MEETING OF THE ASTRONOMY WORKING GROUP
INTERNATIONAL ULTRAVIOLET EXPLORER

March 1, 2, and 3, 1977
NASA Goddard Space Flight Center

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Convening of Meeting

Dr. Albert Boggess called this first meeting for calendar year 1977 of the International Ultraviolet Explorer (IUE), Astronomy Working Group (AWG) to order at 9:00 A.M. on Tuesday, March 1. The meeting attendees and the IUE AWG Members and Advisors are listed in Appendixes A and B, respectively. Boggess distributed an agenda of topics to be presented and discussed at this three day meeting. This agenda is presented in Appendix C*. He reported that Mr. Dennis C. Evans had not yet completed the initial set of vacuum optical bench (VOB) measurements that had been planned as an Agenda item for this first meeting day. Boggess said that the Agenda would be modified to allow Evans to continue his measurements and report on his work later in the meeting.

1. PROGRESS REVIEW OF LAST SIX MONTHS

1.a. The overall project and schedule outlook

Mr. Gerald W. Longanecker began his presentation by reviewing the status of the IUE Integration and Test Plan (Summary) presented at the September 1976 AWG meeting (see F-1 of September 1976 Minutes). At that time it was planned that by the end of February 1977, four cameras would be installed in the scientific instrument and through the VOB testing. At the beginning of March 1977 it was also planned that the scientific instrument would be integrated into the spacecraft, and the acceptance test program, which would eventually lead to a November 1977 launch, would begin.

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*These Minutes were prepared in the order of discussion of topics, which are not necessarily in the order shown in the Agenda. The topics appearing in these Minutes use the Agenda numeration sequence. Appendix C also lists the page numbers in these Minutes where the Agenda topics are to be found.

Based on progress during the past six months, Longanecker reported that a new plan has been prepared. This plan was generated as a result of the late scheduled delivery of the flight model cameras and the need to maintain a calendar 1977 launch. He said that it is important that the launch date be held firm since the manpower that has been utilized on IUE is being assigned to new approved programs. In F-1*, there are presented the proposed plan and the work arounds to achieve a 1977 launch based on the late camera deliveries.

The object of this new plan is to gain time so as to be able to integrate at least three flight cameras into the scientific instrument and conduct a VOB test by June 1977. The flight spacecraft with the ETU scientific instrument is currently undergoing testing. At present the flight scientific instrument contains the qualification model camera and the first flight model camera that was delivered. Shortly, the qualification test camera will be installed within the ETU scientific instrument along with the qualification model fine error sensor. This approach will enable initiation of a portion of the acceptance test program with the ETU scientific instrument and so allow the flight scientific instrument to be brought along on a parallel path. In the middle of June a scientific instrument must be available with at least three flight cameras. Two of these cameras would have the short wavelength spectrographs and so require vacuum conditions for calibration and focusing, and one camera would have the long wavelength spectrograph. A fourth camera would be added about August 1, the time of the thermal vacuum phase of the acceptance test program. This revised plan would allow for six weeks of contingency and shipping preparation. Longanecker said that this new plan will not necessarily result in the best technically performing cameras being integrated into the flight model scientific instrument. He went on to say that if this schedule is not met, this program could be set aside for many months or forever in favor of other new programs.

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*Figures in these Minutes are designated F-1, F-2, etc., and are shown at the back of this report.

Dr. Jeffrey L. Linsky asked whether, during this acceptance testing, sample data would be obtained with the electronics operating in a telemetry mode to check for the absence of electrical interference when the tube is going through target preparation or readout. Longanecker said that images will be obtained using the total system during the acceptance test program. Dr. Blair D. Savage wanted to know when the cameras would be selected in the revised plan. Longanecker said that three cameras will be selected during final VOB testing from May 12 to June 8 (see F-1). If another flight model camera is not available, then the qualification model camera will be used to fill the fourth slot. It was concluded by Savage that the far-UV cameras would have to be fixed early. Longanecker said that, based on the revised schedule, there would not be sufficient time to conduct another VOB test.

1.b. Progress with spacecraft, test results

Mr. Kenneth O. Sizemore brought the AWG up to date on the status of the spacecraft. He started his presentations with a visual aid titled "Integration/Testing Schedule", shown in F-2. This viewgraph was an updated version of the aid presented at the September 1976 Meeting (see F-2 from the September 1976 Minutes). At the time of the last meeting the attitude control system (ACS) integration tests were being conducted. These tests were completed with all of the flight model hardware components, with the exception that the qualification model inertial reference assembly (IRA) was used. The flight IRA is presently undergoing testing at Bendix, and is due at GSFC in early April. Integration of the hydrazine auxiliary propulsion system (HAPS) is completed, and in December the fine pointing test (FPT) for the checkout of the closed loop behavior of the attitude control system was completed. (A discussion of this testing will follow.) In February, the early thermal vacuum (T/V) test was completed. Final mechanical assembly of the spacecraft is currently in process, and when assembly is completed, mass properties of the spacecraft will be determined, i.e., static and dynamic balance, thrust movements of inertia, and center of gravity. The other items on F-2 that are crossed out are no longer operative, because of the revised program schedule of activities.

Sizemore then went through the hardware status of each system: (1) all of the mechanical hardware has been delivered and integrated into the spacecraft, (2) all of the thermal hardware is complete with the exception of some thermal blankets which will be completed in time for the T/V test, (3) all of the ACS hardware with the exception of the flight IRA has been built, tested, and integrated, including spares, (4) the command and data subsystem is complete except for some rework required on the three data multiplexer units (DMU), and (5) the communications, power, and hydrazine subsystems are all complete.

He continued his presentation by describing the results of the early T/V test, which provided the opportunity to check the interfaces of the spacecraft subsystem hardware as a function of temperature, and also to check the performance of each subsystem at orbital temperature. (Such early tests help to reduce the overall schedule risk since problems found can be remedied; the test thus provide a high confidence for the final T/V tests.) The most serious problem was the failure of the DMU during the first cold soak. Following this failure, the redundant DMU was switched in and it worked well. It was also found that some HAPS heaters failed, but this turned out to be a ground support equipment malfunction. Procedural errors were found in the interface between the onboard computers (OBC) and the DMU, as well as with the pyros. It was also noted during the test that some thermal blankets will have to be added at the time of the next test to moderate the thermal excursions.

