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NASA
ELECTRONIC MESSAGE EXPERIMENT
AND STUDY

DETAILED TEST PLANS

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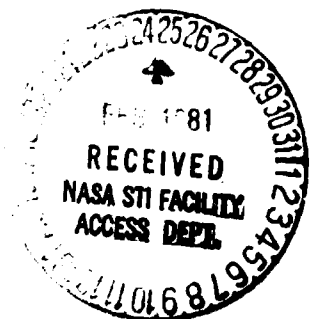


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1.0 INTRODUCTION

The Experiment Test Plans presented in this volume form a methodology for evaluating the utility of high-speed digital facsimile as a component of the projected NASA-wide Electronic Message Network. A complementary volume, the Overview Document, presents a rationale for the Experiment Test Program and lists the goals adopted for it. Briefly summarized, these goals are:

- o to quantify the maximum rates and volumes of facsimile messages that can be accommodated by presently available systems,
- o to determine the limits of image quality and reproducibility imposed by the state of the art in facsimile message components,
- o to estimate the reliability of the test configuration,
- o to assess the level of user acceptance of the system,
- o to provide information with which cost-per-page for an operational system can be projected.

The Experiment test program will be conducted over a twelve-week period. Phase I is two weeks long and is devoted to equipment checkout, operator familiarization, pretest calibration, and the development of procedures. During Phase II, also two weeks long, the facsimile message service will carry duplicates of actual messages sent by other means. Phase III is two months long and is an operational phase during which messages will be sent on a regular basis in order to accumulate the information that will be used to evaluate system performance and project future growth.

The tests themselves fall into two categories, Equipment Performance Assessment (Tests 2.1 through 2.4), and Personnel and Procedures (Tests 2.5 through 2.9). They have been structured to address the experiment program's four Critical Issues, identified in Section 1.5 of Volume I, the Overview Document. Figure 2-1 illustrates the interrelationship between the nine tests and the four Critical Issues. Data from the tests will be accumulated on a time-sharing computer from inputs supplied by the facsimile equipment operators via terminals at their work

CRITICAL ISSUE	TEST TITLE*								
	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
SPEED OF SERVICE				•		•	•		•
REGULARITY OF SERVICE	•					•		•	
IMAGE ACCEPTABILITY		•	•						
ACCOUNTABILITY					•			•	•

* NOTE: Test numbers correspond to those in Detailed Test Plans.

FIGURE 2-1. CORRESPONDENCE BETWEEN TESTS AND CRITICAL ISSUES

stations. Computer manipulation of the data will produce the statistics that form the basis of future performance projections.

2.0 Detailed Test Plans

Descriptions of nine detailed test plans to evaluate the high speed digital facsimile experiment are provided in the remainder of this Volume.

Test 2.1: SYSTEM RELIABILITY

2.1.1 PURPOSE

To compile and interpret statistical data on reliability at the system element level so that the performance reliability of an operational configuration can be predicted.

2.1.2 BRIEF DESCRIPTION

2.1.2.1 Reliability is expressed in terms of three performance indices: 1) Mean Time Between Failures (MTBF), 2) Fault Isolation, and 3) Mean Time To Repair (MTTR). These indices are employed at the level of the major system elements (viz. facsimile transceiver, data network, etc.) rather than their subsystems (e.g., scanner, paper handler, serial/parallel converter).

2.1.2.2 Every reported incident or malfunction that affects the performance of the system is to be noted in the day log. From time to time the statistics will be analyzed by a combination of heuristic and analytical procedures.

2.1.3 PROCEDURE

2.1.3.1 A log is set up as a master file on a time-shared computer accessible by the operators from their data terminals. A record of every service failure which cannot be attributed to improper procedures is entered by an operator, along with the date and time of its occurrence. Pertinent comments are noted as well. When the failure has been diagnosed, the event file is updated with the date and time it is estimated to have occurred and the probable

cause. The time at which normal service is restored and the steps taken to restore it are entered last. Entries can be made by either (or both) operators through their respective terminals.

