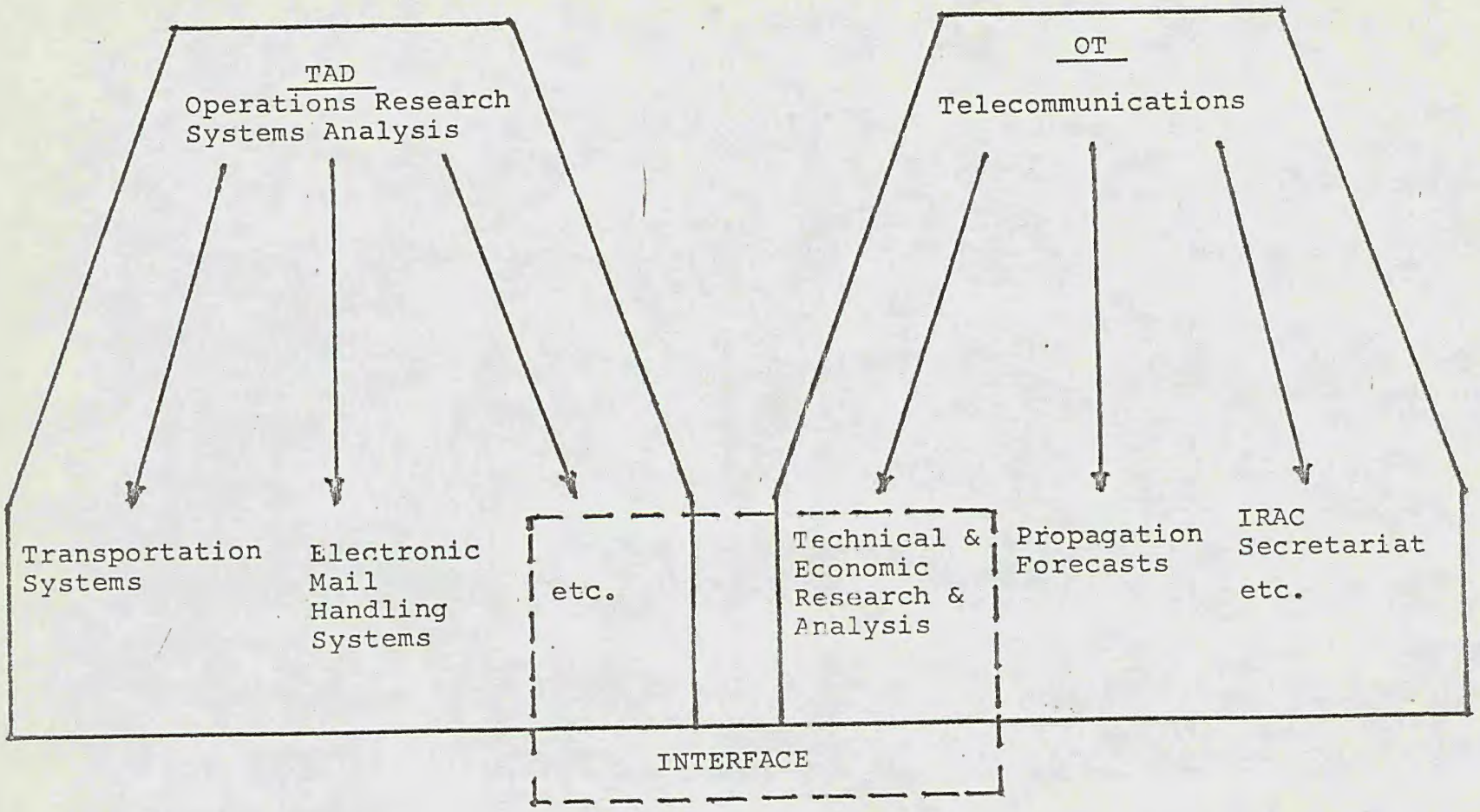

Figure 3 INTERFACE BETWEEN OT AND TAD

APPENDIX

This appendix describes in some detail the major OT program content in standards and measurements.

1. Characterization of Telecommunications Systems.

Motivation:

Better ways of characterizing government telecommunications systems in terms of their technical parameters would provide bases for improved specification, design, procurement, testing, and performance; improved compatibility among systems that share the electromagnetic spectrum; and better compatibility between government and non-government systems.

Objectives:

To develop improved techniques for characterizing telecommunications systems performance in terms of systems technical parameters and to characterize government systems of primary concern; to determine where improved system performance could be obtained by use of additional performance standards; to develop recommended additional standards, to seek their approval through the IRAC as government-wide standards; to submit them to others for voluntary use, to analyze procedures for establishing, enforcing, and revising standards for government telecommunications systems, and to make recommendations for improvement, whenever feasible.

Content:

a. Information on Existing Standards. Compile, organize, and utilize information on existing performance standards applicable to federal telecommunications equipment and systems.

b. Systems Parameters.

1. "Radio" Systems. Using the experience of the IRAC Technical Subcommittee as a guide, give priority attention to transmitters, radars, and receivers. Look at available models for systems performance to see what can be learned regarding parameters to which system performance is sensitive and regarding the optimum values and allowable tolerances for these parameters. Encourage the development of (or develop) new models, if appropriate. Develop recommended performance standards for each radio service (or class of equipment), and seek adoption by the government agencies, through the IRAC Technical Subcommittee and the OTP.

2. "Wire" Systems. Obtain information on the nominal performance of "wire" systems (using open wire lines, coaxial cable, etc.) Determine experimentally and from models, if available, the performance of typical channels, noting problem areas. Catalog and characterize existing techniques and instruments for measuring performance. Coordinate with the NBS Center for Computer Sciences and Technology regarding data communication requirements for computers. Coordinate with the FCC to make the work relevant, whenever feasible, to non-

government networks. Keeping in mind government communications requirements and the efficiency of systems operation, develop recommended standards and suitable measurement methods and submit them to OTP for consideration.

c. Economic Analysis. Conduct analyses to answer such questions as: What government equipment and systems would be made obsolete by the proposed standards? What would be the cost of replacing them? What other costs would the new standards entail? What new types of instruments, if any, would have to be developed for checking compliance with the standards? Incorporate the results of these analyses into recommendations to OTP.

d. Procedures for Establishing and Revising Standards. Analyze the procedures now in effect for establishing and revising telecommunications performance standards. Identify improvements to these procedures, and determine the associated costs and benefits. Recommend that OTP adopt the most promising improvements.

e. Compliance with Standards. At present, there is no formal method for requiring compliance with telecommunications performance standards. Analyze the functioning of the present system to answer such questions as: Is some formal arrangement to secure compliance necessary or desirable? What likely compliance mechanisms can be conceived? What sort of monitoring

would be required? How would the results of monitoring be used for compliance? What would a compliance mechanism cost? What would be its benefits? If an advantageous system can be conceived, recommend it to the OTP.

f. IRAC Technical Subcommittee. Provide the chairman for and operate the IRAC Technical Subcommittee. Use the Subcommittee as a source of information on the radio services in the various government agencies and on the feasibility, from the agencies' point of view, of proposed standards actions. To speed up the standardization process, do outside the Subcommittee more of the substantive analyses leading to alternative proposals for performance standards, so that the Subcommittee can concentrate on the impact on the agencies of the various standards alternatives and proposals. Adopt useful procedures growing out of (d) above.

2. Measurement Methods and Measuring Instruments

Motivation:

Adequate measurement methods and measuring instruments are necessary for characterizing the performance of telecommunications systems and for assuring compliance with performance standards. OTP has begun to establish standards for government telecommunications systems, but has not specified measurement methods for determining whether the standards are being met. Standard methods are widely needed--during design, manufacture, procurement, testing, and operation.

It is important to know whether available methods and instruments are adequate, both in accuracy and in simplicity, for measuring the parameters that must be specified and controlled. Often the problem is not to obtain high accuracy but to obtain moderate accuracy using simple, inexpensive equipment.

In some cases, new concepts are required to describe more usefully the parameters to be specialized and controlled. The development of new concepts leads to the necessity to measure new and different parameters. In such cases it may be impossible to measure adequately with existing instruments. It is important, then, to point out to the industry the need for new or better instruments and, when necessary, to develop them in-house or on contract.

Objective:

To provide measurement methods and measuring instruments which will form a basis (a) for characterizing the performance of government telecommunications systems and equipment, and (b) for measuring each specified parameter of such systems and equipment, so that compliance with performance requirements can be assured.

Content:

The work covers the following topics: transmitters, receivers, antennas, electromagnetic fields, and channel characteristics for "wire" systems. Each is described below.

d. Transmitters

Important transmitter parameters include:

Carrier frequency
Frequency stability
Signal power output
In-band noise power
Spurious emissions
Occupied bandwidth

In general, instruments and methods are available for measuring frequency and power to a high degree of accuracy. However, instruments and methods for use in the field (as distinct from laboratory) may be deficient. The measurement of spurious emissions, in-band noise power, and the determination of occupied bandwidth are likely problem areas.

Compile information on techniques for measuring the different transmitter parameters and on the performance of available measuring instruments. Identify existing methods and instruments where needed, and improved transmitter circuitry and practices where measurement knowledge is particularly applicable.

Concentrate on the parameters identified under Performance Standards as of prime importance to systems performance. Give attention to the following classes of transmitters in the following priority order: high-power fixed radars, other radars, land mobile transmitters, and other radio services (priority to be determined).

Develop a common body of methods for transmitter measurements that will be applicable (with modifications) to transmitters of the various radio services.

Submit the results to OTP for use in specifying standard measurement methods for transmitters in government telecommunications systems. Disseminate the information to others for use in systems specification, procurement, testing, and operation.

b. Receivers

A matter of growing concern is the lack of adequate measures, in the design and development of receivers, to control their susceptibility to interference. Receiver limitations are seriously affecting national frequency assignment practice. Many government services cause interference to television receivers, and receiver spurious responses preclude the use of numerous TV channels. Spurious responses of commercial receivers in the hands of the public (for example, for reception of local weather broadcasts operated continuously by the Department of Commerce on 162.55 MHz) have precluded the full use of government frequency bands. The poor quality of receivers in use for marine radio beacon reception (between the frequencies of 285 and 415 KHz), has prevented the Coast Guard from activating additional stations along the Atlantic coast. Numerous other examples are well documented. The need for improved receiver performance has been recognized in a number of recent telecommunications studies. More stringent receiver performance standards are necessary, and recognized means of measuring all of the parameters important to receiver performance are essential for compliance with the standards.

Important receiver parameters include:

Sensitivity
Dynamic range
Desensitization
Selectivity
Noise figure (or effective noise temperature)
Spurious responses
Demodulator characteristics
Cross modulation
Local oscillator stability
Local oscillator radiation

Give initial attention to receivers for high-power radars and second priority attention to receivers for other radars. Classify in a tentative order of urgency the receiver parameters that are important to systems performance. Survey and evaluate measurement methods specified by other organizations. Recommend those found adequate, stating their range of application. Begin work on deficiencies of method or equipment as revealed by the survey and evaluation. Concurrent with the work on radar receivers, start work on land mobile receivers, following a similar rationale and procedure. As soon as practicable, begin work on receivers for additional radio services according to priority to be established.

The major outputs will be recommended measurement methods and measuring instruments for determining receiver performance and improved receiver circuitry for reduced susceptibility to interference. The outputs will be disseminated as described under transmitters.

c. Antennas

Antennas promote electromagnetic compatibility and spectrum

conservation by confining signals, whenever possible, to the service area of each particular telecommunications system. Spurious antenna responses (side lobes) may result in severe interference. Antenna gain is a direct trade-off for transmitter power or receiver sensitivity.

Antenna efficiency is important, but good efficiency usually is relatively easy to achieve through good design practice. Phase characteristics are growing in importance with the increasing use of phased arrays. The polarization characteristics of off-axis lobes may affect their interference potential. While antenna impedance is measured looking into a transmission line, determination of the other parameters requires measurement of electromagnetic fields in open space. (See also Electromagnetic Fields).

The antennas of interest range from small quarter-wave whips (as used in land mobile communications) to huge arrays and reflectors (as used in radar surveillance and space communications). Therefore, the entire gamut of antenna measurement methods and instruments may have to be exploited to characterize the antennas.

Important antenna parameters include:

Gain (directivity)
Efficiency
Phase
Impedance
Patterns

Concentrate on the topics of urgency identified under "Characterization of Telecommunications Systems." Identify other problem areas, through the IRAC Technical Subcommittee, for example.

Compile up-to-date information on antenna measurement methods and equipment; taking into account complexity, available accuracy, and other limitations. Collect existing information on antenna standards and measurement methods from such sources as IEEE, EIA, and CCIR. Identify methods which appear useful for meeting OT needs. Start work on new or improved methods where necessary.

Determine what additional OT equipment and facilities are needed. Make plans for obtaining access to antennas, by purchase, loan, or travel to installations where they are in use.

Develop specific programs for reducing the uncertainity of practical antenna gain measurements, for measuring the performance of antennas in their environment, and for measuring the performance of large antennas.

d. Electromagnetic Fields (including noise and interference)

Important electromagnetic field parameters include:

Amplitude
Phase
Polarization
Direction of travel
Amplitude probability distribution
Spectral density

Although most of these electromagnetic field parameters are conceptually simple, in practice even the simplest may be

difficult to measure with sufficient accuracy.

The role of electromagnetic field measurements in characterizing antennas already has been pointed out. Such measurements are concerned with desired fields. In addition, undesired electromagnetic fields (noise, interference) arise from several types of man-made sources:

- Devices that should not radiate at all (power lines, light dimmers, automobile ignition systems, neon signs, etc.)
- Industrial, scientific, and medical (non-telecommunications) equipment which must radiate to perform its intended function but which often is not properly controlled
- Transmitters emitting spurious radiation
- Transmitters emitting only signals necessary for communications in other telecommunications systems.

In addition, of course, is the noise caused by natural phenomena such as lighting, solar disturbances, and cosmic radiation. The noise from natural phenomena has been studied extensively and is relatively well known, while undesired signals from man-made devices are less well known and are increasing rapidly. Noise and interference fields may be extremely complex (random, pulsed, etc.) but they must be measured accurately and taken into account in systems design and frequency assignment if optimum use is to be made of the spectrum.

A persistent criticism of government electromagnetic compatibility analysis efforts to date is that the available data base is not good enough. An important part of this data base is obtained from electromagnetic field measurements (transmitter signatures, interference, etc.) The data base can be no more accurate than the measurement methods and measuring instruments used to generate it.

The initial concern in this work will be with man-made noise.

Develop closer contact with federal systems problems arising from man-made noise, through the IRAC Technical Subcommittee. Analyze existing concepts of noise and interference, known measurement methods, and available measuring instruments. Identify methods and instruments that are adequate. Characterize them for accuracy, simplicity, cost, and application. Identify areas in which improved concepts, methods, and instruments are needed. Develop new concepts useful to the engineer in determining the performance of telecommunications systems. Devise improved measuring methods and instruments as needed. Then consider the need for work on other types of noise and interference and other electromagnetic field measurements needed for characterizing the performance of antennas.

e. Channel characteristics for "wire" systems

The term "wire system" is used somewhat loosely to describe a communications system which utilizes open-wire or coaxial

usually give different results. We already have treated methods of measurement. Now we emphasize the importance of other agreed-upon and widely accepted practices.

Although it often is desirable to specify only the required performance, it happens too frequently that if one does so, independent groups have to do the engineering all over again, and each group will get different answers. Thus, standards of practice frequently are appropriate. They are intended to minimize "re-inventing the wheel," to give consistent results, and to provide reliability and economy of design and operation.

For many practices that need standardization, there are no standards. For others there are conflicting standards, developed by various organizations. We could cite instances of widely differing U.S. and European design practices and could show that much spectrum pollution is due to improper practices.

Even some practices that are accepted internationally as standards are inadequate. Therefore, OT efforts toward better standards of practice should extend to the international level.

Objectives:

To analyse alternative practices for telecommunications system and equipment design and operation, to provide supporting evidence and justification for those deemed most satisfactory, to prepare recommended practices, and to seek the wide acceptance of OT recommendations as standards of practice.

Content:

Collect available standard practices from DoD, FCC, CCIR, etc. Add OT recommendations. Do a critical analysis of competing practices. Get additional supporting data, if needed, for the most promising of the practices. Seek wide acceptance of OT recommendations as standards of practice, through OTP, FCC, technical societies, and international organizations.

Include standard practices:

a. For predicting the characteristics of the propagation medium (path loss, noise maps, prevalence of interference, field strength needed at receiver sites, etc.)

b. For use in system and equipment design (for signal processing -- modulation and demodulation, etc.)

c. For use in system operation (message formats, signal characteristics, etc.).

4. International Standardization

Motivation:

A recent survey* shows a $7 billion favorable balance of trade in equipment identified as sensitive to standards and measurements. Relatively modest changes in the import-export pattern of such goods could have a serious impact on the balance of payments. More information is needed on the relation between standards and the balance of trade, specifically for the field of telecommunications.

* NBS Special Publication SP-345-1, "International Standards."

Recent events in Europe may lead to the necessity of a U.S. scheme for the certification of products for export. Three different but possibly merging activities (Tripartite, EXACT, and CENEL) have the common purpose of an international scheme for quality assurance and product certification (with initial emphasis on electronic components) in which all western European countries will participate. Without a certification system acceptable to those countries, U.S. exports probably will be handicapped.

Recent estimates show the need for a ten-fold increase in international engineering standards. Recent trends show that in some important cases U.S. participation in international standardization has decreased while the participation of other nations has increased markedly. If the U.S. wishes its technological practices and standards to be reflected adequately in forthcoming international standards, it must increase its participation in international standards negotiations -- within the next few years if it is to be effective.

Objectives:

To understand better the effect of standards and measurements on the U.S. balance of trade in telecommunications; to propose a suitable U.S. response, for telecommunications, to European schemes for international certification; to improve U.S. participation in international telecommunications standards activities.

Content:

a. Balance of Trade. Review existing data and analyses on the sensitivity of U.S. exports and imports to standards and measurements. Identify the telecommunications content. Monitor the findings, make recommendations to DoC and OTP.

b. International Certification. Analyze the impact of European certification schemes on U.S. telecommunications. Examine practices of other countries with respect to certification and monitoring. Find out what telecommunications equipment is likely to be involved, what U.S. organizations are affected, and what U.S. response to the European certification arrangement would be appropriate with respect to telecommunications. Based on the findings, make recommendations to DoC and OTP.

c. International Telecommunications Standards Organizations.

Examine the structure and extent of U.S. participation in international standards activities pertinent to telecommunications. Determine and implement appropriate OT participation. Submit measurement methods and recommend practices developed elsewhere in this program to suitable international organizations for possible endorsement as standards. Monitor the actions proposed by the international organizations. Analyze the potential impact of these actions on U.S. telecommunications. Coordinate U.S. responses that have potential impact on standards for government telecommunications systems.

Estimated Cost

	Fiscal Year 1972 ($K)	Fiscal Year 1973 ($K)
1. Characterization of Telecommunications Systems		
a. Information Base	20	20
b. Systems Parameters		
(1) "Radio" systems	90	150
(2) "Wire" systems	55	115
c. Economic Analysis	30	50
d. Procedures for Establishing, Revising Standards	3	7
e. Enforcement of Standards	2	7
f. IRAC Technical Subcommittee	10	14
Subtotal	210	363
2. Measuring Instruments and Measurement Methods		
a. Transmitters	75	75
b. Receivers	100	190
c. Antennas	75	110
d. Electromagnetic Fields	75	100
e. Channel Characteristics for "Wire" sys.	20	100
Subtotal	345	575
3. Standards of Practice		
a. For the propagation medium	20	35
b. For Systems and Equipment Design	35	55
c. For Systems Operation	20	10
Subtotal	75	100
4. International Standardization		
a. Balance of Trade	20	15
b. International Certification	20	55
c. International Standards Organizations	35	30
Subtotal	75	100
TOTAL	$705K	$1138K

Notes on Chapter 5, Technical Standards, Requirements and Objectives of the OTP Frequency Management Manual

Inherent Rights

Is the apparent conflict between the 2nd para. of section 5.0 and para. 5.2.1 real? That is, does para. 5.0 take precedence over para. 5.2.1?

Spurious Emissions

There may be inconsistencies between section 5.2.2 (p. 5.12); 5.4.3.4.d (p. 5.22); 5.6.1.2 (p. 5.24); 5.7.1.2 (p. 5.25). Although these recommendations may be replaced in the near future, I believe they should be recast into the form of spectral density, dB/kHz, as used in the radar criteria section 5.3. Modulation conditions for which the spurious emission criteria are to be met should be specified.

It may be desirable to tentatively extend the new spurious emission table to frequencies higher than 900 MHz by requiring that all higher frequency transmissions meet the 900 MHz requirements, for the time being.

5.4 Technical Standards for Operations in the Bands Between 29.89 and 420 MHz

(a) Transmitter Power - For mobile service base stations, a phrase similar to 5.4.2, i.e. for maritime mobile services, might be desirable. It may also be desirable in both cases to couple maximum powers to effective antenna heights and to the required service areas.

In sections 5.4.1.1.d, 5.4.2.1.e, 5.4.2.3.1.d, 5.4.3.1.d, 5.4.4.1.d, it is stated that "Receivers shall have the requisite, stability selectivity, and modulation acceptance to permit FM operations with 25 (30) kHz channel spacing." Unless this is to be interpreted as merely meaning that the receivers should be capable of operating at 25 kHz (or 30 kHz) channel spacing under ideal conditions, it should include some statement

as to the desired-to-adjacent-channel undesired signal ratios with which the receivers should operate. It should also state that the requirement is to be met using transmitters which meet the requirements of section 5.4.

5.5 Necessary and Occupied Band Widths

As pointed out in Mr. Higgin's thoughtful memo of April 13, 1971 to Mr. Kirkewold, there is a great need for methods of defining the "necessary bandwidth" for multiplexed signals, of various types. Once this is done, then section 5.5 requires that the "occupied bandwidth" be kept as close to the "necessary bandwidth" as possible. Since there is a growing trend to use some of the results of information theory which permit trading of power for "occupied bandwidth" (e.g., use of high deviation ratios in FM), it may be timely to reconsider the definition of "necessary bandwidth." Specifically, it is possible that a more meaningful definition might be based on the required information rate at the transmitter input.

5.6.2 Minimum Performance Requirements for Receivers Where Protection from Harmful Interference is Required

(a) Harmful interference requires definition. This will be a major task!

(b) The prescribed slope of the (single signal) selectivety slope, 100 dB/kHz, seems excessive.

(c) Levels at which unwanted signals should not cause desensitization or spurious outputs from the receiver should be specified (see CCIR Rec. 332.1).

