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One specific structural question which was known to be up in the air was the manner in which the startrackers were to be mounted. We learned from Dan that the subject was still under investigation but that a preliminary design had evolved. The two startrackers would be mounted to a single baseplate. The baseplate would, in turn, be tied to the leg (i. e., the beryllium structure) with a structural truss. The truss was tentatively designed of titanium but the material question was not yet decided.

4. Myron advised us that the startracker error analysis document is being revised to reflect the new mounting. The previous issue of the document is still useful for those errors which relate to the tracker itself and not to the manner in which it is mounted. The document is called, "Startracker Error Analysis, Revised - DIN 6633-27-4 (PIR-7170 MOL - 2683)" and is dated 12 September 1967.

5. We next met with Ian Scott who is the responsible GE engineer for the alignment systems. Ian explained the Lambda system which is the redundant alignment monitor system between the primary optics and the hub. The contractor for the Lambda system has not been announced but it will probably be "John" (i. e., Perkin-Elmer). The contract will be ~~S/D~~. The specification for the Lambda system will be essentially identical to the specification for the old High Range Alignment Monitor System. This latter was Specification EC 1712, Revision 3, dated 1 November 1968.

The other alignment monitor systems are the low range systems which monitor the alignment of the tracking mirror from the startracker baseplate and the hub from the startracker baseplate. The alignment system specification is TR 1722, Revision 3. It is known that the specification is not adequate to cover the present alignment scheme. The revision to the specification will probably be called TR 1722, Revision A, and will incorporate requirements for redundancy for each sensor, range of the sensor, and separate redundant electronics. The electronics will probably mount on the beryllium structure and not on the startracker baseplate. The present estimate at GE is that the range of the sensor should be  $\pm 10$  arc minutes movement of the target mirror with a 2 sigma accuracy of  $\pm 30$  arc seconds. Ian believes that the range might not be adequate and hence, he plans to ask for a range of  $\pm 20$  arc minutes movement of the target mirror.

The low range alignment monitor system had previously been the subject of a "make or buy" decision. The decision was "make." The new requirements would seem to dictate a review of the previous decision regarding "make or buy." Ian indicated that such a review might be performed but that he believed a "make" decision would be the outcome.

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6. Ian told us that Leighton Meeks in Building 7 had the responsibility for AGE alignment concepts and how they would be implemented.

B. Thursday, 17 April 1969  
(W. Englehart in other meetings for the entire day.)

1. We met with Myron Smith and Dan Ungvasky to discuss the structural aspects of alignment. Dan made us aware of a document called: "Alignment Requirements - Orbit and Ground" dated May or June 1968. The document number is DIN 50062-286-5. Nick Sipa has the responsibility for review and update of the document.

Dan stated that the divergence of the light beam for the Lambda system was tentatively set at five arc seconds by agreement between GE and EK. He later heard that EK might have trouble meeting such a requirement and that the number might have to be revised.

Dan stated that Ernie Hirschfeld would soon ( $\approx$  one month) be publishing a document dealing with one-g bias effects.

Dan made us aware of a rough draft specification called: "Mission Module Structural Subsystem Specification - SP 200, Revision A, Preliminary" dated April 1969. The following is a partial list of documents which were referenced in the rough draft SP 200, Revision A, specification:

- a. (U) DR 113 - Selected Structural Parts for Use in the MOL Mission Module, General Specification for
- b. ~~(S/D)~~ EC 204 - Structural Assembly (Gimbal)
- c. -- EC 1209 - Performance/Design and Product Component Specification for Bearings
- d. (U) EC 1211 - Performance/Design and Product Component Specification for Pressure Cartridge.
- e. -- EC 1215 - Performance/Design and Product Component Specification for Drive A Lockout Device
- f. ~~(S/D)~~ SP005 - GE-AVE Technical Requirements Specification for CEI-MOL-010A1 and CEI-MOL-010B1.
- g. ~~(S/D)~~ IF 101.2 - Mechanical MPSS to Photographic System Interface Specification

