PAR 230

10X Color Lens

30 October 1964

Approved For Release 2004/07/29 : CIA-RDP78B04770A000800080006-1

PROJECT AUTHORIZATION REQUEST

PAR 230
30 Oct 64

SUBJECT: 10X Color Lens

TASK/PROBLEM

1. Design, fabricate and test a 10X lens to expose maximum quality color prints on the 10-20-40X Precision Enlarger.

PROPOSAL

2. Introduction:

a. The lenses delivered on the 10-20-40X Precision Enlargers are corrected for a narrow wavelength range of light to permit making black-and-white prints with minimum loss of information. Recent improvement of color films and increasing PI interest in color photography make it desirable to also provide this capability for making color enlargements.

b. A recent development effort, under another contract, provided a 20X color lens for the 10-20-40X enlarger. Two concurrent design approaches were pursued.

(1) A new ten-piece, f/3.0 lens design was provided by STAT [redacted] with high theoretical capability but difficult fabrication requirements.

(2) A commercial 52.7mm f/2.0 [redacted] lens [redacted] STAT
STAT [redacted] was installed and tested in a focus assembly of the 10-20-40X Enlarger for making 20X enlargements.

STAT c. Results of the [redacted] lens tests showed lower resolving power and considerably less sharpness than the black-and-white original lens. However, its performance relative to requirements placed upon it by current color films was adequate.

STAT d. The [redacted] lens was recommended for 20X color enlargements and no sample of the new ten-piece lens design was made.

APPROACH

3. In the fixed conjugate length of the 10-20-40X Enlarger, a lens of about twice the focal length of the 20X lens (about four-inches) is required to provide 10X magnification. It appears doubtful that a "scaled-up" version of the 52mm [redacted] lens would have good enough definition due to its greater geometric aberrations.

4. A two-part development program is proposed to provide a lens design suitable for making 10X color enlargements on the 10-20-40X Enlarger. To shorten the elapsed time, it is suggested these two parts be started at the same time. The two parts of the program are:

a. Part 1 - Scale up, and modify as necessary, [redacted] build a sample lens in a focus assembly for the 10-20-40X Enlarger, and make performance tests. Design Specification, No. 469-324 for this part of the program is derived from the design data for the ten-piece 20X lens described above.

b. Part 2 - Design a 10X lens to provide image quality comparable to the 20X [redacted] lens described above. It appears this might be achieved by a seven- or eight-piece design at f/4.0 to f/5.0 with the small six- to nine-degree semi-field required by the 10-20-40X Enlarger. From this design, it is proposed to build a sample lens in a focus assembly for the 10-20-40X Enlarger and to make performance tests. Design Specification No. 469-325 for this part of the program describes a lens of smaller aperture and slightly lower theoretical capability than for Part 1, but which is expected to be simpler to fabricate and adequate for enlargement of present color films and those anticipated over a period of several years.

PROGRAM OBJECTIVES

5. The program objectives are:

a. Part 1

(1) Subcontract [redacted] for design of a lens to Specification 469-324 (minor revision of their Design No. 5829) and fabrication of a sample in a barrel suitable for mounting in a focus assembly for the 10-20-40X Enlarger. STAT

(2) Fabricate a focus assembly, similar to [redacted] for the 10-20-40X Enlarger to receive the above sample lens. STAT

(3) Test the sample lens by making black-and-white and color enlargements.

b. Part 2

(1) Design an f/4 to f/5.0, seven- or eight-piece lens to Specification No. 469-325 and fabricate a sample in a barrel suitable for mounting in a focus assembly for this 10-20-40X Enlarger.

(2) Fabricate another focus assembly as above (paragraph 5.a.(2).

(3) Test the sample lens by making black-and-white and color enlargements.

6. Provide progress and final reports of the development effort.

SCHEDULE

7. A tentative schedule covering major phases of effort is shown in Figure 1. The time span indicated to complete the subject program is based on actual start of work. Upon approval to proceed and/or start of work, schedule will be reviewed and necessary changes reported as required.