All of these problems are being corrected. Dr. John H. Black wanted to know the present weight of the spacecraft. Sizemore said that a slight surplus of about 15 or 16 pounds out of 1,500 pounds still exists, and that next week a very accurate weighing will be made.

Sizemore next introduced Mr. James V. Moore, the Attitude Subsystem Manager for IUE, who described the results of the FPT. Moore began his presentation by reviewing the IUE control systems. In the slew mode of operation, there are two prime sensors: the two redundant star trackers, also called the Fine Error Sensors (FES), within the telescope, and the six inertial reference gyros of the spacecraft. Data from these sensors are outputted through the onboard data multiplexer into the onboard computer which contains the software algorithms that generate the information for spacecraft maneuver. The output from the computer takes the form of digital reaction wheel commands. These commands are transferred to a digital to analog converter thence to a power stage for the reaction wheels, and finally to four reaction wheels. It is the resulting momentun exchange with the wheels that maneuvers the spacecraft.

Up to the time of FPT, the performance was predicted through computer simulation. In early 1976 a test bed was developed that would enable the development of software routines and monitoring techniques of the system. The December tests in the fine pointing test facility were conducted by mounting the telescope to a 2 degree-of-freedom table. These tests were conducted with a starlike source overhead, so that it was possible to operate in a nearly closed-loop fashion. In the facility the cable that is normally connected to the flight reaction wheels is connected to a set of test reaction wheels. The output from these wheels is sent to a simple gear train which corrects the output for a spacecraft maneuver to a comparable output for the table. Four modes of operation were simulated during the tests: (1) a coarse mode that uses digital information only from the gyros for both attitude and rate, (2) a gyro-only mode for attitude with an update of the gyro drift rate with information from the FES, (3) attitude information and gyro rate information, and (4) slewing maneuvers. Moore showed the Group the simulation data for each of these four modes of operation in this successful demonstration.

Sizemore concluded the presentation by showing the Group some photographs taken of the spacecraft during the early T/V test while in the Solar Environmental Simulator (SES).

1.c. Progress with the scientific instrument

Mr. H. D. Vitagliano made this presentation for Mr. Dennis C. Evans, the scheduled speaker. Evans was working to acquire some initial VOB data to present to the Group.

Vitagliano brought the AWG up to date on the telescope tests and the status of the telescope flight unit. He showed the results of optical alignment facility tests of the ETU telescope. In these tests, the positions of the image were measured before and after vibration. The performance requirements were met, with the results of these tests presented in F-3.

He next described the FPT with the engineering model FES, which he said is equivalent to the flight model. The stability was determined to be about 0.2 second of arc, and it was possible to locate a star in the spectrograph aperture with information from the FES. Some changes were detected in the telescope focus as the result of rough procedures and more work will be conducted to understand why this happened. Geometric calibration was accomplished to insure proper alignment of the FES. Work was also performed to improve the ability to track stars fainter than +15 magnitude with the FES by increasing the background of the FES tube. He reported that the flight telescope is provisionally acceptable for flight. F-4 shows telescope performance data based on encircled energy and knife edge measurements. For example, in F-4 under item C, Flight Structure, 83 percent of the energy was included in a 100 μm diameter circle (100 μm is about equivalent to 3 seconds of arc), which is equivalent to 65 μm in the knife edge test. The B&C star indicated on F-4 refers to a Boller and Chivens source. Three tests were also made in the Low Temperature Optical Facility (LTOF) for temperatures at +20°C and -10°C to check telescope performance. The telescope runs at about +10°C in orbit. These tests were conducted at uniform temperatures, i.e., gradients were not present. To improve the knife edge test performance, a design modification was made in the tangent bar that holds the primary mirror, and the improved results are indicated in Test #3 of F-4. Savage said that he would like to see presented an estimate of the point spread functions of the optical system. Boggess said that calculations will be made to generate a best estimate of the image shape at room temperature and its variation with temperature.

Vitagliano said that the flight spectrograph has been mounted to the telescope, and all of the spectrograph mechanisms have been installed. The -17.5 percent contracted format gratings are also installed. These gratings have a minimum order spacing of 215 μm, and the 0 percent and +15 percent alternate gratings have been received. The electronics are in the Experimental Electronics Assembly (EEA), and the radiation shielding has been installed. It will be necessary to rework the lamp power supply as a result of the noise from the command lines. The filters for the incandescent and UV flood lamps used for testing in the VOB are being modified. The cameras that are installed are the qualification model unit, serial number 03, and flight unit 1, serial number 05.

He concluded his presentation by providing the Working Schedule shown in F-5 that has been prepared to satisfy a 15 December 1977 launch ready date.

1.d. Progress with the U.S. ground station

The status of the IUE ground system activities was given by Mr. Charles F. Fueschel. He reviewed the work accomplished since September 1976, and said that almost all of the hardware deliveries had been made. One of three Experiment Display Systems (EDS) was delivered from Bendix in December, with the other two units to be delivered in March. The IUE image header has been modified to reflect the inputs from the U.K. These activities are summarized in F-6, and the status of the Ground System as of March 1977 is summarized in F-7. Fueschel told the Group that only about two-thirds of the IUE Satellite Image Processing Scheme (SIPS) has been converted over to the Sigma 9 computer. He concluded his presentation by a review of the planned activities for the next 6 months.

Linsky wanted to know what would happen if the ground system "crashed" during an exposure/readout from IUE. Fueschell said that a crash would not affect an exposure in process, but if the crash occurred during a readout, the data would be lost. He also said that backup ground recorders could be added.