(d) Rejection of impulsive noise by receiver should be specified.

5.6.3 Minimum Performance Requirements for Antennas

It might be desirable to state some actual requirements here, particularly for point-to-point fixed services and include this section as part of section 5.6.2. This is because the receiving antenna can play a major role in rejecting unwanted signals arriving from directions different from that of the desired signal.

If this section does become part of 5.6.2, then in the title of 5.6.2 the word "receivers" should be replaced by "receiving installations" and levels of incident field, instead of receiver input should be used in 5.6.2.c.

Section 5.7.2 - The remarks directed at 5.6.2 apply here also.

Section 5.7.3 - The remarks directed at 5.6.3 apply here also for receiving antennas. It should be made clear that it is directivity in the horizontal plane that is of major importance. The time may also be appropriate to consider whether higher directivity should be required for fixed services at all frequencies.

General Comments (Partial)

Apart from the Table of Frequency Tolerances and Radar Criteria, most of the criteria apply to equipment working at 420 MHz or below. Criteria should be developed for systems operating at higher frequencies. For example, minimum standards for antenna patterns for microwave line-of-site relay and perhaps trans-horizon systems should be developed, particularly for bands shared with space services.

Definitions of grade of service and harmful interference should be given with indications of the maximum grade of service which can be expected and the degree of harmful interference which systems are expected to tolerate, before remedial action can be taken.

If the standards are modified as suggested above, it should be possible, for many general situations, to draw up curves of frequency

separation versus minimum spatial separation. These would serve as a guide, to users of conforming equipment, showing how closely various equipments could be located.

Finally, some other sections of the manual might well be located in Chapter 5. Examples that occur to me are section 8.2.2.25 on frequency diversity, and the tables in section 9.8.6 on required signal-to-noise ratios. No doubt there are others.

D D Crombie
5/10/71

Attachment 12
Minutes of 5/12/71

DEPARTMENT OF DEFENSE

STANDARDIZATION PROGRAM

PROGRAM ANALYSIS

ELECTROMAGNETIC COMPATIBILITY STANDARDIZATION PROGRAM

(EMCS)

FY 71 - 75

Assignee Activity -Naval Electronic Systems Command (EC)

Participating Activities -Army - Electronics Command (EL)
AF - Air Force Systems Command (10)
Navy - Naval Electronic Systems Command(EC)

APPROVED
30 APRIL 1971

Enclosure (1) to NAVELEX ltr
Ser 179 - 00T-1

FOREWORD

The DoD Directive 3222.3 of 5 July 1967 formally established the Department of Defense Electromagnetic Compatibility Program (EMCP) and placed the responsibility for standardization with the Secretary of the Navy, or his designee. The Naval Electronic Systems Command (NAVELEX) was designated Area Assignee Activity for the EMC Standardization Program (EMCS) by the OASD(I&L) and was directed to carry out its responsibilities in accordance with the Defense Standardization Manual 4120.3-M.

This Program Analysis was prepared by the Defense Standardization and Planning Division (ELEX 00T-1) of the Naval Electronic Systems Command in coordination with the Participating Activities of the military departments, interested Department of Defense and other Government Agencies. This document is in compliance with the Defense Standardization Manual 4120.3-M and represents a technical evaluation of the DoD Electromagnetic Compatibility Standardization Program (EMCS). It formulates and delineates the FY 71 through 75 standardization program for achieving intra and inter-system electromagnetic compatibility through the development, coordination and implementation of military standards and specifications for the design, development, procurement, production, test and installation of all electronic, electrical, and electromechanical equipments, subsystems, and systems of the Department of Defense. Recommendations regarding the implementation and monitoring of the program are also contained herein.

The EMCS standardization program is necessary to avoid conflicting and overlapping requirements which lead to non-uniform and costly engineering, production, test and installation practices. In addition, some degree of electromagnetic compatibility has, in the past, been achieved through suppression measures employed after the engineering design stage. However, this procedure increased the development and procurement costs and usually resulted in relatively unsatisfactory and unreliable suppression. The standardization, evaluation, and use of built-in design features, rather than after-the-fact remedial measures, will greatly reduce operational electromagnetic compatibility problems.

Additions or changes from the last issue of the EMCS Program Analysis are designated with an asterisk (*).

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I. THE DoD ELECTROMAGNETIC COMPATIBILITY STANDARDIZATION PROGRAM (EMCS)

A. Scope of Area Assignment

The DoD Directive 3222.3 of 5 July 1967 established the DoD Electromagnetic Compatibility Program and placed the responsibility for standardization with the Secretary of the Navy, or his designee. The Office of Technical Data, Standardization Policy and Quality Assurance within OASD(I&L) designated the Naval Electronic Systems Command as the Area Assignee Activity for EMC in their memo of 31 August 1967. In addition, the memo defined the scope of the task to cover: "...a complete range of component, circuit, equipment, subsystems and system electromagnetic compatibility (EMC). Related standards for prediction, measurement and validation for EMC are also to be included."

B. Participating Activities

The military departmental Participating Activities for the program are as follows:

Army Electronics Command (EL)
AMSEL-TD-SS
Ft. Monmouth, New Jersey 07703

Engineering Standards Division (SDMA)
Headquarters, Air Force System Command (10)
Andrews Air Force Base
Washington, D. C. 20331

Naval Electronic Systems Command (EC)
ELEX 0517
Washington, D. C. 20360

In addition, the National Security Agency (NSA) and National Aeronautics and Space Administration (NASA) were requested to participate in the development and coordination of the EMCS. NSA has established a Program Management office for EMC at Ft. Meade, Maryland and will receive all documents related to EMC standardization for coordination. NASA is not currently participating in the program. However, coordination with NASA is being pursued. Recently, several other agencies requested participation in the program at the "Participating Activity" level. Accordingly, the Defense Communications Agency (DCA), Electromagnetic Compatibility Analysis Center (ECAC) and Federal Aviation Administration (FAA) have been added as Participating Activities.

Efforts are also being taken to coordinate the EMCS with other Government agencies concerned with EMC, such as the Federal Communications Commission (FCC), Office of Telecommunications Policy (OTP) National *

Bureau of Standards (NBS), Defense Supply Agency (DSA), and the DoD Calibration Coordination Group (DoD/CCG). International standardization efforts in the EMC area are also being monitored through participation in NATO and International Electrotechnical Commission standards groups.

Industry has been advised of the Area Assignment and will continue to be informed of developments and documents in the EMCS through the various Industry Associations such as Aerospace Industries Association (AIA), American National Standards Institute (ANSI), Electronic Industries Association (EIA), Institute of Environmental Sciences (IES), Radio Technical Commission for Aeronautics (RTCA), the Society of Automotive Engineers (SAE) and the Institute of Electronic and Electrical Engineers (IEEE). *

Activities currently reviewing or using the various military EMI/EMC standardization documents are listed below. The DoD activity symbols are consistent with those in SD-1, Standardization Directory, Planning Schedule and Points of Contact. Distribution of this analysis is shown in Appendix A of this document.

Army - EL, MI, AV, AT, ME, WC, GL, CE, MD

Navy - EC, SH, OS, AS, YD, MC

AF - 10, 11, 13, 15, 17, 19, 68, 69, 70, 71, 79, 80, 82, 84

DCA - Defense Communications Agency (DC)

NSA - Ft. George G. Meade, Maryland (NS)

Electromagnetic Compatibility Analysis Center - North Severn, Annapolis, Md.

DESC - Defense Electronic Supply Center (ES)

Industry - AIA, ANSI, EIA, IES, RTCA, SAE and IEEE. *

Other Government Agencies - FAA, FCC, OTP, NBS, etc.

A summary of the Area Assignment structure for the EMC Standardization Program (EMCS) is shown in Table I. Points of contact are also shown in Appendix A of this document.

II. DEFINITIONS

The definitions of terms contained herein are in accordance with Standardization Manual 4120.3-M and MIL-STD-463, Definitions and System of Units, EMI Terminology. In addition, the following definitions apply:

(1) Communication-Electronic (CE) Equipment. Any item, generating, transmitting, conveying, acquring, receiving, storing, processing or utilizing electronic/electromagnetic information in the broadest sense. Such devices are used to meet a variety of

TABLE I - DEFENSE STANDARDIZATION PROGRAM
AREA ASSIGNMENT STRUCTURE FOR EMC STANDARDIZATION PROGRAM (EMCS)

LEVEL OF RESPONSIBILITY	FUNCTION	OFFICE		
DoD	Direct the Defense Standardization Program (DSP)	OASD(I&L) WR		
	Engineering Policies and Determinations Required to Attain Objectives of DSP	ODDR&E and JCS		
Assignee	Provide Departmental Guidance for Conduct of DSP.	SECNAV (CNM as NavyDepSO (MAT-0433))		
Assignee Activity	Manage Standardization Program for EMCS for DoD and Insure its Implementation (Chair DoD EMCS Planning Committee)	NAVELEX; Defense Standardization and Planning Division (OOT-1)		
Participating Activities	Develop & Coordinate MIL-DEPT's Interest in the EMCS	ARMY ECOM(AMSEL-TD-SS)	NAVY NAVELEX 0517	AIR FORCE AFSC-(SDMA)
Preparing Activities	Prepare Individual Standardization Projects as Assigned (Technical Points of Contact)	ECOM(AMSEL-GG-EC) ECOM(AMSEL-NL-C)	NAVELEX 0512 NAVAIR 53356 NAVSEC 6174 & 6179C NAVORD 0451 NAVFAC (CBC)	RADC (RCCM) W-PAFB(ENVCC) ESD(ESLE)
Review Activities	Review and Comment on Studies and Documents Developed and Coordinated under EMCS Program	Government Agencies - Same as Preparing Activities plus: FAA* NASA* ECAC* NSA* DCA* DESC FCC NBS OTP		Industry SAE EIA AIA IEEE RTCA ANSI IES

*In addition, these Agencies have an input to the EMCS (similar to a Participating Activity).

operational requirements such as communications, surveillance, identification, navigation, guided-missile control, countermeasures and space operations. (Based on MIL-STD-461A, EMI Characteristics Requirements for Equipment).

(2) Deviation - A specific written authorization, granted prior to the manufacture of an item, equipment or system, to depart from a particular performance or design requirement of a specification or standard. (Based on MIL-STD-480, Military Standard Configuration Control-Engineering Changes, Deviations and Waivers.)

(3) Electromagnetic Compatibility (EMC). The ability of communications-electronic (C-E), electrical, and electromechanical equipment, subsystems, and systems to operate in their intended operational environments without suffering or causing unacceptable degradation because of unintentional electromagnetic radiation or response (Based on definition in DoD Dir 3222.3).

(4) Electromagnetic Interference (EMI). The obstruction, interruption or degradation of the design performance characteristics of C-E equipment resulting from excessive or undesired emissions.

(5) Electromagnetic Compatibility Program Plan. A plan describing the technical and managerial policies, procedures and actions to assure that a system, subsystem, or equipment can perform its operational mission in its intended operational environments (Note definition 3 above).

(6) System - A composite of equipment, skills and techniques capable of performing and/or supporting an operational role. A complete system includes all equipment, related facilities, material, software, services and personnel required for its operation and support to the degree that it can be considered a self-sufficient unit in its intended operational environment (MIL-STD-499(USAF), System Engineering Management).

(7) System effectiveness. System effectiveness is a measure of the degree to which a system achieves a set of specific mission requirements. It is a function of availability, dependability, and capability. (Based on MIL-STD-499 (USAF)).

(8) Tailoring. The process by which the requirements in a standard are adapted to the peculiarities of a particular system or equipment and the program contractual structure such as the number and types of interfaces, assignment of interface responsibilities, technical and/or management complexity, program life cycle phase, degree of program risk, number of items being procured, etc. Tailoring may take the form of deletion, alteration or addition of requirements in a standard. (Based on MIL-STD-499 (USAF)).

(9) Waiver. A written authorization to accept an item, equipment or system which during production, or after having been submitted for inspection, is found to depart from specified requirements, but nevertheless is considered suitable for use "as is" or after rework by an approved method. (Based on MIL-STD-480).

III. PRESENT STATUS OF THE EMCS

A. EMCS Documents

1. Existing Documents. At present, the electromagnetic compatibility standardization area includes the following existing military standards and specifications:

Existing Tri-Service and Limited Coordination Documents

Number	Title	Preparing Activity
MIL-STD-220	Method of Insertion Loss Measurement	Army (EL)
MIL-STD-285	Attenuation Measurements for Enclosures, EM Shielding for Electronic Test Purposes, Method of	Army (EL)
MIL-STD-449	Radio Frequency Spectrum Characteristics; measurement of	Navy (EC)
MIL-STD-461	EMI Characteristics Requirements for Equipment	Navy (EC)
MIL-STD-462	EMI Characteristics; Measurement of	AF (11)
MIL-STD-463	Definitions and System of Units; EMI Technology	Army (EL)
MIL-STD-469	Radar Engineering Design Requirements; EMC	Navy (SH)
MIL-B-5087	Bonding, Electrical, and Lightning Protection for Aerospace Systems	AF (11)
MIL-E-6051	Electromagnetic Compatibility Requirements for Systems	AF (11)

Existing Single-Service Documents

MIL-STD-1310(SH)	Shipboard Bonding & Grounding Methods for EMC	Navy

2. Superseded Documents. Thirteen superseded EMI/EMC documents are monitored under the EMCS. These documents are listed below. Notes for each document are as follows:

NOTES: (1) Superseded by MIL-STD-461/462. Inactive for new designs.*
(2) Superseded by MIL-E-55301(EL)
(3) Superseded by MIL-STD-826

Superseded Tri-Service and Limited Coordination Documents

Number	Title	Preparing Activity
MIL-I-6181(1)	Interference Control Requirements; Aircraft Equipment	AF (11)
MIL-S-10379 (1)	Suppression Radio Interference; General Requirements for Vehicles (and Vehicular Subassemblies)	Army (EL)
MIL-S-12348(1)	Suppression, Radio Interference, Railways and Maintenance of Ways Equipment	Army (EL)
MIL-I-43121(1)	Interference Reduction for Electric Hand Tools	Army (EL)

Superseded Army Documents

Number	Title
MIL-I-11683(2)	Interference Suppression, Radio, Requirements for Engine Generators and Miscellaneous Engines
MIL-I-11748(2)	Interference Reduction for Electrical and Electronic Equipment
MIL-S-13237(2)	Suppression, Radio Interference Requirements for Watercraft
MIL-E-55301(EL)(1)	Electromagnetic Compatibility

Superseded Navy Documents

Number	Title
MIL-I-16910(SH)(1)	Interference Measurement, Electromagnetic, Methods and Limits
MIL-I-17623(Navy)(1)	Interference Measurement, Electromagnetic, Methods and Limits for Electric Office Machines, Printing and Lithographic Equipment
NAVFAC 50-Y(1)	Overhead Power Lines Operating at Voltages from Zero to 1000KV, 14kHz to 1GHz.

Superseded Air Force Documents

Number	Title
MIL-STD-826(1)	Electromagnetic Interference Test Requirements and Test Methods

(3)

3. Related Documents.

Many Military, Governmental, Industry and International documents contain requirements and/or test procedures which are related to those contained in the EMC documents. Consequently, each of these documents should be monitored and proposed revisions coordinated by the military departments to avoid duplication or conflicting requirements. Unresolvable conflicts should be referred to the Assignee Activity for action. Some of these related documents are listed below:

Preparing Activity	Document Number	Title of Document
AF	MIL-STD-442	Telemetry Standards
AF	MIL-STD-454	Standard General Requirements for Electronic Equipment
AF	MIL-STD-499	System Engineering Management
ANSI	C63.2-1963	Radio Noise and Field Strength Meters, 0.015 to 30 Mc/s; Specifications for
ANSI	C63.3-1964	Radio Noise and Field Strength Meters, 20 to 1000Mc/s; Specifications for
ANSI	C63.4-1963	Radio Noise Voltage and Field Strength, 0.015 to 25 Mc/s, Low Voltage Electric Equipment and Non-Electric Equipment; Methods of Measurement of
ANSI	C95.1-1966	EM Radiation with Respect to Personnel, Safety Level of
ANSI	C95.2-1966	Radio Frequency Radiation Hazard Warning Symbol
Army	MIL-STD-188	Military Communication System Technical Standards
Army	MIL-S-13715	Transients on Vehicles
British Stds. Institution	D65-9371	General Requirements for Electrical Equipments and Indicating Instruments for Aircraft; RFI
CISPR	Publications 1 thru 9	International Special Committee on Radio Interference, Regulations and Test Procedures
DASA	DASA 2114-1	Electromagnetic Pulse Handbook

Preparing Activity	Document Number	Title of Document
DCA	DCAC-330-175-2	DCS Engineering Installation Standards
EIA	Sections 1 thru 10	Designer Guide on EMC
FCC	Part 18	Rules and Regulations for ISM Equipment
FCC	Part 15	Rules & Regulations Radio Frequency Devices
ITU	Geneva 1959	International Telecommunications Union Rules & Regulations
NASA	MFSC-SPEC-279	Geo. C. Marshall Space Flight Center, NASA Specification, EMC
NASA	MSC, Houston IESD-19-3	Interference Control Requirements for Spacecraft Equipment
NASA	MSC, Houston, PACE-S/C, Project Office Spec 53, Revision 1 to MIL-I-26600	Performance Spec for Equipment Grounding Requirements on Pre-Flight Acceptance Checkout Equipment-Spacecraft (PACE S/C) Program
NATO(MAS)	STANAG 3456	Aircraft Electrical System Characteristics
NATO(MAS)	STANAG 3516	EMC Test Methods for Aerospace Electrical and Electronic Equipment
NATO(MAS)	STANAG 3614AE (Proposed)	EMC of Installed Equipment in Aircraft
Navy(AS)	MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
NSA	NACSEM 5100 thru 5105	National COMSEC/EMSEC Information Memoranda, Compromising Emanations Laboratory Test Standards.
RTCA	Doc. No. DO-138	Environmental Conditions and Test Procedures for Airborne Electronic/ Electrical Equipment and Instruments
SAE	J551	Measurement of Vehicle Radio Interference (30-1000 MHz)
SAE	SAE ARP-936 (Referenced in MIL-STD-461)	10 Microfarad Capacitor for EMI Measurements

Preparing Activity	Document Number	Title of Document
SAE	SAE ARP-937	Jet Engine-EMI Test Requirements & Methods
SAE	SAE ARP-958	Broadband EMI Measurement Antennas; Standard Calibration Requirements and Methods

Individual equipment or system specifications detailing EMC requirements are not included in the military series. However, they do reference and expand on the requirements contained in military EMC documents. These specifications should be reviewed to assure that they do not conflict with the requirements in the military EMC standards. Component and tube specifications also contain requirements related to those in the EMC standards. These requirements should also be reviewed to assure that they are consistent with the latest EMC requirements and capabilities.

4. Manuals and Handbooks.

Departmental manuals and handbooks, such as NAVSHIPS 900,000.105 (Electronics Installation and Maintenance Book on RFI Reduction), AF Manuals 100-31 and DH 1-4, RADC TR-66 (Interference Notebk),ECOM Interference Reduction Guide (Volumes I and II), etc., containing EMC design requirements and guidelines, shall be considered as EMCS documents.

B. Policy Regarding Coordination with Other Elements of the DoD EMC Program (EMCP)

In establishing the DoD EMC Program, DoD Directive 3222.3 identified the other elements of the EMCP to include Measurement Techniques and Instrumentation, (MT&I), Test and Validation (T&V), and Data Base and Analysis Capability (DB&AC). The MT&I and T&V areas are being managed by the Army and the DB&AC by the Air Force. The manager is responsible for preparing and coordinating a plan in the specific EMC program element with the other military departments. In addition, coordination of the efforts in these elements with the EMCS area is necessary since standards covering prediction measurement and validation of EMC fall within the scope of the EMCS and are to be processed in accordance with the procedures of the Defense Standardization Program. Accordingly, ODDR&E, in coordination with OASD(I&L) will forward the plans for the other EMC program elements to the Assignee Activity of the EMCS for coordination and review by the standardization Participating Activities in accordance with the procedures of the DSP

Coordination of this program analysis will be accomplished in accordance with the procedures of the Defense Standardization Manual thereby eliminating a separate coordination cycle with the aforementioned EMC program elements managers.

The other EMC program element managers are listed in Appendix A of this analysis.

C. Policy Regarding Relation of EMCS to Other Related Programs

As indicated in DoD Directive 3222.3, the Electronic Countermeasures (ECM), Electromagnetic Pulse (EMP) and Radiation Hazards (RadHaz) programs concern specific aspects of the use of or defense against the effects of electromagnetic radiations. Their existence as separate programs is predicated on either military requirements or overriding urgency due to danger to personnel. The directive further states that as the EMCP progresses, it should "augment, be used by, and, in some instances, be integrated with these programs" and that these other programs should be conducted so that, "as a minimum, equipments and systems developed for their special purposes shall meet all applicable EMC standards of conventional C-E equipment and systems."

At the request of OASD(I&L), several standardization study projects were initiated to determine the status of current and planned standardization activities in the aforementioned programs plus the Electro-Explosive Device (EED) program. Results of these studies will be utilized by DoD when reconsidering the relationship of these programs to the DoD EMC Program.

D. Policy Regarding Waivers to EMC Documents

The DoD Directive 3222.3 states that "adherence by all DoD components to all EMC standards and specifications shall be mandatory for the applicable operational C-E equipments, subsystems and systems unless duly waived." Furthermore, the directive indicates that "authority for waiver control over any of the EMC standards and specifications shall rest at a level as determined by the Secretary of the Military Department or Agency Director concerned for intra-service equipment environments. This authority shall be delegated with careful discretion to prevent evasion of the EMC standards and specifications."

To date, the Army and Air Force regulations (AR 11-13 and AFR 80-23 respectively) which implement the DoD Directive indicate that requests for waivers are to be submitted to the Assistant Chief of Staff for C-E, Department of the Army, and the Headquarters, U. S. Air Force, respectively. By contrast, the Navy's implementing instructions (i.e., OPNAV INST 2410.31A and NAVMAT INST 2410.1) place the responsibility for ensuring EMC of the electronic/electrical equipment and systems with the Commander of each Systems Command and each Chief of Naval Material designated Project Manager.

IV. BENEFITS

The benefits that will be realized as a result of this standardization program include:

A. In Direct Support of Procurement:

(1) Reduction in procurement costs by providing current and realistic EMC requirements to a specific procurement, rather than providing requirements which may be too stringent and thereby increase the size, weight, and cost of the item.