2.1.3.2 From time to time, as appropriate, the day log is scanned by an analyst. Recurrences of specific malfunctions are noted, as well as the times at which the failures occurred. This information is transferred to the MTBF file on the computer. The MTBF file contains for each malfunction, 1) a list of times of occurrence, 2) the time intervals between successive occurrences, 3) the time between each occurrence and the diagnosis of its cause, 4) a list of the times required to repair each malfunction, and, 5) any remarks that seem appropriate. These items enter into the calculations of MTBF and MTTR.

2.1.4 SPECIAL EQUIPMENT

2.1.4.1 A TTY-equivalent CRT terminal for each operator.

2.1.4.2 Access to a time-sharing computer.

2.1.4.3 Software for entering data and for deriving statistical parameters.

2.1.5 PERSONNEL

2.1.5.1 The equipment operators.

2.1.5.2 Math analyst (may be one or both operators).

2.1.6 EXPECTED RESULTS

Design goals for the various system elements are to be supplied in the Final NASA Electronic Message Network

Design Report. They will be based in large measure on the results of this Test.

2.1.7 REMARKS

The underlying theory and derivation of algorithms for calculating MTBF* and MTTR can be found in standard texts on reliability. For instance, see:

- o Myer, Paul L. Introduction to Probability and Statistical Applications, Addison & Wesley, 1965
- o MIL-STD-471, Appendix B, Test Methods

- - - - -

*Often called MTTF (Mean Time to Failure). We prefer MTBF because there is less tendency to confuse it with the acronym MTTR (Mean Time to Repair).

Test 2.2: SYSTEM CALIBRATION

2.2.1 PURPOSE

To determine nominal standards of performance for the facsimile experiment system. These will serve as a baseline against which to compare the system's behavior under a variety of both normal and induced, non-ideal conditions.

2.2.2 BRIEF DESCRIPTION

Performance characteristics are measured in five categories: optical, mechanical, noise response, transmission speed, and color response.

2.2.3 PROCEDURE

2.2.3.1 Optical

- o Resolution is measured with the aid of standard resolution test objects, e.g., star targets, bar patterns and dot-grain scales. A series of standard resolution test objects will be used in these tests which are designed to measure the system response to a spectrum of spatial frequencies.
- o Image distortion (e.g. fanout, pincushioning) is measured again with the aid of ladder patterns.
- o Edge effects are analyzed by inspection of the received images. Test objects near the edges are employed to measure image spread or blur. A densitometer or print contrast meter will be used to measure decreases in contrast ratio.

2.2.3.2 Mechanical

- o Image translation or rotation caused by faulty placement of paper in the transmitter or receiver can be detected through the use of reticles on the original copy. Shifts in position can be detected by measuring the alignment of the received reticle pattern in relation to the edges of the page.
- o Paper handling performance figures specified by the manufacturer will be verified. Automatic paper-feed features at transmitters and receivers are included in this survey.

2.2.3.3 Noise Response

- o With both transmitter and receiver carefully adjusted to proper operating conditions, blank originals are transmitted. The occurrences of specks, stripes, gray areas and other imperfections in the received copy are noted. Repeated occurrences of a specific imperfection are of interest, especially if the same problem occurs on transmissions in both directions.

2.2.3.4 Paper Handling Speed

- o Manufacturers' specifications will be verified. Pages with differing amounts of printed matter are tested to see how paper handling speed depends on the size of the printed area. Pages having 50,25 and 0 complete lines, and the same range of half-lines, are used.