1.f. Progress with European ground station

Dr. F. Macchetto showed the Group a schedule of activities for the IUE ground station at Villafranca, Spain. The activities have been divided into three groups: the ground station hardware, computer and software, and training activities. The only hardware installed in the ground station is the Sigma 9 computer, which has been operating with Operations Control Center (OCC) and image processing software. The S-band antenna has been on site for about a year, and awaits integration. Macchetto said that most of the equipment will start to arrive in May, with delivery and checkout completed by the end of August. There are two hardware items on the critical path: the EDS delivery and the VHF antenna installation. This antenna was loaned by NASA, and is in Spain. The hardware will be completely tested and ready for operation by the simulation personnel at the end of September. He concluded by saying that the European ground station will be ready for a December launch.

1.e. Progress with cameras

The first speaker in the afternoon was Dr. Robert Wilson, and he introduced the other members of the U.K. team who were attending and participating in this meeting of the AWG. He then briefly summarized the material that was to be presented.

Wilson began his technical presentation by reviewing the five technical problem areas that were discussed at the September meeting:

(1) EHT units (extreme high tension or high voltage) are stable and no longer a problem;

(2) UV converters are no longer a problem following development of new converters by ITT and the U.K.'s understanding of the handling requirements of high field devices;

(3) The potting problems have been solved by the use of a stiffer mix of Solithane; this mix was used to pot the four flight cameras and the two spares;

(4) The statistical significance of the high loss of SEC tubes from a screened sample will be explained later in the presentation; and

(5) The drift of the resistors under the thermal cycling problem has been solved, so that they now are qualified, but the transistor components (two in each camera) have failed their qualification tests; this failure poses a major technical problem, the proposed solution of which will also be explained.

Wilson reported that two cameras have failed, with the causes of the failure being investigated. Camera 07 has a performance defect during long exposures in the highest head amplifier gain mode. The The SEC tube in camera 06 has failed, and it is believed that its target is ruptured.

Wilson called on Mr. Michael C. W. Sandford to discuss the SEC tube problem, the transistor problem, and also the two camera failures.

Sandford first reported on the transistor problem. These transistors are used in the camera in two places; (1) the G1 supply, which controls the beam current in the readout section of the camera, and (2) the G3 supply, which furnishes the electrostatic power for the focus operation. These transistors, supplied by Motorola, were built into the cameras before the completion of the qualification tests. It was found that the transistors failed the 2,000 hour, 1 watt operating life test. The failure rate was 7 out of 20, with only one failure being acceptable.

Two routes were followed to correct the problem. The first route was to find a new part (an RCA transistor was identified), and the second route was to reorder a new batch of Motorola transistors. The preliminary qualification of the RCA transistors proceeded satisfactorily, but Marconi, the camera vendor, experienced an unacceptable number of failures in this part. Analysis indicated that the RCA transistor failure mode was the result of electrolytic migration of aluminum coupled with contamination. By the time this result was discovered, the RCA transistors were already installed in all of the camera modules. Reliability analyses with the RCA device indicated an early camera failure, with the failure of at least one of the four cameras almost certain in a 3 year mission. The second batch of Motorola transistors have completed all qualification tests, but are only through 1,000 hours of life test. The failure rate on this second batch is 0 out of 22 compared with 6 out of 21 for the first batch in the same development stage. A voltage-power matrix life test was developed, with the second batch performing well during this test, indicating, so Sandford reported, that Motorola has solved the manufacturing problems so that their transistors are now usable. These new Motorola transistors are now being installed. The camera transistor status is summarized as:

Camera	G1 Circuit	G3 Circuit
03	RCA	M-1
04	RCA	RCA
05	RCA	RCA
06	M-2	M-2
07	M-2	M-2
08	M-2	M-2
09	M-2	M-2

M-1: Motorola batch 1
M-2: Motorola batch 2

Three SEC tubes have experienced leakage failures as a result of corrosion. Sandford showed the AWG pictures of the cracks in the Kovar flanges that are brazed onto the tube ceramic. Cracks that penetrated through developed in the Kovar and in the braze. It is believed that the corrosion arose from the presence of the zinc chloride flux used in soldering connections; this flux had not been completely washed off. Chlorine was found in the corrosion cracks, but Sandford noted that all the tubes did not fail. He believes that there is a good correlation showing the failure of the braze to be related to the fillet shape and the presence of chlorine, and that this shape is related to the quality of the nickel coating on the Kovar. A nickel coating is applied to prevent migration of the copper in the copper/silver braze material. He concluded this presentation on the SEC tubes by evaluating the probability of camera survival:

Camera	Probability of Survival
03 (Qual.)	D
04	A
06	A
08	A
09	A
07	-
05	C

A: highest probability of survival
D: lowest probability of survival

After launch, the possibility of SEC tube leakage should not be a problem, since the tube will be immersed in a vacuum.

Camera 07 has a background problem Sandford reported. After a one-half hour exposure at high gain, a crescent shape can be seen over half of the tube. He showed pictures of this crescent. F-8 shows a summary of the investigation to locate the source of the problem. The problem was manifested by a light breakdown in the potting which appeared after the application of a second layer of potting. A possible cause of the light could be a bubble in the potting but none has been found. Sandford said that the process is underway of cutting the potting out to find the source of the problem. It is possible that there is a thin laminar void with gas in it that has defied detection, and that this void is producing the background.

Camera 06 failed during vibration test at Marconi. F-9 shows the test program followed. The camera passed the initial performance test, but failed its performance test following vibration. The failure was noted by observing a peculiar annulus in the flat field picture. Based on testing, it was concluded that the target was broken. He said that both the tube and its mounting had met their individual qualification tests. Westinghouse, the supplier of these tubes, ran a vibration screening program to weed out bad tubes. This problem is being investigated.

Wilson next reported on the status of the camera development and the details of UCL's approach to rework the parts problems (see F-10 for details). The cameras are processed as pairs: 05&07, 04&06, and 08&09. Program schedules in bar chart form were presented and are shown in F-11. The top schedule was prepared before the failures of cameras 06 and 07, and the bottom schedule reflects the influence of the repair on the scheduling of 06 and 07.

Wilson completed the presentation with a discussion of the U.K.

software tasks which are nearly complete. These tasks are shown in F-12 to F-14.