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- h. ~~(S/D)~~ IF 101.2.6 - Thermal MPSS to Photographic System Interface Specification
- i. (U) TR 1229 - Performance/Design and Product Component Specification for Preloaded Duplex Bearing Assemblies
- j. (U) IFS-MOL-101002 (MDAC)
- k. (U) IFS-MOL-107003 (MDAC) Laboratory Module to GE-AVE Interface Specification
- l. ~~(S/D)~~ IFS-MOL-707006 (MDAC) MMPS to GE-AVE Interface Specification

2. Dan advised us that the performance progress report for work done up to March 28, 1969, contains an error analysis which incorporates thermal distortion values based upon the new startracker mounting configuration (i. e., baseplate connected to a truss and then to the beryllium structure). The thermal distortion values for the new mounting configuration can be found in the minutes of the TD meeting which convened near the end of March 1969.

3. Dan warned us that the report "MMFS Thermal Distortion for B = 0, -20, -45, and -60 degrees" dated 14 November 1968 is based on the old location of the startrackers and alignment monitor systems. Nevertheless, Dan observed that some information (such as distortion of the beryllium structure) was still valid.

4. A document concerning hotdogging was identified. The report is concerned primarily with distortion of the COA with respect to the Lambda system. The report was approved by Ernie Hirschfeld and is called: "Thermal Misalignment, Subsystem B" dated 30 September 1968 (PIR IK 72-RTM-1267).

5. We were advised that a number of interface change notices (ICN) dealing with IF 101.2 were extant. ICN 101.2-1 through ICN 101.2-37 (or thereabouts) should already be incorporated in the latest version of IF 101.2. The ICN's which seemed to bear on the error validation effort are as follows:

- a. ICN-IF 101.2-19 dated 13 June 1968 (DIN 50246-192-3) defines the limits for film, camera, and shutter shifts with respect to the Ross Barrel OA. GE (Dan Ungvarsky) believes that they have no responsibility for such shifts. Dan also believes that Aerospace (Bob Gaylord) agrees with the GE position.
- b. ICN-IF 101.2-22 dated 13 June 1968 (DIN 50246-194-2). "The LOS of the OA and the Lambda light source shall be within TBD arc minutes and shall be known to within 20 arc seconds when the OA is in the simulated zero-g condition." Myron Smith interprets the 20 arc second figure as meaning 20 arc seconds per axis with a uniform distribution.

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c. ICN-IF 101.2-38-001 specifies that "divergence of the light beam for Lambda shall not exceed 2 arc seconds half angle. Also, the light source, as seen from Station 500, shall not subtend more than 3 arc seconds."

6. We met with Bob Boram to discuss the status of the Drive A servo components. Bob gave us a copy of Specification EC 1720A, Torque Motor, Roll, dated 28 June 1968 and also a copy of Specification EC 1710C, Shaft Position Encoder, dated 17 January 1969. Bob noted that a B revision of EC 1720 is in process. Bob also stated that the current specifications for the ATS encoders are ITEK 114149D and ITEK 114148C.

7. We met briefly with Dick Haga regarding the LGA. Dick advised us that the B revision of Specification EC 1704 is not yet released but that it soon would be. The current requirement for the LGA cross axis support capability is about  $10^{-4}$  g. Dick intends to review the basis of this requirement and assess the factor of safety.

8. Our next meeting was with Glen Quassius and was concerned with the startracker. Glen confirmed that the present specification for the startracker is EC 1701D dated 26 November 1968. The overall startracker accuracy requirement is 35 arc seconds ( $2\sigma$ ). The angle encoders used on the startracker are 4 in. diameter Clifton Precision resolvers (64 pole) which have 20 arc second accuracy. The resolver output is fed to a resolver to digital converter.

The startracker gimbal servo jitter is specified as 14 arc seconds ( $2\sigma$ ). Knowledge of alignment of the startracker alignment cube with respect to the startracker mounting feet is specified to be less than 5 arc seconds ( $2\sigma$ ).