2.2.3.5 Color Response

- o Standard-color stripes and gray scales are transmitted. The images received are analyzed with a densitometer, reflectance meter or print contrast meter to determine system response to differing shades of color and varying levels of gray.**
- o Washout of solid inked areas is also investigated. A densitometer can be used to quantify the average washout.**

2.2.4 SPECIAL EQUIPMENT

- 2.2.4.1 Magnifying lens or jeweler's loupe**
- 2.2.4.2 Densitometer, optical character tester, etc.**
- 2.2.4.3 Resolution, color and gray-scale test objects. Figure 2-2 will be used as a test document.**

2.2.5 PERSONNEL

- 2.2.5.1 Equipment operators.**
- 2.2.5.2 Systems Analyst (may be one or both operators).**

2.2.6 EXPECTED RESULTS

- 2.2.6.1 Confirmation of, or exceptions to, manufacturers' specifications.**

2.2.7 REMARKS

2.2.7.1 These tests are performed during the first week of Phase I of the test program.

2.2.7.2 A sample sheet of test patterns has been presented as Figure 2-2. Other patterns may be added as necessary as the tests progress.

DATAQUEST DATAQUEST DATAQUEST DATAQUEST DATAQUEST

TO EVALUATE A COPIER. MAKE A COPY OF THIS SHEET. LOOK FOR FIDELITY OF REPRODUCTION IN SOLIDS, HALFTONES, LINE WIDTHS, COLOR VARIATIONS, AND EDGE DELETION. COMPARE DIFFERENT COPIERS AND PLATE-MAKERS.

DATE _____

COPIER IDENTIFICATION _____

MFG. _____

MODEL _____

COMMENTS _____

SIGNATURE _____

Typewriting with standard electric typewriter using carbon ribbon.

2 point- _____

4 point- _____

6 point- ABCDEFGHIJKLMNOPQRSTUVWXYZ

18 point- ABCDEFGH

36 point- ABCD



ORIGINAL PAGE IS OF POOR QUALITY

Handwriting using a No 3 (hard lead) pencil
Red Handwriting
Blue Handwriting
Green Handwriting



Communications



65 Line Screen



65 Line Screen



65 Line Screen



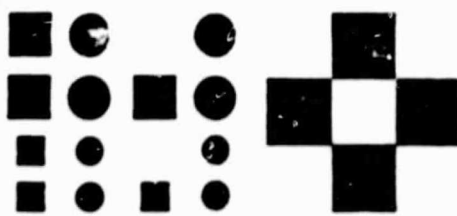
100 Line Screen



133 Line Screen



150 Line Screen



BLACK SOLID

BLUE CARBONLESS PAPER

GREEN CARBONLESS PAPER

GOLDENROD CARBONLESS PAPER

PINK CARBONLESS PAPER

RED CARBONLESS PAPER

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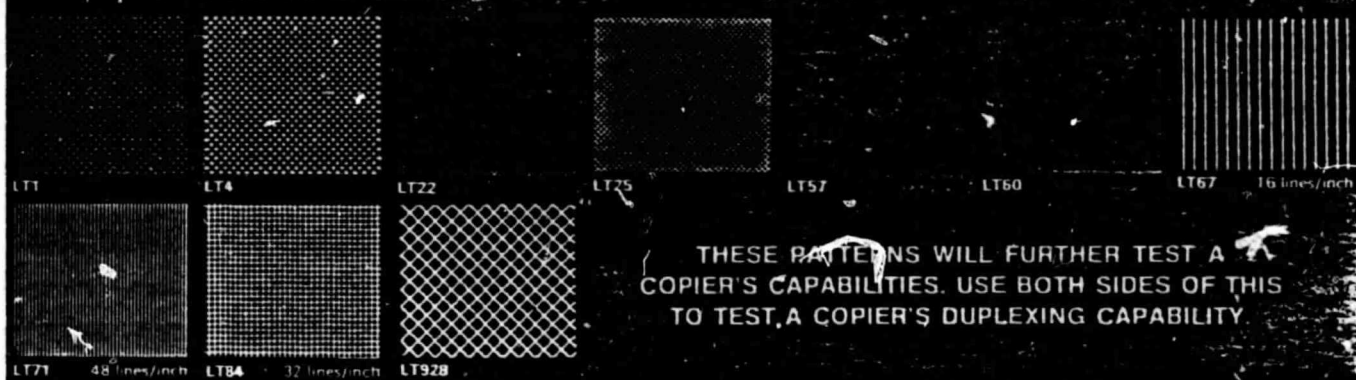
DATAQUEST