Savage asked which are the best cameras and Wilson answered 08, 09, 07, and 06 and in that order. Wilson said that if he had to recommend an approach to satisfy the delivery dates that he would rather reduce or eliminate calibration and so fly the good cameras uncalibrated, rather than fly the bad cameras, calibrated. Calibration, he said, can be performed in flight. There ensued a discussion of the calibration process and various approaches for shortening the time requirements. Wilson said that all the options should be considered and that it would be valuable to identify a route that is scientifically acceptable which would also make a December launch. Longanecker made the point that it would be valuable to compare the VOB testing with the UK calibration to identify possible duplication of efforts. Elimination of duplication could speed up the camera preparation. Boggess concluded the discussion by saying that there will be a discussion tomorrow morning (March 2) of the VOB testing at GSFC and the camera optimization at UCL.

3. INITIAL VOB DATA

The agenda plan was for Dr. Daniel A. Klinglesmith to report on the initial VOB data. Since this data was not available, he spoke about his data reduction procedures, and the application of these procedures to a few images that were obtained from a laboratory mockup of the spectrograph with an engineering camera.

Klinglesmith reviewed the data reduction sequence of events starting with the raw image from the IUE spectrograph. The image is collected in the Sigma 5 computer, and then is passed to be stored on a shared disk in the Sigma 9; it is this later computer that does the image processing data analysis. The first step is to remove noise and blemishes that might show up. This is then followed by a geometric transformation that he expects will have to be accomplished before the photometric corrections. Next, the first stage intensity transfer function for the photometric correction is applied. The wavelength scale for the particular exposure is determined. Radiation background is then subtracted out by comparing the spectrum picture from the camera with a picture from a camera that was just turned on. The spectrum is then extracted by running a slit down the orders which allows for correction of the echelle ripple as a function of wavelength. Finally, a Calcomp plotter produces the tracing of the spectrum.

Klinglesmith then showed a series of deuterium spectra that were taken with the laboratory system. He showed the effects of a 16-fold increase in the exposure time from 90 sec to 1,440 sec. Klinglesmith said that the next step is to figure out how to remove scattered light or background. At present, techniques for echelle ripple correction and quantum efficiency correction are not available and await the production of camera images at GSFC. Macchetto asked whether there is a routine for an extended object that gives the spectrum as a function of position across the slit. Klinglesmith said that a data extraction program exists that can be modified to satisfy this requirement. Dr. Anne B. Underhill asked whether programs have been developed to allow for altering a low resolution spectrum and arriving at intensity as a function of wavelength. Klinglesmith said that this is not yet available, and Dr. David Fischell is working on this program.

Dr. Andre Monfils added a comment concerning the privacy of observations which was a matter of concern at the last meeting. He pointed out that the noise problem should encourage observers to put their results together, and that all data should be available for every observer. There was a brief discussion of priority rights. Boggess summarized by saying that, based on the three agency agreement, if the data is less than 6 months old, it would not be available. The observers would, however, be informed of what is available, so that it would be possible for them to work together.

Klinglesmith then asked Fischel to describe the results of the echelle overlap problem investigation that was requested at the time of the last AWG meeting. Fischel handed out a copy of a report that he wrote, titled IUE Echelle Order Overlap, which presents an investigation of the feasibility of disentangling the contributions from nearby orders. He then proceeded to summarize this work and told the Group that a direct solution method would require about 2 1/2 hours of computational time. The problem is to invert a 120 x 15 matrix for every slice perpendicular to the orders. There was a lengthy and sometimes heated discussion of the factors that led to the matrix size and techniques for matrix reduction and the implication of large overlap on the shortwavelength spectrograph. Fischel offered to make a calculation which shows the effect of the exclusion of a contributing order. Boggess said that some value judgment will have to be made as to the effort that should go into the overlap correction, and if the correction is not acceptable, then it may be necessary to change the dispersion at the sacrifice of spectrum coverage. Linsky said that the Project should consider preparing an algorithm to allow for an approximate correction to the overlap problem.

The first day of the meeting was adjourned at 5:20 P.M.

The AWG assembled in the Conference Room at 9:00 A.M. on Wednesday, March 2, and immediately left for Building 14, the location of the IUE Operations Control Center (OCC).

5. DEMONSTRATION OF EXPERIMENT DISPLAY SYSTEM

Fueschel passed out a Functional Specification-Computer Programs for IUE Experiment Display Systems memo prepared by Bendix Aerospace Systems Division, and he described the Experiment Display System (EDS) hardware in the IUE OCC room. Klinglesmith gave a demonstration of manipulation of images by the EDS. Fueschel also described the Sigma 5 and Sigma 9 equipment. The Sigma 5 computer is used for satellite control functions and the Sigma 9 is used for image data processing.

6. CAMERA OPERATING MODES AND PROCEDURES

The Group returned to the Conference Room at 10:45 A.M. to hear Wilson's introduction to this topic. He said that this presentation would describe all the phases of the camera preparation, including: (1) evaluation and selection of individual components and bonding at UCL, (2) integration into a flight camera system at Marconi, (3) return to UCL for calibration and optimization, and (4) forwarding to GSFC for satellite integration and ultimately operation in orbit. He then introduced Dr. Prab M. Gondhalekar.

Gondhalekar began his presentation by listing the personnel at UCL who are participating in the life tests, analog tests, digital evaluation, and calibration for the camera, and the personnel at Appleton Laboratories who are working on the software development and support, data analysis, and calibration of the software package. He said that the camera has two components: the SEC tube and the UV converter (UVC). F-15 shows a diagram of steps performed in camera preparation. The IUE 502 test sets the baseline performance for the bonded pair, i.e., SEC and UVC. Details of the SEC and UVC acceptance testing are presented in F-16 (left) and F-16 (right), respectively. He said that after tube optimization [see F-17 (left)], a digital evaluation is conducted and the specific tests comprising this evaluation are listed in F-17 (right). These tests are followed by the IUE 502 tests to establish the baseline performance shown in F-18 (left). Optimization is continued after the assembled camera is returned from Marconi according to the steps indicated in F-18 (right). These tests are conducted to optimize the beam acceptance to insure that the target gain, signal to noise, and resolution are all high. These tests have taken longer than planned Gondhalekar said. The prep sequence which follows is crucial to good camera performance to insure the elimination of a possible pattern on the target that would interfere with the read beam and produce a form of noise. The process of determining the best prep sequence is still underway. The prep sequence used for the preparation of the qualification and 05 cameras is shown on F-19. He then described the camera calibration data that is collected (see F-20 for details).