(2) Simplifying procurement methods and processes (competition, pre-contract liaison, etc.) by having definite, invoked standards that are technically correct, attainable and essentially acceptable to Industry.

B. In Support of Engineering (design and development)

(1) Establishment of uniform requirements and design criteria to be used during equipment design which will aid the reduction of electromagnetic interference problems prior to deployment of the equipment. This will reduce the need for costly "after-the-fact" suppression measures.

(2) Establishment of a single series of Tri-Service EMI/EMC test methods and instrumentation requirements, as opposed to many Single-Service or limited-coordination requirements, and thereby: save considerable time and money now expended in the study and interpretation of different requirements; result in more valid, accurate and repeatable measurements; reduce the number of instruments required to perform the tests; and provide a high degree of confidence that Tri-Service (Joint Command) use of the equipment will be possible. In addition, this will reduce the total number of documents managed under the DSP.

C. In Relation to Overall Program Costs

Achieving EMC through compliance with effectively implemented standards and specifications will provide a direct and favorable impact on program costs. The likelihood of satisfactory and reliable functional performance with minimum costs is greatly enhanced when EMC standards are effectively imposed. In addition, a reduction in the number of EMI problems and the downtime resulting from these malfunctions increase the possibility of complying with the planned program completion schedule.

The cost aspect of an EMC standardization program is difficult to define. EMC is an integral part of every phase of the program activity. It is almost impossible to separate it from all other controls to a sufficient extent to say with accuracy "these figures represent the affect of EMC standardization on this program." Difficult as this task may be, however, there are still some very specific conclusions that can be defined and supported relative to EMC and total program costs. These conclusions will go a long way toward destroying the myth that EMC requirements represent an astronomical and out-of-proportion program cost. In addition, they point up the fact that compliance with EMC standards will, actually, be less expensive.

In order to have an electromagnetically compatible system, EMC must be considered from the initial design phase. These "before-the-fact" design requirements and guidelines are imposed to assure: (1) that electromagnetic emissions from individual equipments do not exist by any path other than the intended terminals; (2) that the individual equipments will respond only to emissions entering through the intended terminals; (3) that no electromagnetic emission other than the intended emission is generated; and (4) that there will be no response to any emission other than the intended emission. Applicable limits, above and/or below which emissions and susceptibilities are acceptable for each of these four conditions, are contained in the present Military standards. In addition, EMC design guidelines represent reasonable, valid, and necessary requirements when utilized at the equipment design level. The approach to EMC in the equipment design is not new or different from the approach for any other requirement. Therefore, it can be concluded that the relative cost of equipment design for compliance with EMC requirements is consistent with the costs resulting from imposing other similar program requirements. The prevailing attitude that EMC design costs are necessarily and exhorbitantly high costs is, therefore, incorrect.

Considering the cost of imposing EMC standardization requirements relative to the cost of imposing similar type program requirements is, in reality, another way of saying that the EMC costs should be considered in their proper perspective. This is often not done, especially when EMC standards are not understood. It is not uncommon to hear statements to the effect that, if EMC requirements are imposed, the cost of the program

will be increased by 200 to 300 percent. However, in essentially every situation of this type, the cost of compliance with EMC standards and specifications are quoted out of perspective and, therefore, appear excessive.

In any major program involving electrical and electronic equipment and systems, when EMC requirements have not been imposed, it can be assured that EMI problems at the equipment/subsystem level and electromagnetic incompatibilities at the systems level will appear. These problems may or may not be catastrophic in their consequence, but they will exist. Catastrophic problems may be considered as aborted missions (missile failures), loss of lives caused by unreliable performance of the system, etc. Non-catastrophic problems are not so well publicized, but usually occur day-in and day-out with very little serious effort directed towards their resolution. These problems include undesired signals on data channels, intermittent triggering of logic circuits, and the loss or gain of information bits in pulse train, etc. With the advent of more sophisticated, sensitive and compact electrical and electronic systems and equipment, current experience is proving that living with these problems is unacceptable.

Most non-catastrophic problems appear during or after the testing phase. The resultant costs are a function of the magnitude of the problems and the corresponding actions needed for their resolution. Tangible costs are associated with man-hours expended, structural or electrical equipment modifications incorporated, the new documentation needed to define the incorporated changes, personnel travel and the loss of time from other programs. Intangible costs will take the form of decreased reliability and confidence in the satisfactory operation of the final system.

The above discussion is not meant to imply that compliance with EMC standards and specifications is inexpensive, or, that it is possible to "get something for nothing." However, the following conclusions can be made:

a. The cost of imposing EMC standards is not out of proportion with the costs involved in imposing other similar program requirements.

b. The cost of imposing EMC standards must be considered in perspective with the other program costs. Considering EMC costs in this manner is the only way erroneous evaluations can be prevented.

c. Documented evaluations of various programs clearly show that EMI has caused catastrophic failures that were extremely costly in terms of specific missions, even more costly than compliance with EMC standards.

d. Further documentation exists to clearly show that present operations and programs are hindered by numerous day-to-day EMI problems. These problems are a significant disruption to a satisfactory program operation because of lost time and lack of final system confidence. Both the time lost and the final system confidence directly impact, in an adverse way, the overall program costs.

It should also be noted, however, that compliance with EMC standards and specifications does not guarantee a compatible system. But, an effective EMC program plan which implements the applicable portions of the EMC documents will reduce the number of EMI problems and associated costs for fixes. And too, the costs associated with implementing an effective EMC program will, in the long run, be cheaper than "after-the-fact" suppression.

V. PLANNED COURSE OF ACTION

A. Objectives of EMCS

The objectives listed below must be met to achieve a practical degree of standardization in EMC. Achievement of these objectives will lead to the realization of the Long-Range Plan for the EMCS documents described in Section VI of this analysis.

(1) Develop guides and criteria treating all aspects of designing Military communications-electronic equipments and systems for controlling electromagnetic emission and susceptibility

(2) Develop a handbook describing in detail the elements of the EMC program and procedures for implementing the EMC Program in military projects.

(3) Develop a standard covering EMC requirements and test procedures for all military systems and, in doing so, consolidate the features of MIL-E-6051 and several military handbooks and directives;

(4) Effect an updating program to incorporate the latest design techniques and military operational requirements, and the results obtained by the other EMC Program Areas such as Measurement Techniques and Instrumentation, Test and Validation, etc., into the various EMC documents within the scope of the EMCS;

(5) Assure coordination of EMC with documents containing related or overlapping requirements such as MIL-STD-188, NACSEM's, DCA Standards (currently being converted into military standards), MIL-STD-454 and the various power system standards such as MIL-STD-704; *

(6) Make periodic evaluations of the standardization program to determine operational requirements and standardization costs involved to meet the requirements;

(7) Evaluation of waiver and deviation actions to the EMC Standards by procuring agencies to determine whether changes in existing requirements are necessary and submit proposed changes to cognizant activity. *

(8) Review the various EMC documents detailing electromagnetic emission requirements to assure that they are consistent with the requirements for effective electronic warfare operations.

D. Active EMC Standardization Projects

Table II outlines the scope of each active EMCS project. Projects EMCS-0021 through 0024 were initiated at the request of OASD(I&L). The areas under investigation are not currently within the scope of the EMCS. When/if standardization in any of these programs are determined to be part of the EMCS by the proper office in DoD, standardization projects will be initiated as required. Until then, activities desiring to prepare standards or specifications for these areas should contact OASD(I&L)AR.

It was noted that by virtue of an OASD(I&L)AR memorandum of 7 February 1969, the symbol for the EMC Standardization Program area assignment was changed from EMCP to EMCS. This change was made to some Standardization Project Reports (DD Forms 1585) which were submitted under the original EMCP designation. It is requested that the symbol be changed for all active projects previously reported under the EMCP designation as soon as possible.

TABLE II

SCOPE OF EACH ACTIVE STANDARDIZATION PROJECT

Project Number	Scope
EMCS-0037*	Using the material developed under Project EMCS-0012, prepare and coordinate a handbook describing analytical tools available for use in shielding design. This project was initiated at the request of the USAECOM.
EMCS-A036*	Prepare Interim Notice #2 to MIL-E-6051 detailing specific Army requirements to achieve system EMC (aeronautical systems only).
EMCS-035 and 034*	Numbers will not be used.
EMCS-N033*	Revise and update grounding and bonding requirements for surface ships and submarines in MIL-STD-1310A (SHIPS). This project was initiated at the request of NAVSEC inasmuch as EMCS-0007 has been cancelled.
EMCS-0032*	Study project to develop waveforms for a laboratory simulation of lightning.
EMCS-0031*	Study project to develop requirements for the control of electromagnetic and static hazards during aircraft servicing, fueling and maintenance.
EMCS-A030*	Preparation of an Army notice (#3) to MIL-STD-462 detailing changes to test procedures for Army procurements.
EMCS-A029*	Preparation of an Army notice (#4) to MIL-STD-461A detailing changes to requirements for Army procurements.
EMCS-0028*	Study project to determine the possibility of developing a standard or handbook to detail the composition of an effective EMC program, including the responsibilities of the military and industry in establishing and implementing the EMC Program. This project was initiated upon the request of the preparing activity and replaces project EMCS-0008.
EMCS-0027*	Study project to validate the emission and susceptibility limits in MIL-STD-461A.
EMCS-0026*	Revise and update test procedures and requirements in MIL-STD-285.
EMCS-0025*	Prepare and coordinate a new military standard detailing the minimum criteria for EMC/EMI measuring equipment. Test procedures for determining conformance with the stated criteria is also to be included

TABLE II

SCOPE OF EACH ACTIVE STANDARDIZATION PROJECT
(Continued)

Project Number	Scope	
EMCS-0024 (Completed)	Study project to determine the status of current and planned standardization activities in the area of Electronic Countermeasures (ECM) and discuss the relationship of these activities in the ECM program to the EMCS.	*
EMCS-0023 (Completed)	Same as EMCS-0024 except the area of concern is Electromagnetic Pulse (EMP).	*
EMCS-0022	Same as EMCS-0024, except the area of concern is Radiation Hazards (RadHaz).	
EMCS-0021 (Completed)	Same as EMCS-0024 except tht area of concern is Electro-Explosive Devices (EED's).	
EMCS-0018	Revise and update MIL-STD-461A; eliminate conflicts with MIL-STD-469 and other related documents.	
EMCS-0017 (Completed)	Prepare a notice to MIL-STD-826A concerning the requirements for reprocurements of items previously certified to the standard.	
EMCS-0015	Revise and update the test procedures and requirements in MIL-STD-220A; extend the frequency range of the tests in the standard and to determine filter insertion losses for other than 50-ohm systems.	*
EMCS-0014	Prepare and coordinate a military handbook which would provide a directory of EMC prediction and analysis computer programs and models used in the DoD in the standardization, design, development, procurement and deployment of military electronic equipment and systems.	
EMCS-0013	EP Study on pulse shapes and their use as analytical tools for comparison and standardization of pulse shapes.	
EMCS-0012	Cancelled; see EMCS-0037	*

TABLE II

SCOPE OF EACH ACTIVE STANDARDIZATION PROJECT
(Continued)

Project Number	Scope
EMCS-0011	Revise MIL-STD-449C with particular attention to updating the definitions and test procedures for MIL-STD-449C and coordinating them with the definitions and procedures currently in MIL-STD-463/ 462 and 469 and those planned for inclusion in revisions to these documents.
EMCS-0010	Revise and update the requirements and test procedures in MIL-STD-469; eliminate conflicts with MIL-STD-461/462; consider removing test methods similar to those in MIL-STD-462 and referencing those in MIL-STD-462; consider inserting the general definitions of MIL-STD-469 into MIL-STD-463.
EMCS-0009	Prepare and coordinate a standard detailing EMC requirements for all systems and in doing so expand the scope of MIL-E-6051 and other L. C. documents or instructions; general definitions should be incorporated into MIL-STD-463; consider placing test methods into MIL-STD-462.
EMCS-0008	Cancelled; see EMCS-0028 *
EMCS-0007	Cancelled; see EMCS-N033 *
EMCS-0006	Perform a study to determine the feasibility of updating and consolidating over 4000 existing design manuals into one Military EMC Design Handbook; upon development and approval of a plan, the handbook will be developed.

TABLE II

SCOPE OF EACH ACTIVE STANDARDIZATION PROJECT

(Continued)

Project Number	Scope
EMCS-0005	Revise and update MIL-STD-463; incorporate general definitions of MIL-STD-449, 469, the system standard, the bonding/grounding standard and the remaining definitions in MIL-STD-461/462; general conversion factors and equations may also be included. *
EMCS-0004	Revise and update the test procedures in MIL-STD-462; eliminate conflicts with similar or duplicate procedures in MIL-STD-449 and 469; consider including test methods from the other standards into MIL-STD-462.

C. Time Phase Schedule of Standardization Projects

Table III outlines the schedule for active standardization projects in the EMCS area. Milestone symbols are defined below:

I = Project Initiated

S = Scheduled Completion Date for Work on Project

C = Project Completed
X= Project Cancelled

Completion schedules are based upon those given to the Assignee Activity during coordination of this analysis. Where applicable, the preparing activity should update the Standardization Project Report Form, DD 1585, to reflect the new scheduled completion dates. The Working Group Method, Chapter III, Section 2 of the Defense Standardization Manual 4120.3-M is recommended for use to expedite coordination and completion of the projects.

D. Recommended Actions in the EMCS

The following additional actions are recommended to meet the objectives in V. A. above.

(1) In addition to the officially established EMCS projects detailed in Table II, separate efforts have been underway to review and coordinate the EMC requirements in forthcoming revisions to MIL-STD-188 and the various Defense Communications Agency standards. These efforts should be continuous to assure that the correct EMC requirements are included in future tactical and strategic communications systems and equipment.

(2) Another coordination effort has been attempted by the Assignee Activity with the NSA in their revision to FED-STD-222. The goal of this effort was to coordinate the general test setup in both FED-STD-222 (Revised) and MIL-STD-461. It is recommended that future revisions to NSA documents be coordinated with the EMC community in a similar manner.

(3) Similar coordination efforts are required in other areas, notably the various "power requirements" standards such as MIL-STD-704 and those issued by the DoD Project Manager for Mobile Electric Power (MEP) so as to avoid conflicts in the power requirements permitted by these documents and, (1) the emission and susceptibility requirements in MIL-STD-461, and (2) the system EMC requirements in MIL-E-6051. If problems arise which cannot be resolved, the Assignee Activity can, upon notification from the Participating Activities, take the matter up with the DepSO's and OASD(I&L).

TABLE III

TIME PHASE SCHEDULE OF STANDARDIZATION PROJECTS

EMCS

FISCAL YEARS				1971				1972				1973				1974				FY 1975 and FY 1976	NOTES	
FISCAL QUARTERS				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
ect er	Project Description	Prep Acty.	Departmental Custodians																			
7	Shielding Handbook	EL	EC, 11			I						S								Project assignments during this period will consist of revisions to the existing MIL-STD's. In addition, new projects will be initiated as required to accomplish long-range goals outlined in subsequent sections of this analysis.	(2), (7)	*
6	Preparation of Army Notice #2 to MIL-E-6051	EL				I	S														(2)	*
5	Will not be used.																					*
4																						*
3	Revise MIL-STD-1310A (SHIPS)	SH				I			S												(2), (10)	*

(Continued)
TABLE III

TIME PHASE SCHEDULE OF STANDARDIZATION PROJECTS
EMCS

FISCAL YEARS				1969				1970				1971				1972				FY 1973 thru FY 1975	NOTES	
FISCAL QUARTERS				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
er	Project Description	Prep. Acty.	Departmental Custodians																			
	EP Study - Develop Waveforms for Lab Simulation of Lightning	11	EL, AS										I				S			Project assignments during this period will consist of revisions to the existing MIL-STD's. In addition, new projects will be initiated as required to accomplish long-range goals outlined in subsequent sections of this analysis.	(2)	*
	EP Study -Develop rqmts for control of EM/Static hazards during aircraft servicing/fueling	11	EL, AS										I				S				(2)	*
9	Army Notice to MIL-STD-462	EL										I		C								*
9	Army Notice to MIL-STD-461A	EL										I		C								*
8	EP Study - EMC Program Reqmts, Handbook or Standard?	EC	EL, 11									I				S					(2,4)	*
7	EP Study - Validation of EMC Limits	17	EL, EC							I						S						*
2C	Revise MIL-STD-285	EL	YD, 11							I										S (1973)	(8)	*
25	Prepare Tri-Service Standard on EMC/EMI Meas, Eqmt. Characteristics	EL	EC, 11							I							S				(8)	*

(Continued)

TABLE III

TIME PHASE SCHEDULE OF STANDARDIZATION PROJECTS

EMCS

FISCAL YEARS				FY 1968				FY 1969				FY 1970				FY 1971				FY 1972 thru FY 1974	NOTES
FISCAL QUARTERS				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
PROJ. NUMBER	PROJECT DESCRIPTION	PREP. ACT'Y	DEPARTMENTAL CUSTODIANS																		
4	EP Study on ECM	EC	EL, 11							I							C			Project Assignments during this period will consist of revisions to the existing MIL-STD's. In addition, new projects will be initiated as required to accomplish long-range goals outlined in subsequent sections of this analysis.	*
3	EP Study on EMP	EC	EL, 11							I					C						*
2	EP Study on RadHaz	11	EL, SH							I					S						
1	EP Study on EED's	11	OS, MU						I								C				(1) (2) *
18	Revise MIL-STD-461A	EC	EL, 11						I										S (1972)		*
17	Notice to MIL-STD 826A	11						I							C						*
15	Revise MIL-STD-220A	EL	YD, 11					I											S (1973)		(2) (8) *
14	Prediction Hdbk	17	EL, AS			I												S			(3) *
13	EP Study, Pulse Shapes	EL	SH, 17			I													S		*
12	Prepare Standard on Shielding	EL	EC, 11			I												X			(2), (6) *

(Continued)

TABLE III

TIME PHASE SCHEDULE OF STANDARDIZATION PROJECTS

EMCS

FISCAL YEARS				FY 1968				FY 1969				FY 1970				FY 1971				FY 1972 thru FY 1974	NOTES	
FISCAL QUARTERS				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
PROJ. NUMBER	PROJECT DESCRIPTION	PREP. ACT'Y	DEPARTMENTAL CUSTODIANS																			
0011	Revise MIL-STD-449C	EC	EL, 11						I									S		Project assignments during this period will consist of revisions to the existing MIL-STD's. In addition, new projects will be initiated as required to accomplish long-range goals outlined in subsequent sections of this analysis.		*
0010	Revise MIL-STD-469	SH	EL, 17				I											S				
0009	Prepare Tri-Service Standard on EMC Requirements for Systms	11	EL, EC			I											S					
0008	Prepare Standard on EMC Program Requirements	EC	EL, 11			I										X					(5)	*
0007	Prepare Tri-Service Standard on Bonding & Grounding Methods	SH	EL, 11			I												X			(9)	*
0006	Study for EMC Design Handbook	EL	EC, 11			I													S (4Q72)	S		*
0005	Revise MIL-STD-463	EL	EC, 11			I													S			*
0004	Revise MIL-STD-462	11	EL, EC			I													S (2Q72)	S		*

NOTES TO TABLE III

(1) The Army Munitions Command requested that the preparing activity responsibility be changed for this project. Accordingly, the AFSC (11) was requested to assume preparing activity responsibility at the 16 Dec 1969 meeting to coordinate this analysis. The AF Participating Activity representative accepted and submitted the schedule shown herein.

(2) Assignee Activity has not received a copy of the DD Form 1585.

(3) No DD Form 1585 submitted. This project is being delayed due to (1) lack of resources to prepare handbook, and (2) completion of the DoD Plan on Data Base and Analysis Capability being prepared by the AF.

(4) Project initiated upon cancellation of EMCS-0008. *

(5) See Project EMCS-0028. *

(6) Project cancelled. A new project (EMCS-0037) was initiated to use the material available for the preparation of a handbook. *

(7) See project 0012. *

(8) Scheduled completion changed by Army comments on draft of program analysis. Appropriate DD Form 1585's should be submitted to OASD(I&L). *

(9) Based on the comments received by the preparing activity on the first draft of the standard, it was determined that development of an acceptable standard was not feasible at this time. Accordingly, this project was cancelled and project EMCS-N033 initiated to revise MIL-STD-1310(SH) for ship and submarine requirements. *

(10) Project initiated upon cancellation of EMCS-0007. *

VI. MANAGEMENT CONTROL SYSTEMS IN EMCS DOCUMENTS

A. Introduction

Advance Change Notice to the Defense Standardization Manual 4120.3-M, dated 22 May 1969, prescribes procedures for the segregation of data and management system requirements when expressed in military standards and specifications. Preparing activities are required to comply with these procedures when promulgating or revising the various military standards. OASD(I&L) memorandum AR/PI of 7 July 1969 provides a segment of advance guidance for FY 1970 to supplement the Advance Change Notice. In accordance with the advance guidance, preparing activities of military EMC standards and specifications shall perform the following actions, as appropriate:

(1) Review all military EMC specifications and standards identified as management control system (MCS) documents for compliance with the definition of an MCS document and validate these documents through departmental channels to OASD (Comptroller).

(2) Identify military EMC documents which meet the definition of MCS documents but are not included on the existing Interim Management Control Systems List (MCSL) and provide for their inclusion.

(3) Convert military EMC specification identified as MCS documents (listed or candidates for listing) into military standards (book form) when revision is necessary.

(4) Segregate and identify MCS documents, or elements thereof, and data requirements in all EMC standards and specifications undergoing revision.

(5) Schedule revisions of specifications and standards where they have been identified as containing MCS requirements, or elements thereof, and/or data requirements.

B. Reporting Requirements

In keeping with the need for reporting progress made relative to the segregation of data and management system requirements, OASD(I&L)AR memorandum of 6 August 1969 requests that progress be reported in the semi-annual Standardization Accomplishment Report required by the Defense Standardization Manual 4120.3-M. Accordingly, preparing activities are requested to furnish the following information where applicable to the Assignee Activity for inclusion in its semi-annual report to the Navy DepSO:

(1) Number and identification of EMC standards and specifications added to the MCSL;

(2) Number and identification of EMC standards and specifications deleted from the MCSL;

(3) Number and identification of military EMC specifications identified as MCS documents, converted and scheduled for conversion to military standards;

(4) Number of EMC specification and standards wherein segregation of MCS's, elements thereof, and/or data requirements have been accomplished; and

(5) Number of EMC specifications and standards, wherein segregation of MCS's, elements thereof and/or data requirements have been scheduled.

