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QUARTERLY REPORT
Contract [redacted]

Second Quarter FY-68

(9 September through 1 December 1967)

1 December 1967

Prepared by:

[redacted]

Approved by:

[redacted]

for E. L. Green

Date: 22 December 1967

Prepared at the Contractor's Facility
As Specified by
Contract [redacted]

[redacted]

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1 Dec 67

PROGRAM OBJECTIVE

Under the direction of a three-member configuration change board (CCB), the contractor shall conduct a research and development program to improve the practices, techniques, and equipments concerned with exposure analysis and prediction, processing, reproduction, and evaluation of aerial reconnaissance photography. This effort will define problem areas, study feasible approaches, design and construct and evaluate breadboard models, and design and construct operational prototypes.

1 Dec 67

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SECTION I

INTRODUCTION

Second Quarter FY-68

1 Dec 67

SUMMARY

1. By customer direction, Quarterly Reports are transmitted at least two weeks prior to CCB meetings. CCB meetings are normally scheduled no earlier than fifteen days after the end of a quarter. To meet the above transmittal requirement, this Quarterly Report therefore covers the period from 9 September through 1 December 1967.

2. A CCB Quarterly Progress Review Meeting covering this contract and Contract [redacted] was held at Washington, D. C. on 18 October 1967. Contractor's report, Minutes of CCB Quarterly Progress Review Meeting on 18 October 1967 [redacted] dated 20 October 1967, summarizes the discussion and actions taken at that meeting.

3. Detailed reports covering progress on all active PARs, with the exception of PAR 151, Contract Monitoring, Coordination, and Liaison (FY-68); are included in this document and listed in the Table of Contents.

1 Dec 67

DISCUSSION

4. PAR Index and Summary. Although all PARs under Contracts [redacted] and [redacted] have been completed, these PARs as well as Contract [redacted] PARs are listed in the Appendix because of their technical interrelationship.

5. PARs Completed During the Report Period:

a. PAR 24-7-5S, Exposure Criteria for Acquisition Films [redacted].

INTERIM REPORT*
TRANSMITTED 18 SEPT 67

b. PAR 130S, Film Moisture Control Study [redacted]).

FINAL REPORT
TRANSMITTED 9 OCT 67

c. PAR 25-7-2S, Improve Methods of Microdensitometer Data Collection and Use [redacted]).

FINAL REPORT
TRANSMITTED 11 OCT 67

d. PAR 24-7-2S, High-Altitude Color Acquisition [redacted].

FINAL REPORT
TRANSMITTED 12 OCT 67

e. PAR 86S, Study the Applications of Liquid Gates to Continuous Printers [redacted].

FINAL REPORT
TRANSMITTED 20 NOV 67

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* Effort is continuing under PAR 24-8-5S, Exposure Criteria for Acquisition Films. The Interim Report closes out FY-67 effort.

6. <u>Interim, Special, and Quarterly Reports Completed During the Report Period</u>:

a. PAR 24-7-5S, Exposure Criteria for Acquisition Films, Seasonal Exposure Recommendations for Satellite Systems [redacted].

<u>INTERIM REPORT</u>
<u>TRANSMITTED 18 SEPT 67</u>

b. PAR 24-7-5S, Exposure Criteria for Acquisition Films, Seasonal Exposure Curves for 1000-Series-Type Systems [redacted].

<u>SPECIAL REPORT</u>
<u>TRANSMITTED 19 SEPT 67</u>

c. PAR 24-7-5S, Exposure Criteria for Acquisition Films, Seasonal Exposure Curves for [redacted] Series-Type Systems [redacted]).

<u>SPECIAL REPORT</u>
<u>TRANSMITTED 19 SEPT 67</u>

d. Quarterly Report, Contract [redacted] First Quarter FY-68 [redacted].

<u>QUARTERLY REPORT</u>
<u>TRANSMITTED 29 SEPT 67</u>

e. Quarterly Report, Contract [redacted] Fiscal Summary (through 6 Aug 67) [redacted]).

<u>QUARTERLY REPORT</u>
<u>TRANSMITTED 29 SEPT 67</u>

f. Quarterly Report, Contract [redacted] First Quarter FY-68 [redacted].

QUARTERLY REPORT
TRANSMITTED 29 SEPT 67

g. Quarterly Report, Contract [redacted] Fiscal Summary (through 6 Aug 67) [redacted].

QUARTERLY REPORT
TRANSMITTED 29 SEPT 67

h. Classified Supplement to Quarterly Report, Contract [redacted] First Quarter FY-68 [redacted]).

QUARTERLY REPORT
TRANSMITTED 5 OCT 67

i. PAR 24-7-6S, Target Brightness Studies, First Monthly Report [redacted].

INTERIM REPORT
TRANSMITTED 13 OCT 67

j. Tentative Agenda for 18 October 1967 CCB Meeting, Contract [redacted] [redacted]).

AGENDA
TRANSMITTED 18 OCT 67

k. Minutes of CCB Quarterly Progress Review Meeting, Contracts [redacted] and [redacted] 18 October 1967 [redacted].

MINUTES
TRANSMITTED 10 NOV 67

l. PAR 24-7-6S/R2, Target Brightness Studies, Second Monthly Report [redacted].

INTERIM REPORT
TRANSMITTED 22 NOV 67

SECTION II

PAR PROGRESS REPORTS

Contract [redacted] Task 2

Second Quarter FY-68

PAR 24-7-2S

1 Dec 67

SUBJECT: High-Altitude Color Acquisition

TASK/PROBLEM

1. Through investigations in the laboratory and practical aerial tests, determine the criteria for proper camera exposure, haze compensation, and optimum color correction for high-altitude color photography. These investigations will include adequate examinations of the various steps in reproducing the product and its ultimate use to insure an optimum result is being obtained in the acquisition stage.

DISCUSSION

2. The final report was transmitted on 12 October 1967.

PLANNED ACTIVITY

3. Recommendations of the final report find active application under a newer project, PAR 24-8-8S, "Study the Characteristics and Uses of Suitable Materials for High Altitude Acquisition." Two recommendations have particular suitability for the new study. These relate to:

a. Atmospheric spectral radiance and transmittance.

b. Desirable sensitometry for aerial films.

PAR 24-7-4S

1 Dec 67

SUBJECT: Low Contrast Original Negative

TASK/PROBLEM

1. Compile and correlate laboratory data on various image parameters relative to the process contrast level, type of processing, and ultimate use in order to determine the process conditions which maximize the informational content of high-altitude acquisition material. Arrange, conduct, and monitor practical aerial tests to provide material for the community to evaluate to verify these findings.

DISCUSSION

2. Granularity Measurements on film Type 8430 exposed to Tungsten and Mercury Light

a. Attempts to obtain meaningful results with a 12μ scanning aperture (48X equivalent viewing) in one of the contractor's laboratories were not successful.

b. A fresh attack on this problem was made under another PAR* using a 2μ scanning aperture (288X equivalent viewing) as an adjunct to an investigation of the power spectra of several emulsions and types of processing. Scans were made at densities of 0.62 for both tungsten and mercury exposed samples that had been given identical processing. The results fully confirm that the σ (D) granularity value is higher with film exposed to tungsten light. Following are tabulated the significant differences resulting from the two light sources:

	Mercury Arc	Tungsten
rms σ (D)	0.106	0.120
Variance	0.0113	0.0145

The above difference between the granularity of tungsten and mercury exposed samples was apparent at 50X viewing in the comparison microscope.

* PAR 25-8-3S "Application of Power Spectrum Techniques"

3. Observer Variability. Testing will be completed as quickly as observers can be made available. Preliminary results should be forthcoming in about six weeks time.

4. Yardleigh (dual gamma) vs Trenton (standard) Processing. Comparison testing requires processing of prints from master negatives with the new dual gamma process on the Yardleigh machine. This processing is complete, but evaluation of results is not.

5. Flight Testing. The first flight tests were made. Two local and one high-altitude test received Trenton and Yardleigh (dual gamma) processing. The test results are presently being evaluated.

6. Detection and Recognition. A report on observer threshold for these factors, titled "Effects of Image Size and Contrast on Detection and Recognition" is now being readied for submittal as a special report.

PLANNED ACTIVITIES

7. Complete observer variability testing.

8. Continue evaluation of low and high-altitude acquisitions given Trenton (full) and Yardleigh (dual gamma) processes.

9. Submit, edit, and publish the special report "Effect of Image Size and Contrast on Detection and Recognition."

PAR 24-8-5S

1 Dec 67

SUBJECT: Exposure Criteria for Acquisition Films

TASK/PROBLEM

1. Modify and refine the criteria for exposure of black-and-white and color acquisition films through analysis of data from orbital missions and scientific literature. As significant results are obtained, publish updated exposure recommendations for the reconnaissance community.

DISCUSSION

2. Because of its higher classification, the PAR 24-8-5S quarterly progress report was transmitted under separate cover.

Contract [redacted], Task 2

Second Quarter FY-68

PAR 24-7-6S/R2

1 Dec 67

SUBJECT: Target Brightness Studies

TASK/PROBLEM

1. Evaluate the feasibility of selecting exposure for operation of very-high-altitude photography on the basis of the individual brightness history of each specific target.

DISCUSSION

2. Because of its higher classification, the PAR 24-7-6S/R2 quarterly progress report was transmitted under separate cover.

Contract [redacted] Task 3

Second Quarter FY-68

PAR 24-7-7S/R1

1 Dec 67

SUBJECT: Study of Scanning Techniques

TASK/PROBLEM

1. Establish criteria for improving acquisition, processing, and reproduction based on scan data obtained from black-and-white reconnaissance films.

DISCUSSION

2. Because of its higher classification, the PAR 24-7-7S/R1 quarterly progress report was transmitted under separate cover.

PAR 24-8-8S

1 Dec 67

SUBJECT: Study the Characteristics and Uses of Suitable Materials for High Altitude Acquisition

TASK/PROBLEM

1. Through investigation in the laboratory and empirical testing, determine desirable properties for sensitized materials intended specifically for high-altitude acquisition. Recommend exposure and filtration for existing materials in specific systems.

DISCUSSION

2. Sensitometric characteristics for an ideal high altitude negative material of the Type 3404 variety. Analysis of data from past Red Dot tests has indicated that the average C factor* for the solar altitude range between approximately 30° and 55° and for a film having a spectral response similar to Type 3404 as altered by a Wratten #12 filter, is 8.5. From this we are able to determine several characteristics of an ideal material.

a. Log E range necessary for the product.

(1) Maximum log E range. Considering the range of reflectances from 0% to 100%, the maximum Δlog E can be computed from:

$$\Delta \text{Log } E = \text{Log } (R_1 + C) - \text{Log } (R_2 + C) \qquad (1)$$

In this case $R_1 = 100$, $R_2 = 0.0$, thus

$$\Delta \text{Log } E = \text{Log } (8.5 + 100) - \text{Log } (8.5 + 0.0) = 1.1$$

(2) Practical log E range. Other Red Dot tests have indicated that the plus and minus 2σ limits of reflectance for an urban industrial area are:

$+2\sigma = 44\%$

$-2\sigma \doteq 2.4\%$

*The C factor, or contrast constant, describes the effects of the atmosphere and illuminant in reducing the contrast of the aerial image.

Using formula (1) again, the practical $\Delta \log E$ appears to be approximately 0.68. Thus, approximately 96% of the scene will be included within this $\Delta \log E$ range, and is apparently a proper statistic to consider in determining the fraction of contrast correction to be made in the negative when considering the density scale desired in the negative and positive. It also is indicative of the log exposure range over which a high value for resolving power is desirable.

b. Density scale. The density at which an object of given reflectance is recorded may be determined from the formula:

$$D_2 = D_1 + \left[(\text{Log } R_2 - \text{Log } R_1) \cdot K \right]$$

where:

D_2 = Density for an object having a reflectance of R_2

D_1 = Density for a reflectance of R_1. This is an important design parameter involving practical considerations in the actual manufacture of emulsions, as well as photographic parameters. In this case we are relating D_1 to the mean reflectance on the ground.

R_2 = reflectance of any object on the ground.

R_1 = Mean reflectance object in an urban industrial scene. In terms of density distributions from actual scenes, we have found this to be the most invariant property.

K = Fraction of contrast in scene to be retained in the negative. This factor involves the density scale in the reproduced positive as well as the density scale of the negative.

For the material we are considering the following values have been used:

$D_1 = 1.3$

$R_1 = 15.9$

$K = 0.8$

The value for K was estimated from:

$$\frac{\Delta D_o}{\gamma_D \times (\text{Log } R_{+2\sigma} - \text{Log } R_{-2\sigma})} = K$$

where:

ΔD_o = Delta Density range acceptable to the observer. Previous work by other investigators has indicated that this value falls between 1.4 and 1.6. We have chosen 1.4.

γ_D = Gamma of the dupe material, in this case 1.34.

$R_{\pm 2\sigma}$ = The $\pm 2\sigma$ values of reflectance previously mentioned in 2, a, (2).

Thus, the actual value for K, with these data, is .83.

c. Log E Values

(1) The log E values for the material were determined from:

$$\text{Log } E_2 = \text{Log } (R_2 + C) - \text{Log } (R_1 + C) + \text{Log } E_1 \qquad (3)$$

where:

Log E_2 = log E for the previously determined D_2 values.

Log E_1 = establishes the speed of the material and is related directly to R_1 and D_1.

R_1 = The mean reflectance on the ground.

R_2 = The reflectance of some object on the ground.

C = The C factor, or contrast constant, which describes the effects of the atmosphere and illuminant in reducing the contrast of the aerial image.

For this material the following values were used:

Log E_1 = $\bar{1}.62$

R_1 = 15.9

C = 8.5

(2) Curve 1 in Figure 1 is a direct result of formulas (2) and (3). The actual calculated points are indicated. A coordinated effort with processing researches being carried out under another contract has resulted in a viscous layer process which approximates this ideal curve (Curve 2).

(3) Some increase in toe contrast of Curve 2 would be desirable; however, it should be pointed out that the toe gradients are no less than those of the standard process for Type 3404. The shoulder of Curve 2 may be desirable as it is, because the effect of the scatter of light in the emulsion by high luminance objects is mitigated. The ideal curve does not, as yet, take into consideration the decreasing frequency of occurrence of higher luminance objects. Surely, any ideal product should shoulder off very rapidly as the curve approaches the point where a 100% reflectance is recorded.

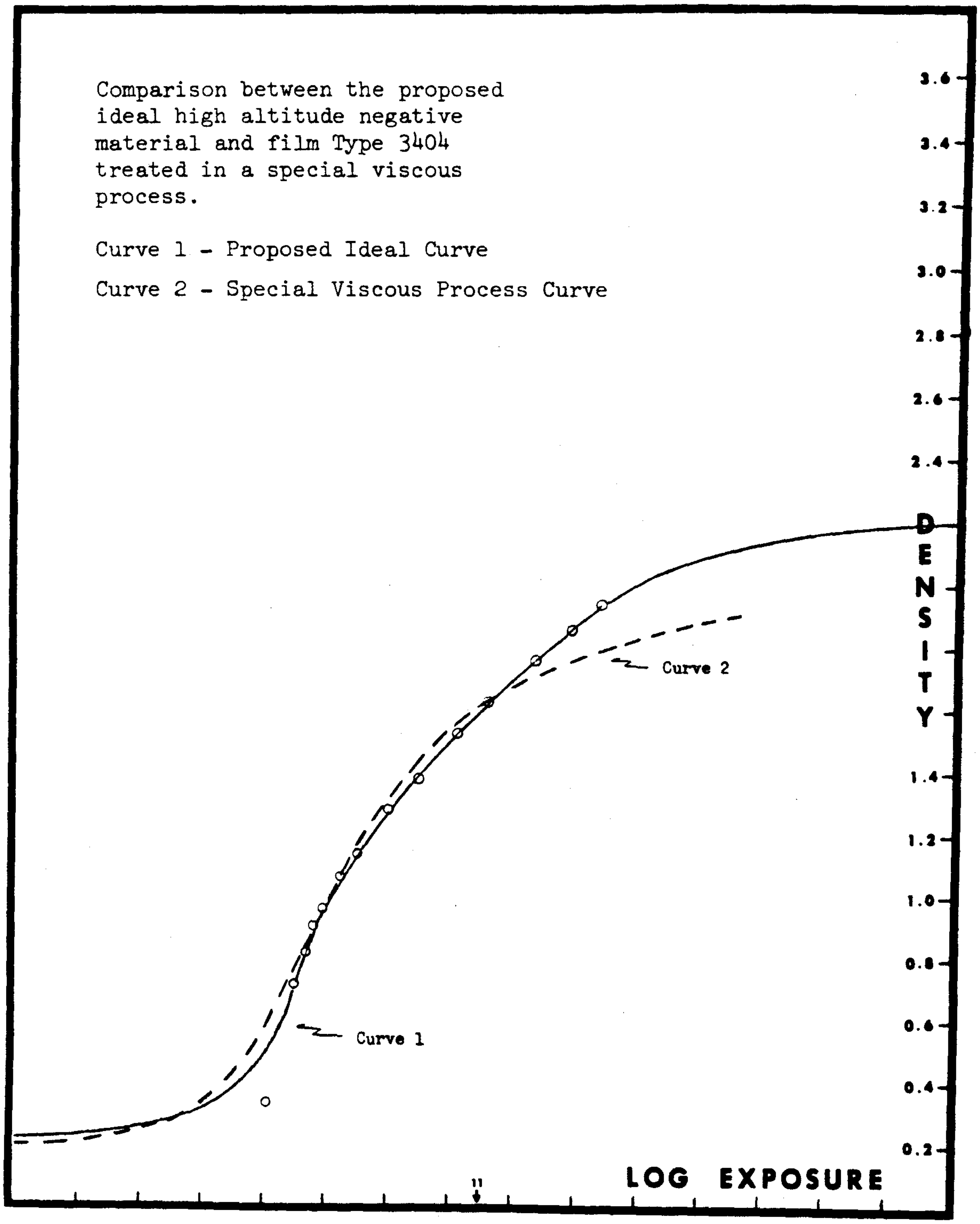
(4) Note that the general scheme of design used in arriving at the so-called ideal curve relates the reflectance of objects directly to sensitometric properties, and that the density or log exposure may be arrived at with partial independence. This facilitates consideration of the many practical factors involved.

3. <u>Exposure prediction computer program</u>

a. Exposure, for a clear day, is based on the luminance of the target area. The luminance is related to the illuminance which, in turn, is directly dependent upon the solar altitude. The solar altitude, in turn, is dependent on the time of day and the specific latitude and longitude at the point of acquisition.

b. The problem becomes more involved because a clear day is hard to find, and photography from a high altitude vehicle is not restricted only to the vertical mode. This means that more emphasis must be placed on atmospheric transmittance and also haze radiance. As the "look" angle increases from the vertical mode, the distance from camera to target increases and the amount of atmosphere the camera must "look" through becomes greater.

Figure 1


Comparison between the proposed ideal high altitude negative material and film Type 3404 treated in a special viscous process.
Curve 1 - Proposed Ideal Curve
Curve 2 - Special Viscous Process Curve
Curve 1
Curve 2
3.6
3.4
3.2
3.0
2.8
2.6
2.4
1.4
1.2
1.0
0.8
0.6
0.4
0.2
DENSITY
LOG EXPOSURE
11

c. Considering all these variables and all the knowledge and data that has been compiled to date, it is now possible to implement the writing of a computer program that will predict exposure for high altitude photography. The computer program, prudently termed "Crystal Ball," is presently available on an experimental basis for use in winged and orbital missions.

d. Inputs to the computer are as follows:

(1) The day, month, and year of the flight.

(2) The time of photography (GMT).

(3) The latitude and longitude at the beginning and end of the pass.

(4) The type of camera system which indirectly determines the scan angles and offset angle.

(5) An estimate of the amount of haze and atmospheric transmittance.

e. The computer outputs are:

(1) Declination of the earth for that date.