NOTE: Specification No. 469-324, and Specification No. 469-325 are attached.

TENTATIVE SCHEDULE

10X Color Lens

PAR 230
28 Oct 64

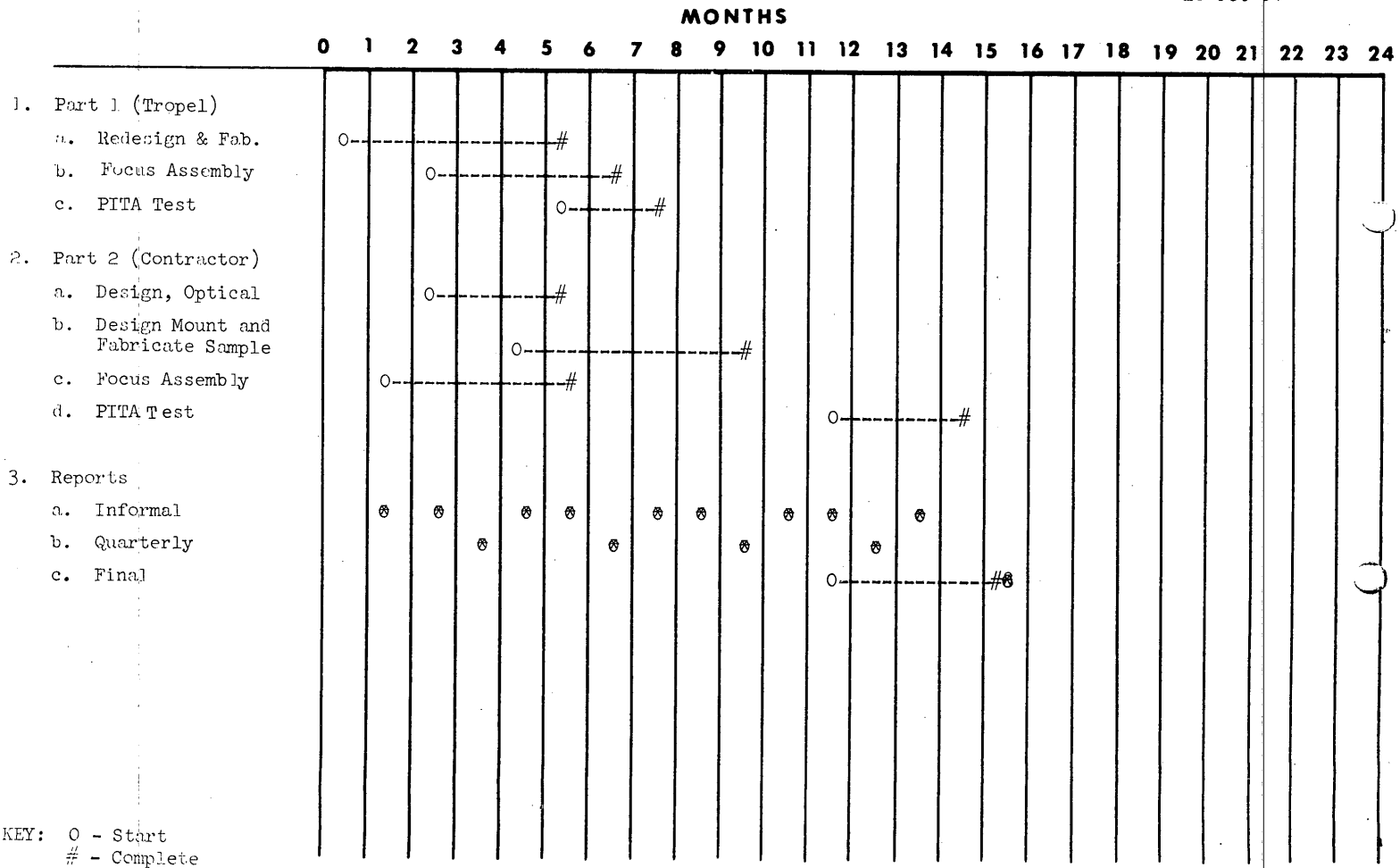

Fig. 1

Specification No. 469-324
30 Oct 64

Design Specification
for
10X Color Lens for Precision Enlarger
(Modification of [redacted] STAT

Focal Length: Approx. 4.0". (Over-all conjugate distance 42.80").