Requirements (1) and (2) above refer to the MCSL dated 15 August 1969, which will be the edition used for reporting purposes. Requirement (3) requires a two-part report. One part covers documents already converted and the other part covers documents scheduled on DD Form 1585 for conversion. In requirement (5), the word "scheduled" refers to those documents scheduled for project action on DD Form 1585. The only EMCS document listed in the MCSL dated 15 August 1969 is MIL-STD-461.

VII. IMPLEMENTATION OF EMCS DOCUMENTS

The effectiveness of the EMCS Program in the military departments cannot be determined until general groundrules are established regarding the implementation of the various EMCS documents. Suggested groundrules are presented below.

A. Tailoring EMC Standards

In general, the EMCS documents provide criteria to guide contractors and Government personnel in planning, managing, executing and evaluating the required EMC effort. All of the requirements detailed in the EMCS standards and specification are not necessarily applicable to all contractors or to all contractual efforts. The requirements in the EMCS documents should be tailored to the particular system or equipment program to insure that the contractual engineering effort efficiently promotes the specific program objectives.

The tailoring process adapts the general requirements in a standard to the pecularities of the particular system or equipment, the mission objectives, intended installation, threat in other environmental factors, minimum acceptable performance requirements, program contractual structure, etc. The procuring activity should make the initial decision regarding application of the EMCS standards and specifications and perform the initial tailoring of the requirements in the documents to meet the project needs. This tailoring process would be reflected in the request-for-proposal. Subsequent tailoring could be proposed by the contractor in his proposal and resolved during negotiation. The final tailored requirements would, then, be included in the contract.

It is recommended that prior to completing the active EMCS projects described in this analysis, guidance for the tailoring of the requirements be included in each of the standards. Tailoring guidance should consider each of the items listed in the preceding paragraph plus the depth of work required and the requirements applicable for each type of contract. It is suggested that MIL-STD-499 be used during the development of the tailoring guidance.

The above discussion on tailoring suggests the need to develop a procedure to quantify EMC as a function of the availability, dependability and capability of a system or equipment to achieve its mission requirements without EMI problems. In other words, a procedure to determine in EMC figure-of-merit is required. Industry and several military activities are attempting to develop such a quantification procedure. When available, it should be incorporated into the EMC standards, either in the system EMC standards (Project EMCS-0009) or in a separate document such as the one being developed under Project EMCS-0028.

B. Reporting Waivers and Deviations to EMC Requirements

Paragraph III.E. of this analysis reiterated the DoD policy, as stated in the DoD Directive 3222.3 of 5 July 1967, regarding waivers to EMC standards and specifications.

In previous years, the Assignee Activity requested that the Participating Activities submit a summary of all waivers to EMC standards and specifications. The summary was to include the nature of the waiver request, the action taken and the reasons for the action. This request was consistent with the responsibilities of the Assignee Activity to determine the adequacy of standardization documents, to assure that standardization decisions are implemented, and to recommend specific actions in the annual program analysis. To clarify the above, the Participating Activities, or the departmental office responsible for controlling waivers to EMC standards and specifications (see III.D. above), are requested to furnish the aforementioned summary information regarding waivers of EMC documents in their respective Departments as well as information regarding deviations to, and tailoring of EMC standards; however, these reports should be submitted only when it appears that changes in the basic EMC standards may be required.

It is not the intent, nor is it the responsibility, of the Assignee Activity to "police" the standards. The information furnished will be used by the Assignee Activity solely for the purpose of evaluating the adequacy of the various EMC documents as implemented in accordance with the suggested general procedures outlined in VII.A. above, and recommending revisions where required.

Definitions of waivers, deviations and tailoring are included in Section II of this analysis.

VIII. LONG RANGE PLAN FOR EMCS DOCUMENTS

There has been considerable effort expended by the Military Departments and Industry during the preparation and revision of each of the current EMCS documents. As the program progresses and new documents are prepared, it is essential that a long range plan be developed to describe the general content of each of the standards. The absence of such a plan, with fixed objectives, could result in a considerable duplication of effort and lead to a useless set of EMC documents.

Accordingly, a general description of each of the EMCS documents, current and planned, is presented in Table IV. The estimated target date for completing the necessary revisions and new documents is 2QFY1973. However, completion depends on the resources available in the military departments to perform the detailed work required to prepare and coordinate each document.

A STUDY OF INTERNATIONAL AERONAUTICAL COMMUNICATIONS/ NAVIGATION SATELLITE SYSTEM-CHANNEL/SPECTRUM REQUIREMENTS (1535-1660 MHz)

The Aeronautical air-ground communications system has evolved into a highly disciplined system utilizing single channel simplex operations with random access to designated channels. This system consists essentially of two primary sub-divisions; namely, Air Traffic Control (ATC) and airline company communications (also known as operational control). It is envisioned that any future satellite system must discretely accommodate both of these subsystems on independent channels to insure safety, regularity and efficiency of air operations.

To determine the number of channels required for the future Aeronautical Satellite system, which must operate double channels, (separate frequencies for aircraft-satellite and satellite-aircraft) consideration must be given to the projected maximum number of aircraft in flight within the control or communications area, the percentage of the total communication traffic which must be accommodated, and the operational requirements of each sub-division.

ATC communications will consist of both voice and digital channels. Air traffic control voice channels are required for air-ground-air communication related to non-routine information such as altitude changes, diversion, urgent communications directly between the pilot and the controller. These are assigned to Area Control Centers (ACCs). ATC voice channels would be supplemented by 1200 bit rate digital communications channels to be used for routine information exchange. This data function is anticipated to support reduced separations between aircraft and is closely associated with the cost benefit considerations in congested international air routes. This function, will eventually prove necessary whether the position information is derived from onboard navigation systems or from an independent radiodetermination system.

Operational control channels are used to exchange information which permits airline management access to vital enroute information concerned with the efficient and economical operation of the aircraft, improved maintenance efficiency, aircraft utilization and schedule performance, reducing the workload for both flight crews and ground personnel. Such operational control traffic is not necessarily confined to a particular region (ACC). Additionally, on international flights, the inflight transmission of data necessary to immigration, customs, and public health clearance, is required to facilitate

prearrival planning and the clearance of passengers through increasingly congested terminal airports. In view of the foregoing, it is envisioned that discrete voice and digital operational control channels will be required for system improvement.

Incidental to the channel utilization for space techniques, it is envisioned that the terrestrial environment would also require UHF (1535-1660 MHz) channels to complement a transoceanic crossing and to provide a transition into the land areas without the necessity to carry other (VHF) equipment, thus providing increased economy for aircraft operators.

In order to determine the number of channels which may be required, the maximum peak (busy) hourly aircraft traffic has been estimated and projected to the year 2000 in Appendix 1. The North Atlantic and Caribbean projections were derived from statistics submitted to the ICAO ASTRA IV Meeting, and the Special ICAO NAT meeting 1971. The information for the Pacific and Indian Ocean areas was obtained from an earlier independent study.

Based on the aforementioned analysis, the forecast peak hourly aircraft traffic is:

	1985	1990	2000
NAT/CAR	592	729	1003
PAC	225	275	375
SEA/MID	110	135	185
AFI/SAM	105	130	180

With respect to channel requirements, it has been estimated that approximately 55% to 70% of all traffic will lend itself to digital transmission. The number of aircraft that can be accommodated on one 1200 bit/sec data channel will vary (30 to 100 aircraft) depending on the rate with which the aircraft must be interrogated in order to satisfy the air traffic control and operational requirements. Further, it is anticipated that one reliable voice channel can accommodate the residual voice communications for 30 to 40 aircraft while recognizing that some pre-operational experience is necessary to determine the exact trade-offs between voice and digital transmission.

BANDWIDTH REQUIRED FOR THE SPACE FUNCTION

In order to accommodate the 304 communications channels (50 kHz) for the year 1985 worldwide implementation, 15.2 MHz is required in each direction. The radiodetermination function requires an additional 1 MHz, totaling 16.2 MHz in each direction.

For the expansion to the year 2000, 512 communications channels are needed. These would require 25.6 MHz in each direction; when the radiodetermination requirement is added, a total of 26.6 MHz are needed in each direction.

It should be noted that the air traffic estimate on which the requirements are based include only commercial airline traffic (not general aviation, company and executive aircraft). Also, historically air traffic projections have been vastly underestimated. It is also probable that the air traffic projections for the years 1985, 1990 and 2000 will fall below the actual traffic that will be encountered for those years. Thus, the traffic projections as well as the channel requirements are a very conservative estimate.

Possible requirements for satellite operations in this band for the two continental European (EUM) and North American (NAM) ICAO regions have not been considered, since there is no immediate need to supplement the existing terrestrial system by satellite techniques. However, the possibility for such a need arising cannot be ignored.

This study has not considered communication channels which may be required to accommodate a future passenger communication service.

APPENDIX I

Projected Peak Hourly Airborne Traffic in the Major World Ocean Areas

TABLE 1

Projected Peak Hourly Airborne - ATLANTIC

Route (See Figure 1)	1985	1990	2000
1	18	22	30
2	278	338	463
3	6	7	10
4	12	14	19
5	59	72	99
6	18	22	30
7	6	7	10
8	36	44	60
9	95	117	148
10	65	80	108
Total (95% all traffic in region shown)	592	729	986

TABLE 2

PACIFIC

Route (See Figure 3)			
1	113	138	188
2	11	14	19
3	4	5	7
4	8	11	16
5	18	22	30
6	4	5	7
7	33	39	56
8	4	5	7
9	11	14	19
10	6	8	12
Total (95% of all traffic in region shown)	225	275	375

TABLE 3

INDIAN OCEAN

Year	Number
1985	110
1990	135
2000	185

APPENDIX II

ATC REQUIREMENTS

The following ATC channel requirements are based on the assumption that the peak hourly traffic is evenly distributed throughout the area and that ATC centers will require additional channels in the ratio of 30 aircraft per voice channel and 100 aircraft per digital channel or fraction thereof except in higher density air traffic areas where 40 A/C per digital channel is assumed.

NAT/CAR

ATC CENTER	ROUTE NOS.	TRAFFIC COUNT 1985	TRAFFIC COUNT 2000	YEAR 1985 VOICE	YEAR 1985 DIGITAL	YEAR 1985 PLR *	TOTAL 1985	ADDITIONAL FOR YEAR 2000 EXPANSION	TOTAL YEAR 2000
GANDER	1 & 2	148	247	5	3	2	10	7	17
NEW YORK	5,8,9,10	128	208	4	3	2	9	6	15
MIAMI				1	1	1	3	2	5
SAN JUAN	6,9,10	89	143	3	1	1	5	4	9
SHANWICK	2	139	232	4	2	1	7	5	12
SANTA MARIA				1	1	0	2	2	4
REYKJAVIK				1	1	0	2	1	3
OTHER CENTERS				15	3	5	19	13	32
	TOTAL			34	15	11	60	40	100

* Peak Load Reserve

PAC

ATC CENTER	ROUTE NOS.	TRAFFIC COUNT 1985	TRAFFIC COUNT 2000	YEAR 1985 VOICE	YEAR 1985 DIGITAL	YEAR 1985 PLR	TOTAL 1985	ADDITIONAL FOR YEAR 2000 EXPANSION	TOTAL YEAR 2000
OAKLAND	1,2	62	104	2	1	1	4	3	7
HONOLULU	1,5,6,10	71	119	3	1	1	5	4	9
ANCHORAGE				1	0	0	1	0	1
GUAM				1	0	0	1	0	1
TOKYO	2,3,5,7	33	56	2	1	1	4	3	7
HONG KONG	7,8	19	32	1	1	1	3	2	5
MANILA				1	0	0	1	0	1
SYDNEY				1	0	1	2	1	3
OTHER CENTERS				18	4	5	27	19	46
	TOTAL			30	8	10	48	32	80

SEA/MID

ATC CENTER	YEAR 1985 VOICE	YEAR 1985 DIGITAL	YEAR 1985 PLR	TOTAL 1985	ADDITIONAL FOR YEAR 2000 EXPANSION	TOTAL YEAR 2000
CAIRO	2	1	1	4	3	7
SINGAPORE	2	0	1	3	2	5
BOMBAY	2	1	1	4	3	7
BANGKOK	1	0	0	1	0	1
KARACHI	2	0	1	3	3	6
TEHRAN	2	1	1	4	3	7
BIERUT	1	0	0	1	0	1
BAGHDAD	1	0	0	1	1	2
OTHER CENTERS	19	4	5	28	18	46

APPENDIX II
Page 3

AFI/SAM

ATC CENTER	YEAR 1985			TOTAL 1985	ADDITIONAL FOR YEAR 2000 EXPANSION	TOTAL YEAR 2000
	VOICE	DIGITAL	PLR			
LIMA	1	1	1	3	2	5
MONTEVIDEO	1	0	0	1	1	2
SANTIAGO	1	0	0	1	1	2
SAO PAULO	1	0	0	1	1	2
EZEIZA	1	0	0	1	0	1
CASA BLANCA	1	0	0	1	1	2
TUNIS	1	0	0	1	1	2
CAPETOWN	1	0	0	1	0	1
RIO DE JANEIRO	2	0	1	3	2	5
OTHER CENTERS	39	5	10	54	38	92
TOTAL	49	6	12	67	47	114

APPENDIX III

OPERATIONAL CONTROL REQUIREMENTS

Based on the projected traffic estimates and recognizing that operation control traffic is not directly related to ACC's, but to peak traffic volume over oceanic areas, the following channel requirements have been developed based on 40 aircraft per digital channel and 30 aircraft per voice channel.

	1985					
	Voice	Digital	Peak Load Reserve (25%)	Total 1985	Add. for Yr. 2000 Expan.	Total Year 2000
NAT/CAR	20	15	9	44	31	75
PAC	8	6	4	18	13	31
SEA/MID	4	3	2	9	6	15
AFI/SAM	4	3	2	9	6	15
TOTAL	36	27	17	80	56	136

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF TELECOMMUNICATIONS POLICY
WASHINGTON, D.C. 20504

Date: May 7, 1971

Subject: OTP Programs/Projects

To: Mr. Stanley I. Cohn (OT)

A book of OTP programs and projects has been prepared. Programs are numbered with Roman numerals; Projects are sub-items under Programs and are numbered 1, 2,, 3, etc. Managers have been designated for each Program and each Project. All documentation is updated monthly.

Ten copies of Program X "Program Plan for Spectrum Management" are being furnished with this memorandum for your distribution and use. Monthly updates will be furnished.

It is requested that Program X be reviewed in detail by the OT staff and suggested changes furnished to this Office, particularly for those items affecting OT.

PROGRAM X

PROGRAM PLAN

FOR

SPECTRUM MANAGEMENT

(Program Manager - W. Dean, Jr.)

MAY 1971

SPECTRUM MANAGEMENT PROGRAM PLAN

A. Schedule of Events and Milestones

Two-Month Schedule

5/6 - IRAC/AH120 meeting (Biomedical telemetering)

5/7 - IRAC meeting (Space WARC)

- URSI National Committee meeting.

5/10 - DoD Joint Frequency Panel meeting.

5/11 - IRAC meeting (Space WARC)

5/12 - OT/OTP meeting on development of spectrum management support.

5/14 - IRAC meeting (Space WARC)

5/17 - Award contract on development of ADP time-sharing system.

- OT to begin development of receiver performance criteria.

5/18 - IRAC meeting.

- Complete development and coordination of draft update to DHC 5000.1.

5/19 - IRAC/FAS meeting (2 days).

5/20 - OT to let contract for equipment characteristics acquisition.

5/25 - IRAC meeting.

- Final report due from SRI on monitoring/measuring contract.

6/2 - Dean and others begin departing for Space Conference.

6/8 - IRAC meeting.

6/16 - IRAC/FAS meeting (2 days).

6/22 - IRAC meeting.

Long-Range Schedule by Categories

Allocations, Regulations, and Procedures

Bi-monthly - Issue revisions to OTP Manual of Regulations and Procedures for Radio Frequency Management.

8-71 - Begin modification of national allocations, regulations, and procedures required as result of the 1971 ITU Space WARC.

- Begin review of Government/non-Government Allocations.

1/72 - Complete modification of national allocations, regulations, and procedures required as result of the 1971 ITU Space WARC.

3/72 - Complete review of Government/non-Government Allocations.

1/73 - Anticipated effective date of Final Acts of the 1971 ITU Space WARC.

1/78 - Complete National implementation of Final Acts of 1976 ITU Maritime Warc.

Standards

7/71 - Begin upgrading Table of Spurious Emissions (TSC/IRAC).

8/71 - Complete Standards Program Documentation (OT).

- Begin development of low power radar standards (TSC/IRAC).

9/71 - Target date for Government agencies to reduce frequency deviation of old systems operating in the band 30-42 MHz.

1/72 - Complete upgrading of Table of Spurious Emissions.

- Target date for Government agencies to convert to narrow-band technical standards all old systems operating in the band 162-174 MHz.

4/72 - Complete development of radar measurement specifications, techniques, and definition.

5/72 - Complete development of receiver performance criteria.

6/72 - Begin development of radio noise standards.

8/72 - Complete development of low power radar standards.

9/72 - Target date for Government agencies to convert to narrow-band technical standards all old systems operating in the band 406-420 MHz.

6/73 - Complete radio noise standards.

9/73 - Target date for Government agencies to convert to narrowban technical standards all old systems operating in the band 30-42 MHz.

ELECTROMAGNETIC COMPATIBILITY

8/71 - Initiate development of National EMC Program.

9/71 - Initial (OT) EMC analysis capability defined.

- EMC Education Program outlined.

- Specific characteristics of equipment for EMC analysis defined.

10/71 - Begin development of equipment processing procedure (SPS/IRAC).

- Contract (OT) on equipment characteristics acquisition completed.

1/72 - Initial (OT) EMC analysis capability developed.

3/72 - Complete equipment processing procedure.

- Long range EMC analysis capability development defined.

8/72 - Initiate equipment processing procedure.

- Complete development of National EMC Program.

Monitoring/Measurement

8/71 - Initial monitoring/measurement Capability Program defined.

3/72 - Initial monitoring/measurement capability completed.

5/72 - Begin definition of long-range monitoring/measurement program.

7/72 - Complete definition of long-range monitoring/measurement program.

Automated Data Processing

7/71 - OT to complete development of logic for computer program to check receiver antenna data on applications.

- Transfer to OT responsibility for maintenance and further development of ADP system.

1/72 - OT to begin first limited use of time-sharing ADP system for unclassified engineering analyses and transmission of retrieval requests.

1/72 - OT to add to ADP User's Manual procedures for Government agencies to retrieve data from the Government assignment data base.

3/72 - Completion date for Amendment No. 1 to contract No. OEP-SE-70-103 with HRB-Singer, Inc.

6/72 - OT to expand limited use of time-sharing ADP system to include classified engineering analyses.

- Transfer to OT responsibility for providing UNIVAC 1108 (Executive VIII) computer for ADP system.

1/73 - OT to expand use of time-sharing ADP system to include submission and processing of frequency applications.

Data Base

7/71 - Target date for Government agencies to include agency serial number in all assignment records.

9/71 - OT to complete study to determine detailed steps required for converting ECAC data base of military overseas spectrum uses to Government assignment data base format.

- Target date for OT to complete corrections to data base in ITU file.

1/72 - Target date for Government agencies to complete update of assignments classified SECRET.

3/72 - Target date for Government agencies to complete amendment of HF fixed assignment records from double sideband to single sideband.

1/74 - Target date for Government agencies to add bandwidth, pulse duration, and pulse repetition rate to all radar assignments authorized before 1/69.

Usage

7/71 - Review and update data on Government reliance on the spectrum.

1/72 - Target date for Government agencies to add number of mobile units to each mobile assignment in the band 162-174 MHz.

1/72 - Review two-year-old HF Usage Reporting Procedure and consider expansion to bands above 30 MHz.

1/73 - Target date for Government agencies to complete first major review and revalidation of all frequency assignments under the Five-Year Review Procedure.

1/75 - Target date for Government agencies to add to assignment data base an entry for each operation in VHF/UHF land mobile bands which had been conducted under broad authority before 1/70.

- Target date for Government agencies to add number of mobile units to each mobile assignment in VHF/UHF bands in existence as of 1/70.

Emergency Preparedness

7/71 - Target date for Government agencies to complete update of HF records in connection with determining compatibility of domestic HF operations.

8/71 - Review and update Emergency Readiness Plan.

Noise

8/71 - Complete study on parameter definition.

- Begin development of noise measurement procedures.

10/71 - Complete noise measurement procedures and integrate with monitoring/measurement program.

11/71 - Begin development of initial noise measurement program.

3/72 - Complete initial noise measurement program and commence measurements.

5/72 - Begin development of long range noise measurement program.

7/72 - Complete long range noise measurement development program.

Side Effects

Continuing - Development of NSF support for side effects study.

9/71 - ERMAC to complete definitions of Side Effects Research Program.

10/71 - Coordinate side effects program with OST, OMB and Government agencies which will conduct research.

1/72 - Finalize Research Program.

4/72 - Initiate coordinated research program.

B. Special Considerations

Government spectrum management must take into account National spectrum requirements, international communication agreements, and plans for international communication systems.

C. Budget/Manpower

The estimated manpower requirements for this program are five manyears professional, three manyears secretarial, and one manyear clerical, each on a continuing basis. Domestic travel will be required up to $5000 annually. No contract studies are planned for FY72. FY70 and FY71 funded contracts are:

... Feasibility of and framework for developing a measure of electromagnetic compatibility; Versar, Inc.; $29,000, draft final report being reviewed.

... Definition of an initial Government spectrum measuring and monitoring program; Stanford Research Institute; $102,755; to be completed by May 1971.

... Initial development of time-sharing computer capability for Executive Branch spectrum management, RFP being issued in March 1971; $100,000.

... Continued development/maintenance of ADP system (pending transfer of system to Commerce); extension of existing HRB-Singer contract; $100,000 (initial extension $50,000).

... Technical and economic studies of the use of the geostationary orbit; extension of General Electric contract which was originally funded by OTP/FCC/NASA; extension is funded by NASA only.

D. Statement of Requirements

The basic justification for establishing this program is the following provisions of Reorganization Plan No. 1 of 1970 and Executive Order 11556:

Reorganization Plan Section 1

SECTION 1. *Transfer of functions.* The functions relating to assigning frequencies to radio stations belonging to and operated by the United States, or to classes thereof, conferred upon the President by the provisions of section 305(a) of the Communications Act of 1934, 47 U.S.C. 305(a), are hereby transferred to the Director of the Office of Telecommunications Policy hereinafter provided for.

E. O. 11556 Section 3

SEC. 3. *Frequency assignments.* The functions transferred to the Director by section 1 of Reorganization Plan No. 1 of 1970 include the functions of amending, modifying, and revoking frequency assignments for radio stations belonging to and operated by the United States, or to classes thereof, which have heretofore been made or which may be made hereafter.

