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FROM: A. J. Pittock

SUBJECT: RTCC INTERIM FACILITY DIGITAL TO TELEVISION (D/TV)
DISPLAY FORMATS TEST & EVALUATION REPORT

The attached report is the result of the test and evaluation of the Interim Facility D/TV display formats, 26, 30, and 31 March 1964, at IBM. The original "D/TV FORMAT EVALUATION" sheets, which contain a photograph of the D/TV display on the 21" (utility) TV monitor, are not included in this report, because of the degradation of the photograph and cost of reproduction. The "D/TV FORMAT EVALUATION" sheets, with photograph, are available for review from the Display Formats Group.

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RTCC INTERIM FACILITY DIGITAL TO TV(D/TV)
DISPLAY FORMAT TEST AND EVALUATION REPORT

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1.0 PURPOSE

The Interim Facility D/TV display formats were tested and evaluated to verify the display format criteria and determine what difficulties and/or deficiencies are inherent in the display design, so that appropriate changes, improvements, and/or additions may be incorporated to the D/TV display format development procedures.

RTCC INTERIM FACILITY D/TV DISPLAY FORMATS

FORMAT NO.	TITLE	FORMAT NO.	TITLE
0001	GEMINI ACME	0021	Ground Point Track
0002	Gemini OAMS	0022	Orbiting Object Location
0003	Gemini ACME	0023	Moonrise/Moonsat Times
0004	Gemini OAMS	0024	Sunrise/Sunset Times
0005	FDO Abort Phase Digitals	0025	Predicted Site Acquisition
0006	FDO Orbit Digitals	0026A	Agena Command No. 1 (2.0%)
0007	FDO Launch Digitals	0026B	Agena Command No. 1 (1.6%)
0008	GLV Stage II, No. 2	0027A	Agena Command No. 2 (2.0%)
0009 (A,B,C)	Gemini Electrical System	0027B	Agena Command No. 2 (1.6%)
0010	Gemini ECS O ₂ Mass Quan.	0028	FDO Re-Entry Digitals
0011	Gemini ECS Lift Suit Inlet Air Temp.	0029	Next Station Contacts
0012	Gemini OAMS Source HE Pressure	0030	Retrofire Table
0013	RGS/IGS Stage II Pitch	0031	Retro-Re-Entry Digitals No. 2
0014	Altitude vs Velocity	0032	Retro-Re-Entry Digitals No. 1
0015	Agena Guidance and Control	0033	DCS Pre-Retrofire Updates
0016 (A,B,C)	Titan Stage I OX and FU tnks	0034	DCS Orbit Navigation Updates
0017 (B,C)	FDO Velocity Ratio	0035	Terminal Energy Management
0018	RETRO Launch Digitals	} <i>additions</i>	
0019	RETRO Abort Digitals		0037
0020	Celestial Point Tract		

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TABLE I

2.0 INTRODUCTION

The test and evaluation was conducted at the RTCC Interim Facility. By programming the Display Generator for Charactron placement of ellipses and random point locations, slide alignment and correctness of placement of background slide data was verified. Then the composite display was tested for compatibility of 7094 Computer-Charactron generated data with verified background slide. (Because of the fact that the background slide provides the scaling for meter displays and other graphic plots, and the computer driven Charactron provides the "needle indicator" for the actual numerical reading, background slide/Charactron alignment is critical.)

The computer jobs were placed on two magnetic tapes. Tape I (#728) contained 18 display format output jobs, and Tape II (#513) contained 16 display format output jobs. Tape I with associated background slides presented composite displays for formats 0005, 0006, 0014, 0019, 0020, 0021, 0022, 0023, 0024, 0025, 0026A, 0026B, 0028, 0029, 0031, 0032, 0033, and 0034. Tape II with associated background slides presented composite displays for formats 0001, 0002, 0003, 0004, 0008, 0009A, 0009B, 0009C, 0010, 0011, 0012, 0013, 0015, 0016A, 0016B, and 0016C. See Table I for consolidated listing of formats. Five launch trajectory formats were not evaluated due to non-availability of computer programs.

Upon completion of the launch trajectory, and other computer output programs, a test and evaluation will be made. If the test results require documentation, an amendment will be published.

The D/TV display formats are classified into three types; alphanumeric displays, graphic displays, and meter displays. The alphanumeric displays include digital, summary tabulation, and summary history formats. The graphic displays have the X and Y axes' values to interpolate, as in the plot and trend formats. The meter displays are vertical scales that require only one value of interpolation.

The test and evaluation of the D/TV Display Format was accomplished by the IBM 7094 driving the display generator to display the format on a 21" (utility) TV Monitor. See Figure I.