9. We next went to the mockup area so that we might become familiar with the overall physical nature of the many elements of the system. It was again brought out that GE plans to mount only the optical portion of the low range alignment monitor systems on the startracker baseplate. The electronics for the low range alignment systems will probably be mounted to the beryllium structure. The startracker baseplate and the structural truss which attaches the baseplate to the beryllium structure are not to be made of beryllium but of titanium or aluminum. One would certainly want to check on the electrochemical corrosion possibilities present with such dissimilar metals.

While at the mockup, it was mentioned that the Drive A pitch bearings might have a cocking problem which results in exceeding the load limits of the bearings.

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C. Friday, 18 April 1969

1. We met with Dan Moore and learned that he is the project engineer whose responsibility is alignment. Dan stated that he requests Roland Mayer (AGE equip eng design) to design the factory alignment equipment and also the equipment necessary to check alignment away from the factory. The remote alignment checkout equipment must also satisfy any needs due to equipment replacement at sites remote from the factory. Dan observed that, for the moment, he was imagining the factory alignment equipment to be identical to the offsite alignment checkout equipment. Dan did admit, however, that the entire ground alignment problem was still conceptual.

Dan Moore has generated a program plan for the alignment equipment. The plan is described in a document by Dan Moore dated 1 April 1969 (PIR 1 H45-MOL-021-69).

The entire alignment problem, both AVE and AGE is evidently the responsibility of Dan Moore. The basic requirements for AGE alignment evidently stem from the following: Preliminary Study for the 114 MMFS Alignment Set, by G. W. Avis, dated 6 March 1969 (BIF-055-2200-69).

Dan mentioned that the main optical cube is mounted on the beryllium structure by GE after the delivery of the beryllium structure to GE. He also indicated that the tracking mirror mounting ring has several optical wedges mounted on the periphery of the ring. The wedges are apparently used for initial installation and alignment of the tracking mirror.

2. Our last meeting of the trip was a summary with Jim McGuckin and George Christopher. Three basic subjects were covered in the meeting. First, the subject of how the error validation effort at GE and at Aerospace should be interfaced was discussed. It was mutually agreed that the interface would be informal, have direct personal contact between responsible individuals and would entail no hard contractual milestones. We agreed that we would deal solely through Dave Hetzell except where Dave instructed us to contact other individuals directly. In turn, Dave was to deal with W. Englehart (or if he was unavailable, with G. Fotou or O. Drummond).

The second subject dealt with the problem of how the error validation effort was to be managed. J. McGuckin agreed that such a plan was necessary, that it was not yet formulated, and that D. Hetzell would be generating such a plan. Target date for mutual review of the plan was set at 26 May 1969.

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The third subject dealt with the problem of how GE was to effect control of the error sources. That is, how and when would configurations be frozen? How would the change control procedure at GE be employed to effect the desired error control? The target date for mutual review of an error control plan was set at 26 May 1969.

Generally, we reported to J. McGuckin that our trip had been profitable and, we believed, mutually beneficial.

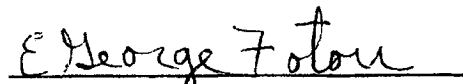
3. We generally accomplished everything which we had set as our goals for the trip. Two specific subjects which we did not cover on this trip were those error sources which relate to the Alpha system and those which relate to the manner in which the error computation is accomplished.

4. A list of sixteen documents which we desired was left with Jim McGuckin who promised to get a copy of each and send them to us.

5. Just prior to leaving for the airport, we had a brief meeting with Leighton Meeks who has the responsibility for AGE alignment equipment design. (We assume that Mr. Meeks is organizationally related to Roland Mayer mentioned earlier.)



O. E. Drummond



E. G. Fotou

OED/EGF:dm

cc: H. L. Ferger  
R. S. Gaylord  
W. G. Smith

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