(2) Equation of time for that date.

(3) All the input parameters.

(4) The beginning and ending headings of the vehicle.

(5) The solar altitude.

(6) The solar azimuth.

(7) The solar direction.

NOTE: Items (8) through (15) are for each of seven different look angles.

(8) The CATS (Camera - Target - Sun) angle.

(9) The haze luminance.

(10) The atmospheric transmittance, based on varying path length.

(11) The luminance of a 10% reflective object based on each of the following illuminances:

(a) Skylight on a vertical surface.

(b) Skylight on a horizontal surface.

(c) Daylight on a vertical surface.

(d) Daylight on a horizontal surface.

(e) Building shadow on a vertical surface.

(f) Building shadow on a horizontal surface.

(12) The luminance of a 25% reflective object based, again, on each of the above illuminances.

(13) The contrast constant for each condition (a) - (f) listed in #(11) above.

(14) The various look angles themselves.

(15) The atmospheric transmittance.

NOTE: The Technical aspects of the above input/outputs and the derivations thereof, are included in the appendix (Appendix A) immediately following this report.

f. As of this writing, the comparison between exposure prediction and actual photography is reasonably close and is best shown in Figure 2. The graphical comparison shows the computer prediction as the solid line and the measurements from a Red Dot Delta III mission (GT-182-67) as the dashed lines. A similar urban area was raster scanned at seven different locations in the frame, 10° apart in scan angle. The vertical offset is 13° forward.

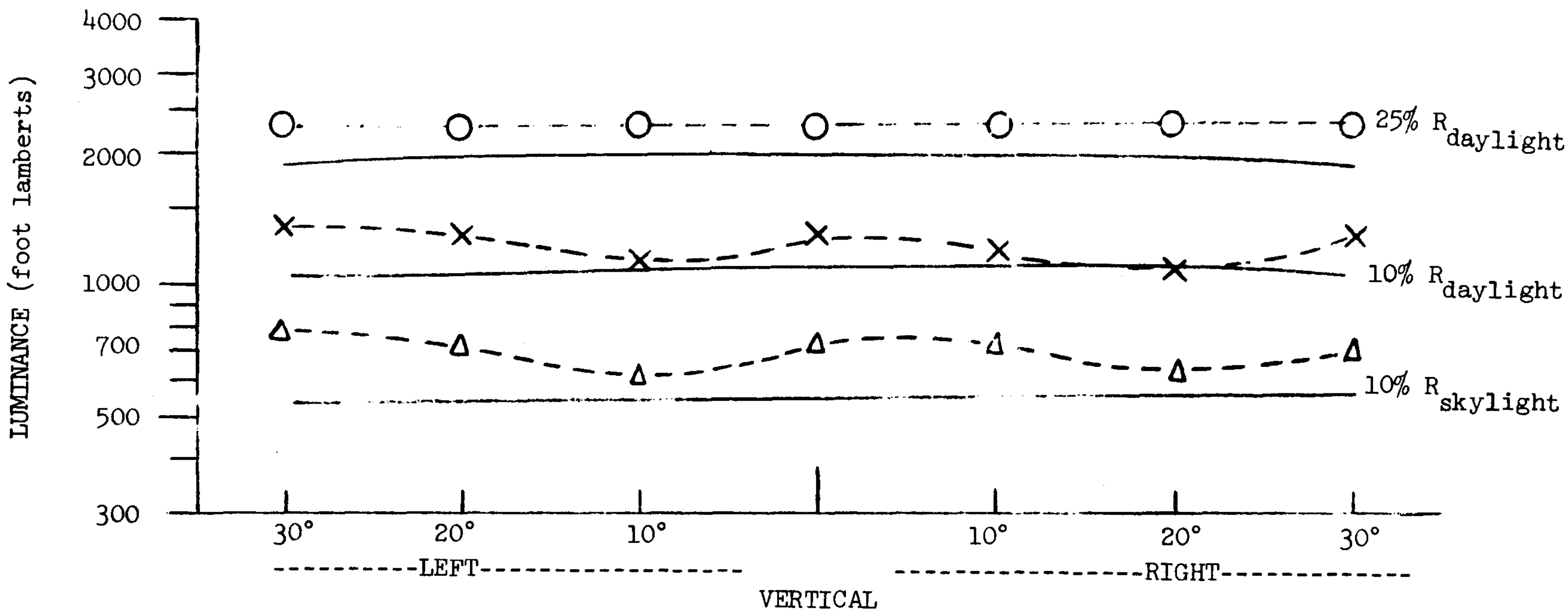
(1) The upper solid line represents a 25% reflective horizontal object illuminated by daylight. This is an estimate of the 95% upper bound for the actual data shown as the upper dashed line.

(2) The middle solid line is the computer prediction of a 10% reflective horizontal object illuminated by daylight. The middle dashed line is the average luminance of the scene.

(3) The bottom solid line is the computer prediction of a 10% reflective horizontal object in the shadows. The bottom dashed line is the 5% limit of the actual data.

Figure 2

Luminance Data Extracted From Mission GT-182-67
Pass #8



Film type: 3404
Solar Altitude: 62°
Solar Direction: -8°
HF: 1.0
t: .65

——— Computer prediction
- - - - Actual mission data
R: Percent reflectance of horizontal objects

4. High Altitude Tests. Four high-altitude Red Dot missions (Package 9) were flown to fulfill the following requirements:

a. Compare, under near-operational conditions, the performance of the new "Hump back" viscous process on the Yardleigh to the present spray process on the Trenton. This required two Delta III flights.

b. Study scene reflectance of urban and industrial areas on a spectral basis. Required one modified A-2 flight.

c. Study luminance variation of scenes in oblique photography (i.e. differing CAT angles). Necessitated one B-2 flight.

5. Low Altitude Tests. One low altitude local test was also flown to test the experimental Vixen process for 3404. This test resulted in several striking photographic examples of increased image quality in minimum luminance scenes and in strong highlight subjects. There was also evidence of supression of specular components, thus improving detail in specular subjects.

6. Ground Based Measurements. Field usage has begun for the Solar Disc Radiometer and Multi-Channel Spectral Radiometer. All "bugs" appear to be out, and routine operation procedures are being developed. We now have a considerable amount of data on atmospheric transmittance and radiance, as well as on daylight irradiance, collected both locally and during the latest Red Dot series on the west coast.

PLANNED ACTIVITIES

7. Begin planning of Red Dot Package 10. This package will include: one flight to compare film Type 3404 to Type SO-230 at the full process condition; two flights to compare the performance of film Type SO-121 to Type 3400 in the B-2 configuration at low solar altitudes.

8. Continue efforts in the design of optimum acquisition materials. Expand present techniques and data to color materials.

9. Continue testing of processes approaching the sensitometric characteristics determined in paragraph 2.

10. An actual operational winged mission has been recalled for analysis of various target sites for comparison with the exposure prediction program. Two additional missions are expected for similar analysis.

11. Consider the initiation of a brief study of the effects of polarizing filters for use in aerial photography. (It appears possible that certain desirable information is lost via the improper use of Polaroid filters.)

APPENDIX A

Methods and Derivations Used in
the Exposure Prediction Program "Crystal Ball"

1. The program consists of a mainline and 12 sub-routines and functions. Given the following information, the computer will calculate the luminance of the target which, in turn, may be used to predict exposure:

a. The type of system.

b. Day, month, year.

c. An adjustment factor to vary the amount of haze.

d. The starting latitude and longitude.

e. The ending latitude and longitude.

f. The time of day (GMT).

g. An estimate of the atmospheric transmittance.

h. An adjustment factor that considers the different spectral characteristics of the film-filter-lens combination.

2. Based on this information, the solar altitude may be computed by first determining the true sun time (TST):

TST = GMT + THETA/15 + Equation of Time

where:

GMT is in hours

THETA is the longitude in degrees. Always positive if east of Greenwich (0° to 180°).

Equation of time (a numerical factor) is determined from a table look-up for the specific day, month and year.

The time before or after true noon (LST) is:

LST = 12 - TST

The solar altitude (H°) then becomes:

$$\sin H° = \cos(\text{latitude}°)\cos(\text{Declination}°)\cos(15\text{-LST}) + \sin(\text{latitude}°)\sin(\text{Declination}°)$$

where:

The starting latitude is given (always positive if North). The declination is found by a table look-up for the day, month and year, (the declination is negative if South).

3. Once the solar altitude is known, the solar azimuth (AZ°) may be found by (azimuth varies from 0° to 360°):

$$\tan(AZ°) = \frac{-\sin(15 \cdot LST)\cos(\text{Declination}°)\cos(\text{latitude}°)}{\left[\sin(\text{Declination}°) - \sin(\text{latitude}°)\sin(H°)\right]\cos^2(H°)}$$

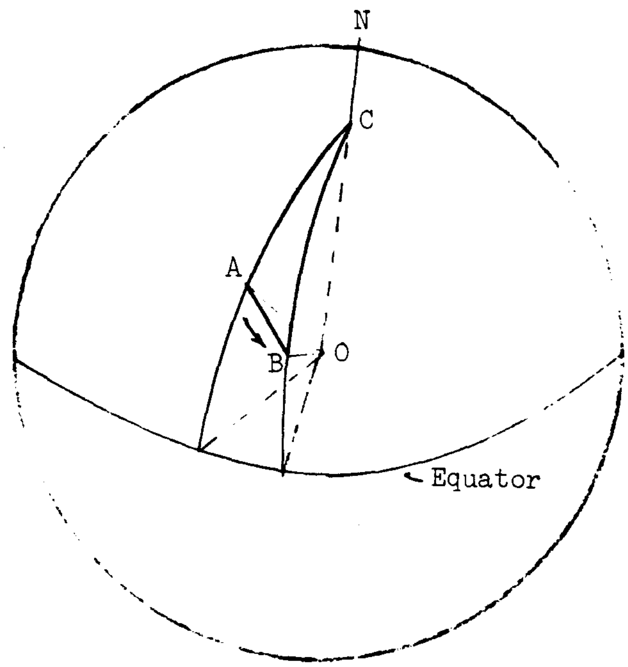
4. The vehicle heading is determined from the beginning and ending latitude and longitude by using spherical trigonometry and computer logic.

Consider a vehicle moving from point A to point B (see Figure A-1) whose latitude and longitude are known. The side $\overline{BC}$ of the spherical triangle = 90° - latitude at B, and the side $\overline{AC}$ is 90° - latitude at A. The angle at point C is the absolute difference in the longitude between point A and point B. Using the half angle formulae:

$$\tan\frac{A+B}{2} = \cos\left(\frac{\overline{BC} - \overline{AC}}{2}\right) \quad \cot\frac{C}{2} \quad \sec\left(\frac{\overline{BC} + \overline{AC}}{2}\right)$$

$$\tan\frac{A-B}{2} = \sin\left(\frac{\overline{BC} - \overline{AC}}{2}\right) \quad \cot\frac{C}{2} \quad \csc\left(\frac{\overline{BC} + \overline{AC}}{2}\right)$$

Figure A-1



Angle A, the beginning heading, and angle B (180° - heading at the end) are found by the simultaneous solution of the preceeding equations. Assuming the earth to be a perfect sphere with a mean radius of 3436.218521 nautical miles,* the distance between the coordinates ($\overline{AB}$) is the radius of the earth times the angle in radians at the center of the earth.

$$\sin \overline{AB} = \sin C \sin \overline{AC} \csc B$$

$$\text{Distance} = (\overline{AB}) \text{ (Radius of Earth)}$$

The heading is always positive and is measured with respect to North. The program contains the proper logic to assume the correct heading for various directions of flight other than the one specifically described.

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*Handbook of Geophysics and Space Environment, A.F. Cambridge Research Lab., S.L. Valley., McGraw-Hill, 1965.

5. To determine the CATS (Camera-Target-Sun) angle, the following equation is used (the derivation for which is rather involved and not presented here):

$$\begin{aligned}\cos CATS^\circ = & -\cos(H^\circ)\ \cos(SD^\circ)\ \cos(SCN^\circ)\ \sin(OFST^\circ)\\ & -\cos(H^\circ)\ \sin(SD^\circ)\ \sin(SCN^\circ)\\ & +\sin(H^\circ)\ \cos(SCN^\circ)\ \cos(OFST^\circ)\end{aligned}$$

where:

CATS is the camera-target-sun angle

H is the solar altitude

SD is the solar direction, easily found by knowing the vehicle heading and solar azimuth. The S.D. is positive if the sun is to the right of the flight line and negative if on the left.

SCN is the camera scan angle; positive if to the right of the flight line from the vertical.

OFST is the vertical camera offset; positive if forward, negative if aft and zero if no vertical offset.

The scan angles and offset angles vary depending on the system type. At present, the program is capable of handling 7 scan angles for each of 2 offset angles. Reading in the system type (i.e., 1, 2, 3 etc., as coded for the computer), selects all the scan and offset angles used in that system.

6. The amount of haze radiance depends on the camera "look" angle and the atmospheric transmittance.

a. The greater the scan angle the greater is the path length through the atmosphere and the transmittance will be smaller. The vertical path radiance ($Nh_{H^\circ,\ vertical}$) --- for any solar altitude --- is known and has been measured by this contractor. It is represented by:

$$Nh_{H^\circ,\ \text{vertical}} = 2^{(22.16525\ -\ 18.25H^{-0.077})}$$

where:

H is the solar altitude in degrees

b. The ratio ($R_{CATS^\circ,\ ZEN^\circ}$) of the energy scattered at the angle between the camera and the sun (CATS°), and the vertical mode and the sun (ZEN°) is:

$$R_{CATS^\circ;ZEN} = \frac{\begin{aligned}[7.98 \times 10^{-17} (CATS^\circ)^8 - 2.244 \times 10^{-14} (CATS^\circ)^7 + 1.04 \times 10^{-13} (CATS^\circ)^6 \\ +3.5 \times 10^{-10} (CATS^\circ)^5 + 1.639 \times 10^{-8} (CATS^\circ)^4 - 6.19 \times 10^{-6} (CATS^\circ)^3 \\ + 2.5 \times 10^{-4} (CATS^\circ)^2 - 8.363 \times 10^{-3} (CATS^\circ) + 2.035]\end{aligned}}{\begin{aligned}[7.983 \times 10^{-17} (ZEN^\circ)^8 - 2.244 \times 10^{-14} (ZEN^\circ)^7 + 1.04 \times 10^{-13} (ZEN^\circ)^6 \\ + 3.5 \times 10^{-10} (ZEN^\circ)^5 + 1.639 \times 10^{-8} (ZEN^\circ)^4 - 6.19 \times 10^{-6} (ZEN^\circ)^3 \\ + 2.5 \times 10^{-4} (ZEN^\circ)^2 - 8.363 \times 10^{-3} (ZEN^\circ) + 2.035]\end{aligned}}$$

where:

CATS° is the angle between the sun's ray and the observer's line of sight.

ZEN° is 90° minus the solar altitude.

c. The optical difference $(D_{L^\circ,t})$ in path length through the atmosphere from the vertical mode is:

$$D_{L^\circ,t} = \frac{1 - t^{\sec L^\circ}}{1 - t}$$

t is the vertical atmospheric transmittance

L° is the angle between the observer's line of sight and the vertical mode. If the angle is greater than 60° then Bemporad's* air mass numbers are used in place of sec L°. The transmittance for the path length observed is then $t^{\sec L^\circ}$.

d. The atmospheric haze radiance $(Nh_{H^\circ,\ CATS^\circ,\ t^\circ})$ is then:

$$Nh_{H^\circ,\ CATS^\circ,\ t} = (Nh_{H^\circ,\ vertical})(R_{CATS^\circ,\ ZEN^\circ})(D_{L^\circ,t})$$

7. The illuminance on horizontal and vertical planes for daylight and skylight at solar altitudes from 0° to 90° are obtained from Jones and Condit** and put in tabular form. The skylight illumination on a horizontal plane, in a shadow, is estimated to be 0.28 of the total horizontal skylight illumination. Likewise, the skylight illumination on a vertical plane, in a shadow, is estimated to be 0.33 of the total vertical skylight illumination.

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*A. Bemporad, "Search for a new Empirical Formula for the Representation of the Variation of the Intensity of Solar Radiation with Zenith Angle." Meteorologische Zeitschrift, Vol. 24, July 1907.

**Jones and Condit - "Sunlight and Skylight as Determinants of Photographic Exposure, I." JOSA, Vol. 39, #9, p. 790 Sept. 1949.

8. All the information necessary to predict exposure has now been presented. We know or have calculated:

a. Time of flight.

b. Latitude and longitude.

c. Solar altitude.

d. Solar azimuth.

e. Vehicle heading.

f. The camera scan angles and offset angles.

g. The CATS angles.

h. The haze radiance at the CATS angles.

i. The illumination of perpendicular planes.

j. The atmosphere transmittance at the different angles.

Using the equation:

$$Ba = I_o R\ t + B_h$$

we can predict the apparent luminance ($Ba_{H° \; CATS° \; t}$) of an object of R reflectance.

Ba = apparent luminance

I_o = incident illuminance

t = atmospheric transmittance

B_h = haze luminance

R = object reflectance (10% and 25% are used in the program)

9. The computer program also calculates the contrast constant (C) for each of the scan angles and illuminances as:

$$C = \frac{B_h}{I_o t} \times 100$$

10. The exposure prediction program is presently available, on an experimental basis, for use in winged vehicles only. Modifications for orbital altitudes are forthcoming.

Contract [redacted] Task 1

Second Quarter FY-68

PAR 25-7-2S

1 Dec 67

SUBJECT: Improve Methods of Microdensitometer Data Collection and Use

TASK/PROBLEM

1. Study methods for improving the applicability of microdensitometer techniques and computation procedures for utilization in the evaluation of reconnaissance materials.

DISCUSSION

2. The final report was transmitted 11 October 1967.

PLANNED ACTIVITIES

3. Recommendations of the final report find application in continuing efforts under the following newer projects:

PAR	Subject
25-8-2S	Microdensitometer Data Collection and Use
25-8-3S	Application of Power Spectrum Technique
25-8-4S/R1	Evaluation of Photographic Images
25-8-5S/M	Simulation of Image and Noise Transfer in Photographic System

Contract [redacted] Task 4

Second Quarter FY-68

PAR 25-8-2S

1 Dec 67

SUBJECT: Microdensitometer Data Collection and Use

TASK/PROBLEM

1. Study methods for improving the applicability of microdensitometer techniques and computation procedures for utilization in the evaluation of reconnaissance materials.

DISCUSSION

2. A study plan covering work in this project is being written.

3. Concurrent with this planning, purchase orders were placed for the electrical equipment required (in modification of the microdensitometers) to permit raster scanning. Such a scanning mode should allow collection of data at fixed positions on the film sample. This capability is needed in two-dimensional image quality measurements, and color studies requiring sequential red, green, and blue readings at the same points on the sample.

PLANNED ACTIVITIES

4. Submit study plan for approval.

5. Continue construction of the raster scanning modification.

6. Start other portions of the project following approval of the study plan.

Contract [redacted], Task 3

Second Quarter FY-68

PAR 25-8-3S

1 Dec 67

SUBJECT: Application of Power Spectrum Techniques

TASK/PROBLEM

1. By method of power spectrum, study the applicability and usefulness for evaluation of photographic systems. Studies to include types of aerial scenes usable for image quality evaluation, potential as a measuring tool for negative image quality, and as a quantitative measure of grain noise transfer through generation printing.

DISCUSSION

2. <u>October CCB Meeting</u>. An oral review of the progress on this project to date was given at the CCB meeting on 18 October in Washington, D.C.

3. <u>Summary of Technical and Theoretical Consultations</u>

a. A meeting with personnel from the film manufacturer's research laboratories was held to discuss measurement testing parameters, problems, and applications of power spectrum measurements to photography.