Aperture: F/4.0.

Magnification: 20:1.

Short Conjugate Field Diagonal: 1.275".

Long Conjugate Field Diagonal: 12.75".

Angular Field: Approx. 9°.

Wavelength Range: Three narrow spectrum bands (70 to 100 Angstroms half pass band width) centered about 4358A, 5461A, and 6563A respectively.

Corner Illumination: Should follow $\cos^4$ law if this does not reduce image quality. No vignetting is a desirable condition.

Distortion: Less than 0.05%.

Performance: In the short conjugate the design goals are:

(a) In the band centered about 5461A, 90% of the rays should fall within a 3 micron circle over at least 6° of the field.

(b) In the bands centered about 4358A and 6563A, 90% of the rays should fall within a 6 micron circle over at least 6° of the field.

(c) Magnification in the three spectrum bands shall be such that 90% of the rays from the three bands fall within a single 7 micron circle over at least 6° of the field.

Special Conditions:

(a) The negative will be registered against the plano surface of a glass element between the film and the main lens assembly. This element may be a .125" thick plate (C-1 glass) or it may be a "field flattener" with one plano surface at the focal plane.

(b) If the lens performance is improved by doing so, the short conjugate distance in the system can be adjusted by moving the negative gate between sequential exposures in the three spectrum bands. The focus movements should be as small as possible.

Reports Required: Upon completion of the modified design, we require:

(a) Energy distribution curves from ray trace data for monochromatic light at 4358A, 5461A, and 6563A for the axis, 3°, 6° and 9° off axis. The curves for 4358A and 6563A should show conditions for the plane of best focus for these wavelengths and for the best focus for 5461A light.

(b) Reproducible copies of the Spot Diagrams at the same conditions as in (a).

Specification No. 469-325
30 Oct 64

Design Specification
for
10X Color Lens for Precision Enlarger
(Model 2)

Focal Length: Approx. 4.0". (Over-all conjugate distance 42.80".)

Aperture: F/4.0 to f/5.0 - May be selected from this range for optimum image quality.

Magnification: 10/1.

Short Conjugate Field Diagonal: 1.275".

Long Conjugate Field Diagonal: 12.75".

Angular Field: Approx. 9°.

Wavelength Range: Three narrow spectrum bands (70 to 100 Angstroms half pass band width) centered about 4500A, 5500A and 6500A respectively.

Corner Illumination: Should follow $\cos^4$ law if this does not reduce image quality. No vignetting is a desirable condition.

Distortion: Less than 0.5%.

Performance: The design goal is to have 90% of the computed rays pass through a circle of the size indicated in the following table:

Light	Circle Diameter to Enclose 90% of Rays 0-3°	3°-6°	6°-9°
5500A (Green)	3μ	6μ	12μ
4500A (Blue)) 6500A (Red)) (1)	5μ	10μ	20μ
4500A (Blue)) 6500A (Red)) (2)	8μ	16μ	32μ

(1) At best focus for blue and red light.
(2) At best focus for 5500A (green) light.

Special Conditions:

(a) The negative will be registered against the plano surface of a glass element between the film and the main lens assembly. This element may be a .125 inch thick plate (C-1 glass) or it may be "field flattener" with one plano surface at the focal plane.

(b) If the lens performance is improved by doing so, the short conjugate distance in the system can be adjusted by moving the negative gate between sequential exposures in the three spectrum bands.

Reports Required: Upon completion of the design we require:

(a) Energy distribution curves from the ray trace data for monochromatic light at 4500A, 5500A and 6500A on the axis, 3°, 6°, and 9° off axis. The curves for the plane of best focus at these wavelengths and for the plane of best focus at 5500A.

(b) Spot diagrams for the same conditions.