Gondhalekar went on to describe the software operations that are carried out on the images [see F-21 (left)], and the photometry testing and corrections [see F-21 (right)]. The Group was next shown the intensity transfer functions and the modulation transfer functions for the qualification and 05 cameras. At this point, Gondhalekar showed slides of images taken with the cameras and the influence of various parameters. The qualification and 05 camera performance is shown in F-22. He then showed some overlap data based on the use of a bar pattern with the camera at 1,900Å and at Lyman α. Gondhalekar concluded that this approach indicated that the major contribution to the reduction in the overlap problem was the result of shifting the image relative to the vidicon rather than the use of a contracted format. The overlap would be reduced even further if the format was not contracted, but then there would be loss of some spectra. He is trying to match the echelle spectrum to the camera performance. There was a discussion of the tradeoffs of the parameters that affect the overlap. Savage said that the 10% overlap that is indicated is very encouraging, but that it will still be necessary to make a correction.

Boggess said that at yesterday's meeting (March 1) the point was made that it might be possible to sacrifice part of the UCL work to allow for a speedup in delivery, and he asked Gondhalekar to identify the essential and less essential camera preparation tasks at UCL. Gondhalekar said that he considered camera optimization to be crucial and should not be sacrificed. He said that there is some room to maneuver to reduce the camera calibration, but Wilson took exception. It may be possible to eliminate the determination of the modulation transfer function (MTF). Also, he believed that some of the photometry testing could be eliminated. Klinglesmith said that it would not be possible to obtain the MTF from orbital operation, and if he had to make the testing decision, he would make this test plus a simple intensity transfer test, and drop the rest.

Gondhalekar said that it will take three weeks per camera at UCL to go through the testing and preparation that he described. This work will be done serially since there is only one facility.

4. DISCUSSION OF PERFORMANCE CRITERIA FOR EVALUATING SCIENTIFIC INSTRUMENT

Following the lunch break, Boggess introduced the subject of camera/ scientific instrument testing at GSFC. He first reviewed the type of measurements that can be made with the scientific instrument on the ground and in orbit. There are three light sources in the scientific instrument. The first of these are tungsten flood lamps which are bright sources, and are used during the prepare sequence. Mercury flood lamps are the second, and although they are not filtered, they emit at 2,537Å. This mercury source is faint, and it is used for the determination of the intensity transfer function. The third source is a platinum wavelength lamp; this source can be passed through the spectrograph optical system, and is used both as a wavelength standard and as the means of monitoring the responses of the system near point emission sources. Reoptimization of the instrument in orbit would be accomplished using these three sources plus a stellar source. There are no brightness monitors for the lamps, but their power supplies are stable sources.

Boggess next described the light sources in the VOB. These sources are well collimated with a minimum angular aperture of about 1 second of arc. The sources can be used in a micrometer mode to scan through many wavelengths. The sources available in the VOB are gas discharges and include (1) H_2 and D_2 spectra which provide continuum radiation, (2) O_2, N_2, and NO which provide molecular spectra, and (3) the possibility to interpose in front of these sources absorption cells (provided by Gondhalekar) containing O_2 and NO to attain absorption spectra.

He told the group about the planned activities for the scientific instrument and the cameras in the VOB using the enumerated light sources. Presently, focus and alignment checks are being conducted. He said that it is believed that after the four camera locations are selected, it will be possible to interchange cameras without the necessity of a refocus test. Gondhalekar asked how the spectrum would be formed on the photocathode. Boggess said that the cameras would be placed in the spectrograph at the nominal focus position. The telescope would then be refocused by moving the secondary mirror, images would be taken, and a new best position would be determined. The next activity, Boggess reported, would be to take a series of platinum arc images which yield the first mapping of the camera in terms of wavelength. Then a series of exposures would be made to obtain the echelle order separation, initially using the long wavelength spectrograph and a deuterium source. Echelle ripple calibration would be the maxt major test. (This refers to the measurement of the blaze function to allow for the preparation of calibration tables for the software people.) He then described some of the test combinations that could be made since the VOB is a scanning spectrometer. Two types of scattered light test will be made: (1) white light, and (2) narrow angle scattered light. Another primary test will be polarization, but these tests can only be done over the spectral range of the long wavelength spectrograph.

Following the VOB tests, Boggess said, it will still be possible to do additional testing in air with the long wavelength telescope, and also during the extensive thermal vacuum (T/V) tests, in which it will be possible to operate both the long and short spectrographs. During the T/V test it will also be possible to simulate the temperature environment in orbit.

Boggess asked the AWG to identify the least important tests that are to be carried out at UCL and GSFC. Underhill suggested that the polarization measurements could be dropped, since they will only be done for the long wavelength spectrograph. Boggess said that if this test were eliminated there would be a significant saving, like several days. There was a lengthy and unresolved discussion of the overlap from one order to another, and this discussion ultimately led to the implication of slipping the launch date. Underhill said that, based on Gondhalekar's comments, she agreed that ground camera optimization is very important and that this work be given a high priority. She went on to say that it will be important to assess the ITF and MTF of the cameras alone and the cameras in the system, followed by the wavelength calibration. The last items she included were the echelle ripple and the system efficiency. Drs. Arthur L. Lane and Jeffrey L. Linsky offered an approach to testing that would require full ground testing of one pair of flight cameras and as much testing of a second pair as possible within the given launch schedule; the calibration of the second pair would be completed in orbit.

Longanecker brought up the topic of camera transistor retrofit. He said that when this modification was originally mentioned, GSFC agreed to it, provided it did not adversely affect the schedule. It is his contention that the Project is not taking an unnecessary risk if the retrofit is not done. Lane countered this with a statement concerning the necessity of success because of the career time invested by the many scientists on this effort. He went on to say that if reliability and calibration problems are known to exist, then the Project must allow for their correction. Longanecker was worried that if the launch date slips, there is the reasonable possibility that the satellite will be mothballed, never to be resurrected.