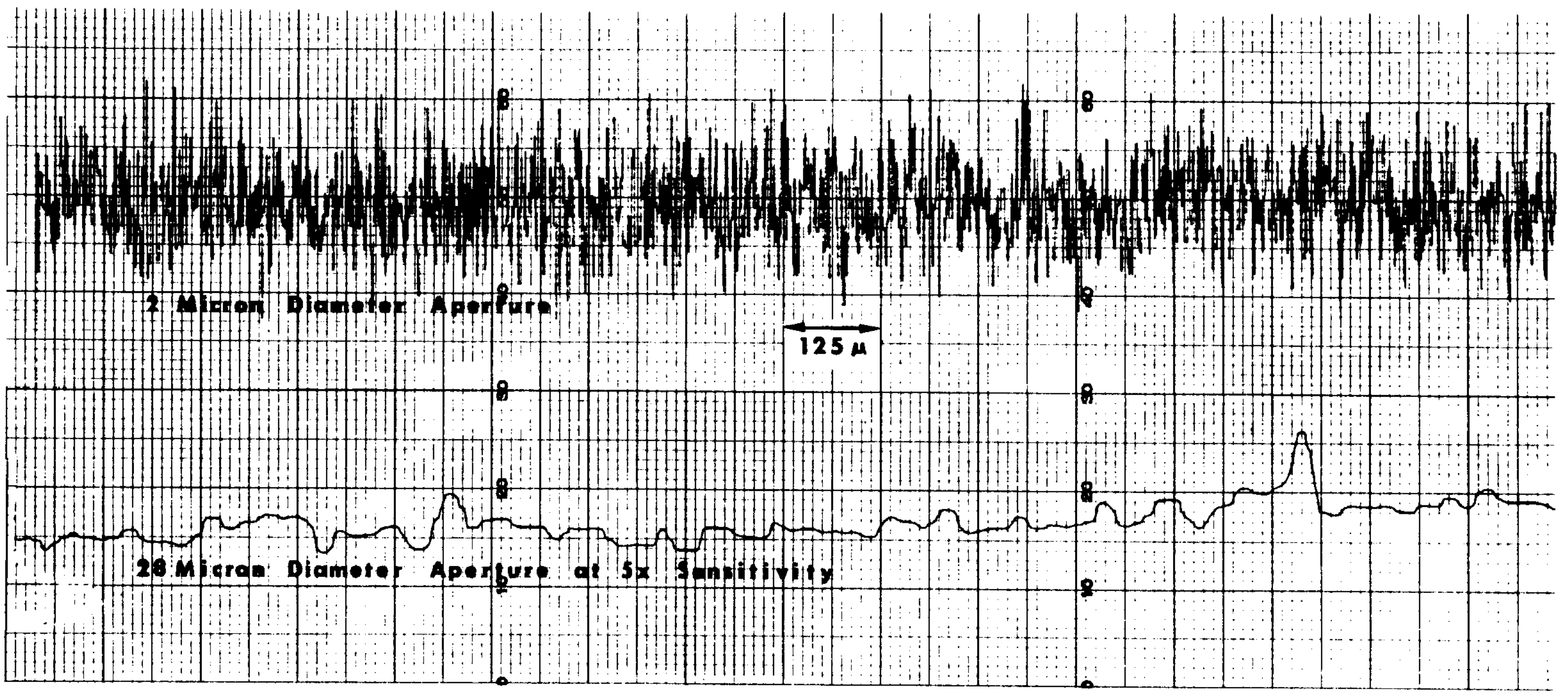
b. The selection of microdensitometer scanning aperture size was briefly covered, with the conclusion that the aperture should be 5 to 10 times the size of the silver halide grains, so that the measurement conforms to granularity theory. Normally, a 24 or 48-micron diameter spot size is used to measure rms granularity. While this range is entirely adequate for commercial products, it does not provide the sensitivity for power spectrum measurements of fine grain aerial products. Therefore, a 2-micron aperture was selected. Figure 1 shows a granularity trace across a uniform density patch made with 2 and 28-micron diameter scanning apertures. Unquestionably, the 2-micron aperture gives the sensitivity that is required, while the 28-micron aperture shows small deviations.* Because of the increased sensitivity the 2-micron aperture is currently being used in this study.

* In order to display any deviations with the 28-micron aperture, the electronic recording sensitivity of the microdensitometer was increased 5X to that of the 2-micron spot.

Figure 1

Comparison of Granularity Traces Using
2- and 28-Micron Scanning Apertures
(Type SO-230 film)

Relative Density



c. Also discussed at the film manufacturer's research laboratory was the linear transfer of granularity in the printing process.* The form of the linear model is defined as:

$$\underset{\text{Print}}{\Phi(\sqrt{,}D)} = \underset{\text{Negative}}{\Phi(\sqrt{,}D)} \cdot \gamma^2 \cdot \underset{\text{Printer}}{[MTF]^2} + \underset{\text{Positive}}{\Phi(\sqrt{.}D)}$$

where:

$\Phi(\sqrt{.}\,D)$ = power spectrum in terms of spatial frequency and density. This model will be used for predicting the effect on granularity transferred through a multi-stage printing operation. The above equation states that the granularity spectrum of the print can be found from the granularity of the negative material, multiplied by the square of both the gamma, (γ , the gain or amplification of the printing operation) and the modulation transfer function of the printer. To the product of this calculation (which determines the contributions that can come from the negative) must be added the granularity of the positive material. By rearranging the equation, the MTF of the printer (the quantity of most interest to us) can be obtained. Therefore, a computer program, using this method, has been written to calculate the MTF of the printer directly from power spectrum measurement data.

4. Spectra of Aerial Films

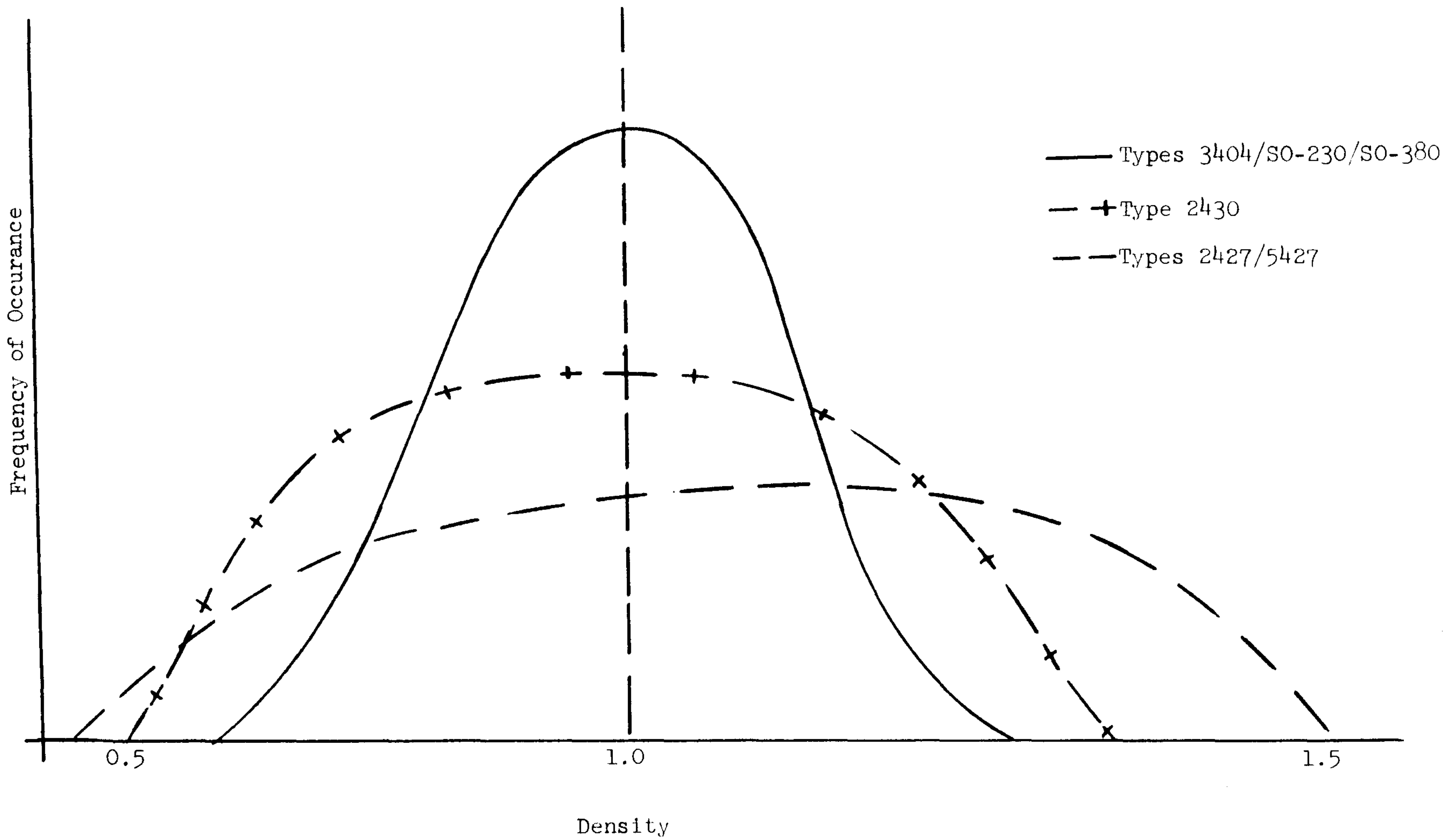
a. Uniform density patches of aerial negative film Types 3404, SO-230, SO-380 (UTB) and duplicating film Types 2430, 5427 and 2427 were scanned on the Model 5 microdensitometer with a 2-micron diameter aperture traversing a distance of 3 millimeters. Before computing the power spectrum function, the raw data was analyzed for statistical properties such as mean, standard deviation (i.e., small spot rms granularity), and frequency distribution.

b. Figure 2 shows the frequency distributions for the products mentioned above. The negative products approximate the statistically normal ("mesokurtic") distribution, while the duplicating films show broader and flatter ("platykurtic") distributions. No difference could be found within the negative film Types 3404, SO-230 and SO-380.

*E. C. Doerner and D. M. Zwick, "Graininess and Granularity Concepts With an Application to Color Motion-Picture Printing", S.M.P.T.E. Conference, 17 September 1967.

Figure 2

Frequency Distribution of Grain Noise



c. The transformation of these data into power spectra is shown in Figure 3. The spectra for each of the products are essentially flat until 100 c/mm, after which they fall off. The fall-off is assumed to be caused by the filtering of the scanning aperture. The ordinate value indicates the amount of noise at each spatial frequency. Type 2430 has approximately 1.5 times, and Types 5427 and 2427 approximately 3.0 times the granularity of the negative films. No difference was detected between the negative films. These spectra will be used as inputs to study grain transfer in the printing operation.

5. Color of Exposing Source

a. The I-B Sensitometer was modified to provide both mercury arc and tungsten "white light" exposures on Type 8430 Duplicating Film.

b. Uniform film densities from these exposures were scanned to detect any noticeable differences in granularity. The film manufacturer's testing division was unable to detect any difference between the samples using their 24-micron spot. The samples were then scanned at this facility using a 2-micron spot. In this instance a significant difference was measured. The white light sample showed 1.4X higher rms granularity than the mercury arc sample (see Figure 4). The reason for the film manufacturer's inability to detect any difference can be explained by their use of the 24-micron aperture, which corresponds to a spatial frequency of about 5 c/mm. An examination of Figure 4 shows that the two exposing light sources produce the same granularity at the 5 c/mm frequency.

c. From these spectra, one can see that the grain noise of the mercury arc sample is lower and falls off faster at high frequencies than does the white light sample. This is one of the reasons why better resolution can be obtained with mercury arc sources.

6. Single-Level Hump-Back Process

To date, the comparison of the hump-back process to the Yardleigh full condition has shown no difference in rms granularity at various density levels. While the special viscous chemistry significantly changes exposure latitude capabilities, power spectrum studies show that granularity is not affected.

Figure 3

Spectra of Negative and Positive Film Samples

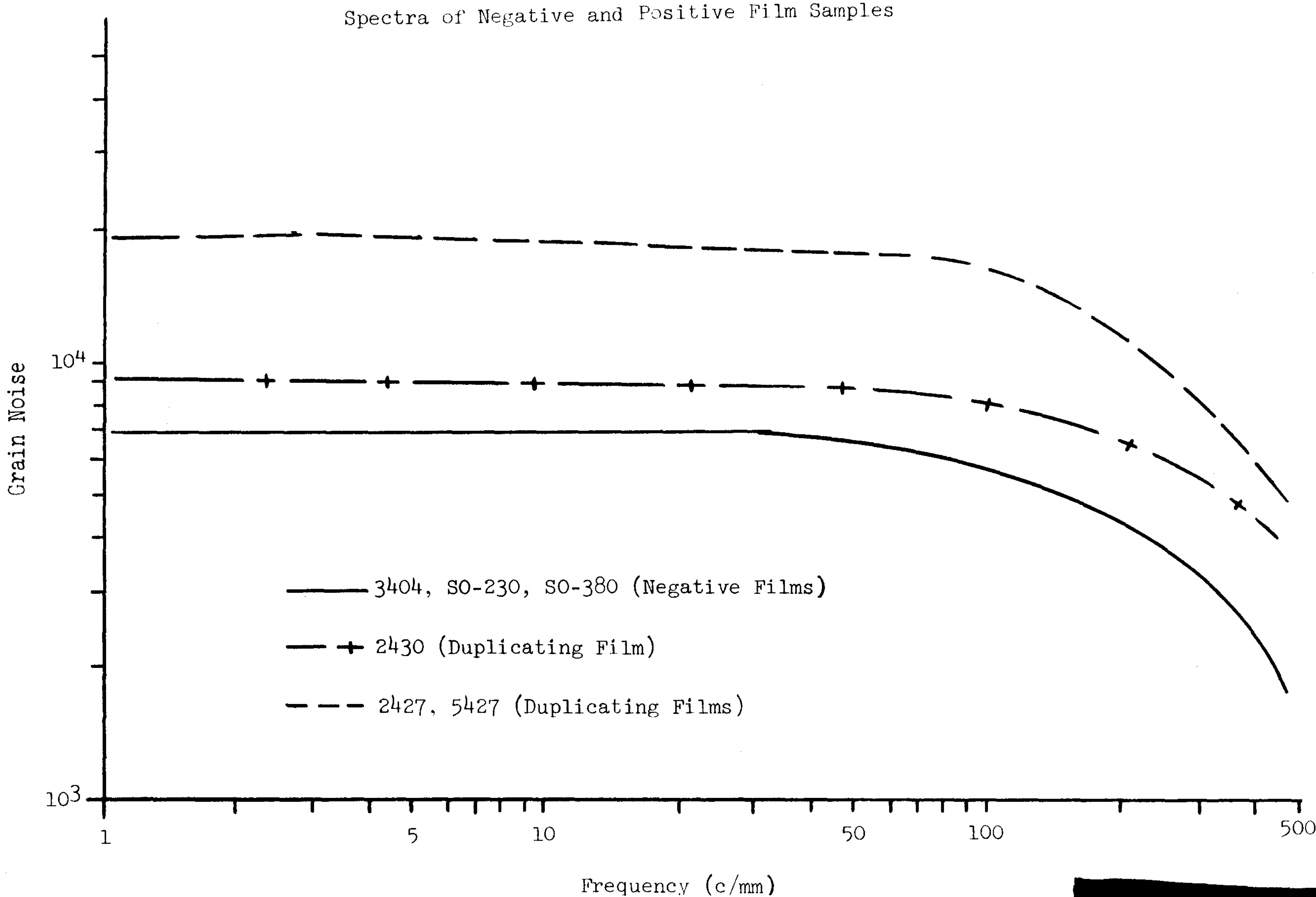
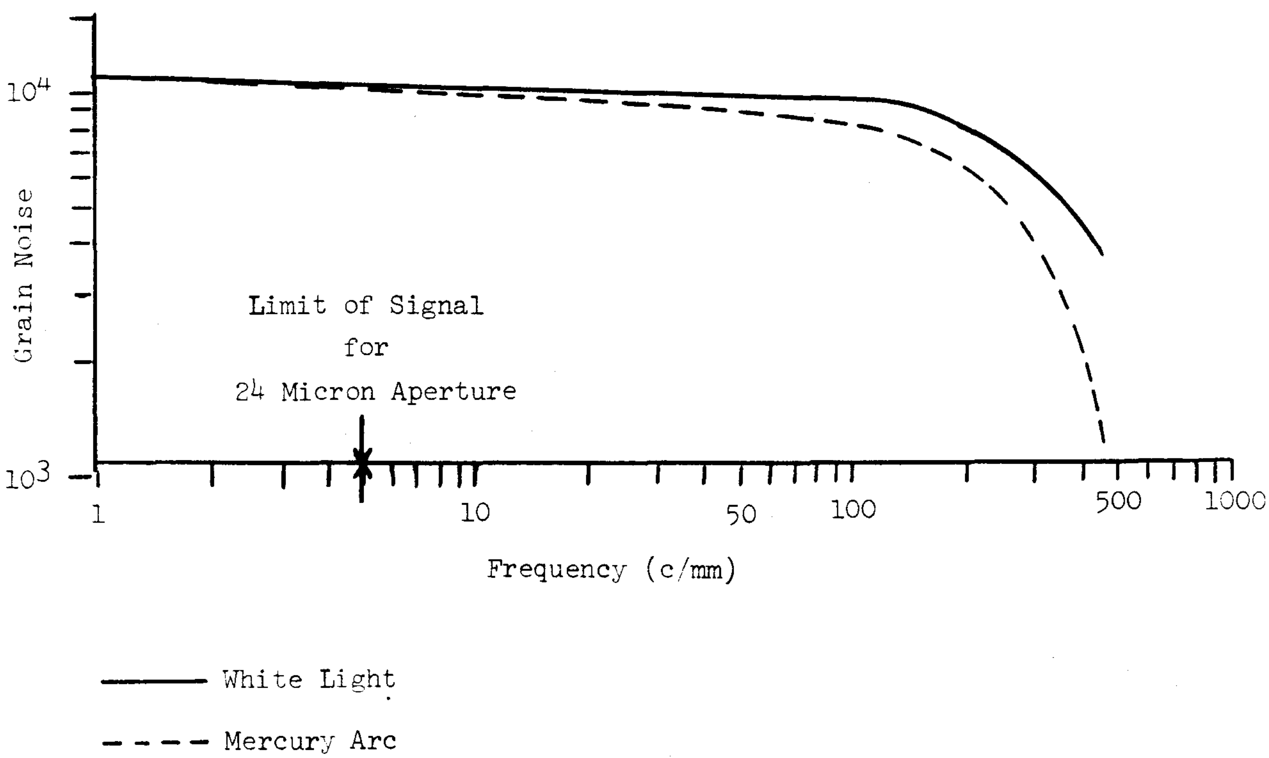


Figure 4

Comparison of Grain Noise using Tungsten and Mercury Light Sources (as scanned with a 2μ aperture)



7. Power Spectrum as a Function of Density

a. It is an established fact that as the density increases on a film sample, the granularity increases also. The visual effect called graininess is the subjective impression produced on an observer by the granular nature of the image which is composed of discrete particles. Since graininess is a visual phenomenon, it is dependent upon the conditions of viewing, i.e., magnification. Power spectrum analysis is not dependent on such a condition and therefore the relationship between density and power spectrum had to be clarified.

b. In order to evaluate a contact printer it was necessary to determine this relationship. Questions concerning the power spectrum characteristics had to be resolved: e.g.

(1) How fast does the spectrum increase with increasing density?

(2) Does the spectrum change shape with increasing density?

c. A strip of Type 3404 film was given a granularity exposure on the I-B sensitometer. This provided ten uniform exposures of increasing density (from 0.52 to 1.63) when developed.

d. Each step was then scanned with a 2-micron diameter aperture. Recorded digital data was then analyzed on the IBM 360 computer for power spectrum determination.

e. Figure 5 illustrates the relationship between increasing density and grain noise per spatial frequency (c/mm). The figure shows that the increase in density is significant, but the shape of the spectra essentially remains the same. The 1.0 density level will be used in studying the transfer of grain noise in a contact printer.