FIGURE 2.2 TFST DOCUMENT

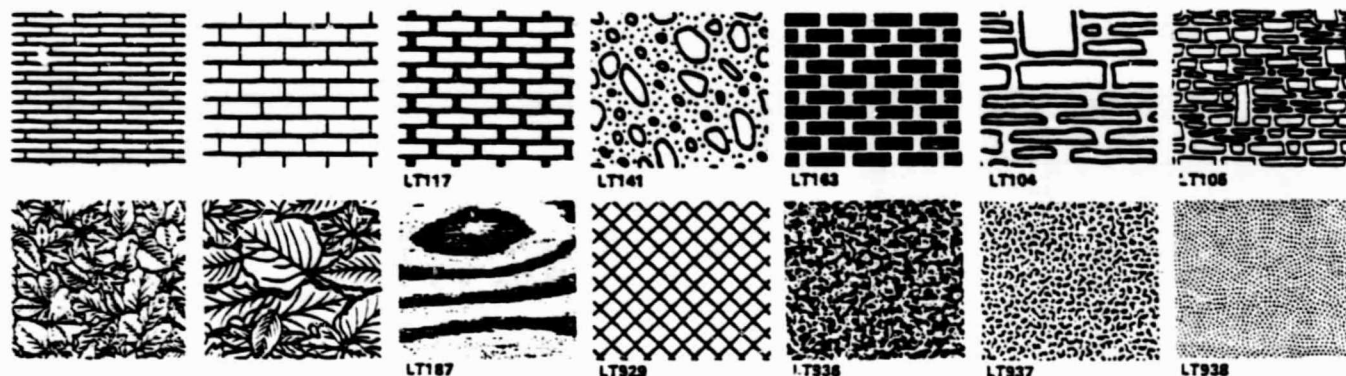
1 94306 USA QUEST P.L.A.

