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DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330 [redacted]

OFFICE OF THE SECRETARY

OCT 16 1968

MEMORANDUM FOR DR. FLAX
GENERAL FERGUSON

SUBJECT: ~~(TS-BYE)~~ EK Study of Possible Future MOL Camera System Improvements

Last week, General Berg and I reviewed the mid-term progress of Eastman Kodak's Phase I study of possible Dorian-camera improvements which might be incorporated into MOL Block II/III systems. They are on schedule toward a verbal report (briefing with charts) in late November and a written report by January 1.

As you will recall, the primary purpose of this EK effort is to analyze feasible/reasonable modifications to the present basic optical system/spacecraft combination which would improve resolution [redacted] A lesser amount of the EK effort is being expended toward reliability/flexibility, etc., improvements. The final report is to identify and analyze the most promising areas and propose any Phase II technology efforts needed to verify the analyses or prove feasibility.

At this point in the study, the following four areas appear to offer the most promise for improvements in resolution:

1. Higher Optical Quality Factor and Tighter Specs for Appropriate Components: Improvements in mirror and lens quality, alignment, focus, tracking mirror drive, etc., may eventually offer about [redacted] resolution improvement.

2. Elliptical Tracking and Newtonian Folding Mirrors: Apparently, a [redacted] can be fitted into the present bay to increase the effective aperture. The weight penalty would be 200 pounds. Analysis is underway on

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manufacturing feasibility and the precision drive of a heavier, elliptical Tracking Mirror. Additionally, an elliptical Newtonian Folding Mirror and narrower mounting struts would reduce obstruction from 12 to 8 percent. The combined effect of these changes appears to offer at least .2 inch improvement in resolution.

3. Ross Corrector Lens Redesign: A proposed new design would arrange nine Ross Corrector Lens in the present barrel to increase the effective focal length to [redacted]. [redacted] If the new Ross Corrector optics could be made and aligned with the necessary precision, resolution should be improved approximately [redacted].

4. Relay Lens/Auxiliary Camera: In a concept something like the present visual take-off from the main optics, the center one-inch of the format would be relayed and magnified through a series of lenses to an auxiliary 70 mm camera. The apparent focal length would be [redacted]; the ground image recorded would be 1000 feet in diameter. The relay diagonal mirror would be withdrawn from the center of the Ross Barrel when the 70 mm camera was not in use. Resolution of the relayed spot should be improved approximately [redacted] (simultaneous operation of the main camera might also be possible, although the center portion of the format would be obscured by the relay mirror).

Also under study are component-improvement efforts such as a two-axis focus sensor, etc. An item of interest in the area of mission flexibility is the possibility of using the main optics with an [redacted]

Although not a part of the MOL camera-improvement study, we also reviewed EK's in-house efforts toward new film emulsions, better processing, and image enhancement. I didn't identify any prospects for major advances in film quality;

however, processing techniques are making progress. Image enhancement techniques in laboratory experiments show promise of improving the apparent resolution of high resolution photography a considerable amount.

In summary, with regard to improvements in the MOL camera, it appears we can anticipate an early resolution improvement to about [redacted] at 80 nm (via higher OQF, more precise TM drive, and elliptical Tracking and Newtonian Mirrors). If desired, this probably can be improved another .2 inch for a small portion of the format via the relay lens/auxiliary camera concept. The best possible resolution (without increasing aperture and Mission Module dimensions) -- combining all concepts presently under consideration, and assuming no negative cross-coupling effects -- appears to be about [redacted] at 80 miles. The improvements will be increasingly difficult to realize as the [redacted] plateau is approached.

In addition to or in lieu of any of the possible camera improvements described earlier, resolution can be improved simply by exercising the operational option of reducing the perigee to about 70 nm for brief periods. At 70 nm perigee, the only apparent penalty for a few revs at a time appears to be additional expendables for drag make-up and orbit-adjust purposes (we presently are analyzing the possibilities of 65 nm perigees for brief periods -- there is some concern re heating). In any event, 70 nm perigees should make the [redacted] resolution plateau achievable with reasonable camera modifications. The best possible resolution at 70 nm -- combining all concepts presently under consideration -- appears to be about [redacted]

As a side benefit (for some of us who did not participate in the early analyses), the EK study is also proving to be a vote of confidence in the present camera design. The obvious difficulty of significantly improving resolution (without a sizable increase in aperture along with other major changes) makes it apparent that the MOL camera design represents an excellent balancing of trade-off options.

JAMES T. STEWART
Major General, USAF
Vice Director, MOL Program

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