PLANNED ACTIVITIES

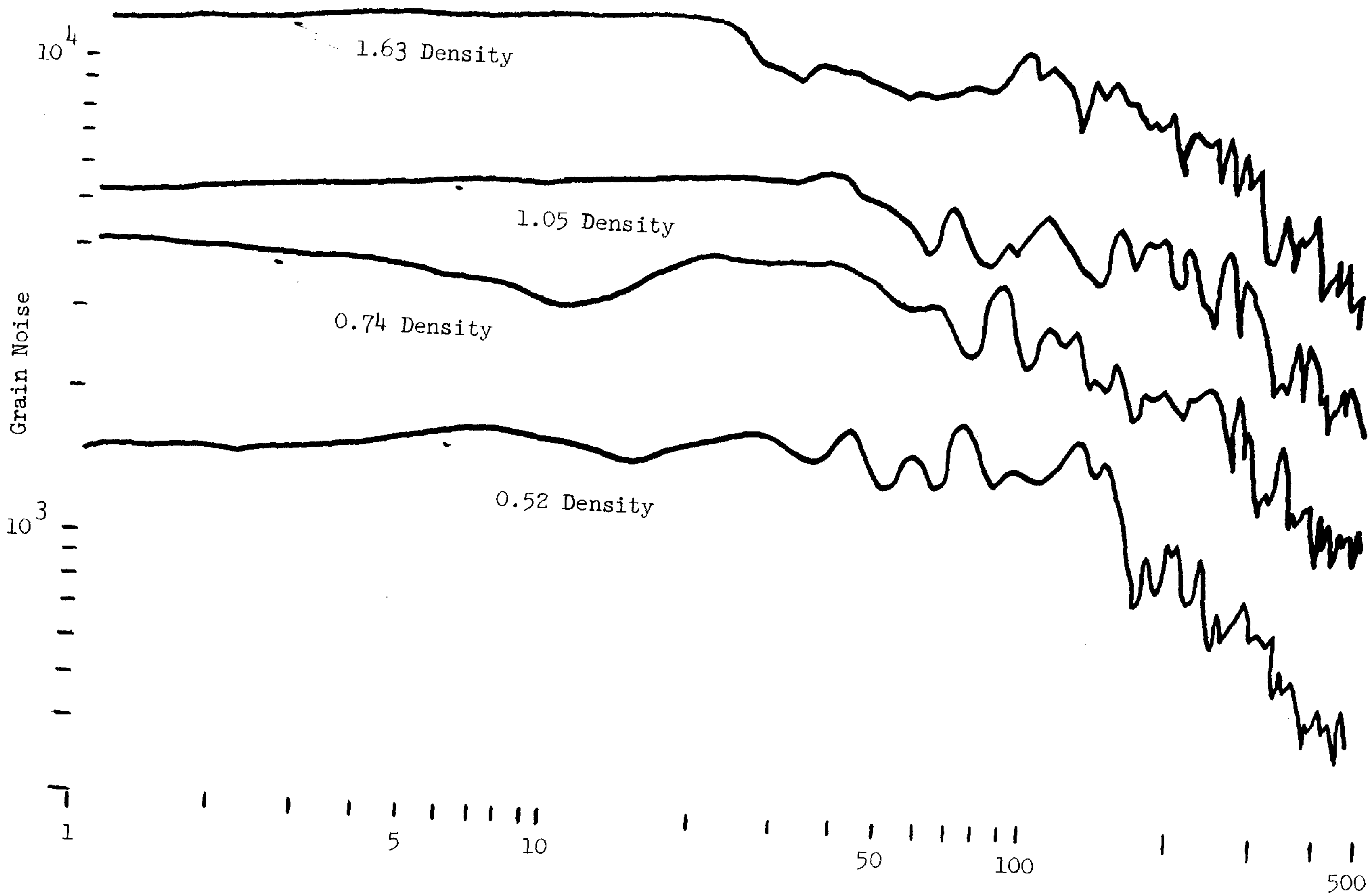
8. Measure noise transfer characteristics of negative film materials printed onto positive stocks.

9. Apply linear theory of grain noise transfer to evaluate printer.

10. Compare liquid gate printer quality with and without liquid application.

Figure 5

POWER SPECTRA AS A FUNCTION OF DENSITY



NOTE:
Grain Noise = $\left| \frac{(D)}{c/mm} \right|^2$

Contract [redacted], Task 4
Second Quarter FY-68

PAR 25-8-4S/R1
1 Dec 67

SUBJECT: Evaluation of Photographic Images

TASK/PROBLEM

1. Investigate the application and usefulness of the recently described methods of objective image evaluation. Examples of these techniques are edge trace resolution, X-ray line exposure, dirac comb test object, isolated lines, SMT acutance, and white-noise targets. These methods have potential utility in the evaluation of reconnaissance missions or the evaluation of the elements that make up the photographic system.

DISCUSSION

2. A study plan was written to detail the work areas for this project.

3. We have started the investigation of objective image evaluation through examination of X-ray line exposure. This method appears the most promising as a sensitive technique for evaluating subtle effects of processing variations on image structure.

PLANNED ACTIVITIES

4. Continue investigation of X-ray line exposure and compare results with white light line exposure.

5. Conduct a literature survey to obtain background information on newly proposed image evaluation techniques.

6. Begin edge-trace study with a performance comparison of Mann-Data and Kodak Model 5 microdensitometers.

Contract [redacted] Task 4

Second Quarter FY-68

PAR 25-8-5S/M

1 Dec 67

SUBJECT: Simulation of Image and Noise Transfer in Photographic System

TASK/PROBLEM

1. Continue study and use of computer simulation of the photographic system, including the following elements: Fourier description of the scene, atmospheric effects, lens and image motion degradations, emulsion and processing effects, printing transfer, and readout of the final image.

DISCUSSION

2. A study plan was written to continue the investigation of the image simulation computer program initiated under PAR 25-7-2S. Included in the work performed under the initial PAR was the contractor modification of the original program as prepared by IBM personnel for use in an IBM 7090 computer. In its present form, the program is compatible with the IBM 360 equipment available in this facility.

3. Input test problems supplied with the original program are now being run in the modified version to test for computational accuracy.

PLANNED ACTIVITIES

4. Continue literature search for applications of photo-optical simulation computer programs.

5. Continue the check for computational accuracy.

6. Attempt to modify program to include simulation of grain noise.

Contract [redacted], Task 1

Second Quarter FY-68

PAR 86S

1 Dec 67

SUBJECT: Study the Application of Liquid Gates to Continuous Printers

TASK/PROBLEM

1. Modify an existing 5-inch continuous contact printer to incorporate breadboard solution applicators and removers so that index-matching solutions can be applied in the printing beam. Evaluate the performance of the modified printer with various solutions and methods of application.

DISCUSSION

2. The final report was transmitted on 20 November 1967.

PLANNED ACTIVITIES

3. Conclusions and recommendations from the final report included the following:

a. The effects of scratches, Newton's rings and measles can be significantly reduced by using refractive index fluid in contact printing.

b. Test results were equivalent when using tetrachloroethylene or methyl chloroform as the refractive index matching liquids, with one exception: tetrachloroethylene was superior in minimizing the effect of base scratches.

c. The use of refractive index matching fluids did not significantly improve resolution.

d. Of the four liquid application techniques investigated, a combination of plush roller application to the base side of the negative and drip application to the emulsion side of the negative is recommended for future liquid gate printers.

e. Because of the toxicity problems associated with chlorinated fluids, a vapor enclosure is necessary to protect the operator. It is recommended that future designs consider methods of executing the printing cycle without purging the vapor enclosure to print each roll.

These results will be considered for incorporation into future generation liquid gate continuous printers.

Contract [redacted], Task 2

Second Quarter FY-68

PAR 97S

1 Dec 67

SUBJECT: Edge Defect Sensor

TASK/PROBLEM

1. Develop, fabricate, and test breadboard equipment to investigate the feasibility of a film-edge-imperfection detector.

DISCUSSION

2. Introduction - Background Information:

a. The current method of detecting film-edge-imperfections during the presplice operation is manual and it depends on skilled operators. Although this method has been successful, the introduction of high-footage-capacity film spools will make manual inspection impractical. Therefore this PAR was initiated to determine the feasibility of automatically detecting film-edge defects and splices.

b. The initial effort on this PAR consisted of studying various commercial sensing systems, sensors, and components. Kluge equipment was built and preliminary testing of ultrasonic and optical (transmission and reflection) detecting methods was conducted. Data was compiled relating optical detection system spot size (resolution) to various types of edge defects. Based on test results, the ultrasonic system was dropped because of slow response time and relative insensitivity. Further modifications were made of the optical kluges to investigate their ability to reliably detect splices and known edge defects such as tears, cuts, foldovers, nicks, and ruffles. High and medium optical reflection and high optical transmission systems were tested. In general, test results indicated that the high resolution optical reflectance system would reliably detect all of the above defects, but is highly sensitive to "noise".

c. Concurrent with the effort summarized in 2.b. above, several rolls of UTB film containing splices and known "Manufactured" edge defects were run through the Yardleigh Processor to determine which types, and severity, of defects could result in film damage and therefore required detection. These tests indicated that only the worst imperfections would result in film damage within a processor.

d. Based on information gained from kluge testing and the types of defects which required detection, and to eliminate false detection of dust particles, emphasis was changed from a high to a medium resolution system. Additional laboratory testing indicated that a medium resolution optical transmission system is the most promising.

3. Progress and Status. Table 1 (page 44) is a summary of the test results conducted prior to and during the subject quarter.

a. The "Detection Need" group of defects labeled "OPTIONAL" in Table 1 are those which will not result in film damage due to processor handling but can and should be repaired if found. Since testing to date has indicated that the medium resolution optical transmission system reliably detects gross edge defects (labeled "MUST" under "Detection Need" in Table 1), an improved ability to find nicks (no removal of material) was sought by adding air jets to separate the edges of the nicks. The improvement was so slight compared to the additional complexity, that this approach was dropped.

b. The major test effort during the quarter was increasing the data base to prove the reliability of the medium resolution optical transmission system. The optical system was repackaged to add flexibility to the kluge equipment by employing fiber optics so that various film widths can be accommodated. All the testing to date has been done on 70mm width film. As part of this effort the electronic design was modified to accommodate signals from the fiber optics.

TABLE 1

DETECTION ABILITY

Detection Need	Defect	High Res. Optical Transmission	High Res. Optical Reflection	Medium Res. Optical Reflection	Medium Res. Ultrasonic Transmission	Medium Res. Optical Transmission	Medium Res. Opt. Trans. w/Air Asst.
MUST	Ultrasonic Splice	Always	Always	Always	Never	Always	Always
	1/4" Tear	Always	Always	Always	Always	Always	Always
	1/8" Cut	Always	Always	Sometimes	Always	Always	Always
	3/16" Foldover	Always	Always	Always	Always	Always	Always
OPTIONAL	1/4" Cut	Always	Always	Sometimes	Never	Sometimes	Sometimes
	1/4" Nick	Always	Always	Sometimes	Never	Sometimes	Sometimes
	1/8" Nick	Always	Always	Sometimes	Never	Never	Sometimes
NEVER	Ruffles	Sometimes	Always	Never	Never	Never	Never
	Dust	Sometimes	Always	Never	Never	Never	Never
TRANSPORT SYSTEM		←— SOLID ROLLER SUPPORT		—→	←— FREE STRAND		—→

c. Testing has been started using a short, free web transport configuration.

PLANNED ACTIVITY

4. Complete the fiber optics and start free web reliability testing using film with known defects. Test and evaluate a short, free web and air roller transport system.

5. Begin final report preparation.

Contract [redacted], Task 2

Second Quarter FY-68

PAR 100-1S

1 Dec 67

SUBJECT: All-Viscous Chemistry

TASK/PROBLEM

1. Develop viscous chemistry specifically applicable to the 9.5-inch all-viscous processor (PAR 100-4B).

DISCUSSION

2. The final report for Phase I is being prepared for publication. The summary of the Phase I final report follows:

"This study has produced a significant increase in the general understanding of viscous chemistry. The evaluation of various thickening agents, coupled with specialized mixing techniques, has resulted in the capability of handling viscous chemistries in volume. These thickened solutions -- while presenting unique handling problems -- possess keeping characteristics equal, and often superior, to their "thin solution" counterparts. Additionally, the capability of matching, in all respects, the quality of an all-viscous process to that of the more conventional processes has been achieved.

"Recommendations cite specific film processes, machine design parameters and areas for further study."

3. Phase II activity is now in progress. The major activity is in providing support operations to engineering checkout on the PAR 100-4B All-Viscous Processor. This checkout activity is nearing completion. Processed-film tests have been employed in conjunction with heated hopper and machine control testing. As yet, sensitometric testing has not been started.

PLANNED ACTIVITIES

4. Publish the Phase I final report.

5. Continue Phase II support through completion of engineering checkout on the PAR 100-4B processor.

6. Begin operational and sensitometric checkout of the all-viscous machine in accordance with the Phase II study plan.

PAR 100-2B

1 Dec 67

SUBJECT: Temperature Control of 9.5-Inch Viscous Hopper

TASK/PROBLEM

1. Develop, fabricate, and evaluate a 9.5-inch coating hopper and power control circuits required to modulate the temperature of the viscous developer.

DISCUSSION

2. Introduction:

a. A 1- by 11-inch, silver-sandwich heated hopper was designed and fabricated for installation on the PAR 100-4B Developmental 9 1/2-Inch All-Viscous Processor. Testing of a 1-inch x 70mm design under PAR 93B (Temperature Control of 70mm Viscous Hoppers) indicated that:

(1) Uniformity of processing across the width is adequate.

(2) A change from full to primary (and vice versa) is possible within 16 inches of film travel at a machine speed of 20 ft/min.

b. The heating elements are held against the silver sandwich heat exchanger by encapsulating the unit in epoxy. Developer temperature is sensed by a thermocouple located in one of the hopper lips.

3. Mechanical Status. Preliminary tests were performed with the hopper on the PAR 100-4B Processor. Heater power was applied in the manual mode. The hopper functioned properly at 150 percent power application with respect to steady-state power levels. Later tests involved two hours of running time while coating film. Uniformity of development will be evaluated in the near future.

4. Electrical Status. The heater feedback control circuit was evaluated in part. Also some checking was made with the scanner control system (manual mode) supplying input signals to the heater control. Minor circuit changes were required to obtain proper signals from the hopper thermocouples. A coarse adjustment was made to calibrate the viscous developer temperature with respect to the input control voltages. Further tests are required to complete calibration and time constant evaluation. A difficulty still exists in the circuit ground system. Eratic operation, due to suspected multiple ground loops, occurs when the hopper makes contact with the processor frame. This problem is being investigated.

5. This PAR's contribution to the PAR 100-series interim report, covering effort through the checkout phase, has been prepared. Completion of this effort depends on completion of the checkout phase.

PLANNED ACTIVITY

6. Continue control circuit checkout to solve grounding problem.

7. Adjust control circuit time constants and evaluate hopper response time within the feedback loop.

8. Conduct uniformity of development tests with the hopper installed on the processor.

9. Complete and transmit the PAR 100-series interim report.

Contract [redacted], Task 1

Second Quarter FY-68

PAR 100-4B

1 Dec 67

SUBJECT: Developmental 9 1/2-Inch All-Viscous Processor

TASK/PROBLEM

1. Develop, fabricate, and evaluate an all-viscous breadboard processor for film widths up to 9 1/2-inches.

DISCUSSION

2. Although primary effort toward a breadboard processor is covered by this PAR, processes and equipment from related PARs will be used to complete the equipment and its testing.

3. Processor installation was completed and mechanical checkout is in progress. Completion of mechanical checkout has been delayed primarily by the following problems:

a. A constant flow rate of viscous solution could not be sustained because of insufficient load on the pump drive motor. A means of pump drive motor control has recently been devised.

b. The first and second developer temperatures have not been within acceptable tolerances. New control valves and thermostats were installed and have decreased temperature variations to an acceptable level.

c. A hesitation in the web transport system has developed and its cause is not yet isolated. Since the hesitation is most significant at the take off end of the machine, its effect on the development process has not been determined.

4. The first wet testing with photographic material (heated hopper in secondary developer) was accomplished on 1 December 1967 with 1000 feet of 9.5-inch wide, Type 3404 thin-base flashed film and four H&D test strips. Evaluation of this test is not complete.

5. An integrated PAR 100-Series interim report documenting effort through installation and mechanical checkout is in progress. Publication of this report will be delayed pending solution of problems listed above and completion of the mechanical checkout.

PLANNED ACTIVITY

6. Complete mechanical checkout with particular attention on the above listed problem areas and begin sensitometric evaluation.

7. Complete and publish the interim report.

PAR 100-5B

1 Dec 67

SUBJECT: IR Scanner and Electronic Control Units

TASK/PROBLEM

1. Develop breadboard, and test an IR Scanner, light source, and control electronics to provide the necessary signals for driving the temperature-controlled hopper for the all-viscous processor.

DISCUSSION

2. Introduction:

a. The scanner and control electronics provide a signal which will define the secondary processing level. The magnitude of this signal is a function of a density minimum measured after partial development. The web is scanned by 80 IR sensitive solar cells (0.06 x 0.10 inch) distributed on 0.10 inch centers across the web. An optical system of 80 fiber optic bundles of 0.06-inch diameter focus a spot on and through the web to the solar cells. The effective spot size is approximately 0.10 inch.

b. The control electronics for the scanner of the PAR and the control electronics for the hopper (PAR 100-2B, Temperature Control of 9.5-Inch Viscous Hopper) are mounted in the processor (PAR 100-4B, Developmental 9 1/2-Inch All-Viscous Processor).

3. Status. The scanner assembly and control electronics for both this PAR and PAR 100-2B, were assembled and installed on the Developmental 9 1/2-Inch All-Viscous Processor (PAR 100-4B) prior to this quarter. Progress and status during the subject quarter consisted of:

a. The preliminary static checkout of the cells, fiber optics, IR lamp and associated electronics, installed in the processor, was completed. The signals obtained with density values inserted in the film plane were checked out. Interface checkout between the scanner and the heated hopper (PAR 100-2B) was started. Manually controlled output signals from the scanner were fed into the heated hopper electronics to provide an input for initial testing of the heated hopper. Image material has not been used as yet. Although there have been no problems to date, more tests are needed to draw firm conclusions.

b. The major portion of this PAR's input to a PAR 100-series interim report, which will document effort through mechanical checkout, has been written. Completing this report depends on completing checkout of the overall processor.

PLANNED ACTIVITY

4. Complete checkout of the scanner assembly and the heated hopper up to the point of releasing the processor for sensitometric evaluation. Final testing, evaluation, and calibration will be part of the integrated Developmental 9 1/2-Inch All-Viscous Processor sensitometric evaluation.

5. Complete and publish the PAR 100-series report documenting effort of sensitometric evaluation.

PAR 100-6S

1 Dec 67

SUBJECT: Drying Equipment

TASK/PROBLEM

1. Study, develop and fabricate breadboards to evaluate rapid drying methods.

DISCUSSION

2. Fabrication and installation of the dryer on the PAR 100-4B Developmental 9 1/2-Inch All-Viscous Processor has been completed.

3. The web transport hesitation which has developed in the PAR 100-4B 9 1/2-Inch All-Viscous Processor is most pronounced in the dryer section (see page 49, PAR 100-4B report). Effort is continuing to isolate and remove the cause of the hesitation.

4. During a sensitometric test on 1 December 1967, the dryer successfully dried 9 1/2-inch wide thin base material (Type 3404) at 25 fpm at a temperature of 110°F.

5. An interim report encompassing mechanical checkout of the All-Viscous Processor is being prepared, and the report on this PAR (100-6S) will be integrated in the interim report on PAR 100-4B, Developmental 9 1/2-Inch All-Viscous Processor.