The following terms are used in this report throughout:

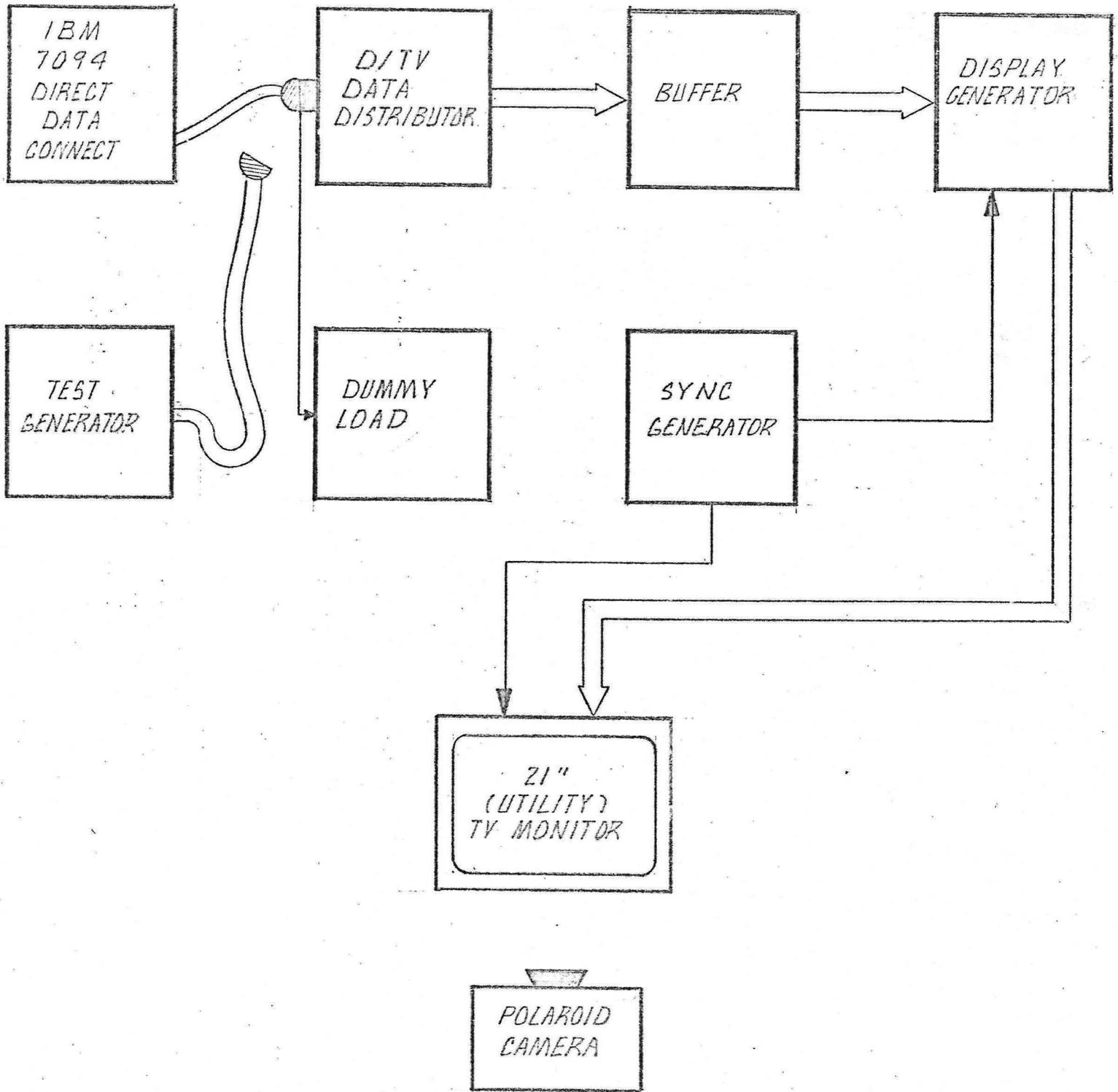
Alignment - The characteristic of having the background slide data coincident with the Charactron derived data, within tolerable limits; i.e. 1.1% of display dimension.

Visibility - The quality of an item which makes it separately visible from its surroundings.

Legibility - The quality of a letter or numeral which enables the observer to positively and quickly identify it to the exclusion of all other letters and numerals.

Readability - The quality of a group of letters or numerals of being recognizable as words or whole numbers.

Irradiation - The ability of a light source to cause letters, numerals, symbols, or lines to blur when the brightness of white on black increases above 10 mL (2.96 ft-C).