E. O. 11556 Section 2(e)

(e) Coordinate the telecommunications activities of the executive branch and formulate policies and standards therefor, including but not limited to considerations of interoperability, privacy, security, spectrum use and emergency readiness.

E. O. 11556 Section 5

SEC. 5. *Foreign government radio stations.* The authority to authorize a foreign government to construct and operate a radio station at the seat of government vested in the President by subsection 305(d) of the Communications Act of 1934, as amended (47 U.S.C. 305(d)), is hereby delegated to the Director. Authorization for the construction and operation of a radio station pursuant to this subsection and the assignment of a frequency for its use shall be made only upon recommendation of the Secretary of State and after consultation with the Attorney General and the Chairman of the Federal Communications Commission.

E. O. 11556 Section 10

SEC. 10. *Advisory committees.* As may be permitted by law, the Director shall establish such interagency advisory committees and working groups composed of representatives of interested agencies and consult with such departments and agencies as may be necessary for the most effective performance of his functions. To the extent he deems it necessary to continue the Interdepartment Radio Advisory Committee, that Committee shall serve in an advisory capacity to the Director. As may be permitted by law, the Director also shall establish one or more telecommunications advisory committees composed of experts in the telecommunications area outside the Government.

E. O. 11556 Section 11

SEC. 11. *Rules and regulations.* The Director shall issue such rules and regulations as may be necessary to carry out the duties and responsibilities delegated to or vested in him by this order.

More specifically, this program is essential to the development and execution of policies and procedures for Government allocation, use, and management of the radio spectrum. It is justified by the fact that a) it is important that essential Government spectrum needs be accommodated expeditiously and efficiently and b) it is important that the Government be responsive to the needs for increased flexibility in the use of the spectrum by both the Government and the private sector.

The fundamental policy issues are: in the light of overall National communication requirements, a) which Government requirements shall be satisfied by use of the radio spectrum, and b) what measures shall be undertaken to ensure the satisfaction of Government requirements in an effective and efficient manner.

E. Interagency Activity

All Government agencies with spectrum requirements have a vested interest in this program because it is the means by which those requirements are satisfied. Those agencies with major requirements participate in this program through their membership on the IRAC, which also affords them an opportunity to interface with the private sector through the FCC liaison representative to the IRAC. Commerce (OT) participation is included in much of this program due to its supporting role under E. O. 11556. National Science Foundation and members of ERMAC participate in the "side effects" project.

F. Program Results

The results of this program are: a) continuing flow of improved allocations, regulations, procedures, decisions and spectrum management capabilities; b) the expeditious and efficient accommodation of essential Government spectrum needs; and c) increased flexibility in the use of the spectrum by both Government and the private sector.

G. Statement of Work

The specific projects** under this program are:

1.0 Provision of guidance and direction for Government allocation, use, and management of the radio spectrum (Dean). Sub-projects are: Allocations; Regulations and Procedures; Standards; and Review of Related Proposals of other Agencies (FCC, FAA, CG, etc).

2.0 Analysis of Government communication-electronic systems prior to procurement to assess their potential electromagnetic compatibility with existing radio facilities (Dean). Sub-projects are: Development of Capability; and Specific EMC Analyses.

3.0 Evaluation of Government spectrum requirements and assignment of spectrum resources therefor (Dean). Sub-projects are: Improvement of Application Processing Procedures; Satisfaction of Government Day-to-Day Requirements; and Emergency Preparedness.

4.0 Evaluation of Government use of the spectrum to ensure that it is in accord with allocations, regulations and procedures, and standards (Dean). Sub-projects are: Assignment Review; and Evaluation of Operations.

5.0 Development, in cooperation with other Government agencies and private organizations, of a mechnaism for minimizing any side effects, e.g. physiological, resulting from use of the electromagnetic spectrum (Jansky). Sub-projects are: Development of Government-wide Research Program; and NSF Support.

** Activities and staff member responsibilities under the sub-projects are identified in Section H which follows.

H. Current and Projected Activities

1.0 Provision of Guidance and Direction for Government Allocation, Use, and Management of the Radio Spectrum.

1.1 Allocations

1) Direct revision of the National Table of Frequency Allocations as part of the national implementation of the 1971 ITU Space WARC; begin 8/71, complete 1/72. (Buss)

2) Monitor compliance by Government agencies with the timetable for implementing the Final Acts of the 1971 ITU Space WARC. (Buss)

3) Monitor FCC inquiry and DoT study contracts on automatic vehicle locator systems and determine need for any reallocations. (Dean)

4) Study requirements for navigational aids and determine the continuing need for multiple aids and their associated spectrum allocations. (Raish)

5) Bring together the Government agencies with a primary concern for the use of the acoustic spectrum and determine how it should be administered. (Raish)

6) Direct review of current and projected military radar requirements and determine continuing need for existing radar allocations. (Dean)

7) Direct review of current and projected Government requirements for use of the band 100-1000 MHz and determine continuing need for existing allocations. (Dean)

8) Direct activities of the IRAC Spectrum Planning Subcommittee. (Buss)

1.2 Regulations and Procedures

1) Maintain and revise as necessary the OTP/FCC Manual for Notifying U. S. Frequency Usage to the IFRB. (Hailey)

2) Maintain OTP Manual of Regulations and Procedures for Radio Frequency Management and issue bi-monthly revisions therefor. (Hailey)

3) Monitor compliance by Government agencies with the timetable for implementing the Final Acts of the 1967 ITU Maritime WARC and ensure completion by 1/78. (Raish)

4) Direct revision of regulations and procedures as part of the national implementation of the 1971 ITU Space WARC; begin 8/71, completed 1/72. (Buss)

5) Monitor compliance by Government agencies with the timetable for implementing the Final Acts of the 1971 ITU Space WARC. (Buss)

6) Monitor compliance by Government agencies with the timetable for conversion of VHF/UHF FM systems to narrowband techniques and ensure completion by 9/73. (Hailey)

7) Review research being conducted in wave propagation and develop coordinated approach to research in this area. (Jansky)

8) Develop procedure for evaluating actual use of the spectrum above 30 MHz. (Hailey)

9) Develop an overall Government EMC Program which will provide guidance and direction to Government agencies in this area. (Jansky)

10) Provide guidance and direction to Government agencies in the area of radio noise measurement and abatement. (Jansky)

11) Develop regulations to provide for field disturbance sensors (intruder alarms). (Hailey)

12) Develop course of action for processing IFRB notifications through OTP/IRAC. (Hailey)

1.3 Standards

1) Provide guidance and direction to OT in the development of an overall Government standards program. (Jansky)

2) Provide guidance and direction for the priority of development of technical standards for use of the spectrum. (Jansky)

3) Direct revision of technical standards as part of the National implementation of the 1971 ITU Space WARC; begin 8/71, complete 1/72. (Buss)

4) Direct extension above 960 MHz of the Table of Tolerances for Spurious Emissions. (Jansky)

5) Direct development of standards to be applied to radionavigation receivers for general sale to the public. (Jansky)

6) Direct development of standards for receivers. (Dean)

7) Direct development of standards for Government land mobile systems. (Jansky)

8) Direct development of Government standards for radar. (Dean)

1.4 Review of Related Proposals of Other Agencies

1) Monitor development of FCC's Chicago regional management center and its bearing on Government spectrum management. (Hailey)

2) Guide development of Government position on FCC rule making on Decca proposal to establish a marine navigation system on New England/New York coast. (Hailey)

3) Guide development of Government position on FCC inquiry on CATV as concerns its impact on air traffic control systems. (Dean)

4) Guide development of Government position on FCC rule making on establishment of bio-medical telemetry systems. (Raish)

2.0 Analysis of Government Communication-Electronic Systems Prior to Procurement to Assess Their Potential Electromagnetic Compatibility

2.1 Development of Capability

1) Develop a procedure for the evaluation of the compatibility of new Government equipments/systems. (Buss)

2) Provide guidance and direction for the development of an EMC analysis capability within OT. (Jansky)

3) Provide guidance and direction for the development of a Government measurement/monitoring capability in support of the OTP in areas of occupancy, compliance, and compatibility. (Jansky)

4) Provide guidance and direction to OT in the acquisition of electronic equipment characteristics and the smooth integration of these data with the Government assignment data base. (Buss)

5) Provide guidance and direction to OT in the acquisition and development of models to be used in EMC analysis. (Jansky)

6) Provide guidance and direction to OT in the study of the applicability and implementation of EMC figures of merit (VERSAR contract). (Jansky)

7) Review EMC problems; provide guidance and direction to OT in the definition of specific problems and the schedule for their solution. (Buss)

2.2 Specific EMC Analyses

1) Direct an assessment of the compatibility of proposed collision avoidance systems, an instrument landing system. and altimeters in the band 1557.5-1637.5 MHz. (Buss)

2) Direct development and application of an assignment simulation model for the 117.975-136.000 MHz band which provides for the variation of all parameters of assignment and use. (Buss)

3) Direct conversion to the OT computer of the models developed under the GE orbit/spectrum contract. (Jansky)

4) Provide for the use by the U. S. Delegation to the 1971 ITU Space WARC an analysis of the technical factors involved in the sharing of spectrum space by troposcatter and space communication systems. (Jansky)

5) Direct development of a capability to quickly analyze proposed new foreign space systems as concerns their compatibility with existing and proposed U. S. operations. (Buss)

6) Direct the analysis of the use of frequency agility and pulse compression techniques in the 2700-2900 MHz band with the objective of determining the impact of these techniques on the use of the spectrum. (Buss)

7) Direct the analysis of the compatibility of postulated systems to provide satellite communication for mobile services. (Buss)

8) Direct the analysis of the compatibility of existing and postulated systems in the 7 and 8 GHz bands, including point-to-point relay, Defense satellites, earth resources satellites, and meteorological satellites. (Buss)

9) Monitor and provide guidance to DoD concerning the compatibility aspects of over-the-horizon radar. (Dean)

10) Monitor and provide guidance to DoD concerning the compatibility aspects of the Sanguine system. (Dean)

3.0 Evaluation of Government Spectrum Requirements and Assignment of Spectrum Resources Therefor

3.1 Improvement of Application Processing Procedure (Hailey)

1) Provide guidance and direction for transfer of the ADP system to Commerce and further development thereof, include development of time-sharing and graphic display capability.

2) Provide guidance and direction for execution of the FY-71 OTP contract on development of initial ADP time-sharing capability.

3) Provide guidance and direction for execution of the FY-71 OTP contract with HRB-Singer for maintenance and further development of the ADP system.

4) Develop procedures for further expansion of the procedure for field level engineering and coordination of spectrum use.

5) Provide guidance and direction for the development of standards for data elements and codes used in the ADP system.

3.2 Satisfaction of Government Day-to-Day Requirements

1) Direct activities of the IRAC Frequency Assignment Subcommittee. (Hailey)

2) Direct satisfaction of Government oceanography requirements. (Raish)

3) Direct resolution of policy matters referred to OTP by IRAC. (Dean)

4) Direct satisfaction of spectrum requirements of the UN in New York and foreign embassies in Washington. (Hailey)

5) Initiate and participate in development of a new frequency assignment plan for the band 30-50 MHz. (Hailey)

6) Participate in satisfaction of HF spectrum requirements for interconnection of electric power networks. (Hailey)

7) Participate in satisfaction of HF spectrum requirements for an AEC mobile security network. (Hailey)

3.3 Emergency Preparedness

1) Direct maintenance of the Emergency Readiness Plan (Dean)

2) Direct review of the compatibility of domestic HF frequency assignments. (Hailey)

3) Direct study of effects of electromagnetic pulses on radiocommunication systems. (Dean)

4) Evaluate the state of emergency preparedness in the spectrum area. (Dean)

4.0 Evaluation of Government Use of the Spectrum to Ensure That it is in Accord with Allocations, Regulations, and Procedures

4.1 Assignment Review (Hailey)

1) Direct Five-Year Review Procedure.

2) Direct Usage Reporting Procedure.

3) Direct individual assignment reviews

... Conversion to narrowband FM techniques

... Conversion of HF fixed to single sideband

... Notifications under group authority

... Addition of new technical characteristics

... Conversion to ADP format

4.2 Evaluation of Operations (Hailey)

1) Conduct headquarters and field level frequency management surveys.

5.0 Development of Mechanism for Minimizing Side Effects (Jansky)

5.1 Development of Government-wide Research Program

Provide guidance and directions for the development of a Government-wide research program in the area of side effects.

5.2 National Science Foundation Support

Encourage the participation of NSF in the side effects program, including NSF funding. Coordinate and integrate the activities of NSF and ERMAC in this area.

5.3 Biological Effects

Determine the biological effects of non-ionizing electromagnetic radiations.

WASHINGTON

Headquarters Projects Approved 4/8/71

9026201	Spectrum management support improvement	$11,320 ✓	
9026202	Electromagnetic compatibility analysis	$13,050 ✓	
9006202	EMC contract	$24,928 ✓	
9026203	Spectrum management data processing development	$11,290 ✓	
9026211	Analysis for international conferences and cooperative programs	$ 1,510 ✓	
9026212	Economic opportunities for community cable distribution	$37,000 ✓	
9026213	Bulk and specialized communication networks	$23,000 ✓	
9026216	Spectrum allocation analysis	$ 5,435 ✓	
9026222	Mobile communications analysis	$ 1,760 ✓	
9026231	Spectrum occupancy monitoring analysis	$ 2,860 ✓	
9026232 6232	Spectrum engineering criteria analysis	$11,700 ✓	
9026233	Telecommunication standards management	$26,500 ✓	
9026234	Analysis for Federal Government communication	$11,210	
9026235	State and local assistance	$ 2,360 ✓	
9026240	Telecommunication analysis division overhead	$46,450 ✓	
9022160	Information base	$10,000	
	~~Pending decision because of Mr. Lowe's reservations.~~ Add'l approved!		
9026 214	International communications analysis	✓ 7,227	Cole
9026215	Community cable distribution (demand)	✓ $20,000	Powers

TOTAL.....$327,600

( ) = FREQ MGMT ITEMS

March 9, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Services for Frequency Management and Use
3. SUBACTIVITY: Assignment of Federal Radio Frequencies
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: Anthony Corrado
8. PROJECT NUMBER: ~~9018299 (9112111)~~ 9636201
9. PROJECT TITLE: Spectrum Management Support Improvement
10. ALLOCATION: $11,320.
11. BACKGROUND:

The Interdepartment Radio Advisory Committee (IRAC), representing 16 government departments and agencies advises the Director of OTP in the management of Federal radio frequencies. The Office of Telecommunications provides, on a continuing basis, the Secretariat for the IRAC and the review, analysis and liaison required for the frequency assignment actions in the Frequency Assignment Subcommittee (FAS). Coordination between Federal and non-Federal users is maintained through continuous staff liaison with the FCC.

Overall planning requires participation in ad hoc committees and the Spectrum Planning Subcommittee (SPS) to recommend improvements in different bands, to review Federal use of specific bands, and to plan future use. Also, personnel participate in working groups to solve particular problems such as the development of standards for marine and land radar, and the use of space techniques in aeronautical and marine mobile communications. The extent to which the Government use of the spectrum has increased results in the necessity of developing a computer technology to keep a limited supply of frequency managers to stay "on top of" spectrum usage.

12. OBJECTIVES:

To help keep the Federal Government "on the air" to meet national needs in areas such as defense, transportation, weather, emergencies and other essential government functions:

a. Continue the day to day frequency management processes in operation.

b. Support the OTP/IRAC subcommittee and ad hoc groups to develop policies for improved management of the frequency spectrum.

c. Enhance and improve computerized outputs for frequency management.

9096201

13. CONTENT:

a. Provide the acting chairman for monthly meetings of the FAS in support of OTP.

b. Provide advice and assistance to Federal agencies as regards established policies.

c. Review all applications submitted to FAS for compliance with established policies and procedures.

d. Recommend policy and procedure changes, if warranted, to the Chairman, FAS.

e. Provide technical assistance to both FAS members and non-members.

f. Review and implement the results of international conferences as regards frequency assignments.

g. Conduct studies of Government assignments as regards usage, assignment plans, etc.

h. Provide the Secretary for the Spectrum Planning Subcommittee in the prepatory work for international conferences and maintenance of the National Allocation Table and plans for the current and future use of the spectrum.

i. Continue improvement of data processing activities to provide automatic screening of applications for compliance with regulations and procedures.

14. COSTS: March 1, 1971 - June 30, 1971

Staff			Finances applied are:
Corrado	.15	3440	3,450
Gamble	.06	1170	1,177
Garber	.03	585	627
Higgins	.07	1460	1,483
Powell	.01	283	265
Total project salary		6938	7,000
Overhead @ 82%		5690	5,700
			12,700
Personnel benefits @ 8%		560	560
Travel and transportation		270	270
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		430	
Other services		2660	0
Supplies and materials		720	
Equipment		0	
		$17,268	13,570

Approved by AAK on 4/8/71 @ $11,320.

March 8, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Services for Frequency Management and Usage
3. SUBACTIVITY: Prediction and Compatibility Analysis Service
4. DIVISION: Special Projects Staff - Frequency Management Support Group (Telecommunication Analysis Division)
5. AUTHORITY: "IRAC" (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: Bruce Higgins
8. PROJECT NUMBER: ~~9018299 (9122III)~~ 9026202
9. PROJECT TITLE: Electromagnetic Compatibility Analysis
10. ALLOCATION: $13,050.
11. BACKGROUND:

The complexity of analyzing interference which might be created or experienced by a new station or system increases steadily because of the growing use of the radio spectrum and of more radio noise producing machines and devices. The interactions involved require computer analysis of: (1) which frequencies have been assigned; (2) locations of existing systems; (3) existing equipment characteristics; (4) the propagation characteristics of different frequencies; and (5) prevailing radio noise levels and terrain at specific locations. This information should be available through rapid and economical procedures both to handle the overall workload of frequency assignment and to handle specific applications of significant, potential impact. Such applications include the evaluation of the potential electromagnetic compatibility of new radio systems with the prevailing environment and the assessment of spectrum availability for such systems prior to equipment procurement. For fine-grain analysis of EMC situations in complex and congested areas, considerations unique to each particular environment must be considered. Consequently, the results of more generalized computer analysis must be formatted to facilitate further manual analysis of such difficult cases by EMC engineers.

12. OBJECTIVES:

Collect, maintain, disseminate, and allow ready access to radio systems and electromagnetic compatibility analysis information as required for frequency management. This includes:

a. The dissemination of ionospheric and tropospheric propagation predictions.
b. The development of a comprehensive and effective program to provide engineering models and standardized techniques for the prediction and analysis of electromagnetic interactions between and among new and existing radio systems.
c. The provision of computerized displays of EMC information in the varied levels of generality required for effective frequency management or further manual analysis.

9096202

d. The development and testing of procedures to provide direct access to the computerized analysis facility for EMC engineers and frequency managers of the OT and principal Federal users of the radio frequency spectrum.

13. CONTENT: (FY-71)

1. Modify and enhance the limited engineering support routines currently available in the OTP automatic data processing facility.

2. Provide engineering support in solving current EMC problems.

3. Develop plans and programs for improved EMC analysis within available resources through the adaptation of analysis techniques currently available within the OT/ITS and other agencies of the Federal Government as appropriate.

4. Improve the existing data base for spectrum management and EMC analysis including development of appropriate supplementary files of equipment characteristics needed for spectrum engineering.

9026202

Costs March 1, 1971 - June 30, 1971

			Funds approved
Staff			
Corrado	.07	1600	1600
Gamble	.09	1760	1760
Garber	.03	587	588
Higgins	.17	3710	3535
Powell	.01	283	265
Total Project Salary		7940	7750
Overhead @82%		6470	6350
			14,100
Personnel benefits @8%		635	620
Travel and transportation		810	880
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		500	0
Other services		3060	
Supplies and materials		1113	
Equipment		0	
		$20,528	$15,600
		Less .164 adj.	-2,550
			$13,050 EJ

Approved by agk on 4/8/71 @ $13,050.

~~April 5, 1971~~
April 5, 1971

PROJECT SUMMARY

1. UNIT: Ofc. of Telecommunications
2. ACTIVITY: Services for Frequency Management & Usage
3. SUBACTIVITY: EMC Analysis
4. PROJECT LDR.: Higgins
5. PROJECT NO.: 9036202
6. PROJECT TITLE: EMC Contract
7. ALLOCATION: $24,928

This is the Sachs-Freeman contract proposal.

Tentatively, the cost allocation is proposed for full funding in FY 1971, i.e., $24,928.00.

However, the procurement people could write this contract up in such a manner that a portion of the obligation would be applicable to FY 71, with the balance applicable to FY 72. Both the manner in which the contract terms are drawn up and the effective date of the contract will play a part in determining the split between years, if any.

Recom. amt:
$24,928 GB.
Funds available.

Should be made a part of 9036207 DC

Approved by agk @24,928 on 4/5/71.

March 9, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Services for Frequency Management and Usage
3. SUBACTIVITY: Prediction and Compatibility Analysis Services
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical - Economic
7. PROJECT LEADER: George Garber
8. PROJECT NUMBER: ~~9018299 (9122121)~~ 9036203
9. PROJECT TITLE: Spectrum Management Data Processing Development
10. ALLOCATION: $11,290.
11. BACKGROUND:

At the present time the UNIVAC 1108 computer of the Office of Emergency Preparedness located in the Washington, D.C. area is used for the processing of applications for radio frequency assignments. This computer is also used for the maintenance of the Government Master File (GMF) of assignments to Government radio stations, for the storage of other radio frequency assignment-related data, for the retrieval as required of information from these data files and for the engineering analysis of the retrieved information. In addition, a CDC 3800 computer and a XDS 940 computer, both located in Boulder, Colorado, are used by personnel of the Institute for Telecommunication Sciences for the development and use of programs analyzing all aspects of radio system performance.

12. OBJECTIVES:

The continuing objective of this task is to develop a flexible computer support capability for the Office of Telecommunications of the Department of Commerce and for the Office of Telecommunications Policy in the Executive Office of the President. The achievement of this major objective will require: (1) the continued development and improvement of the time-shared computer system initiated by the OTP; (2) the continued maintenance of the present batch processing capabilities as needed; (3) the development of generalized information storage and retrieval techniques for the handling of large quantities of yet-to-be defined information; (4) the acquisition of data processing capability for the handling of administrative data, such as program planning, budgeting and accounting information; (5) the application of teleprocessing techniques for the integration of the various geographically separated organizational units involved into such a computer support capability, and (6) the continuing evaluation of advanced computer-related techniques, such as computer graphics terminal equipment, to the functions of the Office.