PLANNED ACTIVITY

6. Complete checkout of dryer as part of the All-Viscous Processor.

7. Complete and publish the interim report.

PAR 107B

1 Dec 67

SUBJECT: Drum Printer with Modulated CRT Source

TASK/PROBLEM

1. Develop, fabricate, test, and evaluate breadboard equipment combining standard flying-spot (CRT) feedback light-control techniques with the known high performance of the Niagara-type printing system.

DISCUSSION

2. The implosion problem of the CRT envelopes is considered to be solved. However, strict safety precautions will be observed upon receipt of the CRT exposure system.

3. On 20 November 1967, contractor personnel visited the subcontractor's installation to observe acceptance tests and to authorize shipment of the CRT exposure system. Authorization could not be granted, however, due to minimal exposure capability caused by a problem in the electronic control circuitry. The subcontractor has since stated that this problem has been solved and has forwarded test prints for evaluation. Although not accepted as yet, authorization to ship the CRT exposure system to the contractor's facility has been given to the subcontractor. Assembly completion and the first test printing is currently estimated for mid-January.

4. Final preparation of the 9 1/2-inch Niagara-type transport system to accept the CRT source is under way.

PLANNED ACTIVITY

5. Upon receipt of the CRT source, complete assembly of the 9 1/2-inch breadboard.

6. Test and evaluate the printer in the areas of exposure capability, resolution, uniformity, banding, and streaking. Report status of these preliminary tests at the January CCB meeting.

PAR 116S/R2

1 Dec 67

SUBJECT: Distortion in Photo Duplication

TASK/PROBLEM

1. By the application of Moiré Techniques, study the effects and the degree of distortion produced in the current film handling systems during the duplication of photographic images.

DISCUSSION

2. Efforts during the second quarter have primarily centered around the replicate testing of Type SO-380 film-distortion created by all Pan-J film handling operations. Both the data obtained from these tests and the procedures used have been included in this report. A knowledge of these procedures should help in understanding what useful information can be obtained from each test method.

3. The replicate Type SO-380 film samples were tested in two ways:

a. Method A. Six composite rolls (containing a total of 30 samples) were subjected to all Pan-J film handling operations with a Moire registration (distortion measurement) made after each operation.

b. Method B. Ten additional composite rolls (containing a total of 50 samples) were subjected to all seven Pan-J film handling operations consecutively, with only a single registration made after completion.

NOTE: A listing of the film handling operations, machine types and machine settings used in these tests is shown in Table 1.

4. Test Method A was used primarily to establish the net, rather than the cumulative, distortional effects of each operation. Therefore, the cumulative distortions tabulated in Table 2 were used as a basis for establishing the net values of Table 3. The reason for this being that repeated environmental conditioning of the film prior to registration (as well as repeated registrations themselves) contributed to repeated reading errors. These errors could be as much as seven times as great overall operations, as between two successive operations. Table 4 shows the cumulative and net distortions of film Type 2430 duplicates printed

Table 1

FILM HANDLING OPERATIONS USED TO SIMULATE A "PAN J" MISSION FOR DISTORTION TESTS

Operation	Machine(s) Used	Machine Settings or Conditions	Remarks
Processing	Trenton I or II	Trenton Spec 603 Intermediate Dryer Temp = 90F	Dryer Temp Ranged from 89F to 92F for All Samples
Titling (Cross Frame)	Unimac #102	Head Temp: 250F Settings: Count - 30 Print - 24 Print - 24	
Lacquering (Cross Frame)	LaCrosse #102	Variac Settings Supply - 15 Take-Up- 19	Cabinet Temperatures Ranged from 100F to 110F Lacquer: VanLac
Cleaning	Clinton Cleaner-Waxer #2	Machine Speed: 150 Ft/Min Variac Settings: Supply - 52 Take-Up- 55	Temperature Range: 100F to 110F Humidity Range: 30% to 35%
Waxing	Clinton Cleaner-Waxer #2	Machine Speed: 70 Ft/Min Variac Settings: Supply - 15 Take-Up- 19	Temperature Range: 105F to 115F Humidity Range: 28% to 35%
Printing	Niagara #316	Printer Speed: 100 Ft/Min. Variac Settings: Neg. S - 40 Neg. TU- 50 Raw S - 45 Raw TU - 50	SO 380 was wound on 4" Dia. Spool Cores 2430 was wound on 2 1/8" Dia. Spool Cores 5 Printing runs of each sample
Tacky Roll Cleaner	Taconic #101	Variac Settings: Supply - 30 Take-Up- 30	

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Table 2

SO 380 - 70MM

MEAN CUMULATIVE FILM DISTORTION DATA FROM 30 COMPOSITE SAMPLES SUBJECTED TO ALL "PAN J" HANDLING OPERATIONS

(DATA FOR EACH OPERATION REFLECTS TOTAL DISTORTION UP TO AND INCLUDING THAT OPERATION)

OPERATION	LENGTH (%)			WIDTH (%)			LEFT DIAGONAL (%)			RIGHT DIAGONAL (%)				
	MEAN DIST. [1]	STD. DEV. (AVE) [2]	MEAN DIST. S.D. [3]	MEAN DIST.	STD. DEV. (AVE)	MEAN DIST. S.D.	MEAN DIST.	STD. DEV. (AVE)	MEAN DIST. S.D.	MEAN DIST.	STD. DEV. (AVE)	MEAN DIST. S.D.	S BAR (%) (AVE) [4]	SO (%) (AVE) [5]
PROCESSING	+.004	.0023	.0076	-.015	.0040	.0064	-.005	.0021	.0064	-.004	.0024	.0075	.0029	.0073
TITLING	-.010	.0046	.0091	-.027	.0050	.0067	-.018	.0028	.0068	-.018	.0029	.0089	.0036	.0072
LACQUERING	-.011	.0027	.0144	-.029	.0055	.0149	-.018	.0027	.0132	-.021	.0035	.0162	.0038	.0077
CLEANING	+.002	.0019	.0163	-.014	.0045	.0168	-.005	.0023	.0149	-.006	.0029	.0182	.0031	.0067
WAXING	-.009	.0021	.0157	-.026	.0059	.0163	-.016	.0025	.0149	-.018	.0035	.0173	.0039	.0076
PRINTING	+.006	.0023	.0160	-.011	.0048	.0162	-.002	.0025	.0146	-.002	.0030	.0177	.0034	.0068
TACKY ROLL CLEANING	+.008	.0031	.0143	-.007	.0050	.0152	+.001	.0029	.0130	+.002	.0034	.0157	.0039	.0070

Notes

1. Mean distortion in one direction (Average of 30 samples)
2. Standard Deviation of all individual distortion measurements making up the mean in one direction (average of 30 samples)
3. Standard Deviation of all Mean Distortion values of the 30 samples in one direction (Distribution of data)
4. Mean of four directional Standard Deviations (average of 30 samples)
5. Overall Standard Deviation about a single mean which is the average of the four directional means (average of 30 samples)

[redacted]

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Table 3

SO 380 - 70MM

NET FILM DISTORTION DATA FOR EACH OPERATION OF A SIMULATED "PAN J" MISSION (30 SAMPLES)

(DATA FOR EACH OPERATION REFLECTS DISTORTION CREATED BY THAT OPERATION ALONE)

OPERATION	Δ LENGTH (%) Δ MEAN DIST.[1]	Δ STD. DEV. (AVE)[2]	Δ MEAN DIST. S.D.[3]	Δ WIDTH (%) Δ MEAN DIST.	Δ STD. DEV. (AVE)	Δ MEAN DIST. S.D.	Δ LEFT DIAGONAL (%) Δ MEAN DIST.	Δ STD. DEV. (AVE)	Δ MEAN DIST. S.D.	Δ RIGHT DIAGONAL (%) Δ MEAN DIST.	Δ STD. DEV. (AVE)	Δ MEAN DIST. S.D.	Δ S BAR (%) (AVE)[4]	Δ SO (%) (AVE)[5]
PROCESSING	+.004	(+).0023	.0076	-.015	(+).0040	.0064	-.005	(+).0021	.0064	-.004	(+).0024	.0075	(+).0029	(+).0073
TITLING	-.014	(+).0030	.0086	-.012	(+).0030	.0069	-.013	(+).0019	.0076	-.014	(+).0016	.0095	(+).0021	(-).0012
LACQUERING	-.001	(-).0037	.0073	-.002	(+).0023	.0101	0	(-).0007	.0079	-.003	(+).0020	.0094	(+).0012	(+).0027
CLEANING	+.013	(-).0019	.0104	+.015	(-).0032	.0112	+.013	(-).0014	.0097	+.015	(-).0020	.0119	(-).0022	(-).0038
WAXING	-.011	(+).0009	.0112	-.012	(+).0038	.0120	-.011	(+).0010	.0103	-.012	(+).0020	.0126	(+).0024	(+).0036
PRINTING	+.015	(+).0009	.0071	+.015	(-).0034	.0069	+.014	0	.0061	+.016	(-).0018	.0077	(-).0019	(-).0034
TACKY ROLL CLEANING	+.003	(+).0021	.0052	+.004	(+).0014	.0063	+.003	(+).0015	.0078	+.004	(+).0016	.0058	(+).0019	(+).0017

Notes

1. Net mean distortion in one direction (average of 30 samples)
2. Net Standard Deviation of individual distortion measurements in one direction, reflecting the amount of local distortion. The sign (+ or -) reflects only the addition or subtraction of local distortion caused by the operation itself (average of 30 samples)
3. Standard Deviation of all Δ Mean Distortion values of the 30 samples in one direction (Reflects distribution of Distortion data)
4. Mean of four net directional Standard Deviations (Average of 30 samples)
5. Net Overall Standard Deviation about an average mean distortion (Average of 30 samples)

[redacted]

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Table 4

PRINT DISTORTION FROM 30 COMPOSITE SAMPLES PRINTED ON A NIAGARA PRINTER AS PER "PAN J" MISSION HANDLING

SO 380/2430 - 70MM

	LENGTH (%)			WIDTH (%)			LEFT DIAGONAL (%)			RIGHT DIAGONAL (%)				
	MEAN DIST.[1]	STD. DEV.	MEAN DIST. S.D.	MEAN DIST.	STD. DEV.	MEAN DIST. S.D.	MEAN DIST.	STD. DEV.	MEAN DIST. S.D.	MEAN DIST.	STD. DEV.	MEAN DIST. S.D.	S BAR	SO
TOTAL PRINT DISTORTION	+.047	.0051	.0194	-.014	.0150	.0179	-.029	.0176	.0266	+.050	.0081	.0174	.0126	.0377
	Δ MEAN DIST.	Δ STD. DEV.	Δ MEAN DIST. S.D.	Δ MEAN DIST.	Δ STD. DEV.	Δ MEAN DIST. S.D.	Δ MEAN DIST.	Δ STD. DEV.	Δ MEAN DIST. S.D.	Δ MEAN DIST.	Δ STD. DEV.	Δ MEAN DIST. S.D.	Δ S BAR	Δ SO
NET DUPLICATING DISTORTION (Printing + Dupe Processing)	+.055	(+).0046	.0106	+.012	(+).0138	.0071	-.013	(+).0174	.0125	+.068	(+).0073	.0122	(+).0120	(+).0369
NET DUPE PROCESS DISTORTION	+.004	(+).0031	.0032	-.001	(+).0044	.0022	+.001	(+).0023	.0025	+.001	(+).0028	.0027	(+).0033	(+).0038

Notes

1. Definition of Headings on Previous Tables

[redacted]

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from the six Type SO-380 rolls.

5. Net distortion data indicate that the processing of the negative contributes most significantly to overall Type SO-380 distortion (Δ SO = .0073, see Table 3), although Niagara-printing creates the largest distortion in the whole processing/reproduction system.

6. Test Method B was used to determine the cumulative distortional effect of all film handling operations by simulating the procedure without interruption, thereby avoiding the measurement errors introduced in Method A, (these data appear in Table 5). Because the data of all 50 samples have fallen in a distribution closely approximating a random distribution (see Figure 1), the results obtained via this method are considered more accurate. Moreover, the method allows distortion predictability, for samples handled in a like manner, by using the value of mean distortion standard deviation. For example, the data shown in Table 5 indicates that 68% of the time subsequent film handling operations will result in a mean lengthwise-distortion of +.030 ±.007 percent.

7. At present, the following tests are in progress.

a. Film storage distortion.

b. Heat splice distortion.

c. Processor dryer distortion.

Results of these tests, along with an analysis of all testing, will appear in an interim report on Type SO-380 distortion testing.

PLANNED ACTIVITIES

8. Continue storage testing of film Types SO-380, 3404 and 2430.

9. Initiate film handling distortion tests of Type 3404 film materials.

10. Publish an interim report on SO-380 film distortion.

11. Consider study of progressive distortion effects when printing successive duplicates from an original negative.

[redacted]

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Table 5

MEAN TOTAL DISTORTION DATA FROM 50 SAMPLES RUN CONTINUOUSLY THROUGH ALL "MAN J" MISSION HANDLING OPERATIONS

SO 380 - 70MM

	LENGTH (%)			WIDTH (%)			LEFT DIAGONAL (%)			RIGHT DIAGONAL (%)				
	Mean Dist.	Std. Dev. (Ave)	Mean Dist. S.D.	Mean Dist.	Std. Dev. (Ave)	Mean Dist. S.D.	Mean Dist.	Std. Dev. (Ave)	Mean Dist. S.D.	Mean Dist.	Std. Dev. (Ave)	Mean Dist. S.D.	S Bar (%) (Ave)	SO (%) (Ave)
Negative (SO 380)	+.030	.0012	.0071	+.016	.0039	.0075	+.026	.0014	.0070	+.020	.0021	.0077	.0024	.0061
Dupe (2430)	+.069	.0042	.0128	+.009	.0147	.0103	-.004	.0174	.0143	+.068	.0076	.0144	.0122	.0375

NOTES

1. Definition of Headings on previous tables

2. Only one distortion measuring registration made on each sample at the conclusion of the Tacky Roll Cleaning Operation. This procedure more closely simulates actual mission handling.

[redacted]

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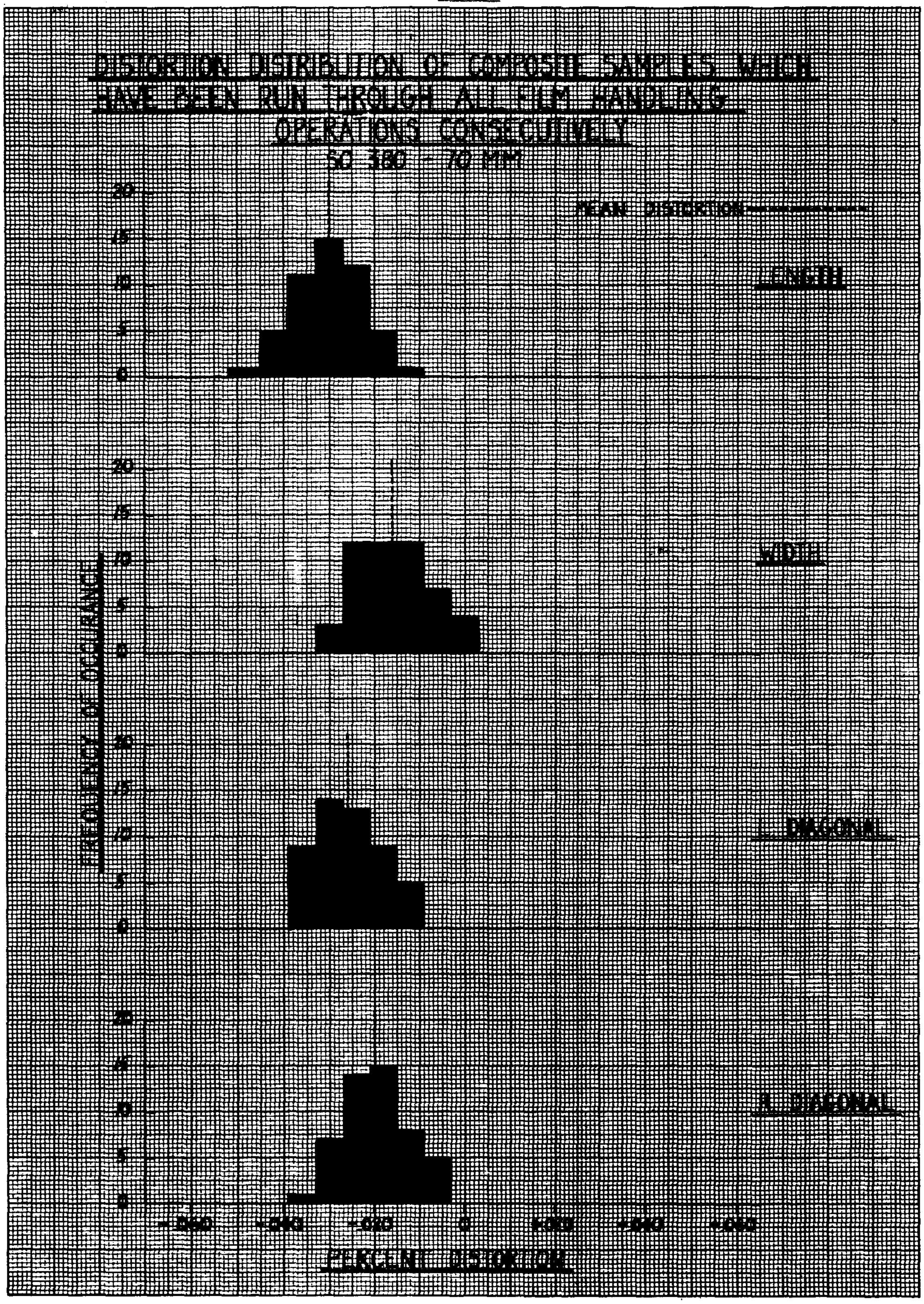
Figure 1


DISTORTION DISTRIBUTION OF COMPOSITE SAMPLES WHICH HAVE BEEN RUN THROUGH ALL FILM HANDLING OPERATIONS CONSECUTIVELY
SO 380 - 70 MM
MEAN DISTORTION
LENGTH
WIDTH
⊥ DIAGONAL
R DIAGONAL
FREQUENCY OF OCCURANCE
PERCENT DISTORTION
-.060
-.040
-.020
0
+.020
+.040
+.060

PAR 122B/R1
1 Dec 67

SUBJECT: Five-Inch Experimental Processor

TASK/PROBLEM

1. Develop, fabricate, test, and install a 5-inch film processor having the capability of all viscous, all spray, or any combination of these techniques for experimental use in evaluating film processing parameters.

DISCUSSION

2. Introduction. As reported last quarter, the pump stand/control station and five temperature control stations were assembled and installed, the film dryer was renovated, and preparations were made for the arrival of the film handling section.

3. Status:

a. The film handling section of the processor was received from the subcontractor, and installation, including all piping and wiring, was completed.

b. Engineering checkout was started. The transport rollers were aligned, the piping and electrical circuits were checked for proper operation, and film was successfully threaded and transported in the processor.

c. Due to late delivery of the transport section, the engineering checkout was not completed as originally planned. Hopefully this lost time can be made up with no change in the completion date.

PLANNED ACTIVITY

4. Complete engineering checkout and sensitometric testing.

5. Prepare and transmit the final report.

PAR 123P

1 Dec 67

SUBJECT: Color Matrix Continuous Printer (Prototype)

TASK/PROBLEM

1. Design, fabricate, and test a 9.5-inch continuous color printer having a color matrix control which will compensate for filter, dye, and densitometer color interactions. The purpose of this control is to reduce color shift when a density change is desired and to reduce density change when a color correction is applied.

