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BELLCOMM, INC.

SUBJECT: Trip Report to MSC 12/11-12/64 to Review Revised Test Procedure and Monitor Digital-to-TV Converter Phase IV String Test - Case 219

DATE: December 31, 1964

FROM: L. A. Ferrara
R. O. Wise (BTL)

MEMORANDUM FOR FILE

A trip was made to MSC on December 11 and 12 in order to review the revised test procedure and monitor the conduct of the Digital-to-Television Converter Test #4F4-260.

This memorandum reports the authors' observations during the test, and makes further comments on the test procedure. To put this test into context with the Phase IV effort, this report will also present a summary of our activities in the Phase IV test area with certain recommendations for the conduct of the remainder of the Phase IV tests.

MCC Acceptance

Prior to NASA's acceptance of the Mission Control Center at Clear Lake (MCC), the implementation contractor, Philco Houston Operations (PHO), is conducting a five phase installation and test program. These phases are:

I. Installation - installing and connecting cabling to the equipment.

II. Installation Checkout - power-on and physical integrity verification.

III. System Checkout - verification of mechanical, electrical, and optical alignment of the units along with integrated subsystem and system testing across equipment interfaces.

IV. MCC Systems Integration and Validation - demonstration that the overall electromechanical capability of the MCC equipments, when integrated into data flow strings, meet specified MCC performance requirements.

V. MCC Operational Checkout - an exercise of the entire system, hardware, computer programs, operating personnel and procedures on an integrated basis with Network and Launch Systems to verify the MCC capability to perform its mission.

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(NASA-CR-62853) TRIP REPORT TO MSC 12/11-12/64 TO REVIEW REVISED TEST PROCEDURE AND MONITOR DIGITAL-TOTV CONVERTER PHASE IV STRING TEST - CASE 219 (Bellcomm, Inc.) 11 p

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At NASA's request,[1] the contractor submitted a "MSCC (MCC) Readiness Demonstration Test Plan" TR-154 dated June 30, 1964, defining the concepts and plans for demonstating the ability to control Gemini missions from the MCC. Bellcomm, Inc. as part of their task to assist NASA in a review of the contractor's demonstation plans and tests leading toward MCC acceptance, commented upon TR-154 in mid July. The plan was considered inadequate in many areas and was returned to the contractor for revision. Since the demonstration plan has not been reissued, we have focused our attention on the available documentation and conduct of a selected number of Phase IV string tests. Satisfactory completion of these tests is a prerequisite to the forthcoming Phase V operational test series which we have been asked to critique.

Phase IV Tests

The purpose of the Phase IV tests is to demonstrate the successful integration of the MCC systems. As a control for these tests it is assumed that the MCC Test Program Directives issued by PHO are still governing and therefore the following abstracts from the test program directives[2] specific to Phase IV are appropriate:

1. "Phase IV tests (will) demonstrate that the overall electro-mechanical capability of the IMCC (MCC) equipments, on an integrated basis, meet all specified IMCC (MCC) performance requirements."

2. "This phase (the initial phase of Phase IV testing with the Real Time Computer Complex at one end of a string) will provide detailed verification of the capability of the integrated IMCC (MCC) hardware (external to the RTCC) to accept, handle and process all classes of input data, within specified tolerance limits."

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1. NASA LTR of 5/8/64 to IBM/Philco re: IMCC (MCC) Acceptance

2. PHO IMCC (MCC) Test Program Directive number 100, dated February 14, 1964.

[redacted]

3. "At the completion of Phase IV testing, the following will have been accomplished:

   a) All IMCC (MCC) hardware and hardware interfaces will have been proven operational and will have satisfied established equipment, interface and system specifications.

   b) Where applicable, Phase IV tests will have demonstrated that the integrated IMCC (MCC) hardware is capable of satisfactorily handling data (both in quantity and quality) at its maximum specified performance."

As previosuly stated, Bellcomm's primary interest in the Phase IV tests is to assure ourselves and NASA that an appropriately tested integrated system is used as the basis for the Phase V operational test series. Since the Phase V tests will be mission oriented and functional in nature, any equipment limitations should be determined during the Phase IV series.