9026203

13. CONTENT:

Monitor the OTP contract for time-sharing system development. Monitor the OTP contract for maintenance of the existing batch processing capability. Monitor (in conjunction with the Office of Emergency Preparedness) the OTP/OEP contract for the evaluation of a secure UNIVAC 1108 EXECUTIVE system for the simultaneous processing of classified and unclassified data. Review contractor performance in the study and evaluation of equipment operational information and its relationship to the OT data base requirements. Continue to participate in the activities of the Federal Telecommunications Program Standards Committee for Data Elements and Codes and to lead the IRAC ad hoc group (109) developing the standards for Radio Frequency Management data elements and codes. Participate in the Office of Telecommunications' internal committee for the development and evaluation of computer systems alternatives for the support of OT and OTP requirements.

14. COSTS:

Staff			Approved Funds:
Corrado	.03	$688	688
Gamble	.02	390	420
Garber	.24	4700	4700
Higgins	.03	625	625
Powell	.01	283	265
Vacancy I	.01	1000	-0-
Total Project Salary		7686	6700
Overhead @ 82%		6300	5500
			12,200
Personnel benefits @ 8%		615	536
Travel and transportation		325	764
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		485	0
Other services		2950	
Supplies and materials		1070	
Equipment		0	
		$19,431	13,500
		Less adj:	-2,210
			11,290

Approved by AJK at 4/8/71. for $11,290.

March 9, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Analysis of U.S. Position on International Telecommunications
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: George Stelzenmuller
8. PROJECT NUMBER: ~~9018299 (9212111)~~ 9026211
9. PROJECT TITLE: Analysis for International Conferences and Cooperative Programs
10. ALLOCATION: $1,510.
11. BACKGROUND:

The radio spectrum is finite, and must be shared by all nations according to international agreements. The U.S. must participate in these agreements to meet national defense needs and to help ensure full growth of its economy. Development of appropriate U.S. technical/economic position recommendations require analysis of international telecommunication matters considering the needs of government, science and industry and the overall capabilities of U.S. industry.

12. OBJECTIVES:

To improve coordination within the U.S. among different government agencies and scientific and industrial groups on questions concerning international telecommunication issues and to develop recommendations for consideration in determining U.S. policy.

13. CONTENT:

a. Compile and review studies and findings of international telecommunication committees and U.S. national committees.
b. Provide technical support for U.S. participation.

14. COSTS: March 1, 1971 - June 30, 1971

Finances approved:

Staff

Stelzenmuller	.03 MY	$871 ←	871
Total Project Salary		871	
Overhead @ 82%		715	714
			1585
Personnel benefits @ 8%		70	70
Travel and transportation		34	150
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		55	
Other services		335	
			1805
			-295

Approved @ $1,510 by agk at 4/6/71.

9026211

Supplies and materials	152	-o-
Equipment	0	-o-
	$2,232	See previous page ($1,510)

March 8, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Economics of New Communications Services
4. DIVISION: Special Projects Staff (Telecommunications Analysis Division)
5. AUTHORITY: REA&TS (Research, Engineering, Analysis, and Technical Services)
6. SUBDIVISION: Urban Telecommunications (Technical--Engineering and Physical)
7. PROJECT LEADER: R. S. Powers
8. PROJECT NUMBER: ~~(9222111)~~ 9086212
9. PROJECT TITLE: Economic Opportunities for Community Cable Distribution
10. ALLOCATION: ~~$50,000~~ $37,000
11. BACKGROUND:

There are a number of critical issues which must be resolved in order to determine the optimum role of wideband cable distribution of communication services in our society and to set the stage for its development. Perhaps the most far-reaching question is under what circumstances and to what extent is cable operation a "natural monopoly" in any given geographical area. The answer to this question will have profound implications on several other issues: What jurisdiction should local, state, and federal governments have over the industry? What kinds of cross-ownership (cable/broadcaster, cable/newspaper, cable/common carrier, etc.) should be permitted? Should exclusive franchises be issued or should several be issued for the same area? Should cable operators be regulated as common carriers, in whole or in part? Other issues include whether interconnection to public usage networks should be allowed or even required, and what kinds of performance standards and standards to permit interconnection of the cable systems themselves should be imposed.

Rational resolution of these issues by the FCC, OTP, and the Congress will require extensive information and analysis concerning (1) the technical and economic opportunities available through cable distribution, (2) the nature of the technology which provides the services, and (3) how those services relate to present and potential over-the-air services and public usage networks.

12. OBJECTIVES:

The long term objective of this project is to identify feasible applications of cable communications technology and to evaluate the costs and benefits associated with using that technology to its fullest potential, together with other modes of transmission.

#9026212

The most immediate objectives are to identify as clearly as possible (1) the range of technical possibilities for coaxial cable distribution of communication services in the 1972-1977 time frame, including possibilities for adding new services to existing cable systems; and (2) the economic feasibility of the most promising of those possibilities.

Time span: The short term objectives above will be met in approximately 1½ years. This project will lead into a pilot project for actual demonstration of cable technology. The nature of this project will be re-assessed at that time.

Milestones: End of FY 1971 -- Draft report covering one or more schemes for multiple services on a single coaxial cable including one-way and two-way services. End of FY 1972 -- Final report including service possibilities on multiple cable systems; switched and unswitched, digital and analog systems; and systems combining cable distribution with microwave, millimeter wave, and optical distribution as well as with UHF and VHF over-the-air distribution.

13. PROGRAM CONTENT:

a. Chairmanship of the Spectrum Allocation Subcommittee, Cable Television Task Force, IEEE. Committee will examine possible schemes for frequency usage on cables.

b. Technical studies, largely at Boulder, to back up the Committee activity and to provide the basis for the above-mentioned reports.

c. Study of the technical and economic problems of adding new (e.g., two-way) services to typical existing cable systems.

14. COSTS:

a. Staffing (including 82% overhead)

			Finances Approved are:
Powers	.33 MY	$ 14.6K	7.2
Wieder	.08 MY	5.0K	1.8
GS-13 Engr. (2)	.66 MY	22.0K	9.9
Cole	.05 MY	2.3K	1.3
Steltzenmuller	.05 MY	2.3K	1.4
Zois	.05 MY	2.0K	-0-
		Total salaries	21.6 Salary
		Overhead @82%	19.4
			41.0

b. Other Objects

Travel	Benefits	1.2K	2.0 Benefits
Printing		.3K	1.2 Travel
Supplies and Materials		.3K	44.2
Other Services		--	-7.2 Less .164 adj.
TOTAL		$ 50.0K	37.0K total

[illegible] Kn[illegible]

[illegible] @ $37.0

March 10, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Economics of New Communications Services
4. DIVISION: Special Projects Staff (Telecommunication Analysis Division)
5. AUTHORITY: Office Overhead (REA&TS)
6. SUBDIVISION: Business - Economic
7. PROJECT LEADER: Richard Gabel
8. PROJECT NUMBER: ~~9001913 (9222141)~~ 9036213
9. PROJECT TITLE: Bulk and Specialized Communication Networks
10. ALLOCATION: $23,000.
11. BACKGROUND:

The Federal Communications Commission has initiated a rule-making inquiry with regard to establishment of policies and procedures in considering applications to provide specialized common carrier services in the domestic public point-to-point microwave radio service. The inquiry is the outgrowth of the filing of some 1700 applications for radio frequency licenses to provide specialized common carrier service. Regardless of the disposition made by the FCC in the current rule-making inquiry, there will be need for continuing analyses of the effects of the new specialized communication networks and services and their relation to the structure and performance of the common carrier industry. Anticipated pricing changes will have impact on market demand in both monopoly and competitive communications services. The underlying price policy adopted by the carriers must be studied from the viewpoint of benefits and penalties to all classes of users.

12. OBJECTIVES:

To provide an empirical and analytic base from which OTP can formulate national policy. The work will be done in phases with an initial statement of the public policy concerns and the effect of alternative choices on these concerns submitted before June 30, 1971. The work to be performed during fiscal 1972 will be an extension; in depth, of the analyses initiated this year.

The long-term objectives include examination of the following questions:

1. The required regulatory ground rules for the competitive environment assuming the entry of new suppliers;

902613

2. The performance history of existing common carriers in providing new communication services, specifically data transmission;

3. Evaluation of existing demand studies for specialized communication services and preparation of independent forecasts;

4. The interference problems imposed on existing terrestrial common carriers and new applicants in the 4-6 GH_z portion of the spectrum with growth of domestic satellite systems;

5. The effect of market competition on nationwide average rates for private line services;

6. The effects of competition, ease of entry and exit of communication suppliers on innovation and the rate of introduction of new technology;

7. The effects of new communication suppliers on defense requirements for communication services and on national security;

8. The relative public advantages and disadvantages of alternative modes of providing local distribution plant; i.e., ownership, rental arrangements, indefeasible lease rights.

13. CONTENT:

In the present fiscal year the conceptual problem will be organized, resource material assembled and a preliminary report prepared. This report should be sufficient to allow OTP to determine what, if any, policy position needs to be expressed in the specialized common carrier proceeding (Docket 18920). The work will be organized to be responsive to the issues set forth by the FCC in that proceeding.

14. COSTS: March 1, 1971 - June 30, 1971

			Finances apprised:
Staff			
Gabel	.3 MY	$18,400	$10.0K
Engineer	.2 MY	5,600	6.2
			16.2 Salary
Other objects - costs		Overhead @ 8%	8.2
		Benefits	1.1
Data Base		3,700	-0-
Travel		2,500	2.0
Printing		1,000	-0-
ITS (E. Hayden)		5,800	-0-
Total		$37,000	27.5

Approved: [illegible] Approved by AOK 4/5/71 @ $23.0 -4.5 Lmadi.

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Economics of New Communications Services
4. DIVISION: Special Projects Staff (Telecommunication Analysis Division)
5. AUTHORITY: Office Overhead (REA&TS)
6. SUBDIVISION: Business - Economic
7. PROJECT LEADER: Jack Cole
8. PROJECT NUMBER: 9036214
9. PROJECT TITLE: International Communications Analysis
10. ALLOCATION: $7,227
11. BACKGROUND:

Technical advances have greatly increased the communication capacity of communication satellites and underseas cables. With the increase in available services, there has been an increase in demand for ordinary telephone circuits for business use, for groups of telephone circuits for data services, and for broadband video channels. This exists in the Atlantic Basin; is rapidly expanding in the Pacific Basin and also to the South -- as markets expand with the development of South American countries. These circumstances are exerting new pressures to re-examine the traditional methods used to meet our international telecommunication requirements.

12. OBJECTIVES:

To provide a better basis for decisions concerning which combination of international telecommunications facilities should be encouraged as a matter of investment policy and which should be authorized as a matter of regulatory policy. This will include a survey of past and current international tariffs and the important factors which determine rate relationships; determination of comparative costs of means of achieving various levels of reliability for alternative transmission facilities and systems; determination of trunking requirements for selected years and areas; and determination of optimum mix and timing for introduction of international transmission facilities.

13. CONTENT: (FY -71)

1. Determine the past (since 1950) and current tariffs for international message, private line, record, data, and video service between the U.S. and selected foreign countries in the Atlantic and Pacific Basins.

2. Determine possible correlation between changes in tariffs and changes in technology, demand, market structure, and U.S. and foreign policy.

14. COSTS: May 3, 1971 - June 30, 1971

Staff

Jack Cole	.165 MY	$4401
Tot. Proj. Salary		$4401
Overhead @ 82%		$3609
Personnel benefits @8%		352
Travel and transportation		100
Rent, communication and utilities		- overhead
Printing and reproduction		- 50
Other services		
Supplies and materials		- 50 "
Equipment		- 400
		~~$8,962~~ 8,462
Less amt. allocated to Proj. 9036212 for Mr Cole		-1,235
Amt approved for allocation		7,227

RH
5/4/71

March 9, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Economics of Radio Spectrum Use
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical - Economic
7. PROJECT LEADER: William Gamble
8. PROJECT NUMBER: ~~9018299 (9232121)~~ 9036216
9. PROJECT TITLE: Spectrum Allocation Analysis
10. ALLOCATION: $5,435.
11. BACKGROUND:

The radio spectrum "resource" is limited and already extensively used. To manage this resource so that it can support projected communication requirements, it is necessary to understand the extent and limitations of the resource as well as the impact of new technology and operating conditions upon spectrum utilization. As there are many users of this resource, adequate measures of usage rights and use should be examined and potential sharing options should be identified.

12. OBJECTIVES:

To identify significant development (past, present and future) in practical radio and non-radio technologies and techniques which affect the amount of spectrum resource needed by telecommunication systems, as well as the associated costs; to evaluate the operational and spectrum usage advantages and disadvantages which might accrue from each; to examine the basic processes of radio signal transmission and reception; to identify the nature and dimensions of the spectrum "resources" and develop a system capable of specifying both the use of this resource and usage rights of reasonable expectation, in comprehensive and quantifiable terms; and to conduct studies of particular frequency sharing options in order to identify necessary and sufficient design and/or operating conditions on both services which will permit effective sharing, and identify the economic costs and benefits associated with each option.

13. CONTENT:

a. Identify advancements in communication technology which affects the amount of spectrum resource needed.

b. Identify the nature, dimensions and measures of the spectrum "resources".

c. Identify necessary and sufficient design and/or operating conditions which will permit effective frequency sharing.

9026216

d. Evaluate the costs and potential impact on spectrum utilization associated with the advancements in communication technology and the frequency sharing options.

14. COSTS:

			Funds approved
Staff			
Corrado	.05	1130	1130
Gamble	.07	1369	1390
Powell	.01	283	285
Total Project Salary		2782	2805
Overhead @ 82%		2240	2300
			5105
Personnel benefits @ 8%		218	225
Travel and transportation		106	156
Transportation of things		0	
Rent, communication and utilities		-	overhead
Printing and reproduction		172	
Other services		1050	0
Supplies and materials		382	
Equipment		0	
		6950	6500
Less adjustment			-1,065
			$5,435 ES

Approved by AJK at 4/8/71 for $5,435.

March 9, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Utilization of Telecommunications Technology
3. SUBACTIVITY: Technological Characteristics of Telecommunication Services
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: Anthony Corrado
8. PROJECT NUMBER: ~~9018299 (9312112)~~ 9036222
9. PROJECT TITLE: Mobile Communications Analysis
10. ALLOCATION: $1,760
11. BACKGROUND:

New demands for radio communications have created serious congestion in frequency bands used for mobile communications and affect areas such as law enforcement, aeronautical communications, Federal and industrial services. Policy recommendations to meet these pressures for expansion should be based on evaluations of how well the service needs are being met by existing systems and what improvements are technically and economically feasible.

12. OBJECTIVES:

To identify and evaluate a number of alternative technologies and operational approaches for providing mobile communication services (land, sea, and air) for large segments of the public; to identify and analyze opportunities for new and expanded applications of mobile communications systems in the 1975-80 time frame and to evaluate the potential benefits and costs of alternative approaches for providing mobile communications to support law enforcement and public safety services.

13. CONTENT: (FY-71)

a. Identify transmission technologies, terminal devices and operating techniques for providing mobile communication services.

b. Develop equipment and/or operating criteria in an effort to provide more efficient use of that portion of the radio spectrum in which mobile communications is permitted.

14. COSTS: March 1, 1971 - June 30, 1971

			Finances approved:
Staff			
Corrado	.03 MY	$688	686
Gamble	.02 MY	390	372
Total Project Salary		1078	1060
Overhead of 82%		885	870
			1930
Personnel benefits @ 8%		86	84
Travel and transportation		42	86
Transportation of things		0	-0-
Rent, communications and utilities		-	overhead
Printing and reproduction		68	-0-
Other services		414	-0-
Supplies and materials		151	-0-
Equipment		0	-0-
		$2,724	2,100
Less: .164 adjustment			- 340
			1,760 ← 8

Approved by agk @ $1,760 on 4/8/71.

March 11, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Improvement of Government Telecommunication System
3. SUBACTIVITY: Extension of Frequency Assignment Compatibility
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: ~~George Stelzenmuller~~ B Higgins
8. PROJECT NUMBER: ~~9018299 (9412111)~~ 9036231
9. PROJECT TITLE: Spectrum Occupancy Monitoring Analysis
10. ALLOCATION: $2860.
11. BACKGROUND:

Efficient management of the valuable radio frequency spectrum resource is heavily dependent upon the existance of a capability to detect and verify the actual level of frequency usage on a selective basis. The ability to observe and measure the technical and operational characteristics of radio emissions is also required to determine the effectiveness of existing regulatory procedures and limitations on frequency authorizations, the degree of compliance with those limitations, and the effects of technical characteristics of equipments upon adjacent users of the spectrum. No suitable capability of this type is presently available at the appropriate level of management. Such a facility would provide:

1. A means for selective determination by frequency band, times and area/location of the actual level of spectrum occupancy in verification of and as a supplement to existing records;

2. A means to support the development, improvement and enforcement of technical criteria affecting spectrum economy;

3. A means for refinement and enforcement of rules and limitations affecting frequency sharing; and

4. A means for the validation and refinement of theoretical models and techniques for EMC analysis.

12. OBJECTIVES:

Provide within a reasonable limit of applied resources a frequency monitoring/measuring capability with appropriate mobility:

1. To accomplish relatively simplified monitoring of frequency usage by hand, area and time period for use as a basis for assessments of frequency availability, levels of saturation, records verification and the like;

2. To monitor selected bands and areas and make measurements necessary to determine the degree of compliance with prevailing standards and assignment limitations;

3. To accomplish detailed measurements of emissions in certain selected frequency bands and radio services (e.g., direction of arrival, polarization, signal duration, spurious levels, etc.) as a tool for the prediction and analysis for EMC; and

4. To provide a means for integration of the output of the monitoring/measurement facility into the overall program for frequency management through the use of compatible data formats, computer software, etc.

13. CONTENT: (FY 71)

1. Continue assistance to the OTP in supervising the contract study of the SRI to define and cost/analyze alternative monitoring/measurement programs;

2. Review, in conjunction with ITS/OT, SRI's recommended programs taking into account any available ITS facilities, upon receipt of SRI's final report; and

3. Develop, in conjunction with ITS, both an interim and a long-range program to provide a facility which will fulfill the objectives stated above.

14. COSTS: March 1, 1971 - June 30, 1971

Staff			Funds approved
Higgins	.03	$625	$625
Powell	.01	283	265
Stelzenmuller	.03	874	875
Total Salaries		1782	1765
Overhead @ 82%		1460	1445
Personnel benefits @ 8%		142	140
Travel and transportation		70	70
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		112	0
Other services		692	
Supplies and materials		250	
Equipment		0	
		$4,508	3,420
		Less adj.	- 560
			$ 2,860

Approved 4/8/71 by agk @ $2,860.

9026232

March 11, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Improvement of Government Telecommunication Services
3. SUBACTIVITY: Extension of Frequency Assignment Compatibility
4. DIVISION: IRAC (Telecommunication Analysis Division)
5. AUTHORITY: IRAC (REA&TS)
6. SUBDIVISION: Technical - Economic
7. PROJECT LEADER: George Stelzenmuller
8. PROJECT NUMBER: ~~9418299 (9412121)~~ 9026232
9. PROJECT TITLE: Spectrum Engineering Criteria Analysis
10. ALLOCATION: $11,700.
11. BACKGROUND:

In the process of frequency management at the National level, the area of spectrum engineering criteria (often called technical standards) has always been accorded a minor role. It is an unpopular area because the most immediate effect of mandatory technical standards is to limit the freedom of choices in design, procurement and operation of radio systems, and to generally increase the time and cost involved in establishing and maintaining a radio communication capability. Decisions to set values on and to adopt engineering criteria have been very slow in the executive branch because the power to make these decisions have been placed in the hands of the organizations to whom they apply. Self-regulation on the part of users of an important and limited National resource does not promote the application of criteria which are at the same time both uniform and also appropriately restrictive in the National interest.

Nevertheless, those user Government agencies to whom spectrum engineering criteria will apply must be instrumental in their development. The key to obtaining an effective balance for such criteria in the whole area of spectrum resource management is the provision of a small but effective centralized activity where sound criteria can be formulated under uniform and objective guidelines.

12. OBJECTIVES:

The long-term objective of this project is to develop spectrum engineering criteria that are scientifically sound, technologically achievable and economically acceptable for use by OTP as effective spectrum management tools.

The most immediate objective of this project is to continue the development of certain spectrum engineering criteria already initiated, and to initiate several specific efforts most essential to progressive evolution of the long-term objective.

9006232

The activities already under way are:

1. Guidance of effort in TSC Working Group on Radar Spectrum Engineering Criteria. This effort is in its second phase (criteria for medium/low-power and mobile radars) and is expected to take an additional 1 1/2 years.

2. Guidance of effort in TSC Working Group on Land Mobile Minimum Performance Specifications, plus technical and coordinating effort necessary. This effort is expected to require an additional 10 months.

3. Guidance and technical development for an effort in TSC Working Group on a study of the Table of Tolerances for the levels of Spurious Emissions. Technical development is needed for:

   a. The specification of conditions for measuring the unwanted emissions (bandwidth, modulation), with necessary definitions.

   b. The development of unwanted emission criteria for transmissions above 960 MHZ (no provisions are in the Table for this part of the spectrum. The most urgent requirement is for the bands from 960 MHZ to 10 GHZ.

   c. A revision of the format of the Table to specify in more detail the criteria for the several types of radio services and categories of stations.

4. Continuation of an effort to review and determine the parameters of electromagnetic noise emissions that will provide the means of subsequently assessing the interference potential of noise and establishment of appropriate control measures for this form of pollution.

The following aspects of spectrum engineering criteria should be initiated at once:

1. A review is required of the OTP Manual to ascertain what technical effort is needed to correct deficiencies in existing provisions, and to formulate a total development plan for Government spectrum engineering criteria. This will require 0.03 man-years in FY 71, and 0.1 man-year in FY 72.

2. A determination is needed of those parameters relating to radio receiver influence on spectrum usage. This will require 0.25 man-years. Following the determination of critical parameters, plans should be established for

902232

procurement of the technical data which the Government agencies will furnish via the frequency management mechanism. This will require 0.5 man-years. Following the establishment of this plan, it will be desirable to develop advisory evaluations as guidance to the potential users of radio receivers of the various categories.

3. The development of measurement procedures necessary to the application of the Radar Spectrum Engineering Criteria is an urgent requirement. This will take 0.05 man-years in FY 71, and 0.50 man-years in FY 72, plus the establishment of a technical advisory group on radar measurement procedures (including the cost of travel reimbursement for a small number of out-of-town members).

