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DORIAN OPTICAL QUALITY FACTOR

The MOL Reconnaissance System employs a camera which has a set of optics of large aperture and focal length. An important factor in achieving the design ground resolution will be the ability to manufacture and assemble the elements of the optical subsystem to standards that are high enough to be consistent with the other system parameters. The manufacture and assembly are rated by the "Optical Quality Factor," a parameter expressed as a fraction obtained by dividing the modulation transfer function of a given set of optics by the modulation transfer function of a theoretically perfect set. Because the development of the GAMBIT 3 camera has experienced a learning-curve route to achieving best performance, there is legitimate reason to inquire whether the MOL DORIAN optics will have from the beginning of the launch program the performance for which it is designed.

The DORIAN design optical quality factor is [redacted] a value compatible with achieving a ground resolution of [redacted] at 5:1 contrast ratio from 80 n.m. and [redacted] at 2:1 contrast from that altitude. If for some reason the optical quality factor were to fall as low as [redacted] the 5:1 performance would degrade to [redacted] and the 2:1 resolution would be [redacted]

The MOL Program Office has examined the contractor's positive statement that the [redacted] quality factor will be met in the first flight unit and that a factor of [redacted] is a valid near-term objective. There are many reasons for confirming this prediction. They can be classified into two groupings:

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a) the effect of new methods and devices being developed in the GAMBIT 3 Program which will be employed in DORIAN and b) features which are specific to the MOL Program. They are summarized briefly below.

New Developments from GAMBIT 3

1. The techniques of laser interferometry are being refined together with an effective set of software which will permit a very accurate measurement of the surfaces.

2. Equipment for selective electroplating is in the process of adaptation as a method of achieving extreme surface quality.

3. A new polishing control method has been developed.

4. An improved air-bag support has been perfected which will provide a more accurate representation of the zero-g condition for test purposes.

5. The introduction of Cer-Vit promises to improve the uniformity of the tracking mirror.

6. New aspherizing techniques for the primary mirror have proved to be superior to older methods.

7. Mechanical gaging procedures have been coupled with new software which increases the precision of measurement.

The above improvements are being employed now in the production of GAMBIT 3 cameras which will exceed the performance of any that have been orbited to date. All of the techniques, materials and devices will apply to DORIAN.

Special MOL Features

1. The DORIAN optics are on a schedule which will permit a full development cycle before orbital testing is begun. There is an interval of 50 months between the delivery of the first light-weight blank and the first DORIAN/GAMBIT

MOL launch. By comparison, in GAMBIT 3 this interval was only 16 months -- less than one-third of the MOL time.

2. The DORIAN system was afforded an unrestricted preliminary design. The payload was selected by optimizing and the spacecraft and booster then were fitted to it. GAMBIT 3 was constrained by spacecraft weight and dimensions and by launch vehicle performance.

3. The DORIAN optics will be aligned on orbit, eliminating completely the cut-and-try procedures, involving considerable guesswork, of aligning a rigid structure under one-g conditions so that it will be correct under zero-g. The DORIAN alignment mechanism will operate either in the manned or in the automatic mode.

4. DORIAN incorporates a focus sensor that determines the sharpness of the actual scene being presented to the camera.

5. DORIAN, because it is designed around a frame-type camera, can employ exposure bracketing, the procedure of taking several photographs of the same target at different exposures in order to assure that the best exposure has been achieved.

6. MOL astronauts will provide a manual backup for any out-of-specification performance of the alignment or focusing mechanisms. The first launches will be manned and any problems with these devices can be bypassed so that the quality of the photography will not be degraded.

7. The DORIAN primary mirror has strain-free mounts that will eliminate a source of possible distortion which has existed in previous systems.

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8. The DORIAN tracking mirror is circular, a simpler shape to fabricate than the ellipse of the GAMBIT stereo mirror.

9. The DORIAN tracking mirror does not have the center cut-out of the GAMBIT 3 mirror, a much more difficult configuration to fabricate.

10. There is little asphericity in the DORIAN primary mirror, a feature which greatly simplifies the grinding and polishing.

11. New on-back testing facilities for DORIAN will eliminate the transverse g-loading distortion which in the horizontal position has been a serious problem in accomplishing meaningful testing.

12. The DORIAN facilities will provide evacuated-chamber testing which will approach orbital conditions adequately.

13. A null compensator is needed for testing the primary mirror. Because of the DORIAN smaller amount of asphericity, the null compensator is correspondingly simpler and a better test can be accomplished.

14. The employment of statistical techniques in complex optical testing is important. The DORIAN schedule provides ample time for these procedures.

The above considerations fully support the conclusion that the first DORIAN flight camera will achieve the desired [redacted] optical quality factor in the only meaningful sense -- on orbit -- and that the first incremental increase to [redacted] will be readily achievable.

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