To determine the degree to which equipment limitations are disclosed, Bellcomm agreed to critique and monitor those Phase IV tests thought to be most searching in establishing proper support requisite for Phase V testing.

By the end of November, twenty-six Phase IV tests had been made available to Bellcomm. All of these were surveyed and 10 were considered satisfactory and required no further comment. Of the remaining 16, 11 have been examined in depth and comments were given in working sessions to the designated NASA - Flight Support Division (FSD) personnel. The remaining five (plus approximately 12 more test procedures which have been received during the last month) are still being reviewed. These initial Phase IV tests dealt primarily with the Display and Control system of the MCC. The method of review has been primarily a comparison of the test procedures with the requirements as listed in TR-120, the applicable equipment specifications, and the prerequisite and associated tests. Since current specifications were unavailable in some instances, a given test procedure was usually discussed by telephone with the cognizant NASA engineer to make sure that the latest documentation was used in the review. This also gave the NASA personnel the most timely input on the procedures which they could then combine with their own comments for discussion with the contractor. Certain Phase IV tests were considered to have sufficient impact on successful Phase V testing as to merit direct monitoring of the tests by Bellcomm personnel. Two tests in this category are the Digital-to-Television Converter Equipment string test (4F4-260) and RTCC-to-X-Y Plotboards (4F4-265)

Comments on these two test procedures were hand carried to MSC; the plotboard comments on September 24, and the D/TV converter on October 23, 1964. Subsequent reviews of the material were held with FSD personnel. It is desired that these comments

indicate to NASA the minimum requisites of a test procedure necessary to demonstrate compliance with a particular requirement or specification.

Recently, a revised plotboard test procedure has been issued which (with the exception of the omission of a stability determination test) is judged to be a technically sound method of establishing hardware capability to meet the functional requirements and specifications. It is recognized that this type of test procedure is time consuming but a rigorous prosecution of detailed test procedures is believed to be the only way that NASA and the contractor can be assured that the equipment is properly installed and capable of fulfilling mission requirements.

Comments on Digital-to-TV Converter Test Procedure

The recent revision to the test procedure (4F4-260) was examined on December 11, 1964, and found to be considerably better than the first version. There are, however, several significant aspects which we believe deserve attention. Comments in this regard are presented in the following paragraphs while a more detailed critique of the procedure is found in Appendix 1 to this report.

Specific comments to Revision A 4F4-260 Test Procedure follow:

1. Where measurements are called for, limits of acceptability are not stated. (These were to be furnished by PHO test personnel at start of test, but were not available or referenced during the test.)

2. The method of measuring resolution of the TV system is considered too qualitative (use of EIA test pattern instead of oscilloscope measurement as called out in the Digital-to-Television Converter specification 1S2502-00090B). The test pattern should be used to determine that resolution has not significantly changed, but only after the Digital-to-TV Converter and precision monitor resolution has been established by more quantitative measures.

3. The cross talk check in this test is qualitative only and should not be accepted as a measure of cross talk for the TV subsystem. (It is understood that cross talk will be tested in a subsequent Video Switching Matrix or Television Subsystem string test.)

4. The drift test is not appropriate to the intended mode of operation wherein the equipment is energized continuously. It does not verify the stability requirements of the applicable specification. (A drift test is scheduled to be performed on several equipments at a later date.)

5. It is believed that this Digital-to-TV Converter test would have been more definitive if formal tests on the related Television, Video Switching Matrix and Reference Slide File subsystems had been performed and documented as prerequisites.

General comments, applicable to all Phase IV tests, and which have been discussed with NASA personnel during the reviews of Phase IV test procedures, are as follows:

1. It is not clearly stated in the procedures that equipment must have passed its controlling acceptance specification before becoming a part of Phase IV test. A statement to the effect that the equipment has met the appropriate section of the specification or the modification of the specification which was permitted should be documented in the test procedures.

2. Quantitative measurements, where appropriate, should be called out with limits as required by the equipment specifications stated on the test procedure data sheets.

3. Test prerequisites, such as alignment, adjustment or calibrations should be specified and required to be verified as having been performed prior to starting the test.