14. COSTS: March 1, 1971 - June 30, 1971

Approved funds:

Staff

Gamble	.02	391	376
Higgins	.03	625	625
Powell	.05	1414	1,195
Stelzenmuller	.17	5100	4,947
Total project salaries		7530	7,138
Overhead @ 82%		6160	5,852
			12,990
Personnel benefits @ 8%		614	570
Travel and transportation		294	440
Transportation of things		0	
Rent, communications and utilities		-	overhead
Printing and reproduction		475	0
Other services		2900	
Supplies and materials		1050	
Equipment		0	
		5323	14,000 &
Less adj.			-2,300
			11,700

Approved 4/8/71 for $11,700 by agk.

62,360

62.4
52.7
9.7 leeway
left at 1430/71

35.2 ACRS
2.0 SUB TO ITS
1.1 TVL
14.5 KIRBY
52.7

Approved by
3/11/71
(illegible)

R.S. Powers
February 26, 1971

PROJECT SUMMARY

1. ORGANIZATIONAL UNIT: Office of Telecommunications
2. ACTIVITY: Research and Analysis for Policy Formulation
3. SUBACTIVITY: Economics of New Communications Services
4. DIVISION: Special Projects Staff (Telecommunications Analysis Division)
5. AUTHORITY: REA&TS (Research, Engineering, Analysis and Technical Services)
6. SUBDIVISION: Urban Telecommunications (Technical--Engineering and Physical)
7. PROJECT LEADER: R.S. Powers
8. PROJECT NUMBER: ~~9100110 (9222143)~~ 9036215
9. PROJECT TITLE: Community Cable Distribution (Demand)
10. ALLOCATION: $20,000
11. BACKGROUND:

The same set of FCC inquiries and rule-making proceedings which motivate a study of the technical capabilities of cable for information and entertainment services (see Project 910) required knowledge of the potential demand for the proposed services. In fact, the realization of the technical possibilities depends critically on the availability of money which in turn is controlled by the demand for the services. Thus there is no point to studying either potential demand or potential technical developments without equivalent consideration of the other.

12. OBJECTIVES:

The FY 1971 objective of this project is to produce a comprehensive report estimating the demand during the 1970's for those technically feasible cable distributed services which seem at first look to be economically reasonable. The services to be examined will include one-way and two-way services. Those services proposed by the National Academy of Engineering, Committee on Telecommunications (final report due in the summer of 1971) and those to be considered by the IEEE Cable Television Task Force will be among those considered in this project.

Time span: Since the Office of Telecommunications is not prepared to perform this type of study in-house, it will be performed on contract. The contract will be let before the end of FY 1971, and will be completed during the summer or early autumn of 1971. A precise completion date will be determined during negotiation of the contract.

13. PROGRAM CONTENT:

The project will consist of a study done by an outside contractor, to examine the demand as described under item 12, above.

902615

14. COST:

a. Staffing

Work statement definition and contract monitoring will be performed by project personnel under the accompanying project, #910

b. Other Services

Contract: $20,000

TOTAL: $20,000

Finances approved @ $20.0K.
EJ

Approved subject to review of contract. I seriously question whether any meaningful demand study can be accomplished for 20k.
RWL

9022160

Project No.: ~~2190~~
OT Program: Information Base
Sponsor: OT
Title: Information Base Program

Date: 3/15/71
Leader: R.K. Salaman
Alloc: ~~$20K~~ Suppl. $10.0K

Background:

A primary function of the Office of Telecommunications is to provide information to the Office of Telecommunications Policy and other agencies as necessary to make telecommunication related decisions. The scope of this information includes summary and evaluation of telecommunication requirements, advancements, deficiencies, opportunites, and alternatives based on national and international activities in the areas of science, technology, and socio-economics. Specific activities include information source identification, data access, and information analysis.

Long Term Objectives:

To develop and maintain the base of information required for and resulting from research, analysis, and policy decisions as necessary to assist in attaining the national telecommunication goals.

Current Year Specific Activities

Guidance will be provided for the information base program. Primary projects within this activity are 2100 Survey of EM Wave Propagation, 2110 Resource Inventory, 2120 Population Information, 2140 Propagation Assessment, and 2260 Telecommunication Information Center. Availability of business/economic data will be determined. Pertinent policy information will be collated.

Costs:

Biweekly Sal. Rate		Daily Sal. Rate		Cal. Days	Paid Days		Salaries
853.96	R.K. Salaman	85.40	.1 MY	36	26	$5K	2.2
751.20	W. Gamble	75.12	.1 MY	36	26	$5K	2.0
	Other assistance (NTIS)		.1 MY	OBJ CLASS 25		$4K	-0-
						Salaries	4.2
						82% Overhead	3.4
							7.6
						Pers. Benefits	0.4
							8.0
							2.0 TRL
							-0-
							$10.0K recom.

Other Objects Class:

Travel $2K
Other services $2K + 4K
Transportation
Supplies and materials
Rent, communication
Equipment
Printing and reproduction ~~$1K~~

Approved: RMK

$10,000 FY71 funds available. (EZ)

W Kamsom
4/12/71

March 10, 1971 9062410

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Overhead
3. SUBACTIVITY: Division
4. DIVISION: (Telecommunication Analysis Division)
5. AUTHORITY: Division Overhead
6. SUBDIVISION: Division Project
7. PROJECT LEADER:
8. PROJECT NUMBER: ~~(9542902)~~ 9062410
9. PROJECT TITLE: Telecommunication Analysis Division Overhead
10. ALLOCATION: ~~None~~ $46,450,
11. BACKGROUND:
12. OBJECTIVES:
13. CONTENT:

To provide direction and administrative services required for division management.

14. COSTS:

Costs to be charged against division projects when required.

Boreman	4242.80
Gary	6038.56
Burke	2569.60
Colbert	3200.32
Disney	2674.72
Dolton	1740.32
Mullins	2014.80
22,881.12	Salaries
18,762.52	Overhead
41,643.64	
1,945.00	Benefits
2,851.36	
Funds available	$46,440

Administrative approval only

Approved by agk @ $46,450 on 4/8/71

rev 4/28/71

902 6r3f

14. COSTS: March 1, 1971 - June 30, 1971

Staff

		Funds approved
Garber	.03	588 588
Powell	.13	3680 3190
Salaman	.33	(Included in ITS Projects)
Stelzenmuller	.05	1450 1435
Vacancy II	.15	3020 -0-
Total project salary		8738 5213
Overhead @ 82%		7150 4275
Subtotal		9488
Personnel benefits @ 8%		699 417
Travel and transportation		340 395
Rent, communications and utilities		- overhead
Printing and reproduction		550
Other services		3350 0
Supplies and materials		560
Equipment		660
		$22,047 $10,300

-1690 adjustment

$8,610 recom.

Approved by agk 4/8/71 @ $8610.

$ 11,710 revised 4/71

Approved: Ford

March 10, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Improvement of Government Telecommunications Systems
3. SUBACTIVITY: Analysis of Federal Government Telecommunications Expenditures
4. DIVISION: Special Projects Staff (Telecommunication Analysis Division)
5. AUTHORITY: Office Overhead (REA&TS)
6. SUBDIVISION: Technical - Economic
7. PROJECT LEADER: R.C. Powell
8. PROJECT NUMBER: ~~9001913 (9422121)~~ 9026234
9. PROJECT TITLE: Analysis for Federal Government Communication
10. ALLOCATION: ~~$8,610.~~ $11,210 revised 4/71
11. BACKGROUND:

The technology exists today to greatly improve the effectiveness and versatility of telecommunications for both government and business. Cost savings can be realized by better planning of government systems, by substitution of communications for more expensive resources and by more effective coordination of Federal systems research and developments.

12. OBJECTIVES:

To determine what changes in teleprocessing system structure, standards, operation and management arrangements would be needed to achieve feasible improvements, to develop methodology for reviewing telecommunication research and development supported by government and industry, to develop means for allocating costs for Federal government common user networks and to develop a pilot telecommunications system incorporating advanced techniques.

13. CONTENT:

Collect and evaluate descriptions of research and development sponsored by the Federal government particularly for basic data and formula useful to the frequency assignment process. Analyze in depth computer and communication requirements of the Office of Telecommunications, analyze operating procedures which might be improved by use of computer. Develop specifications for computer and communication systems for OT and initiate improvements. Develop means for optimizing costs of common user networks under various economic and legal constraints.

March 10, 1971

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Improvement of Government Telecommunications Systems
3. SUBACTIVITY: Analysis of Federal Government Telecommunications Expenditures
4. DIVISION: Special Projects Staff (Telecommunication Analysis Division)
5. AUTHORITY: Office Overhead (REA&TS)
6. SUBDIVISION: Technical
7. PROJECT LEADER: Harvey Lance
8. PROJECT NUMBER: ~~9001913 (9422III)~~ 9006233
9. PROJECT TITLE: Telecommunication Standards Management
10. ALLOCATION: $26,500.
11. BACKGROUND:

Standards are useful guides to telecommunications system design and operation. They promote economy in procurement and interchangeability of equipment. They provide a basis for effective utilization of the spectrum. The standards effort to date has been carried out at a low level, with long delays, and not all needed standards have been produced. In most cases, there are no recognized measurement methods or measuring instruments for determining compliance with the adopted standards. The rapid growth in government telecommunications makes essential a more comprehensive standards and measurements program.

12. OBJECTIVES:

To define and implement a telecommunications standards and measurements program for OT which will meet present and foreseen needs of government telecommunications and which will be a useful contribution to standards for non-government telecommunications. Major outputs: recommended standards for government telecommunications systems; measurement methods for determining compliance with the standards. Milestones: project to meet urgent needs initiated during FY 1971. Report recommending future program, to be completed by the end of FY 1971; to be sharpened and extended during FY 1972.

13. CONTENT:

Survey the various government radio services to ascertain problem areas; conduct systems analysis for determining the effect on systems performance of factors considered for standardization, where suitable models are available; make economic impact and trade-off studies, maintain coordination with OTP, FCC, NBS, and other government agencies. By June 30, 1971, issue a report

9026233

describing major features of the proposed program, containing tentative assessment of priorities, alternatives, impact, resources required, and a plan for implementation of the program. The report (or source material gathered for it, if required earlier) will provide information useful in programming FY 1972 work and in preparation of the FY 1973 budget.

14. COSTS: March 1, 1971 - June 30, 1971

Staff

Lance	0.33 MY	$17,650	9,750
Stelzenmuller	0.05 MY	2,400	1,435
Gamble	.05 MY	1,700	965
Cole	.05 MY	2,400	1,315
Gabel	.05 MY	2,700	1,455
Powell	.05 MY	2,400	1,195
Zois	.08 MY	3,200	-0-
		Salary	16,145
		82% Overhead	13,735
		Benefits	1,290
Travel		1,200	1,030
Printing and reproduction		350	-0-
Total		$34,000	31,700
		Less adjustment	5,200
			26,500

Approved @ $26,500 by ASK at 4/8/71.

OT RESEARCH AND SERVICES PROJECT [illegible]
Dec. 15, 1970 to June 30, [illegible]
(Estimate)

Date: [illegible]

9006235

1. Proj. No.: ~~6210~~ 2. OT Prog Element Ref: [illegible]

4. Title: State and local assistance [illegible]

6. Allocation: ~~$80,000~~ ~~$72,360~~ 62,360

7. Background:

This is a two-directional program in that it involves the Office of Telecommunications Policy in coordinating Federal assistance programs in the telecommunications area and the Secretary of Commerce in the carrying out of the broad functions assigned to him as they relate to telecommunications in State and local government activities.

8. Long-term objectives, estimated duration, major outputs and milestones:

a. Provide advice and assistance--technical, legislative, administrative, financial -- in response to State and local government requests on a case-by-case basis;

b. Develop a data base of information on Federal assistance available for State and local government telecommunications activities;

c. Develop a data base of information on State and local government telecommunications;

d. Develop and carry out analytical studies that pinpoint the means whereby telecommunications can more effectively support Department of Commerce activities [illegible] to State and local governments. During [illegible] of FY 1971, special emphasis will be devoted to Alaska communications. That is, a comparative analysis of domestic satellite filings will be conducted and problems to Alaska as will be the development of a [illegible] telecommunications institutional arrangements [illegible] other State governments. In support of the Secretary of Commerce, the latter half of FY 1971 will be devoted to program development.

9. Specific activities to project end, accomplishments and [illegible]; milestones; reports planned, scope and date:

Make presentation to State of Alaska [illegible] March 5, 1971; print report of [illegible]

902635 ~~902635~~

to Alaska by April 30, 1971; conduct [illegible] with [illegible] Commerce officials to determine Commerce [illegible] and refine program parameters and objectives; develop [illegible] Commerce program by June 30, 1971. The latter [illegible] will be concerned primarily with organizational [illegible] development tasks.

10. Costs (through June 30, 1971):

a. Staffing. Names, salary, man-years, [illegible] labor, including all overheads:

		To May 26, 1971	Addl. to June 30, 1971	
C. E. Lathey		7750	15,641	
A. Levanthal		6420	14,651	
E. Disney		1290	4,864	FOR COLE
	Subtotals	$15,460	35,156	

b. Other Objects

Travel		$2000 Gone	$ 1,100
Transportation		-0-	-0-
Rent, Communication		-0-	-0-
Printing, Reproduction		-0-	2.000 — by memo 902635 - ITS suballoc'd
Other Services			
ITS		1450	7.640 — o —
Est.		1940	-0-
Supplies and Materials		-0-	-0-
Equipment			200
	Subtotals	$18.444	10.940
	Totals	$80,000	Lundsaid. 72,360 Eg.

Approved: Zinn

Approved by AGK 4/8/71 @ 72.360 K reduced to → 62,360 as at 4/27/71

of which 2,000 for printing report is sub-alloc. to ITS.

March 10, 1971 9036240

PROJECT SUMMARY

1. UNIT: Office of Telecommunications
2. ACTIVITY: Overhead
3. SUBACTIVITY: Division
4. DIVISION: (Telecommunication Analysis Division)
5. AUTHORITY: Division Overhead
6. SUBDIVISION: Division Project
7. PROJECT LEADER:
8. PROJECT NUMBER: ~~(9542902)~~ 9036240
9. PROJECT TITLE: Telecommunication Analysis Division Overhead
10. ALLOCATION: ~~None~~ $46,450,
11. BACKGROUND:
12. OBJECTIVES:
13. CONTENT:

To provide direction and administrative services required for division management.

14. COSTS:

Costs to be charged against division projects when required.

Brockman	4242.80	
Gary	6030.56	
Burke	2569.60	
Colbert	3200.32	
Veaney	2674.72	
Dolton	1746.32	
Mullins	2014.56	
	22,851.12	Salaries
	18,762.52	Overhead
	41,643.64	
	1,945.00	Benefits
	2,851.36	
	Funds available $46,440	

Approved by agk @ $46,450 on 4/5/71

BOULDER

ITS Projects

		$
4280 ✓	Compatibility of frequency assignments	70.0 ✓
7110	Tele. network interconnections	50.0
(5120)	Mobile communications	35.0
5100 ✓	Applications of communication theory	25.0 ✓
3270 ✓	VHF/UHF systems & propag. model devel.	29.0 ✓
2120	Computer retrieval	15.0 ✓
2130	Atlas of rain (satellite studies)	30.0
2110	Resource inventory	20.0
2160	Information base	25.0
2140	Propagation assessment	5.0
4250 ✓	EMC analysis development	111.0 ✓
4255 ✓	Radio spectrum occupancy	85.0 ✓
6110	Alaska study	26.0
	Sub-total ITS	526.0

✓ Cohn Arecs.

70
25
111
85
29
320K for Spectrum

( ) = NOT SPECTRUM

ITS RESEARCH AND SERVICES PROJECT SUMMARY

Dec. 15, 1970 to June 30, 1971

Date: 2-9-71

1. Proj. No.: ~~4110~~ 4255
2. OT Prog Element Ref: 04
3. Leader: A. F. Barghausen
* $105.0 funds avail. [illegible]

4. Title: Radio Spectrum Occupancy
5. Sponsor:
6. Alloc: 20K + 85K (Supp) (if OA, also indicate FY 72 reserve)

7. Background:

Data on actual usage of the electromagnetic spectrum for the various radio servi[ces] is not available. Concepts and measures of channel saturation and utilization need development. There are several existing (VOA) or planned (FCC) radio spectrum occupancy measurement programs at this time; however, these are by necessity limite[d] to priority problems (urban mobile, HF broadcasting) to alleviate specific congestion areas. Programs in (1) electromagnetic compatibility analysis development and servic[es] (2) telecommunication systems performance, and (3) research and analysis for policy formulation are dependent on realistic radio spectrum usage information as a data base (over)

8. Long term objectives, estimated duration, major outputs and milestones:

To provide a data base of realistic radio spectrum usage information for research projects in telecommunications engineering, management, and policy formulation. Th[e] objective is accomplished through coordinated efforts in (a) understanding the nature and significance of spectrum occupancy as it is or may be related to the achievement of efficient spectrum management practices, (b) techniques of measurement, and (c) analytical procedures. The establishment of a strong interface with the OTP (IRAC), and military is essential to the program. A measurement program utilizing existing o[f] (over)

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones, reports planned, scope and dates:

A series of prerequisite studies will be made to define:
--the component parts of radio spectrum occupancy;
--the relationship between these component parts to determine spectrum usage;
--analytical procedures necessary to establish a useful data base for EMC analysis development, system performance (standards), and policy formulation;
--techniques of measurement; and
--measurement programs.

A detailed study of other Federal Agency existing and planned "ad hoc" spectrum usage (over)

10. Costs:

a. Staffing. Names, Salary, tenths of man year, cost of labor including all overheads:

A. F. Barghausen	$23,591	0.37 MY	$18,986	*W. H. Ahlbeck	$16,404	0.14	5,043
R. T. Disney	21,905	0.50 MY	23,642	*K. Beasley	9,726	0.13	2,746
R. J. Matheson	16,543	0.46 MY	16,707	*L. R. Espeland	13,878	0.17	5,021
L. D. Schultz	18,353	0.10 MY	3,985	*W. O. Robinson	14,589	0.13	4,080
A. D. Spaulding	19,537	0.05 MY	974	*A. Milton	17,545	0.18	6,706
D. W. Zacharisen	17,545	0.25 MY	9,391			TOTAL	100.000
C. Jurgens	8,324	0.15 MY	2,719	*temporary through 3-6-71 - to be reassigned			

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel $500

22.0 Transportation

23.0 Rent, communication

24.0 Printing and reproduction $1,000

25.0 Other svcs - (computer, contracts) $1500

26.0 Supplies & Materials - $2000

31.0 Equipment

* Funds approved, but project summary to be split into 2 and rewritten.

Signatures:

Proj. Ldr. [signature] Assoc. Dir. [signature] Dir. ITS RKS. Dir. OT [signature]

7. (continued)

Similarly, man-made, atmospheric, and galactic noises are an important part of any definitive radio spectrum occupancy program since it establishes the level of the unoccupied spectrum with which radio service signals must compete. In this context, man-made noise is defined as unintentional EM radiation (igniyion, power lines, etc.). Intentional EM radiation (interference) from other radio services may in the broadest sense, be considered as man-made noise, but must be treated separately. However, this type of interference is of major importance in many systems and will receive priority. Important factors here are the spatial and/or angular distribution of the interference.

8. (continued)

newly acquired OT/ITS facilities and equipment may be necessary to demonstrate useful specific techniques for measuring channel occupancy. Data would be made available to other program areas for study and use.

9. (continued)

programs will be made to determine their possible application to other spectrum occupancy measurement needs. A report describing the results of the prerequisite studies will be prepared as an OT Research Report. An OT Tech Memo will be issued describing a feasible pilot channel occupancy measurement program, and the design and recommended techniques for a long-term spectrum occupancy measurement program. As a part of this report, a short-term (few days) measurement program will be undertaken with temporary personnel and existing equipment. An OT Research Report will be issued which will survey all currently available man-made noise measurement results within OT/ITS, define parameters of man-made noise for standardizing measurements and recommend uses of data for EMC development and further work.

Dec. 15, 1970 to June 30, 1971

Date: 2/16/71

1. Proj. No.: 5100 2. OT Prog Element Ref: 05 3. Leader: M. Nesenbergs

4. Title: Application of Communication Theory

6. Alloc: $40K
Supp: $25K

E.S.D. Funds available 4/2/71

5. Sponsor: OT

7. Background:

The efficient use of electrospace depends on keeping signal-to-interference ratios, as well as signal-to-noise ratios, in workable regions. New techniques of spectral sharing, notable spread spectrum, apply to satellite, mobile, and other data systems, and may offer important opportunities in terms of electrospace usage and system capabilities. Similarly, the role of multiple access is growing in both civilian and defense applications. Typical digital radio systems suffer from errors caused by harmful noise, interference, or signal distortion effects. These channel characteristics are relevant events and need to be studied using the large ITS propagation expertise.

8. Long-term objectives, estimated duration, major outputs and milestones:

Known signal-to-interference protection ratio tables apply to a few types of modulation, in the absence of fading. We will extend these tables to other important types of modulation under realistic (viz., fading) conditions and to protection ratios required, when interfering signals are modulated differently from the wanted signal (6 mos.). The usefulness of pseudo-noise sequences, either as modulation or subcarriers for multiple access systems, will be investigated (6 mos.). In addition,

continued on following page

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates:

Will derive signal-to-interference protection ratios for selectively fading radio channels. Signal intensity, bandwidths, frequency separation, and other parameters will be included. Will seek effective signal-to-noise ratios for simplest cases (i.e., perfect phase lock, etc.) of random type multiple access using spread spectrum techniques. Will identify measurable error-causing features of the scattering function. Before the end of 1971, anticipated significant results on all topics will be: submitted for inside or outside publication, used in definition of ITS programs, proposed to amend operational tables (such as CCIR).

10. Costs:

Name	Salary/Year	Man Years	Cost/Overhead
M. Nesenbergs	24,285	0.42	22,032
H. Akima	22,203	0.33	15,986
G. R. Peterson	15,141	0.25	8,236
M. T. Ma	24,979	0.30	16,186
		Total	62,440

Other Objects:	
Computer	1,500
Printing, Reproduction, Typing	600
Travel	460
Grand Total	65,000

Signature [illegible] DD Coombs [illegible] 1971

8. (Con't.)

the most useful channel characteristics for determining communication system performance will be identified and provided to other groups as a guide in development of their measurement programs (6 mos.).

ITS RESEARCH AND SERVICES PROJECT SUMMARY

Dec. 15, 1970 to June 30, 1971

Date: 2/16/71

1. Proj. No.: 5120   2. OT Prog Element Ref: 05   3. Leader: D. D. Crombie

$55.0 Funds avail.