RTCC INTERIM FACILITY TEST
EQUIPMENT SET UP

FIGURE I

ALPHANUMERICS		GRAPHICS			METERS	
DIGITALS	TABULATIONS		TRENDS	PLOTS	ANALOGS	
0005(L)	0001(H)	0026A(H)	0010(L)	0013(H)	0014(L)	0008(L)
0006(L)	0002(M)	0026B(H)	0011(L)	0016A(M)		0009A(H)
0028(L)	0003(H)	0029(L)	0012(L)	0016B(M)		0009B(H)
	0004(M)	0031(L)		0016C(M)	0020(M)	0009C(H)
	0019(M)	0032(L)			0021(M)	0015(M)
	0023(M)	0033(M)			0022(H)	
	0024(M)	0034(M)				
	0025(H)					

(L) - Low Data Density
(M) - Medium Data Density
(H) - High Data Density

TABLE II

3.0 SUMMARY OF TEST RESULTS

Caution should be used in applying the results contained herein since this information was obtained from test and evaluation of a 21" (utility) TV monitor, rather than the 14" (precision) TV monitor that will be used on the MOCR's flight controller console. The 14" TV monitor should give a better presentation of the D/TV display.

Alphanumeric Displays:

1. The eighteen (18) alphanumeric displays that were tested and evaluated confirmed most of the criteria that was established for this type of display format.
2. The 1.6% size lower case alphanumerics did cause difficulty in reading.
3. All displays that used the 2.0% character box size (CBS) alphanumerics with the typewriter mode of computer programming must be re-formatted because of slide/Charactron incompatibility.

Graphic Displays:

1. The eleven (11) graphic displays that were tested and evaluated established line widths to be used on trend, plot, and analog display formats.
2. Grid line widths should not exceed 0.02". If major, minor, and/or intermediate grid lines are required, line widths of 0.02", 0.01", and/or 0.015" are to be used respectively.

3. With the D/TV Converter Buffer 100% loaded no noticable flicker was observed on the TV monitor.

Meter Displays:

1. The five (5) meter displays established that up to sixteen (16) meters may be placed on one display format.
2. The graduation marks must be placed on the background slide, rather than the Charactron.
3. A minimum of 0.07" spacing must be allowed between graduation marks.

4.0 CONCLUSIONS AND RECOMMENDATIONS

General: The present system used for the development of D/TV display formats is workable, but improvement can be attained. The conclusions and recommendations that follow cover general areas where display optimization can be achieved.

- o As much of a display format should be placed on the background slide as possible, because of the high information density, flexibility, legibility, and readability of the background slide's art work.
- o In several instances, users of the Coordinate Identification Sheets (CIS) did not follow specified information. Draftsmen and computer programmers will be instructed that only the Display Format Change Order (DFCO) will be accepted as an official change or deviation from the CIS.
- o The 1.6% size lower case alphanumerics should not be used because of difficulty in legibility.
- o Line widths should not exceed 0.02 of an inch.

Alphanumeric Displays

- o The 2.0% character box size alphanumerics that used the typewriter mode must be re-formatted.
- o The grouping of parameters, up to five (5), but preferably no more than three (3), assists in obtaining associated data on tabulation type display formats.

- When using tabulation, the parameters' title should be as close as possible to the dynamic data.

Graphic Displays

- Grid line widths should not exceed 0.02" or be spaced closer than 0.10" from one another.
- Up to four (4) vertical scales may be placed on one format. As the number of scales are increased the reading accuracy is decreased.
- The recommended symbols generated by the Charactron for dynamic data are the zero length vector, the 1.6% lower case "x", the 1.6% upper case "X", and the 1.6% open diamond (◇), in that order of preference.
- With the D/TV Converter Buffer 100% loaded, no noticeable flicker was observed on the TV monitor.

Meter Displays

- Up to sixteen (16) meters can be placed on one display format.
- When sixteen (16) meters are required for a display format, the graduation marks must be placed on the background slide. Fourteen (14) meters or less will allow the graduation marks to be generated by the Charactron.
- Spacing between graduation marks should not be less than 0.07 of an inch.

- o Line widths of graduation marks should not exceed 0.02". Major, minor, and intermediate graduation marks line widths' of .02", .01", and .015" are recommended respectively.

5.0 ACTION ITEMS

When the 14" precision TV monitor is installed, PHO DFG will observe the re-assembled IMB tapes (#567 and #780) of the output programs for the trajectory and telemetry D/TV display formats.

The PHO DFG will establish and specify the background slide alphanumeric, symbols, and line widths to be used on the operational D/TV display formats. A meeting with members of the Display and Control Dept., Engineering Services Dept./Drafting Section, Human Factors Dept., and Display Formats Group in attendance is to be held.