DISCUSSION

2. Introduction. The successful completion of development effort on PAR 84B/M, Three-Lamp Lamphouse for Belair Printer, and on PAR 51B, Step-and-Repeat Color Printer, provided the basis for the design of this prototype Color Matrix Continuous Printer. The prototype will consist of a continuous color printer of the Belair type with a three-lamp additive printing source and a color matrix control to simplify the color balance problem. The matrix is the command system for printing lamp intensity. Through a feedback system, the intensity of each lamp is monitored and regulated to maintain a preset matrix level. The matrix also permits adjustment of color balance on overall print density without interaction; that is, the operator can change the color balance without affecting the overall print density and can change the overall density without affecting the color balance.

3. Status:

a. The method planned for solving the problem of uneven motion of the main color and density cables was reported last quarter. This solution, which involved the addition of a gear ratio to the output of the flexible shaft that drives the color and density controls, was successfully implemented during this quarter.

b. Engineering checkout of the printer and matrix, both separately and as a system, was completed.

c. Sensitometric evaluation has been started. Uniformity tests required to establish criteria for a uniformity mask, and tests to establish the range and calibration of the density control were completed.

PLANNED ACTIVITY

4. Complete the sensitometric evaluation and prepare the final report.

PAR 125SOB

1 Dec 67

SUBJECT: Continuous Reduction Optical Printer

TASK/PROBLEM

1. Develop and fabricate a Continuous Reduction Optical Printer to duplicate 9.5-inch-wide negatives having up to 50 lines/mm limiting resolution upon 5-inch-wide, fine-grain, duplicating stock (Type 8430 or equivalent) with good information preservation.

DISCUSSION

2. The main drum drive has been modified to handle the increased friction load imposed by the new bearing seals. Preliminary tests of this drive indicate adequate torque capacity. The new seals are being tested currently.

3. The stainless-steel drum mounting rings are complete and both sets of glass drums have been received from the vendor.

4. The condenser lenses are complete. The damaged objective lens element reported in the last report has been remade. However, wedging has been discovered in the cement layers of the doublets* for the objective lens. Present planning is to complete assembly of the lens so that at least a preliminary evaluation of its performance can be made. Concurrently, work will progress on replacement doublets which can be retrofitted when and if needed. These replacement elements are scheduled for completion about 15 January 1968.

5. All long-lead-time castings are complete and in various stages of finish machining. The main-frame weldment is in fabrication and delivery is expected about 1 January 1968. Detail drawings for the

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* Doublet: A compound lens consisting of two elements.

lamphouse assembly are about 80 percent complete and some long-lead-time items have been released for fabrication. Detail drawings for the negative and rawstock transport systems are about 60 percent complete and about 30 percent of the parts have been released for fabrication.

6. Electrical control circuit design is complete and about 20 percent of the electrical drawing effort is complete.

PLANNED ACTIVITY

7. Mount the glass drum mounting rings to the main drum and bearing assembly. After this the glass drums can be mated to their mounting rings.

8. Complete analytical testing of the drum drive to determine that its angular velocity characteristics are adequately uniform.

9. Perform preliminary performance evaluation tests on the objective lens. Because of the unusual object and image space configurations present in this printer design, final lens performance cannot be meaningfully evaluated until printer assembly has progressed to a point where the optical system is complete.

10. Complete printer hardware and electrical design.

PAR 129S/R1

1 Dec 67

SUBJECT: Film Transport Control Study

TASK/PROBLEM

1. Investigate the feasibility of maintaining and controlling a predetermined film path length for viscous systems which preclude contact with the coated surface. Develop and fabricate necessary experimental equipment.

DISCUSSION

2. Introduction and Summary of General Approach. Laboratory equipment (kluge) is being fabricated to transport an endless belt over a serpentine path. Photographic film will be laid against the prewetted belt surface and viscous photographic solutions applied. The belt-supporting rollers will be arranged to allow variation in process time by adjusting belt length between points of film contact and removal.

3. Status. During this quarter all fabricated and purchased components were received, and machine assembly was started.

4. Due to a delay in delivery of major castings, assembly was not completed and testing was not started during this quarter (as stated under Planned Activity in the previous Quarterly Report). It is anticipated that the schedule slippage can be made up with no change in the completion date.

PLANNED ACTIVITY

5. Complete mechanical assembly and electrical wiring.

6. Check out the completed machine mechanically.

7. Carry out the planned test program, modifying as dictated by experience.

8. Begin writing final report.

PAR 130S

1 Dec 67

SUBJECT: Film Moisture Control Study

TASK/PROBLEM

1. Investigate the feasibility of controlling film moisture content in a processor drying station.

DISCUSSION

2. The final report, PAR 130S, Film Moisture Control Study [redacted] was transmitted to the customer on 9 October 1967. Following is the Summary from that report:

"The current method of controlling the moisture content of film leaving processors is manual and qualitative. The purpose of this study was to determine the feasibility of automatic and quantitative control. A lithium-chloride-type sensor system was installed on a Dalton Processor and tests were made to determine sensor accuracy, processor drying effectiveness, and dryer cabinet performance.

Tests indicated that:

a. Sensor performance was adequate for this application.

b. Processors with conditioner cabinets now dry black-and-white film satisfactorily; for this reason, automatic control is not warranted.

c. Automatic control of drying is feasible, and its use may be required in the future by processor speed, size, or weight specification.

Specific future drying requirements depend on results of PAR 116S/R2, Study Distortion in Photo Duplication.

PLANNED ACTIVITY

3. Activity under this PAR is considered completed. Based on the results of this study it is recommended that:

a. Because of the favorable drying results now being obtained from manual practices on processors having conditioner cabinets, no attempt be made at this time to include automatic drying sensors and controls. Although the sensor might provide useful information to the operator, the cost of providing such information is too high.

b. Upon completion of PAR 116S/R2, Study Distortion in Photo Duplication, evaluate the need for an automatic control system as a means of decreasing film distortion.

c. Consider using an automatic drying control in future processors such as:

(1) Processors without conditioner cabinets

(2) High speed processors

(3) Future color processors

Contract [redacted], Task 2

Second Quarter FY-68

PAR 131S

1 Dec 67

SUBJECT: Mathematical Color Duplication Model

TASK/PROBLEM

1. Describe a mathematical model of a color duplication system which will simulate the tone reproduction cycle from an original to a viewed duplicate.

DISCUSSION

2. The computer programs constituting the new math model are operational. Occasional problems arise, but these are to be expected until the model has been used extensively. Calculations are now being made to test the theoretical performance of printing filters used in the Rainbow Printers. Computations on the color analyzer are proceeding with the use of the new model rather than with use of previous programs written on PAR 88S/M, Mathematical Color System Model.

PLANNED ACTIVITIES

3. Continue with analysis for color analyzer.

4. Start analysis of complete color duplication system.

Contract [redacted] Task 2

Second Quarter FY-68

PAR 132S

1 Dec 67

SUBJECT: Preliminary Color Printing Control Study

TASK/PROBLEM

1. Investigate objective methods for assessing color originals to determine optimum printing conditions.

DISCUSSION

2. Duplicates, whose printing conditions were determined by objective tone reproduction techniques, were scanned using the GAF Microdensitometer to verify calculations.

3. Densities of selected scenes were measured on the breadboard LATD (large area transmission densitometer).

PLANNED ACTIVITIES

4. Continue collecting density data from originals and duplicates using both Micro-D and LATD instruments.

5. Be in readiness to conduct tests and analyze results when:

a. Color processing is available as part of mission effort under other projects.

b. Micro-D capability is provided to scan exactly the same spot pattern (for red, green, and blue) along a given trace path.

6. Initiate density measurements of originals using TD-218DR and TD-203 densitometers.

7. Duplicate those originals whose printing conditions have been determined by TD-218DR and TD-203 densitometers. Evaluate duplicates using the same instruments.

Contract [redacted] Task 1

Second Quarter FY-68

PAR 135S

1 Dec 67

SUBJECT: Experimental Study of Color Processing Methods

TASK/PROBLEM

1. Investigate the merits of different processing methods for the several steps in the photographic development of SO-121 and SO-271 color films.

DISCUSSION

2. Color Viscous Chemistry. In-depth color viscous chemistry studies have begun. Testing will be conducted on film Types SO-121 and SO-271 (16mm) and will include evaluation of:

a. Sensitometry (viscous vs conventional processing).

b. Physical effects. An estimation will take into account physical damage differences of viscous vs conventional chemistry.

(1) Numerical count of emulsion defects.

(2) Scratch tests to determine gelatin hardness.

(3) Dirt-entrapment evaluation (when viscous solutions are applied to both dry and pre-wet film).

c. Objective image quality:

(1) X-ray and light edges

(2) Definition pictures

(3) Pattern exposures

(4) Granularity tests

(5) Undercuts

(6) MTF patterns

d. Subjective image quality. This will consist of observations of many actual aerial scenes.

NOTE: The above evaluations of sensitometry and imagery will be made on samples having received: all-viscous chemical stages, all-conventional chemical stages and, in the case of the first developer, various combinations of viscous and thin stages. Samples of SO-121 processed in these various modes will be printed onto SO-271 which will in turn be processed in different combinations of viscous and thin first-developers to determine the presence of any cumulative effects.

e. Uniformity. This will be conducted on wide web samples processed on the hand platen (9 1/2") and the Vixen (70mm).

3. Scanner Studies

a. Initial scanner studies have been completed. These tests were aimed toward determining the feasibility of scanning Type SO-121 in the negative stage of development. A special coating of Type SO-121 was used for these tests. This coating incorporates an antihalation coating which yields a lower density during the negative stage of processing. Tests were conducted on the Yardleigh-6 using existing black-and-white scanning equipment associated with this processor.

b. The scanner response curve for this material and a comparison to familiar black-and-white products is shown in Figure 1. Future testing will include:

(1) Correlation of negative data with color reversal results.

(2) Subject failure evaluation.

(3) Corrective processing of actual color-aerial-scene imagery that has been subjected to a wide range of exposure levels.

4. Uniformity - Agitation Studies

a. Mechanical check-out of the SAP (submerged agitation plenum) was completed. Check-out tests were conducted in a single plexiglas tank and included black-and-white photographic tests along with the mechanical studies of orifice size, orifice configuration and various pressure studies.

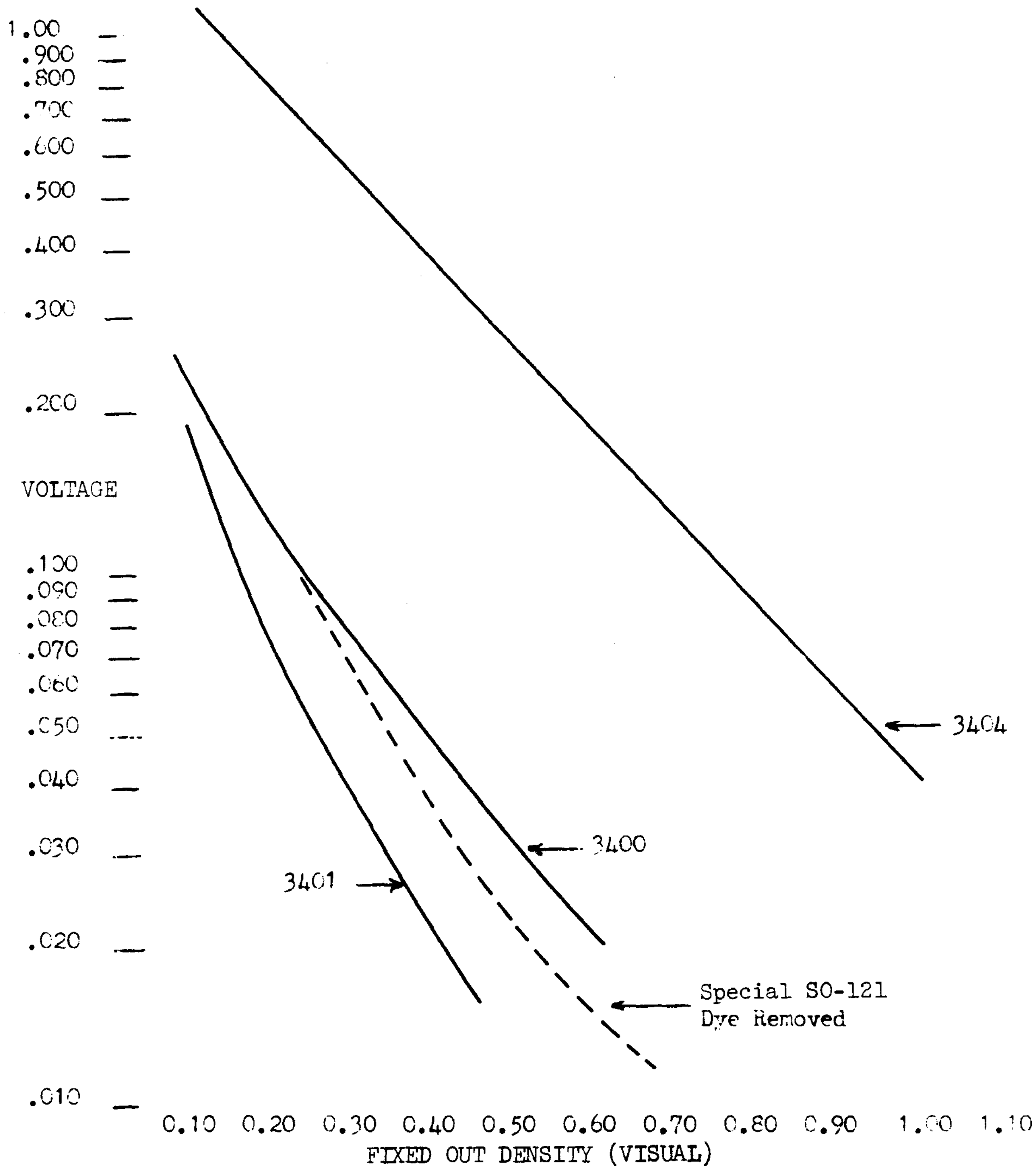
b. Phase II of the preliminary studies with the single SAP consisted of installing the plenum in the first developer of the Grafton. Testing was done with flashed film Type SO-271. These tests consisted of:

(1) Checks; standard operating conditions for the Grafton.

(2) SAP installed in the front portion of the first developer tank with the following variations:

Figure 1

Infrared Scanner Response



(a) Various recirculation rates on the Grafton first developer turbulators.

(b) Various SAP recirculation pressures.

(c) Various SAP orifice configurations.

NOTE: The aim of the above testing was to:

(1) Detect any undesirable effects such as bands or streaks on the film caused by uneven impingement of the first developer onto the film surface.

(2) Observe any improvement in processing uniformity (primarily mottle) due to the presence of the single plenum.

Results were especially encouraging because of the fact that the tests showed both an improvement in the processing-induced mottle, and the absence of any detectable pattern due to this method of agitation. Construction has therefore proceeded on the six additional plenums to be installed throughout the entire first developer stage. It is also planned to build additional plenums for installation in the prehardener and color developer. (Preliminary work under this PAR has shown that the agitation in the prehardener and color developer also affect the processing uniformity of these products.) The additional plenums will permit the simultaneous testing of all critical stages.

5. Processing Specification Aims

a. Work is continuing on dye stability testing aimed at determining the color stability and extent of image degradation of film Type SO-121 when subjected to typical storage conditions. This data will be used as a guide and comparison of new processing techniques tried in PAR 135S studies.

b. Testing is completed on the determination of the relative rates of reactions of various Ektachrome chemical formulas. The purpose of this work was to establish which chemical formulations currently available for use with Ektachrome films offered the minimum reaction times.

Results of these studies have shown that the present bleach and fix chemicals used in the Grafton and Ragdoll are the fastest-acting of the commercially available Ektachrome formulations. Data from these studies will be evaluated for possible inclusion in the PAR 135S Final Report.

6. Spray Processing (Open Spray). Studies evaluating the feasibility of employing the technique of a spray application of the first developer to Type SO-121 color film have been completed under work done under another contract. Those results, although concerned only with the negative stage of color development, were sufficiently encouraging to justify a more extensive study of color spray processing under PAR 135S. Testing is scheduled to begin this month and will be directed toward determining the chemical feasibility and resultant color reversal effects (with special consideration to be given to the processing uniformity obtained).

PLANNED ACTIVITIES

7. Continue studies to evaluate color viscous processing.

8. Continue scanning studies with materials processed to a full color reversal.

9. Begin spray processing studies.

10. Continue construction of the submerged agitation plenums.

PAR 136S

1 Dec 67

SUBJECT: Footage Indicator Study

TASK/PROBLEM

1. Investigate methods for metering film footage without contacting the web.

DISCUSSION

2. Introduction:

a. This project was initiated to study the feasibility of expediting primary breakdown for possible future large rolls of ultra-thin-base (UTB) film. Non-contacting sensors will be used to monitor film roll radius. From this information, film footage will be calculated. Kluge equipment will be designed, fabricated, and tested to determine feasibility and, if successful, to establish design parameters for production equipment.

b. Of the three types of sensors originally investigated (air, IR, and ultrasonic), the air sensor was discarded because it was necessary to place the sensor so close to the film there was chance of film damage.

3. Status:

a. The technique for radius measurement uses an IR source which projects a beam onto an IR sensor. The beam axis is perpendicular to the roll axis. The IR source and sensor are mounted to a common bracket which is movable on a track perpendicular to the roll and beam axis. The source and sensor are positioned so that the curved edge of the roll interrupts the IR beam; the position where interruption occurs is a measure of the roll radius. The accuracy of film footage on a roll using this technique for radius measurement is approximately 1 percent.

b. Ultrasonic roll radius measuring equipment was purchased and evaluated. This equipment is subject to drift and requires frequent (day-to-day) calibration. Accuracy of ultrasonic equipment (not considering the drift) equals the IR measuring system for roll radii greater than five inches. For rolls smaller than five-inch radius, the roll surface area is too small to reflect enough ultrasonic energy back to the sensor for accurate radius measuring.

PLANNED ACTIVITY

4. Continue testing and evaluating IR radius measuring system.

5. Investigate an IR "side look" sensor. This method would project an IR beam sideways across the roll through slots in the sides of the spool. It requires simpler equipment and is believed to provide comparable accuracy to the above method.

6. The manufacturer of the ultrasonic equipment has been contacted about the drift problem. They have suggested possible causes which will be investigated in an attempt to correct drift problems.

Contract [redacted], Task 2

Second Quarter FY-68

PAR 137S

1 Dec 67

SUBJECT: Large-Roll Film Handling Study

TASK/PROBLEM

1. Develop and test a kluge mock-up for de-spooling large rolls of unprocessed UTB film, and accumulate experimental data as a basis for eventual design of a pre-splice station.

DISCUSSION

2. Introduction. Future systems may result in the delivery of large rolls of unprocessed ultra-thin-base (UTB) film. Such rolls may be loosely wound or further misshapen when received at a processing station. It is the purpose of this PAR to study and accumulate experimental data with regard to handling, rewinding, and inspecting these rolls prior to processing.

3. Status. Activity has progressed along the plan outlined in the Fourth Quarter FY-67 report.

a. Mechanical fabrication, assembly, and electrical wiring have been completed.

b. Initial mechanical and electrical checkout is complete and initial de-spooling (first 12,000 feet) of the large film spool was completed successfully.

c. An electrical modification which adds a directional friction signal to the electronic controls has been completed and is functioning properly.

d. A strain gauge roll has been installed and checked out on the breadboard to record web tensions during de-spooling of the large roll.

PAR 137S

1 Dec 67

PLANNED ACTIVITY

4. De-spool the remaining 43,000 feet of film remaining on the 65,000 foot roll and gather operating data.

5. Because rolls of film wound by the camera manufacturer will not be available before the completion of this PAR, the 65,000 feet of de-spooled film will be rewound onto the large roll in a manner that simulates a poorly wound roll. This roll will be de-spooled to determine some of the extreme roll conditions under which the transport system can operate.