Monfils said that in his opinion there are three operations that must be carried out: optimization, assurance of high reliability, and determination of the correct order of magnitude of the ITF and MTF.

12. IN-ORBIT COMMISSIONING OF IUE

12.a. Spacecraft checkout

Boggess introduced the subject of the in-orbit commissioning of the IUE, and summarized the conclusions reached at the last meeting on the subject. The AWG at that time indicated preference for a minimum initial checkout, followed by routine observing, with the esoteric testing being conducted with the aid and assistance of the astronomers rather than detailed thorough initial checkout. He said that there will be meetings starting on Friday, March 4, to make specific plans based on the approach recommended by the AWG, and that he wished to review the current approach and gain the AWG's new insights. He introduced Mr. Frank A. Carr, who proceeded to make a presentation on spacecraft checkout.

Carr told the Group that detailed plans for the checkout of the spacecraft and scientific instrument have not been completed. Before observations can begin, he said that it will be necessary to follow an engineering checkout phase of the prime and redundant electronics on the spacecraft and in the instrument. At the time of shipment of the spacecraft and its instrument to the Cape, checkout and assembly will be complete, with the possible exception of the sunshade. Once at the Cape, electrical tests will be performed to check that the spacecraft survived shipment. Following spacecraft mating to the Delta, some additional functional tests will be performed. During the 21 hours of the launch injection phase, there are no plans for checkout of the instrument. After 21 hours, the satellite will be at the synchronous orbit altitude, and the apogee injection motor will be fired. After the burn, the spacecraft spin is removed, the solar array is deployed, and there follows a rigorous functional checkout. Carr introduced Dr. Richard H. Freeman, who discussed the engineering checkout phase of the mission.

Freeman, the Project System Engineer, started his discussion of checkout with the system test at the Cape, which should occur about 1 week before launch. Just prior to launch there will be a go/no-go test. During the orbital injection and coast phases, engineering monitoring and support data is collected. At apogee, the boost motor is ignited. After this, the vehicle is two-axis stabilized and the solar arrays are deployed, a process that takes about 2 hours. As a result of the new orbit that was accepted after the last meeting of the AWG, the satellite will be on-station. About 24 hours of data collection is needed for orbit determination, and an additional 12 hours are needed for the satellite to coast to its perigee, where the orbital correction is applied. During this 36-hour period, the third axis attitude is determined, and the spacecraft primary and secondary systems will be turned on. It is the opinion of the Project that the telescope cover will be removed after the orbit correction maneuver. Checkout of the high voltage systems would then be initiated 3 1/2 days after launch. Following spacecraft checkout and high voltage turn on, the scientific instrument check-out would begin. Freeman said that the camera checkout program has not been determined.

12.b. Initial scientific instrument checkout

Boggess reviewed the kinds of tasks that would be conducted on the scientific instrument after the engineering tests. He said that it is important to identify what is essential. FES tests are important to determine guidance quality as well as the ability to get a star in the telescope field of view. FES tests also allow for check of the telescope focus. It will also be necessary to measure the telescope focus with respect to the spacecraft orientation relative to the sun. Preliminary estimates indicate that refocus will not be necessary. After the cameras are turned on, engineering tests will be made based on U.K. recommendations. He went on to say that the mercury flood lamps will be used to measure the ITF so as to establish confidence, and probably the first spectrum will be taken with the platinum lamp. After the cameras are working routinely, the particle radiation contribution to the background will be measured. Also, the scattered background tests due to earth light will be determined initially. Star spectra will be taken to (1) test the focus of the system, (2) assess the scattered light, (3) check for system response relative to the wavelength of standard stars, and (4) accumulate a library of sample spectra. These are the operations, he said, that could be performed to make certain that the scientific instrument works.

Linsky added that the contingency set of observations should be included in the event that the spacecraft malfunctions early. These tests should probably be conducted before the standard star and wavelength calibration tests. Macchetto made the recommendation that the contingency data should be acquired and set aside, and only used if the satellite fails. Boggess suggested that all contingency observations be put into a file and made available to all people who intend to observe the object with IUE.

Boggess asked the AWG for its recommendations for the kinds of tests and calibrations that should be done initially and for the work that could be deferred. Dr. John B. Hutchings recommended that measurements be taken for objects on the standard star lists that have also been observed by Copernicus. Savage said that the initial checkout should be made as simple as possible, and that the real problems will come out as the instrument is used.

Underhill said that during the observation of bright stars for purposes of calibration, some of the Users who have had experience should be brought in for support to help interpret targets selected by the Project. There was a discussion of the length of time for checkout before the satellite would be available to Guest Observers. Wilson suggested that each agency should select Guest Observers to support the commissioning process.

12.c. U.K. and ESA participation in checkout

Wilson said the scientific commissioning would be an integrated effort, among the three agencies. The persons that participate in this process would be those considered best to assist the commissioning process and their reward would be some scientific data.

Macchetto told the AWG that the main issue was the calibration that had to be accomplished as part of the commissioning process and the selection of the best suited objects. The priority list should be considered later to determine whether some of them should be included among the test objects.

Dr. Donald K. West said that experience indicates that if satellite failure occurs, it usually happens early after launch. He proposed that the measurement of high priority objects should await some indication of trouble.

Savage said that it will be difficult to obtain correction data for both interorder spillover, general background, and radiation field background. It was his opinion that it will take about 2 or 3 months before these corrections have been identified, due to the need to collect and process a large quantity of data.

Boggess then summarized the discussion that had ensued, and said that in the beginning (1) a check must be made to assess that the telescope and spectrograph are functioning at an acceptable level, and (2) preliminary estimates must be made of scattered light, the background problem, and wavelength calibration to allow for correction and interpretation of data. After this rudimentary evaluation, outside observers could be brought in and the three agencies could then go their own way. Linsky added the thought that during the first few months of operation a certain fraction of time should be allocated to the questions that require a long baseline of satellite operation for their evaluation.

