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To: R. Geiger

Date: 31 December 1968

Subject: Dorian Block II Study

From: A. J. Boardman

On 12 December 1968 we listened to Jim Collinge brief us on the results of the ONF four-month Phase I study of the potential improvements to the Dorian payload that might be incorporated in the second block of vehicles. The emphasis was clearly on improved resolution. In summary, Collinge concluded that "significant" improvements are possible within the configuration. Specifically:

- a. The [redacted] baseline resolution could be improved to [redacted] by increasing the OQF from [redacted] percent, by decreasing the obscuration attributed to the spider holding the Newtonian flat, by making the Newtonian flat elliptical and beveling its edges, by making the tracking mirror elliptical, by optimizing the lens prescription, and by improving the shutter efficiency. These changes would require new test glass, new corrector elements, new blank designs, mounts, a new barrel yoke and drive, and improvement of manufacturing and test techniques.
- b. The [redacted] ground resolution can be improved to [redacted] by the addition of a partial field relay system which magnifies (2X) the center of the format. It is interesting to note that the implications on smear rate requirements for this scheme are such as to show a resolution advantage of SO 121 (color) over 3404 at smear rates above [redacted] per second.
- c. The [redacted] resolution can be further improved to [redacted] by reducing the altitude. As far as I can tell this ten or so nautical mile reduction in altitude need not be specifically geared to Block II changes.

Although we have not participated in this study, I feel obligated to offer my candid comments to the briefing. ONF initiated this study sometime after our interest peaked in the shallow angle intersection of the Dorian MTF and AIM curves. They, as well as we, are quite aware of the deleterious effects on resolution, contrast, and information content of an

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MTF curve which falls so drastically in the midfrequencies. Conversely, it is clear to all the large improvement potential of boosting the MTF in this region. Collinge, several times in his briefing, made references to this phenomenon when he indicated the various ways considered for improving contrast by reducing obscuration. He went into some detail about the one or two percent MTF improvement that could be obtained by redesigning the Newtonian spider. He had details on the improvements made by "streamlining" the Newtonian flat. He talked about the fact that some of these relatively minor improvements would seem much more significant at contrasts lower than 2:1. But he offered no significant means of boosting the values of MTF in the region of the AIM intersection.

Dr. Meinel, Dr. Baker, and our own people have discussed somewhat enthusiastically the possibility of a redesigned optical system which causes the image of the primary mirror to converge at the folding flat to be then relayed through corrector elements to the focal plane. Such a concept allows large improvements in MTF by the virtual elimination of the large obscuration. This concept was not altogether unthought of at ONF. Collinge did mention that a relay system was considered as a means of doubling focal length. (To digress, increasing focal length in a highly smear limited system seems to be a questionable thing to consider but in partial answer to that Collinge discussed the possibility of decreasing the 2σ smear rate from [redacted] per second to [redacted] per second.) ONF's investigation of a relay system left them with no design solution. Collinge stated that they developed the scheme to the point that they had a design which was not diffraction limited and had eleven refractor elements. In my opinion a more detailed investigation should be conducted of this relay concept (but maintaining the [redacted] effective focal length) in search of a low obscuration diffraction limited design.

The Phase I study did not deal with any aspect of achieving the [redacted] baseline resolution--perhaps understandably. But treating the [redacted] as an accomplished fact can lead to some unjustified conclusions. Consider, by way of example, the matter of OQF. Programming the OQF from [redacted] percent might be meaningful if [redacted] percent were a demonstrated achievement throughout the lives of a fair number of Dorian payloads, and if the increase were to occur over a reasonable time base. Of course, this is not the case. Most of the work required to reduce the ground resolution from [redacted] (above) is in many respects tantamount to building a new optical system. There certainly will be a discontinuity in the learning curve which is incompatible with any positive change in OQF. Therefore, the statement that [redacted] can be bettered by raising OQF is toothless. To minimize the expenditure of effort leading to recommendations of questionable practicality, I propose that the [redacted] number be thrown open to scrutiny in future phases of this study. Some portion of the Collinge effort should be addressed to an objective and detached view of the program, a determination of the phenomena most likely to prevent the achievement (and maintenance) of the promised [redacted] and the definition of the hardware improvements desirable to cover all bets.

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Collinge recommended that follow-on study effort be directed toward the suggested modifications to the lens design, a better look at the 2X center format magnification scheme and further sensor work. I urge that the contractor be directed during the next phase of the program to investigate in depth the potential of the low obscuration scheme and the question posed in the preceding paragraph relative to obtaining and maintaining the promised



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cc: R. Stephenson

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