Establish quality control procedures so that the background slide's art work is identical to the Display Format Worksheet and Coordinate Identification Sheets.

Test and Evaluate the Launch Trajectory D/TV formats when computer programming becomes available. If the test results require documentation, an amendment will be published.

6.0 DETAILS OF TEST AND EVALUATION

ALPHANUMERIC DISPLAYS*

- Digitals - There were three (3) digitals formats that were tested. All of these formats used the 3.2% character box size and had a low density of data.
 - The ratio of base character height to subscript height was too low. (Should be 2:1)
 - Spacing between background slide titles and character generated data was too much.
 - 1.6% character box size lower case letters were difficult to read.
- Tabulations - There were fifteen (15) tabulation formats that were tested. Twelve (12) of the fifteen (15) tabulation formats used vertical lines for column grouping, the remaining three (3) did not use any lines. There were five (5) 1.6%, four (4) 2.0%, five (5) 2.4%, and one (1) 3.2% character box size alphanumerics used for the tabulation's character generated and background slide data.
 - The line widths of 0.03" was too wide, causing an overflow of illumination blending with adjacent alphanumerics.
 - Some of the alphanumerics were placed too close to vertical or horizontal lines.

- oo The parameter titles were spaced too far from the first vertical line.
- oo Vertical lines were not extended to the bottom of the format. If lines were extended to the bottom of the format, last minute changes could be accomplished by the computer programming only.
- oo Over-printing of alphanumeric's by Charactron does not present legible information.
- oo Degree "°" symbol and number "#" symbol of format 0002 were not legible.
- oo The grouping of parameter on formats 0001, 0002, 0003, and 0004 gave a good guide for following associated Charactron generated data.
- oo The "." symbol requires more horizontal spacing than other Charactron generated symbols.
- oo Stroke width of Greek symbols was too narrow; the stroke width should be approximately 10% of the letter or symbol height.
- oo Background slide 2.0% character box size lower case "i" stroke width was too narrow, causing loss of information.
- oo All displays that used the 2.0% character box size alphanumeric's with the typewriter mode of computer programming must be re-done. (The background slide and Charactron generated display were not compatible.)

- oo Double "change in continuity" lines were spaced too far apart from each other.
- oo The line separating a column's double title header should have a line width less than other major lines in format.
- oo Not all tabulation formats require lines for ease of association, when low or medium density of data is presented and grouped properly. (Formats 0033 and 0034 are examples of this.)
- oo When the Charactron generates a variable number all digits should be present; zeros should not be dropped. By dropping digits too much space may be placed between title and associated data.

GRAPHIC DISPLAYS*

- o Trends - There were three (3) trend formats that were tested. All of these used the 2.4% character box size numbers for their horizontal and vertical scales. The 0010 format had a grid of 0.015" and 0.03" line widths. The major grid lines were also extended from the normal grid pattern. Formats 0011 and 0012 were designed for a grid of 0.01" and 0.02" line widths, also with the "extended" grid.
- oo Using grid line widths of 0.015" and 0.03" made it almost impossible to discriminate the Charactron's dynamic data.

- oo The line width of 0.01" and 0.02" for the grid allowed for discrimination of the dynamic data.
- oo Three (3) of the Charactron's symbols ("x", "X", and "◇") and the zero length vector were used for the random plot of dynamic data. The order of preference was the zero length vector, lower case "x", upper case "X", and the open diamond "◇". When several upper case "X's" or "◇" were located close together, a large blotting effect was created.
- oo The spacing of the scales values from the extended grid line of .07" placed the scale close enough to the grid for proper association.
- oo The variable line width of a limit line did not stand out as was hoped. It was concluded that there should have been a dashed line.
- o Plots - There were four (4) plot displays that were tested. Format 0013 had four (4) parameters plotted against time. This display had a high density of data. The other three (3) displays were of the same format, only presented in three (3) different ways (100% Charactron generated; dynamic data and reference lines Charactron generated with alphanumerics, scale values, and scale on the background slide; and only the dynamic data Charactron generated with the reference lines, alphanumerics, scale values, and scale on background slide.)