PAR 138S

1 Dec 67

SUBJECT: Hole Detection Study

TASK/PROBLEM

1. Study the system requirements for detecting holes placed in unprocessed film as breakdown markers.

DISCUSSION

2. Introduction. Future mission material may contain end-of-pass or end-of-operation marks in the form of perforations placed in the film during the mission. To provide fast, reliable, and convenient breakdown of large rolls, an automatic system for sensing these holes is needed. Several existing techniques for hole detection require investigation of reliability and speed as well as the effect of hole placement and configuration on the operating characteristics of the technique. In addition, the suitability of each technique for safelight or darkroom operation must be investigated. Because the camera manufacturer has stated that the types of perforations which he can furnish are limited, this fact will be a constraint on the systems being analyzed; that is, capability must be developed to detect the kind of perforations the camera manufacturer can supply. For this reason, close coordination will be maintained with the camera manufacturer to optimize total system performance and to insure compatibility between the detection system and the ultimate design of the camera.

3. Status. The camera manufacturer has indicated the type of mark will be changed, possibly even eliminated. Therefore, the project has been held up since October 1967 pending direction from the customer as to what type of pass mark is to be detected. Several types of marks other

than holes are being considered, such as a magnetic mark, slits, or no marks at all. Work will not proceed until the type of marks to be used is determined. Once work is resumed, a new schedule will have to be set up.

PLANNED ACTIVITY

4. None until mark configuration is resolved.

PAR 139B

1 Dec 67

SUBJECT: Automatic Continuous Identification Printer

TASK/PROBLEM

1. Develop, fabricate, and test a breadboard, program-controlled automatic printer for continuous printout of identification leaders and trailers.

DISCUSSION

2. Introduction. Systems studies indicate the need for a high-speed identification printer capable of producing a variety of "ident" formats from prepared tape or computer inputs. For the development effort under this PAR, punched paper tape will be used. However, the logic design philosophy will include consideration of future input methods (computer or possibly magnetic tape). The "idents" of future formats may contain additional information - either specified by the customer or to be used during in-house production operations; therefore, design effort will strive for maximum versatility.

3. Status:

a. Replies were received from four vendors for the alpha-numeric printout device. A contract is being forwarded to the accepted vendor. Delivery is expected 24 weeks from date of acceptance of contract. It is anticipated that a June delivery date will not delay the schedule of this PAR.

b. The possibility of a future modification to add on instructional paragraph or a binary code is being considered in the present design.

c. Delivery of the programmable-logic unit is expected early in December (four to six weeks ahead of original delivery date). Contractor personnel have attended the manufacturer's briefing on operation and interface requirements of the programmable-logic unit and are ready to start the initial phase of writing a program for the first format.

d. Work has proceeded on the printer modifications, the cut and fog lamp assemblies, and the interface design.

PLANNED ACTIVITY

4. Write format program.

5. Fabricate cut and fog lamp assemblies.

6. Firm up interface design and purchase parts.

7. Attend manufacturer's briefing on the maintenance of the programmable logic unit.

PAR 140B

1 Dec 67

SUBJECT: Splicer for Dupe Processor

TASK/PROBLEM

1. Develop, fabricate, and test a pressure-sensitive tape splicer for use at the feed end of dupe film processors, which will permit the splicing operation to be completed in less than ten seconds.

DISCUSSION

2. Introduction. The intent of this project is to reduce splicing time on a dupe processor from the present 30 seconds to less than 10 seconds to allow time for inspection and, if necessary, repair a faulty splice using the present film elevator design. At current 100 ft/min film-transport speeds, a faulty splice results in machine shutdown, rethreading, film printing, and handling to replace the film lost in the machine.

3. Status:

a. Fabrication, assembly and engineering checkout were completed.

b. Acceptance testing was conducted and the splicer was installed on a Dalton Processor. Testing shows that the splicer will make reliable splices on the emulsion side of all films from 70mm to 9.5 inches wide, standard or thin base, in less than 10 seconds per splice.

c. The final report has been written and is now being published.

PLANNED ACTIVITY

4. Transmit the final report.

Contract [redacted], Task 2
Second Quarter FY-68

PAR 141S
1 Dec 67

SUBJECT: Processor Waxer Study

TASK/PROBLEM

1. Investigate the feasibility of waxing film directly on a film processor.

DISCUSSION

2. Introduction. The intent of this PAR was to study the feasibility of, and provide design parameters for, a film waxer which would permit waxing on a processor and thus eliminate the secondary operation. Specifically, it was to study extension of a waxing process recently developed for motion picture film processing (16mm, 35mm, and 70mm) to material widths up to and including 9.5 inches. Laboratory equipment (kluge) was developed, fabricated, and used for evaluating techniques. Optimum cleaning and waxing conditions were determined by analyzing film that has been run through the machine at various film transport speeds, various plush-covered roller compositions, and roller speeds.

3. Status. A final report has been written, approved, and submitted for publication. As indicated in this report, results of this investigation indicate that waxing directly on a film processor is feasible.

PLANNED ACTIVITY

4. Transmit the final report.

PAR 142B

1 Dec 67

SUBJECT: Narrow Resistive-Heated Hopper

TASK/PROBLEM

1. Develop, fabricate and test an 11-inch, resistive-heated hopper which uses a narrow heat exchanger for controlling the temperature of viscous developer solutions.

DISCUSSION

2. Introduction. Results of studies conducted on PAR 93S, Temperature Control of 70mm Viscous Hopper, indicate that a narrow, low mass heat exchanger will result in a more rapid rate of viscous developer temperature change than will be obtainable using the hopper being developed under PAR 100-2B, Temperature Control of 9.5-Inch Viscous Hopper.

3. Status:

a. The heat leveling, silver, back-up plates for the heat exchanger, which were not machined to tolerance, have been reworked to closer tolerances. The alternative method of manufacturing these back-up plates by chemical milling was successful, and enough parts to make one heat exchanger were received. Two heat exchanger assemblies have been diffusion bonded (one machined and one chemical milled version).

b. Drawings of the tools to be used in bonding the heater strip to the silver sandwich are 99 percent complete and fabrication of the tools is about 95 percent complete. Assembly of the tools to the main die shoe has been started.

c. Layout and detail drawings of the hopper are 98 percent complete. The main hopper body and associated parts are complete.

d. All purchase items have been received.

PAR 142B

1 Dec 67

PLANNED ACTIVITY

4. Continue assembly of tools for cementing heater to heat exchanger.
5. Cement heater to heat exchanger.
6. Final assembly of complete 1/4-inch heated hopper.
7. Test hopper.

[redacted]

SECRET

Contract [redacted] Task 3

Second Quarter FY-68

PAR 143S

1 Dec 67

SUBJECT: Study Detailed Production Systems Requirements

TASK/PROBLEM

1. Study the detailed operations and production control requirements for the processing and reproduction of large-roll mission material.

DISCUSSION

2. Because of its higher classification, the PAR 143S quarterly progress report was transmitted under separate cover.

[redacted]

SECRET

Contract [redacted], Task 3
Second Quarter FY-68

PAR 144S/M
1 Dec 67

SUBJECT: Primary/Secondary Breakdown Station Study

TASK/PROBLEM

1. Conduct a study to determine the hardware required to facilitate inspection, breakdown, densitometry, and handling of UTB original negative.

DISCUSSION

2. Because of its higher classification, the PAR 144S/M quarterly progress report was transmitted under separate cover.

PAR 146S/R1

1 Dec 67

SUBJECT: Printing Exposure Modulation Study

TASK/PROBLEM

1. Study and test the feasibility of controlling exposure level in semiautomatic printers by exposure lamp and variable density filter modulation techniques.

DISCUSSION

2. Introduction. Under this PAR, printing exposure modulation will be investigated by studying and testing two possible methods: printing lamp modulation and use of a variable-density filter. These methods are discussed below.

a. Printing Lamp Modulation. Primary effort will be to investigate mercury-arc printing lamp modulation. Other possible light sources will be investigated, but active laboratory testing will not be performed unless results with the mercury-arc indicate marginal performance. The mercury-arc lamp to be used will be similar to those on Niagara Printers. Intensity modulation will be attempted by varying current to the lamp. A photoelectric feedback loop will be used to stabilize and monitor lamp output intensity. To obtain the desired range of intensity control, it is necessary to maintain bulb temperature by use of external heat.

b. Variable-Density Filter. This filter will be purchased and installed on a laboratory printer. The filter's characteristics will be studied to determine its suitability for printing exposure modulation.

3. Status:

a. Mercury-Arc Lamps. Initial effort to investigate the feasibility of modulating the printer lamp for density control has utilized the 100-watt lamp used on the Niagara Printer. Additional effort has also been expended in determining the applicability of a 400-watt lamp. Because of promising results to date and the need for higher illumination intensity and range in future printer applications, effort will be directed towards the 400-watt mercury-arc lamp. Although most of the effort reported below was oriented towards the 100-watt lamp, the information obtained is applicable to the design of a 400-watt system:

(1) With heat to maintain bulb temperature, the 100-watt mercury-arc lamp has been manually intensity modulated from 20 to 140 watts. Log intensity variations from 0.0 to 1.5 were obtained, with response times of less than 10 milliseconds appearing possible.

(2) Photoelectric control loop circuit and thermal control circuit designs are in progress. More meaningful response time information must await this system.

(3) Tests to determine the feasibility of modulating a 400-watt mercury-arc lamp are in progress. Results to date appear very promising.

b. Variable Density Panel (VARAD):

(1) The VARAD components have been specified, ordered, and received (panel, power supply, and solution).

(2) An available Niagara Printer lamphouse is being modified to accept the VARAD panel to provide a means of using a photometer to monitor both the VARAD and the printing lamp light outputs.

(3) All pumping, piping, and heat exchanging components for the VARAD solution cooling and recirculating system are on hand or on order. Design of this system is nearly complete.

PLANNED ACTIVITY

4. Complete 400-watt mercury-arc lamp feasibility evaluation.
5. Begin 400-watt-lamp control loop design and start fabrication.

PAR 146S/R1
1 Dec 67

6. Install VARAD components, photometer, and solution cooling and recirculating components on the breadboard Rainbow Printer chassis.

7. Start photographic quality evaluation of the VARAD system on the above printer.

PAR 148B

1 Dec 67

SUBJECT: Viscous-Developer Dupe Processor

TASK/PROBLEM

1. Develop, fabricate, test, and evaluate one viscous-developer dupe processor capable of processing all film widths up to and including 9.5-inch at transport speeds up to 100 feet per minute.

NOTE: While this PAR proposes the development of a single viscous dupe processor, projected production requirements can only be met by four such machines. It is proposed therefore that a second machine plus modifications to two existing Daltons be completed, on a separate contract, concurrently with this PAR.

DISCUSSION

2. <u>Introduction</u>:

a. Based on studies conducted under PAR 121S, Define Objectives for a Systems Improvement Program, it was recognized that additional dupe processing equipment would be required to handle anticipated future work loads. The subject PAR was submitted as the means of providing the additional dupe capacity, and viscous dupe processing was recommended in order to realize the distinct and important advantages that viscous development has over conventional spray and immersion development.

b. At the October 1967 CCB meeting, the customer approved the design phase only, and authorization to proceed with design was received by CCN #3, dated 1 November 1967.

3. Status. There has been no effort to date pending completion of a review and evaluation of the various methods available for providing the required adjustable length film path for the viscous processing section. There is a requirement that there be no mechanical contact with the coated film from the point of application to the point of removal of the viscous processing solution.

PLANNED ACTIVITY

4. Complete the review and evaluation of various processing cabinet configurations and select the most feasible method of providing the adjustable film path length.

5. Begin design layout effort.

PAR 149B

1 Dec 67

SUBJECT: Yardleigh Data Recorder/Monitor System

TASK/PROBLEM

1. To collect, monitor, display, and record data as necessary for analysis of mission processing functions and machine operations for both Yardleigh Processors; data thus obtained will be suitable for mission reporting.

DISCUSSION

2. Design of the oscilloscope monitor and meter display console is progressing and some laboratory testing has been completed.

3. The investigation of timing problems and equipment interfacing as related to the software system and design objectives is progressing satisfactorily.

4. Programming and debugging of the executive system portion of the software effort has progressed to the point where it has the following capabilities:

a. Interrupt recognition and interrogation for all 12 interrupt levels.

b. Input/output capability on the 1816 keyboard printer.

c. Partial output capability on the 1443 printer.

5. The computer to be used on this project has sufficient speed and storage capability to handle many analog sensor points. A PAR is being prepared for submission in January which would provide additional sensors for both Yardleigh Processors. If approved they will be included in the final recorder system.

PAR 149B

1 Dec 67

PLANNED ACTIVITY

6. Continue design of oscilloscope monitor and meter display console and procure materials as required.

7. Continue programming effort on the executive system program.

8. Continue design of interface and signal conditioning equipment.

PAR 150S

1 Dec 67

SUBJECT: Study Incorporation of Optical Titling on Original Negative (ON) Processors

TASK/PROBLEM

1. Procure an optical titling printout device and fabricate kluge controls for conducting exposure and character legibility tests on a viscous processor.

DISCUSSION

2. Introduction. The purpose of this PAR is to determine whether optical titling is feasible for placing programmable alphanumeric information on negative material inside the processor. Tests will be conducted to determine the location, within the initial primary processing stage, where sufficient development has occurred to permit frame lines or pass indicators to be detected. In addition, a kluge system consisting of a punched-paper-tape, programmed, optical alphanumeric printer will be built and installed within the initial or primary development stage of an all-viscous processor. Tests will be made to determine what exposure level will produce satisfactory densities within the remaining partial primary development, but will not produce objectional bleed effects when subjected to full development. No attempt will be made to combine the frame detector and optical printout systems. However, every effort will be made to ensure that the two systems will be compatible for a future prototype design of the optical system.

3. Status:

a. Electrical. Systems design including control circuits and interface between the tape reader and the serial printer has been completed. All purchased parts were ordered. Approximately 40 percent of the parts were received. Specifications for the serial printer have been finalized and accepted by the vendor. Delivery is expected by mid-February 1968. Engineering drawings are approximately 80 percent completed. Assembly of the control circuits has been started.

b. Mechanical/Optical. Preliminary planning for the mechanical/optical design has started. Methods for mounting the recording head are being investigated. Mounting dimensions of serial printer assembly must be received from vendor before the mechanical design can be completed.

PLANNED ACTIVITY

4. Obtain mounting dimensions for serial printer from vendor.
5. Proceed with mechanical design.
6. Continue assembly of control circuits.
7. Complete electrical engineering drawings.
8. Set up trip to serial printer vendor and obtain test strips for preliminary exposure evaluation.

Contract [redacted], Task 4

Second Quarter FY-68

PAR 152S

1 Dec 67

SUBJECT: Dual-Gamma Processing Techniques Study

TASK/PROBLEM

1. Conduct a study to investigate the advantages and limitations of dual-gamma processing.

DISCUSSION

2. A study plan is being prepared.

3. Sensitometric evaluation and inter-comparison of experimental developers was started.

PLANNED ACTIVITY

4. Complete the study plan and continue work in accordance with this plan.

PAR 153P

1 Dec 67

SUBJECT: Advanced Step-and-Repeat Drum Printer for UTB Film

TASK/PROBLEM

1. Design and fabricate a prototype step-and-repeat drum printer, incorporating an advanced tension control system, for routine reproduction of density cuts from selected frames of UTB negative film.

DISCUSSION

2. Introduction. A breadboard step-and-repeat drum printer was developed under PAR 52B, Step-and-Repeat Drum Printer, which proved the basic concept of step-and-repeat printing. The design of this more advanced step-and-repeat printer will follow the basic concepts of PAR 52B with additional requirements which follow:

a. A tension-controlled system on the negative which will safely handle UTB film. Improved tracking, web tension control, and film guiding to reduce the possibility of physical damage to web will be tried by a major redesign of the film transport system.

b. The reproduction of "density cuts" printing which allows printing a given frame several times in succession at different printing levels on the same roll of duplicating film.

c. An improved exposure control system eliminating the use of combinations of four neutral density filters inserted in the light path.

d. Punched paper tape programming of printer function to minimize operator surveillance.

3. Status. Authorization to proceed on this PAR was received in CCN No. 3 dated 1 November 1967.

PLANNED ACTIVITY

4. Begin preliminary studies and design.

SECTION III

APPENDIX

APPENDIX

CONTRACTS [redacted] and [redacted]

PAR INDEX AND SUMMARY

1 Dec 67

PAR No.[1]	Title	Contract and Task[2]	Status	Effort Category	Associated PAR Numbers
1B	10-20-40 Roll Holder	N/A	Complete Aug 64	Printing	
2S	3.6 Reduction Lens Design	N/A	Complete Jan 64	Printing	
3B	20X Color Lens	N/A	Complete Aug 64	Printing	
4S	Automatic Exposure Control Printer	N/A	Cancelled	Printing	
5B	Scanning Densitometer	N/A	Complete 29 Nov 66	Printing	
6S	400-Watt Mercury Arc Source	N/A	Complete Oct 63	Printing	36S
7S	Commercial Components	N/A	Complete Oct 65	Miscellaneous	
8S	Frame Coding and Detecting	N/A	Complete Dec 64	Printing	
9B	Frame Detector and Counter	N/A	Complete 1 Jun 66	Printing	
10B	Automatic IR Densitometer	N/A	Complete 29 Aug 66	Processing	61B, 124B
11S	Testing Unsharp Masks	N/A	Complete Aug 64	Printing	
12B	Redesign MRT Camera	N/A	Complete Mar 66	Printing	
13B	Frame by Frame Printer	N/A	Complete Oct 64	Printing	53S, XIX-6P
14B	Modification of Mod [illegible] Micro-D	N/A	Complete Nov 64	Miscellaneous	
15B	Reversal Processor	N/A	Cancelled	Processing	
16-1S	70mm Breadboard	N/A	Complete Jan 64	Processing	54S, 58S, 58-5-1S, 58-5-2S, 58-5-4S, 58-5-8S, 58-5-9S, 74S
16-2S	Viscous Developer Coating	N/A	Complete May 64	Processing	76B, 76B/Rev. 1, 85S/M, 93S, 94B, 100-1S, 100-2B, 100-4B,
16-3S	70mm Prototype Processor	N/A	Complete Apr 65	Processing	100-5B, 100-6S, XIX-9P
16-4B	FxF 9.5-Inch Processor (Yardleigh)	N/A	Complete Apr 65	Processing	
17B	Bidirectional Printer	N/A	Complete Oct 64	Printing	84B/M
18B	Color Printer	N/A	Complete Jan 64	Printing	
19S	Exposure Control Criteria	N/A	Trans. to PAR 24	Investigation	24S
20S	Advance Components for Printer	N/A	Complete Oct 65	Printing	
21S	Phosphor Viewer	N/A	Cancelled	Miscellaneous	

(1) a. A letter following the number identifies the PAR as one of the following types: S - Study; SOB - Shippable Operable Breadboard; B - Breadboard; P - Prototype:

Study - A theoretical and/or empirical analysis or examination of techniques and methods. Development and fabrication of hardware is limited to special equipment for data acquisition or determination of feasibility of techniques.

Shippable Operable Breadboard - The development, fabrication and testing of functional breadboard equipment for production use. Documentation will consist of sketch drawings, suitable for in-house fabrication, and informal operating instructions. The equipment will be capable of use, at locations other than the contractor's facility, by technically oriented customer personnel with proper training by the contractor.

Breadboard - The development, fabrication and testing of equipment to prove production feasibility of a design concept. Documentation will consist of sketch drawings and operating instructions suitable for in-house fabrication, testing, and operation.

Prototype - The design, fabrication and testing of equipment for production use. Documentation will consist of drawings, parts list and manual suitable for external fabrication, testing, operation and maintenance.

b. A letter following a slant line (/) identifies the PAR as: /R1, Revision 1; /R2, Revision 2, etc.; /M - Minor Project.

(2) Contract [redacted] no task identification (N/A). Contract [redacted] identified by Task A, B, C, D, E or F. Contract [redacted] identified by Task 1, 2, 3 etc.

U - No task assigned.