8. PUBLICATION OF IUE OBSERVING LISTS

West handed out a list of stars which included: (1) photometric standard stars designated as PHSTD301, (2) representative stars, RP1ST301 and RP2ST301, and (3) high priority targets, HPTGT301. A partial page of his 11-page handout is shown in F-23, with the column headings indicated. The format shown in F-23 is the same as for the target list. The sources (see F-24) for the selection of these objects came from one of the original User Group Meetings, and the interest group leaders at that time were responsible for their selection.

The meeting ended at 5:53 PM

The Group assembled for the third and last day of this meeting at 9:00 A.M., on Thursday, March 3.

10. SELECTION OF NEW AWG MEMBERS

Boggess said that the IUE observatory will need a policymaking body, and for this reason, he wants the AWG to continue after launch. He then told the Members of the AWG that their term is for a period of 2 1/2 years, and that the terms of Drs. John B. Hutchings and Donald K. York would expire following this meeting. He also told the Group that a replacement must also be found for Underhill, who will be on another assignment for a year. He will use his prerogative to select the GSFC replacement for Underhill. A list of the present and past AWG Members as well as other non-NASA Users was written on the blackboard. There were six nominations made, and the Group voted for all six persons, who were then ranked in three groups, one of which was a group of astronomers familiar with Copernicus. Boggess will contact these people and determine which two can serve as Members.

11. DATE OF NEXT AWG MEETING

The last AWG Meeting before the launch of IUE will take place on Tuesday, September 27, and Wednesday, September 28. A Users Meeting was also scheduled for Thursday, September 29, and Friday, September 30.

6. CAMERA OPERATING MODES AND PROCEDURES

Wilson described the operation of the bonded UV Converter/SEC tube shown in F-25. He then proceeded to review viewgraphs, titled "Hazardous and Undesirable Command Sequences", "Sequences Available to Astronomers", and "Observer's Choice of Operating Parameters", that were presented at the September 1976 IUE AWG Meeting (see F-18, F-20, and F-19, respectively, in the September Minutes). Monfils brought up the subject of standard calibration transfer. Wilson said that the absolute calibration would be accomplished by using OAO-2, S-268, and Copernicus data. IUE would observe the same object as these other satellites, and the output signals would be integrated over the same pass band and equated to allow for transfer of calibration. Monfils then asked whether the camera calibration could be used to make the necessary intensity transfer. Wilson said that this was not known; the present calibration philosophy is to check the laboratory calibration at UCL against the onboard mercury lamp signal output.

3. INITIAL VOB DATA

Mr. Dennis C. Evans showed the Group the first processed images taken in the Vacuum Optical Bench (VOB) Facility. The images were taken by using the long wavelength qualification model camera in the low dispersion mode with a deuterium source. The first spectrum obtained was overexposed as a result of stray light present due to the absence of an optical baffle. The second image was an echelle spectrum obtained of the deuterium source with a 2-hour exposure.

This spectrum indicated the presence of the echelle ripple. Another image was made of a single order centered at 2,500Å. There followed a discussion of the significance and limitations of these results. The echelle order spacing appeared to be incorrect and there was speculation that this could result from using the wrong cross-disperser. (After the AWG Meeting, Evans determined that the long wavelength and short wavelength cross dispersers had been interchanged.) Evans said that the flight model camera is in bonded storage and after final approval of the software, this camera too would be tested in the VOB.

Evans reported his plans for the next few weeks. Checkout of the electrical harnesses required for operation in the VOB will continue. Following this checkout, the harnesses will be baked out to enable operation in low vacuum. During this bake out, the spectrograph instrument will be removed and aligned. By the end of March the vacuum measurements should be complete, and from the middle of April to the middle of May, the camera will be in the low temperture facility for acquisition and focus testing studies, and long wavelength stray light testing. The cameras will then be returned to the vacuum facility for final focus calibration.

13. OTHER BUSINESS

Boggess reported that Monfils had given him a list of stars that had been well observed by TD1. These objects might be suitable as calibration standards for the low dispersion spectrograph. He passed out the list of proposed stars along with supporting text. Monfils briefly discussed these assumptions. It was stated that since the TD1 cut-off is at 1,350Å, a good deal of work would be required to extend the TD1 calibration. Boggess asked Monfils to provide the TD1 inputs for the calibration task. Boggess asked that the subcommittee on photometric standards, headed by Savage, assume responsibility for specifying the ways standard star data should be used to calibrate IUE. (Boggess has named Dr. Ralph C.

Bohlin from Goddard to work with Savage on this problem.)

7.d. Rules for government-furnished magnetic tapes

West told the Group of the latest NASA General Management Instruction (GMI) that will require that magnetic tapes be furnished to the Principal Investigator's institution. There has been a problem in the past of accountability of tapes as a result of astronomers moving from place to place. This will mean that the Guest Observers will not be able to take the data with them when they leave GSFC. A plan is being worked out by GSFC that will allow the Guest Observer's institution to issue a courier's authorization which would enable the Observer to leave with the data.

The March meeting of the IUE AWG adjourned at 12:00 A.M. on Thursday, March 3, 1977.

APPENDIX A

ATTENDANCE LIST
IUE ASTRONOMY WORKING GROUP MEETING

Members	Organization
Dr. John H. Black	University of Minnesota
Dr. Albert Boggess	Goddard Space Flight Center
Dr. Andrea K. Dupree	Harvard College Observatory
Dr. John B. Hutchings	Dominion Astrophysical Observatory
Dr. Arthur L. Lane	Jet Propulsion Laboratory
Dr. Jeffrey L. Linsky	Joint Institute for Laboratory Astrophysics
Dr. Andre Monfils	Institut d'Astrophysique
Dr. Blair D. Savage	University of Wisconsin
Dr. Anne B. Underhill	Goddard Space Flight Center
Dr. Robert Wilson	University College London

Advisors	Organization
Mr. Peter J. Barker	Science Research Council
Mr. Leon Dondey	NASA Headquarters
Mr. Dennis C. Evans	Goddard Space Flight Center
Dr. Daniel A. Klinglesmith	Goddard Space Flight Center
Mr. Gerald W. Longanecker	Goddard Space Flight Center
Dr. F. Macchetto	European Space Agency
Dr. Donald K. West	Goddard Space Flight Center