Test Conduct and Observations

The test commenced Saturday at 0800 and was scheduled for a minimum period of five hours. It could not be completed due to inaccuracies in some sections of the computer test program. In addition, degradation in the operation of the TV subsystem was becoming apparent, (i.e.) 60 cycle modulation on some channels, decrease in resolution, and distortion. After consultation between the NASA and PHO personnel, it was decided to halt the test, and reschedule at least the uncompleted parts of the test at a later date.

During the conduct of the test, the following observations were made:

1. Some precision monitor presentations were observed to be less than "readable" although readability was not quantitatively defined in the Test Procedure. The charactron generated slide background reference number was obscure but the slide derived reference number was clearly readable.

2. Considerable "streaking" on all precision monitors was observed but in most instances did not interfere with readability of the display. The test procedure, however, specified no streaking should be present. Consideration should be given to a more quantitative definition of this requirement.

3. No attempt was observed to determine that the displays generated by test messages 1,2,4, and 5 met the accuracy limits specified. These accuracies relate to the relative positioning of the slide background and the computer generated dynamic data. Message 2 (#009C) requires a display accuracy of ± .6% of overall display height. While instrumentation for such a measurement was not provided, it could be clearly observed that the display accuracy was considerably less than that specified as related to the meter scales.

4. While the special test section (6.7) of the procedure was not formally conducted, a brief display of the EIA 800 line resolution chart indicated no more than a 500 line vertical resolution capability at the precision monitor (specification requires 650 lines). The horizontal resolution appeared to be about 600 lines (specification requires 750). A small sampling of observer opinions as to the effective resolution observed, indicated again the need for a more precise method for determining display resolution.

Summary

1. As the prerequisite for the Phase V operational test series, which will form an important element of the MCC Acceptance, the Phase IV string tests should quantitatively verify that the equipment meets its design specifications.

2. Functional capability alone should not be accepted by NASA as a suitable criterion of system performance. Documentation of quantitative test measurements, the more significant of which should be repeated during the Phase IV tests, should be available in summary form to test personnel prior to the start of the test.

3. Phase IV testing may be the only area in which some of the "limiting capability" (of the MCC hardware) can be established, therefore equipment should be tested to design limits wherever possible.

4. The revised Y plotboard test procedure is considered a good model for a satisfactory Phase IV test procedure. NASA is urged to require the contractor(s) to incorporate the test philosophies of this procedure (with respect to quantitative measurements, reference to related specifications, etc.) into all the Phase IV procedures.

5. The current issue of the test specification and procedures should reflect any and all relaxations in the applicable equipment specifications.

6. Tests of several equipment strings which should be performed simultaneously (e.g. tests for mutual interference, cross talk, stability) should be referenced in each Phase IV test where appropriate. The Phase IV test should not be considered complete without the results of these tests.

7. The general and detailed comments on the Digital-to-TV Converter test procedure listed in this report should be accounted for in the revised test procedure before formal completion of the test (4F4-260).

L. A. Ferrara

R. O. Wise

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Appendix I

Detailed Comments on Test Procedure 4F4-260 (revised)

As a prerequisite to Phase IV testing all the equipment included in the "string" should have passed the corresponding equipment specifications or a modified version of such specifications after due consideration of the effects of such modifications upon the system requirements.

In addition, during Phase IV testing certain critical parameters of the equipment should be retested to insure continuing performance within the required system requirements.

In the case of the Digital to Television Converter these equipment specifications include 1S2502-00090B Digital-to-Television Converter Specification; 1S2100-00061A, IMCC Television Subsystem Specification; and 1S2500-00073C, Computer Display/Control Interface Subsystem Specification.

Among the parameters recommended for retesting are the following, listed by specification and paragraph number:

1S2502-00090B Digital to Television Converter

3.2.3.5.3 After Image. "No pulse corresponding to a symbol erased by an update command word shall exhibit more than 100 millivolt after 160 milliseconds of receipt of the word by the buffer.

3.2.3.5.5 Overall Resolution. "A television video pulse corresponding to a Charactron "one" symbol of the smallest size displayed at any position, X,Y, shall have fallen below 10 percent of its maximum height when the pulse corresponding to a "one" symbol at X + ΔX, Y has risen to 10 percent of its maximum height. ΔX shall be 0.30 percent of display width.