APPENDIX

CONTRACTS [redacted] and [redacted]

PAR INDEX AND SUMMARY

1 Dec 67

PAR No.(1)	Title	Contract and Task(2)	Status	Effort Category	Associated PAR Numbers
22B	Trenton Recorder and Warning System	N/A	Complete Jan 64	Processing	94B, 149B
23S	Processing/Printing Improvements	N/A	Complete Mar 65	Proc./Print	23-5-2S, 23-5-4S, 42S
23-5-1S	Frame by Frame Printing	N/A	Complete 21 Mar 66	Printing	
23-5-2S	Contact Print. & Optical Components	N/A	Complete 13 Sep 66	Printing	23S, 42S
23-5-3S	Spray Process	N/A	Complete 11 Mar 66	Processing	
23-5-4S	Improved Use of IR Densitometer	N/A	Complete 13 Sep 66	Processing	23S
23-5-5S	Measle Study	N/A	Complete 17 Aug 66	Investigation	
23-5-6S	Gold Treatment	N/A	Complete Jul 65	Investigation	
23-5-7S	Clean and Protect Film	N/A	Complete 20 Jun 66	Handling	
23-5-8S	Density and Contrast Study	N/A	Complete 20 Oct 66	Investigation	
23-5-9S	IFDV in Mission Films	N/A	Complete 16 Jun 66	Investigation	
23-5-10S	Multiple Generation Study	N/A	Cancelled	Printing	
24S	Red Dot Tests; Processing Red Dot Tests; Scene Luminance	N/A	Complete Nov 64	Processing Investigation	
24-5-1S	Low Altitude Reconnaissance	N/A	Complete 18 Apr 66	Investigation	
24-5-2S	High Altitude Color Acquisition	N/A	Complete 29 Sep 66	Investigation	24-7-2S, 24-8-8S
24-7-2S	High Altitude Color Acquisition	2	Complete 12 Oct 67	Investigation	24-5-2S, 24-8-8S
24-5-3S	Night Photography	A	Complete 29 Mar 66	Investigation	24-7-3S
24-7-3S	Night Photography	U	Disapproved	Investigation	24-5-3S
24-5-4S	Contrast of Original Negatives	N/A	Complete 10 Nov 66	Processing	24-7-4S
24-7-4S	Low Contrast Original Negatives	1	Active	Investigation	24-5-4S
24-5-5S	Exposure Criteria, Acquisition Films	N/A	Complete Jul 65	Investigation	24-6-5S,24-7-5S
24-6-5S	Exposure Criteria, Acquisition Films	B	Complete 13 Jan 67	Investigation	24-5-5S,24-7-5S
24-7-5S	Exposure Criteria for Acquisition Films	1	Complete 18 Sept 67	Investigation	24-5-5S,24-6-5S,24-7-7S
24-8-5S	Exposure Criteria for Acquisition Films	3	Active	Investigation	24-5-5S,24-6-5S,24-7-5S
24-7-6S/R2	Target Brightness Studies	2	Active	Investigation	
24-7-7S/R1	Study of Scanning Techniques	3	Active	Investigation	24-7-5S, 53S, 61B, 70B
24-8-8S	Study High Altitude Acquisition Materials	3	Active	Investigation	24-5-2S,24-7-2S

(1) and (2) See Page A-1.

1 Dec 67

APPENDIX

CONTRACTS [redacted] and [redacted]

PAR INDEX AND SUMMARY

PAR No.(1)	Title	Contract and Task (2)	Status	Effort Category	Associated PAR Numbers
25S	Image Analysis	N/A	Complete Sept 65	Investigation	25-6-1S,25-6-2S,25-7-1S,25-7-2S,25-8-2S,25-8-3S,25-8-4S/R1, 25-8-5S/M
25-6-1S	Mission Analysis	B	Complete 18 Jan 67	Investigation	25S,25-7-1S
25-6-2S	Study Refinements in Applications of Micro-D Data	B	Complete 8 Feb 67	Investigation	25S,25-7-2S,25-8-2S
25-7-1S	Mission Analysis	U	Cancel	Investigation	25S,25-6-1S
25-7-2S	Improve Methods of Microdensitometer Data Collection and Use	1	Complete 11 Oct 67	Investigation	25S,25-6-2S,25-8-2S
25-8-2S	Microdensitometer Data Collection and Use	4	Active	Investigation	25S,25-6-2S,25-7-2S
25-8-3S	Application of Power Spectrum Techniques	3	Active	Investigation	25-7-2S
25-8-4S/R1	Evaluation of Photographic Images	4	Active	Investigation	See 25S
25-8-5S/M	Simulation of Image and Noise Transfer in Photographic Systems	4	Active	Investigation	See 25S

(1) and (2) See Page A-1.

[redacted]

SECRET

APPENDIX

CONTRACTS [redacted] and [redacted]

PAR INDEX AND SUMMARY

Dec 67

PAR No.(1)	Title	Contract and Task(2)	Status	Effort Category	Associated PAR Numbers
26S	Effect of Radiation	N/A	Complete Jan 64	Investigation	
27B	Mod. 6 Micro-D	N/A	Cancelled	Miscellaneous	
28S	Modular Processor	N/A	Cancelled	Processing	
29S	R&D Processor for QC	N/A	Cancelled	Processing	
30S	Test Waxing on Processor	N/A	Cancelled	Handling	
31S	Ultrasonic Cleaner	N/A	Complete Jan 64	Handling	
32S	Ultrasonic Splicer	N/A	Complete Oct 63	Handling	
33B	Mod. III Titler	N/A	Complete Nov 65	Handling	
34	-	N/A	Not Issued	-	
35	Travel FY-64	N/A	Complete	Miscellaneous	66, 111, 127, 151
36S	1000-Watt Source	N/A	Complete Jul 65	Printing	6S, XIX-1B
37S	Improved Versamat Processor	N/A	Complete Oct 63	Processing	
38B	Adjustable Slitter	N/A	Complete 4 May 66	Handling	
39B	Light Source Test Fixture	N/A	Complete Aug 64	Printing	
40B	Grafton Conversion	N/A	Complete Jan 64	Processing	134S/M, 135S
41B	Speltron	N/A	Complete	Processing	
42S	Advanced Filter Components	N/A	Complete	Printing	23S, 23-5-2S
43B	Heat Seal Splicer	N/A	Complete Jul 64	Handling	
44B	Sens. Edge Printer for Processor	N/A	Complete 18 May 66	Printing	
45B	Mod. EN18	N/A	Cancelled	Processing	
46S	Ultra Thin Film Handling	N/A	Complete 29 Sep 66	Handling	98B, 118S/M, 147B
47B	S&R Color Printer	N/A	Not Issued	Printing	
48B	Automatic Micro D-5	N/A	Not Issued	Miscellaneous	
49B/R1	Edge Flasher	A	Complete 7 Nov 66	Handling	
50S	Optical Add-On Titling	A	Complete Nov 65	Handling	113S/M
51B	S&R Color Printer	N/A	Complete 22 Dec 66	Printing	
52B	S&R Drum Printer	N/A	Complete 19 Dec 66	Printing	84B/M, 123B, 153P
53B	Automatic Exposure Control Study	N/A	Complete 22 Dec 66	Printing	13B, XIX-6S, 24-7-7S/R1
54S	All-Viscous Processor Study	N/A	Complete Oct 65	Processing	16-1S, 16-2S, 16-3S, 16-4B, 58S, 58-5-2S, 58-5-3S, 58-5-4S, 58-5-8S, 58-5-9S, 93S, 100-1S, 100-2B, 100-4B, 100-5B, 100-6S
55S/R1	Bimat Study	N/A	Complete 3 Nov 66	Processing	
56S	Bimat Processor No. 1	N/A	Complete 14 Jun 66	Processing	
57S	Bimat Processor No. 2	A	Complete 14 Nov 66	Processing	
58S	Adv. Proc. Techn. Study	N/A	Complete Mar 65	Processing	58-5-2S
58-5-1S	Wash Water Studies	N/A	Complete 26 Apr 66	Processing	80B
58-5-2S	Viscous Developer Studies	N/A	Complete 6 Jul 66	Processing	16-1S, 16-2S, 16-3S, 16-4B, 54S, 58S, 58-5-2S, 58-5-3S, 58-5-4S, 58-5-8S, 58-5-9S, 93S, 100-1S, 100-2B, 100-5B, 100-6S

(1) and (2) See Page A-1.

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PAR INDEX AND SUMMARY

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PAR No.(1)	Title	Contract Task(2)	Status	Effort Category	Associated PAR Numbers
58-5-3S	Viscous Washing Studies	N/A	Complete 6 Jul 66	Processing	
58-5-4S	Removal of Viscous Coatings	A	Complete 6 Jul 66	Processing	
58-5-5S	Film Drying Studies	N/A	Withdrawn	Processing	100-6S
58-5-6S	Solution Carrier Studies	N/A	Withdrawn	Processing	
58-5-7S/M	Study of Silver Recovery	N/A	Complete 10 Mar 66	Miscellaneous	
58-5-8S	Viscous Coating Temperature Study	A	Complete 6 Jul 66	Processing	See 58-5-2S
58-5-9S	Viscous Fix Studies	A	Complete 6 Jul 66	Processing	58-5-2S
58-5-10S	Long Length Bimat Film Study	N/A	Withdrawn	Processing	
59S	Flying Splicer	N/A	Cancelled	Handling	
60S	Film Handling Technique	N/A	Complete 29 Mar 66	Handling	
61B	Improved IR Scanner	N/A	Complete 20 Dec 65	Processing	10B, 24-7-7S/[illegible]
62S/M	Central Control Study	N/A	Complete 15 Aug 66	Processing	
63S	Raw Stock (Film) Cleaning Inv.	A	Complete 29 Nov 66	Handling	
64S	Wide Film Handling Study	N/A	Withdrawn	Handling	
65S	Non-Photo Supply Investigation	N/A	Cancelled	Miscellaneous	
66	Travel and Liaison FY-65	N/A	Complete	Miscellaneous	35, 111, [illegible]
67S	Study Dist. of Niagara Printer	N/A	Cancelled	Printing	
68B	Identification Printer	A	Complete 3 Nov 66	Printing	
69B/M	Ultrasonic Edge Detector	N/A	Complete 15 Aug 66	Handling	
70B	Film Scanner Recorder	B	Complete 6 Sept 67	Investigation	24-7-7S/R.
71	-	-	Not Issued	-	
72B	B&W, S&R, Bed Printer	N/A	Complete 25 Apr 66	Printing	
73	Administration FY-65	N/A	Complete	Miscellaneous	112
74S	Airborne Proc. Lab	N/A	Cancelled	Processing	
75B	Airborne Insp. Work Center	N/A	Cancelled	Handling	
76B	Upgrade Yardleigh Processor	N/A	Complete 16 Aug 66	Processing	16-4B, 76B/R1, XIX-9P
76B/R1	Upgrade Yardleigh Processor	N/A	Complete 24 May 66	Processing	16-4B, 76B, XIX-9P
77B/R1	Processed Film Slitter	N/A	Complete Feb 66	Handling	
78S	Cross-Frame Lacquerer	N/A	Complete 31 Mar 66	Handling	117P
79P	Unimak Film Titler	A	Complete 7 Dec 66	Handling	133S/M
80B	Ion Exchange System	N/A	Withdrawn	Processing	58-5-1S
81S/M	Versamat Water Reduction	N/A	Complete Dec 65	Processing	
82B	Two-Strand Stereo Viewer	A	Complete 9 Sep 66	Handling	
83S/M	Versamat Rack Washer	N/A	Complete Dec 65	Processing	
84B/M	Three-Lamp Lamphouse	N/A	Complete 12 Apr 66	Printing	17B, 52B, 123P

(1) and (2) See Page A-1.

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PAR INDEX AND SUMMARY

Dec 67

PAR No.(1)	Title	Contract and Task(2)	Status	Effort Category	Associated PAR Numbers
85S/M	Airborne Proc. Layout Study	N/A	Complete Jul 65	Investigation	
86S	Study Application of Liquid Gates	1	Complete 20 Nov 67	Printing	
87S/M	Variability in Resolution Values	B	Complete 7 June 67	Investigation	
88S/M	Mathematical Color System Model	E	Complete 13 May 67	Investigation	131S
89S	Study Proc. of Stellar Image Records	D	Complete 13 Sep 66	Processing	
90S	Film Tension and Transport Study	B	Complete 2 July 67	Handling	
91P	Respooler for Ultra Thin Base Film	D	Complete 3 Mar 67	Handling	
92	-	-	Not Issued	-	
93S	Temp. Control of 70mm Viscous Hoppers	B	Complete 17 July 67	Processing	16-4B, 54S, [illegible]S, 100-2B, 100-4B, 100-5B
94P	Yardleigh Recorder	B	Complete 14 Nov 66	Processing	22E, 149P
95B	Experimental Printer for UTB Films	D	Complete 29 Mar 67	Printing	
96B	Galaxy Print w/Variable Intensity Light	-	Withdrawn	Printing	
97S	Edge Defect Sensor	C	Active	Handling	
98B	Splicer for Ultra Thin Base Materials	U	Withdrawn	Handling	46S, 118S/M, 147B
99	-	-	Not Issued	-	
100-1S	All-Viscous Chemistry	2	Active	Processing	See 100-4B
100-2P	Temp. Control 9.5-Inch Viscous Hopper	1	Active	Processing	58-5-8S, 93S, 100-4B, 100-5B
100-3B	Film Footage Marker	C	Complete 11 Apr 67	Handling	100-4B
100-4B	Devel. 9.5-Inch All Viscous Processor	1	Active	Processing	16-1S, 16-2S, 16-3S, 16-4B, 54S, 58-5-2S, 58-5-3S, 58-5-4S, 58-5-8S, 58-5-9S, 93B, 100-1S, 100-2B, 100-3B, 100-4B, 100-5B, 100-6S, 142B
100-5B	IR Scanner and Electronic Control Units	1	Active	Processing	100-2B, 100-4B
100-6S	Drying Equipment	1	Active	Processing	58-5-5S, 100-4B
100-7B	Lightweight Presplice Complex	U	Withdrawn	Handling	100-4B
101B	Macrodensitometer Breadboard	D	Complete 14 Feb 67	Miscellaneous	
102B	Sensitometric Spray Proc. Breadboard	U	Withdrawn	Processing	
103B	Printer-Processor Breadboard	U	Withdrawn	Print-Proc.	
104S	Discrimination Between Clouds, Water and Terrain	U	Withdrawn	Investigation	
105S	High Temp. Proc. Non-Rev. Color Films	-	Cancelled	Processing	
106S	Reversal Proc. B&W Acq. & Dupe Films	-	Cancelled	Processing	
107B	Drum Printer with Modulated CRT Source	2	Active	Printing	PART XIX, Item 6P, 146S
108B	Air Roller Viewing Table	-	Cancelled	Handling	
109S	Viscous Monobath Techniques Study	B	Complete 8 Mar 67	Processing	
110B	Microdensitometer for Roll Film Samples	U	Withdrawn	Miscellaneous	
111	Travel and Liaison (FY-66)	D	Complete 7 Aug 66	Miscellaneous	35, 66, 127, 151
112	Administration (FY-66)	D	Complete 7 Aug 66	Miscellaneous	73, 112, 151
113B	Spool Elevator Viewing Table for UTB Film	1	Complete 30 June 67	Handling	

(1) and (2)
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PAR No.(1)	Title	Contract and Task(2)	Status	Effort Category	Associated PAR Numbers
114	-	-	Not Issued	-	
115S	Silver Recovery from Viscous Fix	U	Cancelled	Miscellaneous	
116S/R2	Study Distortion in Photo Duplication	2	Active	Print-Proc.	
117P	Cross-Frame Lacquerer	1	Complete 22 Aug 67	Handling	78S
118S/M	Ultra Thin Base Films Splicing Study	D	Complete 26 Jan 67	Handling	46S, 98B, 147B
119S/M	Continuous Reduction Printer	E	Complete 31 Jan 67	Printing	125SOB
120S/M	Preliminary Planning for Systems Improvement	E	Complete 4 Sep 66	Miscellaneous	121S, 143S
121S	Define Objectives for a Systems Imp. Program	1	Complete 25 Aug 67	Miscellaneous	120S/M, 143S
122B/R1	5-Inch Experimental Processor	1	Active	Processing	
123P	Color Matrix Continuous Printer	2	Active	Printing	84B/M, 51B
124B	Density IR Scanner	U	Withdrawn	Processing	10B, 61B
125SOB	Cont. Reduction Optical Printer	2	Active	Printing	119S/M
126	Administration (FY-67)	1	Complete [illegible] Aug 67	Miscellaneous	73, 112, 151
127	Travel and Liaison (FY-67)	1	Complete 6 Aug 67	Miscellaneous	35, 66, 111, 151
128	Not Issued	-	-	-	
129S/R1	Film Transport Control Study	2	Active	Handling	
130S	Film Moisture Control Study	1	Complete 9 Oct 67	Miscellaneous	
131S	Mathematical Color Duplication	2	Active	Printing	88S
132S	Preliminary Color Printing Control Study	2	Active	Printing	
133S/M	Optical Titling and Readout Study	1	Complete 30 June 67	Handling	50S, 79B, 150S
134S/M	Color Processing Study	1	Complete 22 Aug 67	Processing	40B, 41B, 135S
135S	Experimental Study of Color Processing Methods	1	Active	Processing	40B, 41B, 134S/M
136S	Footage Indicator	2	Active	Miscellaneous	
137S	Large Roll Film Handling	2	Active	Handling	
138S	Hole Detection Study	2	Active	Miscellaneous	
139B	Automatic Continuous Identification Printer	2	Active	Printing	68B, 133S/M
140B	Splicer for Dupe Processor	2	Active	Handling	
141S	Processor Waxer Study	2	Active	Miscellaneous	
142B	Narrow Resistive-Heated Hopper	2	Active	Processing	See 100-4B
143S	Study Detailed Production Systems Requirements	3	Active	Miscellaneous	120S/M, 121S
144S/M	Primary/Secondary Breakdown Station Study	3	Active	Handling	
145B/R1	Frame Data Correlation Sensor	3	Deferred	Handling	

(1) and (2) See Page A-1.

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PAR No.(1)	Title	Contract and Task(2)	Status	Effort Category	Associated PAR Numbers
146S/R1	Printing Lamp Exposure Modulation Study	3	Active	Printing	PART XIX, Item 6P, 107B
147B	UTB Splicer	3	Deferred	Handling	46S, 98B, 118S/M
148B	Viscous-Developer Dupe Processor	4	Active	Printing	See 100-4B
149B	Yardleigh Data Recorder/Monitor System	3	Active	Processing	22B, 94B
150S	Study Incorporation of Optical Titling on ON Processor	3	Active	Printing	133S/M
151	Contract, Monitoring, Coordination and Liaison	3	Active	Miscellaneous	35, 66, 73, 111, 112, 126, 127
152S	Dual-Gamma Processing Techniques Study	4	Active	Processing	
153P	Advanced S&R Drum Printer for UTP Film	4	Active	Printing	52B
154S	UTB Splicer-Tape Study	3	Awaiting Cust. Action	Handling	
PART XIX					
Item 1B	1000-Watt Continuous Printer	N/A	Withdrawn	Printing	6S, 36S
Item 2B	Waxer-On Processor	N/A	Withdrawn	Handling	
Item 3P	Moveable Head Densitometer	A	Complete 5 Dec 66	Miscellaneous	
Item 4B	Two-Strand Film Viewer	N/A	Complete 25 Mar 66	Handling	
Item 5P	Automatic Recording Densitometer	N/A	Complete 28 Jun 66	Miscellaneous	13B, 53B
Item 6P	Galaxy Continuous Printer	N/A	Complete 22 Dec 66	Printing	107B, 146S
Item 7B	Trenton Processor	N/A	Not Submitted	Processing	
Item 8B	Lab Contact Printer	N/A	Cancelled	Printing	
Item 9P	Yardleigh Coating Hopper	N/A	Complete Mar 66	Processing	

(1) and (2) See Page A-1.