4. Title: Mobile Communications Study   6. Alloc: $20 K, ($35K supp.)

5. Sponsor: (if OA, also indicate FY 72 reserve)

7. Background:

Needs for mobile communications have been increasing substantially over the past few years, and a comprehensive study of technical as well as nontechnical requirements is essential for efficient electrospace utilization and coordination with other services.

8. Long term objectives, estimated duration, major outputs and milestones:

Long term objectives are assessment of available techniques and requirements for land, air, marine, and other potential mobile services, a study of alternatives, and definitions of present and anticipated requirements on the electrospace.

This program may require a number of years for completion; partial outputs may consist in definition of service requirements (nontechnical) and the establishment of system performance standards.

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates:

(a) Definition of various technical and nontechnical sub-tasks with proposed methods of attack.

(b) A plan for propagation and system performance measurements and analysis in urban areas will be developed and published. This will include estimation of the distribution of available wanted to unwanted signal ratios and its application.

(c) Continuation of propagation model adaptation for mobile systems, including analysis of available data on propagation and systems performance in large cities.

(d) Available literature on land mobile congestion in urban areas will be reviewed to find where the main problems appear to be.

10. Costs:

a. Staffing. Names, Salary, tenths of man year, cost of labor including all overheads:

Crombie, D. D.	0.1	6,000
Longley, A. G.	0.2	6,000
Barsis, A. P.	0.2	12,500
Willis, H.	0.4	22,000
Gierhart, G.	0.2	6,000
TOTAL		---$ 52,500

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel $1000

22.0 Transportation

23.0 Rent, communication

24.0 Printing and reproduction $1000

25.0 Other svcs - (computer, contracts)$500

26.0 Supplies & Materials

31.0 Equipment

Signatures:

[signature]   [signature] Div.   [signature] Dir. ITS   [signature] Dir. OT [signature]

ITS RESEARCH AND SERVICES PROJECT SUMMARY

Dec. 15, 1970 to June 30, 1971

Date: 2/9/71

1. Proj. No.: 9103270 2. OT Prog Element Ref: 03 3. Leader: G. Hufford

$67. of funds available. Jacket

4. Title: VHF/UHF System and Propagation Model Development

5. Sponsor: OT

6. Alloc: $40 K, $29 K (supp) (if OA, also indicate FY 72 reserve)

7. Background:

Development of models and calculation methods for estimating and analyzing tropospheric (VHF/UHF line of sight and beyond the horizon) radio transmissions is an essential requirement for predicting and evaluating system performance and for efficient utilization of the radio frequency spectrum or electrospace. A pool of basic propagation data and of data characterizing the properties of terrain and of the atmosphere is available for continued utilization in model improvement.

8. Long term objectives, estimated duration, major outputs and milestones:

To acquire and apply experimental data and theoretical methods to the development of models and computation methods for predicting radio wave propagation in the (approx.) 20-15,000 MHz frequency range through the non-ionized atmosphere and over irregular terrain; to estimate performance characteristics of telecommunication systems utilizing these propagation mechanisms, and to provide information and support applicable to studies for efficient electrospace utilization. This is a continuing effort, since new usages and new basic data require adaptation of existing and development of new models.

9. Current year specific activities to June 30, 1971, accomplishments anticipated, milestones; reports planned, scope and dates:

1. Assisting in the adaptation of existing propagation models to form part of a unified and customer accessible time-share computer program.
2. A study of the cost benefits which result from various degrees of improvement in the predictability of VHF/UHF systems. First draft: June 1.
3. A comparison of data with current point-to-point predictions for the statistics of hourly median loss. First draft: May 1.
4. An analysis of some air-ground data at 800 MHz. First Draft: March 1.

(Cont.)

10. Costs:

a. Staffing. Names, Salary, tenths of man year, cost of labor including all overheads:

G. Hufford	$ 4.8 K	R. Reasoner	$ 5.9 K
A. Longley	$ 8.3 K	C. Samson	$ 7.7 K
G. Gierhart	$ 6.4 K	P. McQuate	$ 2.0 K
M. Johnson	$ 5.8 K	Other Labor	$ 4.5 K
R. Wilkerson	$16.3 K	TOTAL	$64.5 K
J. Montgomery	$ 2.8 K		

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel $1 K

22.0 Transportation

23.0 Rent, communication

24.0 Printing and reproduction $3 K

25.0 Other svcs - (computer, contracts) $0.5 K

26.0 Supplies & Materials

31.0 Equipment

Signatures: [illegible] RKR. Dev. OT

9. (Cont.)....

5. A description of some mobile data taken through foliage at different times of the year. First draft: April 1.
6. A study of the diurnal variation of low-level refractivity profiles. First draft: July 1.
7. An atlas of obstacle gains. First draft: April 1.

ITS RESEARCH AND SERVICES PROJECT SUMMARY
Dec. 15, 1970 to June 30, 1971

Date: 2/17/71

1. Proj. No.: 4250 2. OT Prog Element Ref: 04 3. Leader: D. N. Hatfield
#136 Groundwave, Egelan

4. Title: Electromagnetic Compatibility Analysis Development 6. Alloc: $25K + $111 K (Supp.)

5. Sponsor: OT (if OA, also indicate FY72 reserve)

7. Background:

This project supports Electromagnetic Compatibility Analysis Services. That service will provide the technical basis for frequency allocations and assignments for IRAC and others; it will lead to more efficient use of the spectrum through fuller exploitation of electrospace sharing. The procedures, computer programs, and data bases for the EM analysis service are many and complex and the success in providing such analyses depends directly on them.

8. Long term objectives, estimated duration, major outputs and milestones:

The long term objective of this program is to provide the technical support for the Electromagnetic Compatibility Analysis Service (ECAS) previously described. The technical support will include (1) collection and development of the data base and (2) adaption and development of analysis techniques in the form of computer programs and procedures. The data, programs, and procedures will be obtained from other ITS project, ECAC, other research organizations, etc. The data base will include information on and models of equipment characteristics (e.g., image response of receivers and spurious outputs from transmitters), surface features (topography) and electrical constants of the ground, atmospheric and ionospheric characteristics, channel characteristics, and current frequency allocations. The analysis techniques will include computer based methods for analyzing the level and effect of the interference among systems using the electrospace as required by ECAS. It is expected to be a continuing project.

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates:

1. Support of and in cooperation with IRAC, began an analysis of one of their higher priority compatibility problems. This will provide for immediate experience and the establishment of the necessary liaison.

2. Determine specific ECAS requirements for analytical models and data, especially those models and data which have immediate use or require extensive development. This will involve close liaison with FCC, ECAC, and others.

3. Initiate and complete a survey of available analytical techniques and data that will meet or partially meet the requirements of (1).

(continued on next page)

Signatures:
Proj. Leader D. N. Hatfield
Assoc. Dir. M. Baughman for D. Cumming
Dir. ITS A. Rutkowski
Dep. Dir. OT R. M. Jones

4. Identify the most essential and immediately useful techniques/data and adapt or develop them for use on the Boulder Labs' computers. This will allow early development and application of the service and the accumulation of practical operating experience.

5. Become familiar with the following four OTP priority problems and initiate solutions as appropriate:

(a) Resolve a question of possible interference to ATC 118-136 MHz communications when sharing these frequencies with CATV.

(b) Develop a technique for optimally assigning the specific channels in the 118-136 MHz ATC band to the operating units. It will minimize self interference and maximize usage.

(c) Investigate the feasibility of sharing a frequency assignment between the ATA CAS system and the current L-band aircraft altimeters.

(d) Modify an existing geostationary satellite system computer analysis program for engineering use.

The major anticipated accomplishment is to have the group personnel become familiar with FCC, OTP, FAA, and IRAC. A remote computer terminal will be installed in Boulder to give access to the Washington Univac 1108 computer.

The current OTP priority problems will be acted on as follows:

(a) An analysis of the CATV interference potential was sent (along with recommendations) to OTP on Feb. 2, 1971.

(b) Study of the existing assignment techniques and initial plans for computer model implementation have begun. A primary, computer based assignment technique (sub-optimal), will be completed by June 30, 1971.

(c) The study of the CAS and altimeter system will be completed by June 30, 1971.

(d) The computer program will be modified for the CDC 3800 and tested for accuracy. Some programming changes will be made towards a user oriented program.

Working papers and/or ITS reports will be issued as appropriate.

10. Costs:

a. Staffing, Names, Salary, tenths of man year, cost of labor including all overheads:

Name	Salary (inc. O.H.)	Man years	Costs
Hatfield. D. N.	39.4 K	0.23	9.1 K
Adams, J. E.	37.6 K	0.41	15.9 K
Ax, G. G.	34.2 K	0.42	14.4 K
Berry, L. A.	57.0 K	0.17	10.0 K
Crombie, D. D.	64.3 K	0.05	3.2 K
Enoch, G. R.	17.9 K	0.44	7.9 K
Herman, J. E.	33.4 K	0.42	14.0 K
Jurgens, C. A.	21.7 K	0.21	4.6 K

(continued on next page)

Juroshek, J. R.	33.4 K	0.30	10.0 K
Roberts, W. M.	18.4 K	0.46	8.5 K
Operation Research	34.2 K	0.20	6.8 K
		TOTAL ---------	$104.4 K

b. Other objects: costs (identify individual items over $1000)

21.0 Travel - $3 K
24.0 Printing and reproduction - $2 K
25.0 Other services - (computer, contracts) - $24.6 K*
26.0 Supplies and materials - $2 K

*Computer terminal lease $10 K.

ITS RESEARCH AND SERVICES PROJECT SUMMARY
Dec. 15, 1970 to June 30, 1971

Date: February 22, 1971

1. Proj. No.: 7110 2. OT Prog Element Ref: 4.2. 3. Leader: T. deHaas

4. Title: Telephone Interconnection and Attachment Standards Alloc: $15 K + 365 Funds avail. & $50 K (supp)

5. Sponsor: OT (if OA, also indicate FY 72 reserve)

7. Background:
This task was initiated as a result of reprogramming in December 1970. During the intervening period, several relevant documents have been reviewed and a technical familiarity with the problems associated with interconnection has been achieved. The initial thrust of this task is presently being defined by the Project Leader through discussions with OT, OTP and others.

8. Long term objectives, estimated duration, major outputs and milestones:
The long term objective of this task is to provide technical support to OTP in the formulation of policies, rules and/or tariffs to promote the efficient use of common carrier networks by commercial interests - particularly for small business interests. These policies and rulings must withstand technical criticism, must be legally responsible and must promote an equitable economic environment for both the common carrier and the potentially large number of users.

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates: (1) Make several field trips to representative user and common carrier agencies to establish program elements, objectives, existence of available technical material and resources, establish technical, economic and intra-agency biases and positions, and to develop a proper direction for the study and recommendations; (2) Collect existing manuals and standards of practice procedures and review for general applications; (3) Develop requirements for interconnections - especially for PBX and PABX systems. Develop requirements for network protection as defined by common carrier and evaluate; (4) Develop standards, do economic assessment, develop proposed rulings as required.

10. Costs:

a. Staffing. Names, Salary, tenths of man year, cost of labor including all overheads:

T. deHaas	0.55 MY	$28,896
L. Livingston	0.3 MY	9,591
J. Hull	0.1 MY	7,150
Other personnel as required		16,363
		$62,000

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel $2,500
22.0 Transportation
23.0 Rent, communication
24.0 Printing and reproduction $500.
25.0 Other svcs - (computer, contracts)
26.0 Supplies & Materials
31.0 Equipment

Signatures:
Proj. Ldr. Assoc. Dir. Dir. ITS Dep. Dir. OT

ITS RESEARCH AND SERVICES PROJECT SUMMARY

Dec. 15, 1970 to June 30, 1971

Date: February 22, 1971

1. Proj. No.: 2130

2. OT Prog Element Ref: Telecommunications Information Base

3. Leader: P. L Rice

4. Title: Atlas of Rain Statistics to Support Satellite Interference Studies

5. Sponsor:

6. Alloc: $30 K funds available. E Zucker (if OA, also indicate FY 72 reserve)

7. Background: OT/ITS has been evaluating the sharing criteria as adopted by the CCIR for the allocation and assignment of frequencies to terrestrial and satellite services sharing common bands. A statistical model has been proposed by ITS for calculating the probability of interference caused by rain for any given location and in a given area in order to predict interference probabilities. Such an assessment of data for several locations in other parts of the world where appropriate data are available has been under way for some time. These data properly normalized and rearranged, are necessary for the application of the above model.

8. Long term objectives, estimated duration, major outputs and milestones: The long term objective of this task is to assemble adequate meteorological data for several regions of the world as necessary for the prediction of service probability and sharing criteria. This task in the long term should develop the meteorological data base for specific satellite sharing decisions. The initial studies have been and are based on excessive precipitation statistics which were initially gathered for the assessment of water resources. Future collection of rain statistics should be oriented toward communication interference requirements.

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates:

(1) This task will produce a technical report which will contain the data described in 7 above. This report will be a referencable document to support the statistical model which has been presented at the Feb. 1971 CCIR International Working Party.

(2) Assemble available data and make necessary normalizations.

(3) Make necessary plots of data as required to support the statistical model.

(4) Develop several examples to show applicability of model.

(5) The document will also demonstrate the kind of meteorological data required for any location where the interference is to be applied.

10. Costs:

a. Staffing. Names, Salary, tenths of man year, cost of labor including all overheads:

Rice	0.05 MY	$2,212
Samson	0.1 MY	3,240
Moncure	0.1 MY	3,184
Coyle	0.35 MY	5,362
Holmberg	0.15 MY	2,904
Gray	0.1 MY	2,243
Capps	0.15 MY	3,455
Grant	0.1 MY	3,081

Total $25,681

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel

22.0 Transportation

23.0 Rent, communication

24.0 Printing and reproduction $1K

25.0 Other svcs - (computer, contracts) $3K

26.0 Supplies & Materials

31.0 Equipment

Signatures: OK Assistant mgr. Dep. Dir. OT

Dec. 15, 1970 to June 30, 1971

Date: 2/8/71

1. Proj. No.: 8280 2. OT Prog Element Ref: 08 3. Leader: G. W. Haydon

4. Title: Radio System and EMC Prediction Services

6. Alloc: $55,000 $70,000 (supp.)

5. Sponsor: OT

(if OA, also indicate FY 72 reserve)

7. Background:

Frequency management, radio system planning, and operations planning, require rapid authoritative prediction services which estimate probability of transmission loss, signal-to-noise and signal-to-interference ratios, and optimum frequency.

8. Long term objectives, estimated duration, major outputs and milestones:

To provide rapid, authoritative and inexpensive radio system performance predictions for system design, operation, and electromagnetic compatibility analysis. Predictions will take the format required by users, normally expressed in probabilities, available as charts, tables, or computer routines, including time-share services. Will include appropriate long term ionospheric prediction services and disturbance warning; VHF/UHF transmission prediction, and regular services to IRAC EMC analyses.

9. Current year specific activities to June 30, 1971; accomplishments anticipated, milestones; reports planned, scope and dates:

1. Publication of a quasi permanent substitute for "Ionospheric Predictions" by June, 1971.
2. Catalog of prediction services available with sample application.
3. Continuation of radio disturbance warning service at 1 manyear level.
4. A merger of ITS prediction routines to improve uniformity of formats and nomenclature.
5. Extension of routines to include other models as appropriate--e.g. space system models developed by G. E. for OTM, models developed by SRI at ECAC and DEPG.
6. Simplify prediction routines for use on time-share with emphasis on interface with model communication system.
7. Initiation of a regular service to the IRAC EMC Analysis program.
8. Continue publication of "Ionospheric Predictions" through June, 1971.

10. Costs:

a. Staffing, Names, Salary, tenths of man year, cost of labor including all overheads:

G. W. Haydon	.3 MY	$14.0 K	R. Rosich	.3 MY	$12.0 K
F. Stewart	.3 MY	$10.0 K	M. Ballard	.2 MY	$ 3.0 K
M. Leftin	.4 MY	$17.0 K	F. Starck	.1 MY	$ 2.2 K
J. Harris	.5 MY	$20.1 K	R. Peterson*	.1 MY	$ 4.0 K
J. Finney	.1 MY	$ 1.2 K	L. Proctor*	.1 MY	$ 4.0 K
E. Powell	.2 MY	$ 0.5 K	TOTAL		$88.0 K

*to be reassigned

b. Other objects - costs (identify individual items over $1,000)

21.0 Travel $1.5 K
22.0 Transportation
23.0 Rent, communication
24.0 Printing and reproduction $24.0 K
25.0 Other svcs - (computer, contracts) $11.5 K
26.0 Supplies & Materials
31.0 Equipment

Signatures:

Proj. Ldr. James E. Finney Signed in absence of George W. Haydon

Assoc. Dir.

Dir. ITS

Dep. Dir. OT

Project No.: 2160
OT Program: Information Base
Sponsor: OT
Title: Information Base

Date: 3/15/71
Leader: R.K. Salaman
Alloc: .$25K
Funds available. [illegible]

Approved: Dir., OT

Background:

This project will provide support for the smaller tasks within the program to develop telecommunication information bases that are not identified as separate projects. It includes the identification and acquisition of pertinent information and data, and its dissemination.

Long Term Objective:

To support the telecommunication information base program by acquiring information not available through other programs.

Current Year Specific Activities:

Develop a data file of pertinent characteristics of currently important telecommunication systems.

Provide support for computer access to telecommunication information.

Costs:

R.K. Salaman	.02 MY	$1K
J.J. Tary	.1 MY	$4K
Other assistance	.1 MY	$3K
P.L. Rice	.1 MY	$5K

Other Object Costs:

Travel $2K	Rent, communication
Other services $9K	Equipment
Transportation	Printing and reproduction $1K
Supplies and materials	

RKS.

Approved
[illegible]
Dep. Dir. OT
RKL

Project No.: 2120
OT Program: Information Base
Title: Population Information
Sponsor: OT

Date: 3/15/71 *
Leader: D. R. Ewing
Alloc: $15 K
Funds available. Exodus

Approved: Dir., OT

Background:

An analysis of alternative telecommunication opportunities requires an appreciation of the distributed influence of society, i.e., not only where people are located, but their unique requirements. An analysis of the 1960 census for the U. S., Canada, and Mexico resulted in a computer program for determining the number and density of the population at any distance around arbitrary geographic points. The census data soon to be available for 1970 will form an important part of the information base required in telecommunication analysis.

Long-term Objective:

To provide a demographic data base that can readily be used to both answer specific questions, and be incorporated in comprehensive analysis programs.

Current Year Specific Objectives:

The Census Bureau MED lists for 1970 data will contain first counts for approximately 250,000 enumeration districts. Coordinates and areas of the ED's will be tabulated to allow a numerical description of the population. These data will be placed in the information service inventory by June 30, 1971. Several specific problems requiring demographic data will be selected in cooperation with other OT and OTP program requirements, and studied to guide further development of this data base.

Other Object Costs (above $1,000):

D.R. Ewing	0.3 MY	$9,236
R. Espeland	0.25 MY	$2,531
		$11,767

Travel
Rent, communication
Other services $1K
Equipment

Transportation
Printing and reproduction
Supplies and materials $3K

RKE, Note: this is a rewrite of your (ITS) 2/22/71 draft of the same project.

Approved
for
Dir. OT

Project No. 2110
OT Program: Information Base
Title: Resource Inventory
Sponsor: OT

Date: 3/15/71 *
Leader: R. Michael Jones
Alloc: $20 K
Funds available. Ejecutar

Approved: Dir., OT

Background and Justification:

The Office of Telecommunications is acquiring the basic information necessary to allow responsive, timely decisions. The majority of decisions are based on information that is available through services within 100 feet of the decision maker's desk, and which require a minimum of interpretive processing. The major lacking ingredient is timely accessibility to pertinent authoritative information that is largely available from many diverse sources.

Long-term Objectives:

To develop a retrieval system that will allow timely access to information required to make telecommunication decisions, minimize the time required for information search, and allow multidisciplinary analysis.

Current Year Specific Activities:

To develop a prototype information retrieval system to demonstrate information accessibility, and specify detailed system requirements for the next several years.

Included is the preparation of a prototype retrieval program and the generation of typical data files such as source information, system characteristics, and socio-economic data.

The prototype system development will be coordinated with the other information service program activities, for example to assist in obtaining germane data. This prototype development will be finished by June 30, 1971.

Costs:

R. Michael Jones	$16,042	.20 MY	$7.0K
Judith J. Stephenson	$14,720	.20 MY	$6.4K

Other Objects-Cost (above $1,000):

Travel $1.0	Transportation
Rent, Communication	Printing & reproduction
Other services $5.6	Supplies & materials
Equipment	

RKS.
Approved

Note: This is a rewrite of your (ITS) 2/22/71 draft of the same project.

Project No.: 2140
OT Program: Information Base
Title: Propagation Assessment
Sponsor: OT

Date: 3/15/71
Leader: W.F. Utlaut
Alloc: $20K *
Funds available. [illegible]

Approved: Dir., OT

Background:

A most important function of the information base is to assess the status of areas contained within the telecommunication field, and identify authoritative services of information. Project 9102100 will survey EM wave propagation primarily within OT/ITS. This project will determine the status of the propagation area from the broader national/international view.

Long-term Objective:

To assist in providing an understanding of the current status in propagation, and guidance for future development of this area.

Current Year Specific Objectives:

1) Determine in summary form, the state-of-the art in propagation and propagation related areas;

2) Briefly discuss the activities currently in progress, and list the principal investigators; and

3) Discuss the merit of future activity including priorities, the basic area of benefit for future work (e.g., environmental, communication, remote sensing), the level of effort alternatives, appropriate organization to perform the work, etc.

Costs:

W. F. Utlaut

Other Objects Costs (above $1,000):

Travel $5K	Transportation
Rent, communication	Printing and reproduction
Other services	Supplies and materials
Equipment	

RKS.

* Includes $5.0K supplemental and $5.0K funds reprogrammed from original ITS allocation to Project 2100.

Approved
[illegible]
Dep. Dir.

Attachment 16
Minutes of 5/12/71

AGENDA
OTP/OT FREQUENCY MANAGEMENT SUPPORT MEETING

JUNE 30, 1971
1325 G St. NW

0900

1. Electromagnetic Compatibility - Further discussion on scope and magnitude of overall area, including:

    a. Analysis Capability

    b. Data Base

    c. Automated Data Processing

    d. Monitoring

2. Status of Action Items

    a. Propagation

    b. Specific Items

    c. Standards

3. Noise

4. Receivers

5. EMC Education

6. Equipment Characteristics - Sachs/Freeman Contract

7. Program/Project Administration

8. Other Business