- oo Time "tick marks" did not show up, because line width was too narrow (Format 0013).
- oo All four (4) vertical scale values were too close to vertical line, with the exception of the "0" value (Format 0013).
- oo Greek symbol stroke widths were too narrow.
- oo Zero length vector for plotting was acceptable.
- oo With buffer loaded 100%, no noticeable flicker was observed.
- oo All information but the dynamic data should be placed on the background slide. If a precise value is needed, the digital value obtained from the display.
- oo There was no problem created placing two (2) plot scales on one display format.
- oo A maximum of four (4) vertical scales is considered the limit for optimum monitoring. (Eight vertical scales may be placed on a format by dividing the horizontal in two.)
- oo Time "tick marks" on format do not serve much of any function. "Tick marks" should be between lines and scale values.
- o Analogs - There were four (4) displays tested that had scale values plotted against each other, that were not time. Format 0014 plotted ALTITUDE VS VELOCITY. This format had a low data density. Formats 0020, 0021, and 0022 had medium to high values on data density. These formats had a mixture of alphanumerics and plots placed on a grid.

- oo Format 0014 used a standard grid and placed the scale values on both sides, the top, and bottom.
- oo The spacing between standard grid line and scale values should not be less than 0.10".
- oo More spacing is required between alphanumerics that form parallel lines, such as (NM). Without the increased spacing the alphanumerics will tend to blend together.
- oo A grid with only major lines may use a line width of 0.01" so that the dynamic data can be better discriminated.

- oo Formats 0020, 0021, and 0022 were designed to evaluate major and minor grid lines whose line widths 0.02" and 0.01" respectively. When the art work was completed the major grid line width was 0.03" and the minor grid line width 0.015". The 0.03" and 0.015" line widths were too wide causing difficulty in discriminating the Charactron's dynamic data from the background slide grid. It is still felt that line widths of 0.02" and 0.01", spaced not closer than 0.10", will present a grid that will not clutter the display and make the dynamic data discriminable.
- oo When a scale range goes from minus values to plus values, the zero value should be of a bigger character box size to show that there has been a change sign value.
- oo If a standard grid is used in the format, the spacing between scale values and the grid should be a minimum distance of 0.10". The 0.06" and 0.02" spacing used on Formats 0020 and 0021 was too narrow.
- oo The scale titles should be spaced a character box width for vertical titles or a character box height for horizontal titles from their associated scales.
- oo Multi-scale values are acceptable for one of the grid's axes, but dynamic data must be coded so that the data can be easily identified to the appropriate scale.

- oo The spacing between the "extended" grid lines and the scale value of 0.03" was acceptable, but minimum spacing distance of 0.05" is recommended.
- oo When placing Charactron data on line with parameter title of background slide, care should be taken so that spacing is not greater than two character boxes or less than one character box.
- o Meters - There were five (5) displays tested that had meters formatted for presentation. Format 0008 had six (6) meters for its display. Format 0015 had twelve (12) meters for its display. Format 0009 had three (3) displays of sixteen (16) meters formatted so that 100% of the display would be Charactron generated; or the Charactron would display the graduation marks and pointers while the background slide projected the scale values and meter titles; or the Charactron would generate only the pointers and the background slide the graduation marks, scale values, and meter titles.
 - oo For vertical scales that cover the full height of the T.V. monitor, the 2.4% character box size numbers was acceptable, providing that the number of scale values did not crowd the scale. (The character box height should be maintained for the spacing between scale values.)
 - oo The character box sizes of 1.6%, 2.4%, and 4.8% for the graduation symbol (—) presented the correct relationship for major and minor graduation marks.

- oo Placement of the dynamic pointer "◆" was aligned to the graduation marks within acceptable tolerances. (Format 0008)
- oo The placement of digital scale readings was correct and the frequency of change was not too fast. (Format 0008)
- oo Scale values to graduation spacing too much on Format 0008. This format had the Charactron generate the graduation marks and pointers, while the background slide projected the scale values and meter titles.
- oo The graduation spacing should not be less than 0.07".
- oo When double vertical meters are placed on a format, the 2.4% size character box numbers tend to crowd the display.
- oo The evaluation of graduation mark presentation by the Charactron or background slide indicated that the background slide would display graduation marks properly and give the flexibility of obtaining various line widths and lengths.
- oo The Charactron composed "#" and "%" symbols were not as legible as background slide symbols.
- oo Background slide graduation mark line widths of .02" and .01" gave a good ratio of line width to length.

- oo Scale values spaced approximately 0.07" to the left of the graduation mark had better association to major graduation mark.

- oo Degree symbol on Format 0015 used a lower case "o" of 1.6% character box size. The stroke width is too wide, 1:4.

- oo When placing background slide alphanumerics or symbol on drafting mat, the width of alphanumeric or symbol and spacing is less than the Charactron's generated alphanumerics or symbols.

- oo Zero scale value "off-set" shows that a change in sign has occurred.

- oo When meter titles and subtitles are used, the title character box size of 2.4% and subtitle character box size of 2.0% is recommended over both the title and subtitle having the same character box size.