DATAQUEST

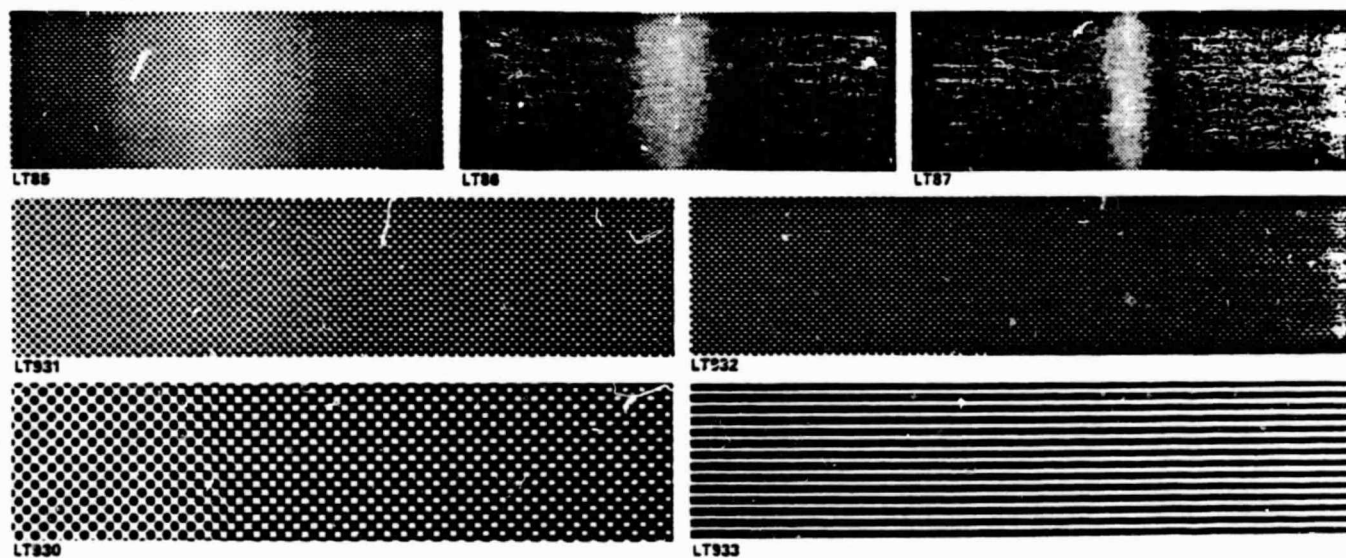
Letratone Patterns in White



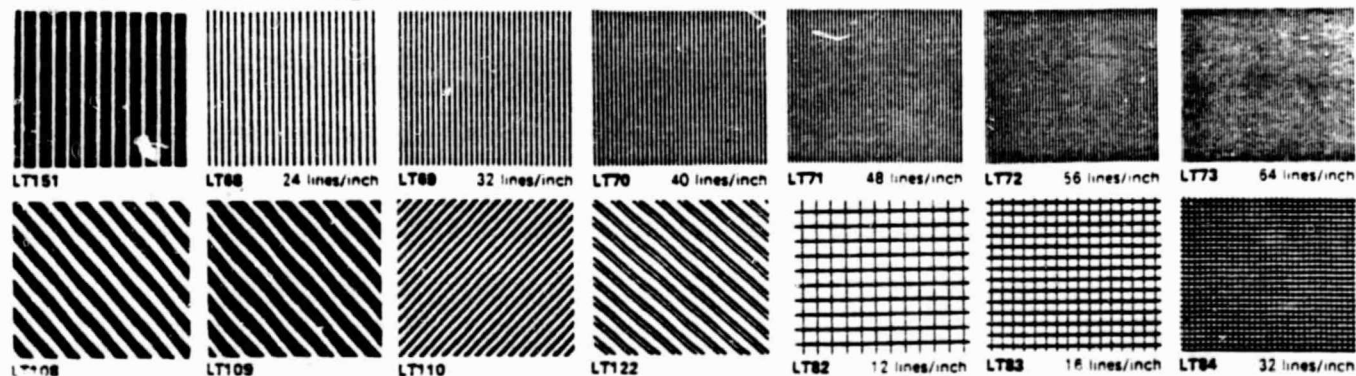
Architectural Patterns



Graduated Tones



Lines, Cross-hatchings and Grids



Test 2.3: COPY QUALITY

2.3.1 PURPOSE

To estimate the long-term variations in system performance as reflected in the quality of received copy, based on analyses of the test results.

2.3.2 BRIEF DESCRIPTION

Periodically throughout the operational phase of the test program (Phase III) the calibration indices derived in Test 2.2, System Calibration, are recalculated. Variation and trends are noted and analyzed.

2.3.3 PROCEDURE

Repeat the procedures performed in Test 2.2 at (TBD) intervals. Tests on Optical Response and Color Response may have to be done off site if the optical test equipment is not available on site. In this case, samples are shipped to a central location for testing. Time is not a critical item in these tests.

2.3.4 EQUIPMENT

2.3.4.1 Magnifying lens or jeweler's loupe

2.3.4.2 Densitometer, optical character tester, etc.

2.3.4.3 Resolution, color and gray-scale test objects. Figure 2-2 will be used as a test document.

2.3.5 PERSONNEL

2.3.5.1 Equipment operators.

2.3.5.2 Systems Analyst (may be one or both operators).

2.3.6 EXPECTED RESULTS

Variations in system parameters as a function of time and external influences.

2.3.7 REMARKS

Unspecified intervals in Paragraph 2.3.3. will be determined as a result of the Phase I tests.