1S2100-00061A IMCC Television Subsystem

3.3.2.1.3.6 Resolution.-"Horizontal - greater than 800 lines at center and 600 lines in corners (measured with EIA resolution chart and 1000 line test wedge).

Vertical - greater than 650 lines in center.

The horizontal square wave response of the camera measured at the camera output shall meet the requirements of figure 1*without aperture correction and with the video bandwidth specified."

1S2500-00073C

Computer Display/Control Interface Subsystem Specification

3.4.3.1.4 Optical Image Registration. "When the static data on a slide in the slide projector associated with each converter is registered to within 0.1 percent of its projector aperture height, the optically mixed composite picture from the converter shall show the data from the charactron and data from the slide registered to within 1.1 percent of display dimensions."

3.4.3.8.2 Composite Image Registration After Adjustment. "The center of one of the 88 symbols of any size when positioned at the center of the display as specified by the appropriate computer word, shall appear on the TV monitor within a rectangle whose edge lengths are one-half that of the reference rectangle edge lengths. The center of this rectangle shall coincide with the center of the corresponding rectangle on the fiducial grid". The element of stability implied by "after" in the above requirement should be specified.

3.4.3.15 Maintainability for the Digital-to-TV Converters.

3.4.3.15.1 Time Between Adjustment. -"Each converter channel shall meet the requirements of paragraph 3.4.3.8.5 through 3.4.3.8.5.6 of this specification for 10 hours without need for adjustment. No converter channel shall, for a period of 72 hours, fail because of need of adjustment to meet the requirements of paragraphs 3.4.3.8.5 through 3.4.3.8.5.6 of this specification relaxed by a factor of two. Mean-time between adjustment shall be greater than 24 hours for requirements of paragraphs 3.4.3.8.5 through 3.4.3.8.5.6 of this specification."

3.4.3.8.5 Electrical Characteristics of the Output Lines.

3.4.3.8.5.1 Camera Output.-"The Vidicon camera output shall work into a 75 ohm line, shall be terminated at the input of a waveform monitor of 75 ohms, shall generate a pulse height corresponding to 100 percent white which is between 0.8V and 1.25V as the camera scan views either Charactron symbols or slide lines or symbols."

*Figure 1, pg. 19 of the referenced specification is a graph indicating minimum square wave response for TV cameras.

3.4.3.8.5.2 Flicker. -"During any composite dynamic data and static data display generated by any converter channel with the Vidicon scanning at 30 frames per second, no given pulse within the repeated pulse train shall vary by more than 8 percent from its 100 percent white value."

3.4.3.8.5.3 After Image. -"No pulse corresponding to a symbol erased by an update command word shall exhibit more than 100 millivolts after 160 milliseconds of receipt of the word by the buffer."

3.4.3.8.5.4 Contrast. -"During any static display, the RMS inter-symbol (background) pulses shall be more than 40 db below symbol pulse height."

3.4.3.8.5.5 Overall Resolution. -"A television video pulse corresponding to a Charactron "one" symbol of the smallest size displayed at any X-Y position, shall have fallen below 10 percent of its maximum height when the pulse corresponding to a "one" symbol at $(X + \Delta X)$ Y has risen to 10 percent of its maximum height. ΔX shall be 0.30 percent of display width."

3.4.3.8.5.6 Scanning Parameters of the Television Camera Outputs. - The scanning parameters of the television camera outputs shall be as follows:

Field/frame rate:	60/30 cps with 2:1 interlace
Line rate:	28,350 cps
Lines/frame:	945
Aspect ratio:	3 units of height by 4 units of width

This stability requirement may be established by a separate test but should be defined for each major unit since an overall composite test may include compensating elements yielding good results for a particular test configuration but poor results for some other equally operational composite.

3.4.4.3.3.6 Repeatability Error. -"Repeatability error of a slide in the view position shall not exceed 0.1 percent. Repeatability is defined as: the capability of entering, removing, and re-entering the same slide repeatedly into a precision viewing gate so that any point in the display area of the slide shall not be displaced from its original position. The percent of repeatability error is defined as: the ratio of the displacement

distance of the point from its original position to the display width multiplied by 100, or:

$$\text{Percent of repeatability error} = \frac{\text{Displacement Distance}}{\text{Display Width}} \times 100 \text{"}$$