Frequency of testing will depend partly on the time required to perform recalibrations and partly on the results and trends noted as a result of preceding tests.

Test 2.4: THROUGHPUT SPEED

2.4.1 PURPOSE

Wideband facsimile is aimed at increasing document throughput speed. This test is to determine throughput speed as a function of various governing influences such as number of pages per document, type of binding, operator workload, etc.

2.4.2 BRIEF DESCRIPTION

Every document is time-stamped as it passes through the transmittal sequence. The record of time stamps entered into the day-log is used for tracing its progress. Accompanying header information contains descriptive information such as: Document ID; Number of Pages; Type of Binding; Priority; etc. The log is entered onto the computer, and sorted by descriptor. Statistics are calculated on throughput time in each category.

2.4.3 PROCEDURE

2.4.3.1 Each document is time-stamped when it is picked up or submitted for transmission. Following the transmission, the operator enters the time and descriptive information through his terminal. After transmission has been completed, times of receipt and delivery (or notification) are appended to the file. All log entries are made by operators between transmission sessions.

2.4.3.2 An analyst processes the results periodically on the computer to obtain current and

cumulative statistics. It may actually be feasible to have the computer update the statistics automatically after each transmission session.

2.4.4 EQUIPMENT

2.4.4.1 A time stamp for each operator.

2.4.4.2 A data entry terminal for each operator.

2.4.5 PERSONNEL

2.4.5.1 Equipment Operators.

2.4.5.2 Math Analyst (or the operators).

2.4.6 EXPECTED RESULTS

Statistical distributions of throughput time as a function of various governing factors.

2.4.7 REMARKS

It is not clear a priori what all of the governing influences are. The results should be analyzed daily at first to see whether some effects may have been omitted from consideration.

Test 2.5 Service Features

2.5.1 PURPOSE

2.5.1.1 To test the adequacy of the features offered by the facsimile message service.

2.5.2 BRIEF DESCRIPTION

2.5.2.1 Electronic message service features were identified in the Test Plan Overview Document. They are: Addressing, Printing, Pickup-Delivery, Notify, Envelopment, Tracking, Acknowledge. A log is kept of the document's progress within the system. Any difficulties, inadequacies or complaints are recorded. From analyses of the data, areas of weakness in the procedures are noted. Wherever possible, these deficiencies will be rectified as the test program proceeds.

2.5.3 PROCEDURE

2.5.3.1 A Routing and Service Form accompanies each document and is transmitted with it. It contains information supplied by the originator which identifies the addressees, the level of priority for the document, whether envelopment is requested, and whether acknowledgement of receipt is required. This information is keyed into the day-log after the transmission is completed.

2.5.3.2 The document is printed at the remote station and disposed of according to the instructions on the Routing and Service Form. Acknowledgement of delivery is written onto the

Form by the addressee or his authorized agent. If delivery service is not offered, the operator confirms that the addressee has been notified mail is waiting to be called for. In such a case, addressee acknowledgement of receipt is made at the time of pickup.

2.5.3.3 Adequacy of service is determined by analyzing the day-logs and by surveying the document originated. Inspection of the logs will reveal whether the various services have been properly performed.

2.5.4 SPECIAL EQUIPMENT

2.5.4.1 A CRT data terminal at each location.

2.5.5 PERSONNEL

2.5.5.1 No additional personnel required.

2.5.6 EXPECTED RESULTS

2.5.6.1 Determination of adequacy of the service features and identification of those features that are inadequate.

2.5.7 REMARKS

2.5.7.1 A copy of the Routing and Service Form is attached.

2.5.7.2 A User Survey Questionnaire is also attached. To the maximum extent the schedule allows, surveys will take the form of personal interviews with users. Conducted by the operators,

these interviews will also offer a chance for the interviewers to form their own assessment of the users' level of satisfaction, inferring as much as is possible from offhand remarks, vocal intonations, choice of words, and perhaps even facial expressions of users while they are being interviewed.

NASA ELECTRONIC MESSAGE EXPERIMENT STUDY

ROUTING AND SERVICE FORM

DATE:

STATION:

OPERATOR:

DOC. ACC.#

TITLE:

NO. PAGES: BINDING: NONE; STAPLE; CLIP; RING

ROUTING:

 NAME

 INSTALLATION

 CODE

ORIGINATOR

ADDRESSEES

PRIORITY LEVEL: NORMAL
 URGENT
 BATCH

SENSITIVITY: NO
 YES

DISTRIB. METHOD: NOTIFY
 DELIVER

ENVELOPMENT: NO
 YES

ACKNOWLEDGE RECEIPT: NO; YES

DOCUMENT LOG:

 DATE

 TIME

 BY

PICKUP RQST

PICKUP MADE

AT DISPATCH

TRANSMITTED

PRINTED

NOTIFIED

DELIVERED

PICKED UP

ACKNOWLEDGE

**NASA ELECTRONIC MESSAGE EXPERIMENT STUDY
USER SURVEY QUESTIONNAIRE**

DATE: _____ **TIME:** _____ **INTERVIEWER:** _____

PERSON INTERVIEWED: _____ **ORGANIZATION:** _____

SERVICE

Is very fast transmission of messages important to you? Why?

To what extent would pickup and delivery at your office make a difference in your usage of the service?

How often do you need to send/receive documents larger than 8½x11"?

Would you make more or less use of the service if the telecopier were available on a self-service basis?

Please comment on the adequacy and ease of current procedures for using the service? Describe features you don't like, and offer any appropriate suggestions for improving the service.

COPY QUALITY

Have you found overall message throughput speed faster with this service than with other telecopier options, such as Rapifax and Panafax?

Please comment on the following factors from two points of view, viz. (a) acceptability, and (2) in comparison with other services:

OVERALL LEGIBILITY _____

DISTORTION _____

FADING IN DARK AREAS _____

SPECKLES AND SMUDGES _____

DISTORTION _____

RESPONSE TO COLORED ORIGINALS _____

OTHER _____

FUTURE NEEDS

Would the availability of the service at other NASA Centers and Contractor locations be important to you? Which locations? Describe the extent of impact on your usage.

Do you see any major change in your need for the service in the foreseeable future?

EVALUATION

Give an overall evaluation of the message service, including any specific features that were not mentioned above, e.g. regularity of service, impact on your operations, etc.

Test 2.6: SIMULTANEOUS TRANSMIT/RECEIVE

2.6.1 PURPOSE

The facsimile transmitter and the receiver can operate independently of one another. Simultaneous transmission in both directions will be necessary to maintain an acceptable flow of mail. This test evaluates the ability of the operators to handle transmittals and receptions simultaneously and to assure smooth and rapid flow of documents in an ultimate operational network.

2.6.2 BRIEF DESCRIPTION

This is a test of operator procedures under normal conditions.

2.6.3 PROCEDURE

2.6.3.1 Each session normally calls for simultaneous transmission in both directions. The operators will attempt to keep up with the traffic flow.

2.6.3.2 If problems arise, procedures and/or schedules may have to be modified to compensate. Problems will be noted in the day-log for further evaluation at a later time.

2.6.4 EQUIPMENT

No special equipment required.

2.6.5 PERSONNEL

No additional personnel required.

2.6.6 EXPECTED RESULTS

Refinement of procedures and workload estimates for terminal operators.

2.6.7 REMARKS

There should be no serious mechanical problems since each unit has automatic paper stackers and output feeders. However, keeping current with log-in and tracking may be burdensome.

Test 2.7: REAL-TIME RESCHEDULING

2.7.1 PURPOSE

From time to time an urgent need arises to send a high priority document at once, even if there is no transmission session in progress. This test evaluates the ability of the message service to adapt to such emergencies.

2.7.2 BRIEF DESCRIPTION

A URGENT level of priority is established. When an URGENT document is submitted to be transmitted the operator attempts to have it sent as soon as possible. The aim is to establish a routine procedure for accommodating the changes in schedule.

2.7.3 PROCEDURE

At irregular intervals URGENT documents are submitted for transmittal. In some cases, pickup and delivery may be required; others may involve interfaces at the dispatch desks. Upon being notified that an URGENT document is to be sent the operator notifies his counterpart at the receiving terminal. The latter prepares to receive the document and, if necessary, to deliver it to the addressee by the fastest possible means. If delivery is not specified, it may be permissible to phone the addressee to tell him (or his representative) that an URGENT document is being received and will be ready for pickup shortly.

2.7.4 EQUIPMENT

FTS telephone at each site.

2.7.5 PERSONNEL

Terminal Operators

2.7.6 EXPECTED RESULTS

2.7.6.1 Development of effective procedures for handling URGENT requests.

2.7.6.2 Statistics on throughputs in response to emergencies.

2.7.7 REMARKS

None

Test 2.8: UNATTENDED OPERATION

2.8.1 PURPOSE

Bulk transmission of messages after hours is a service feature to be offered through the operational system. This test evaluates the ability of the system to transmit bulk messages with minimal operator intervention.

2.8.2 BRIEF DESCRIPTION

Bulk transmissions of bulk messages will be carried out during slack periods and scheduled bulk-message periods. Mechanical and procedural problems will be noted and corrected wherever possible.

2.8.3 PROCEDURE

2.8.3.1 The transmitter's paper hopper is loaded with a stack of outgoing messages.

2.8.3.2 At the appointed time the transmitter and receiver are switched on and transmission begins. Operators will monitor the transmission but not interfere except to refill the stacker, or unless malfunctions occur. A record of each session is kept on the day-log.

2.8.4 EQUIPMENT

No special equipment required.

2.8.5 PERSONNEL

No additional personnel required.

2.8.6 EXPECTED RESULTS

Development of procedures for and limitations on bulk message transmittal.

2.8.7 REMARKS

None

Test 2.9: USER QUALIFICATIONS

2.9.1 PURPOSE

2.9.1.1 "Users" are the originators and addressees of the documents to be transmitted. The purpose of this test is to determine how much instruction users require to take full advantage of the service.

2.9.1.2 Self-service operation is a distinct possibility for the future. Users are tested to see whether any special training is required for a first-time user to run the facsimile equipment.

2.9.2 BRIEF DESCRIPTION

2.9.2.1 Users having various levels of orientation or instruction are asked to submit documents for transmittal. Difficulties encountered are noted and attempts are made to correct them.

2.9.2.2 Some users are asked to try operating the facsimile equipment essentially without training.

2.9.3 PROCEDURE

2.9.3.1 Cooperative users are solicited from among the professional staff at the two installations. At least a dozen or more volunteers at each site will be sought. Two user categories are established:

- (1) First-time users who receive no instruction other than a telephone number to call for pick-up and delivery or else the location of the dispatch desk; and
- (2) First-time users who are instructed on procedures to be followed and who are asked to fill out transmittal forms themselves.

2.9.3.2 Each group is asked to submit documents for two or three consecutive transmission sessions.

2.9.3.3 After intervals of varying lengths (days, weeks) the participants are asked to submit documents once again using procedures they employed previously. User problems are noted.

2.9.3.4 A few users are supplied with concise instructions for operating the facsimile units. They attempt to do so with the operator in attendance to assure that the equipment is not abused. The degree of success is noted.

2.9.4 EQUIPMENT

No special equipment required.

2.9.5 PERSONNEL

2.9.5.1 Equipment Operators

2.9.5.2 A dozen or more cooperative volunteers at each site.

2.9.6 EXPECTED RESULTS

2.9.6.1 An estimate of the level of instruction which must be provided to users.

2.9.6.2 An assessment of the feasibility of running wideband facsimile terminals on a self-service basis.

2.9.7 REMARKS

None