Others	Organization
Mr. Frank A. Carr	Goddard Space Flight Center
Mr. C. Cheng	RCA (IUEOCC)
Mr. Juergen Faelkner	European Space Agency
Dr. David Fischel	Goddard Space Flight Center
Dr. Richard H. Freeman	Goddard Space Flight Center
Mr. Charles F. Fuechsel	Goddard Space Flight Center

APPENDIX A (Concluded)

ATTENDANCE LIST
IUE ASTRONOMY WORKING GROUP MEETING

Others	Organization
Dr. Prab M. Gondhalekar	Science Research Council
Dr. Sara R. Heap	Goddard Space Flight Center
Mr. James V. Moore	Goddard Space Flight Center
Dr. P. M. Perry	CSC
Mr. E. J. Pyle	Goddard Space Flight Center
Mr. Michael C. W. Sandford	Science Research Council
Mr. Kenneth O. Sizemore	Goddard Space Flight Center
Dr. Warren M. Sparks	Goddard Space Flight Center
Dr. Brian Stewart	Science Research Council
Dr. Graham R. Thomas	Science Research Council/GSFC
Mr. F. Thomason	RCA (IUEOCC)
Mr. H. D. Vitagliano	Goddard Space Flight Center
Dr. Chi-Choa Wu	CSC

- -

Mr. Howard B. Winkler	DYNATREND INCORPORATED

APPENDIX B

IUE ASTRONOMY WORKING GROUP MEMBERSHIP

March 1977

Black, John H. Dr. School of Physics and Astronomy University of Minnesota Minneapolis, MN 55455	March 1976*
Boggess, Albert Dr. Code 673, Goddard Space Flight Center Greenbelt, MD 20771	
Boksenberg, Alex Dr. Dept. of Physics and Astronomy University College London Gower Street London WCIE 6BT England	
Dupree, Andrea Dr. Harvard College Observatory 60 Garden Street Cambridge, MA 02138	September 1975
Hutchings, John B. Dr. Dominion Astrophysical Observatory Victoria, B. C. V8X 3X3, Canada	September 1974
Lane, Arthur L. Dr. Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, CA 91103	September 1976
Linsky, Jeffry L. Dr. Joint Institute for Laboratory Astrophysics University of Colorado Boulder, CO 80302	September 1975
Monfils, A. Prof. Dr. Institut d'Astrophysique Avenue de Cointe 5 B4200 Cointe-Ougree Belgium	
Moos, H. Warren Dr. Dept. of Physics Johns Hopkins University Baltimore, MD 21218	March 1976

*Date at which 2.5 year term starts

IUE ASTRONOMY WORKING GROUP MEMBERSHIP

Savage, Blair Dr. September 1976
Dept. of Astronomy
University of Wisconsin
Madison, WI 53706

West, Donald K. Dr.
Code 672, Goddard Space Flight Center
Greenbelt, MD 20771

Wilson, Robert Dr.
Dept. of Physics and Astronomy
University College London
London WCIE 6BT England

York, Donald G. Dr. September 1974
Princeton University Observatory
Princeton, NJ 08540

(At this time, March 1977, one ESA place is vacant.)

APPENDIX B (Concluded)

IUE ASTRONOMY WORKING GROUP ADVISORS

March 1977

Barker, Peter Mr.
Appleton Laboratory
Ditton Park
Slough, Bucks, SL39JX, England

Bohlin, Ralph D. Dr.
Code 672, Goddard Space Flight Center
Greenbelt, MD 20771

Dondey, Leon Mr.
Code SG, NASA Headquarters
Washington, D. C. 20546

Evans, Dennis C. Mr.
Code 401, Goddard Space Flight Center
Greenbelt, MD 20771

Evans, Roger G. Dr.
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Heap, Sara R. Dr.
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Greenbelt, MD 20771

Holtz, John Mr.
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Klinglesmith, Daniel A. Dr.
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Greenbelt, MD 20771

Longanecker, Gerald W. Mr.
Code 401, Goddard Space Flight Center
Greenbelt, MD 20771

Macchetto, F. Dr.
ESTEC
Domeinweg, Noordwijk
The Netherlands

Roman, Nancy G. Dr.
Code SG, NASA Headquarters
Washington, D. C. 20546

Winkler, Howard B. Mr.
DYNATREND INCORPORATED
131 Middlesex Street
Burlington, MA 01803

APPENDIX C

AGENDA

IUE ASTRONOMY WORKING GROUP MEETING

March 1, 2, 3, 1977

GODDARD SPACE FLIGHT CENTER

BUILDING 26, RM. 200, AT 9:00AM

March 1

			Page
1.	PROGRESS REVIEW OF LAST SIX MONTHS		
a.	The overall project and schedule outlook	- G. W. Longanecker ...	1
b.	Progress with the spacecraft, test results	- K. O. Sizemore	3
c.	Progress with the scientific instrument	- D. C. Evans	6
d.	Progress with the US ground station	- C. F. Fuechsel	7
e.	Progress with the cameras	- R. Wilson	8
f.	Progress with the European ground station	- F. Macchetto	8
2.	TEST PLAN FOR SCIENTIFIC INSTRUMENT	- D. C. Evans	
3.	INITIAL VOB DATA	- D. A. Klinglesmith ..	13,26
4.	DISCUSSION OF PERFORMANCE CRITERIA FOR EVALUATING SCIENTIFIC INSTRUMENT	- A. Boggess	18

March 2

5.	DEMONSTRATION OF EXPERIMENT DISPLAY SYSTEM	- C. Fuechsel	15
6.	CAMERA OPERATING MODES AND PROCEDURES	- R. Wilson	16,26
7.	IUE USER-RELATED CONSTRAINTS	- D. K. West	
a.	Scheduling and scheduling restrictions		
b.	Responsibility for identifying star field		
c.	Observing options open to user		
d.	Rules for government-furnished magnetic tapes		28
8.	PUBLICATION OF IUE OBSERVING LISTS	- D. K. West	25
9.	NEXT IUE USERS MEETING: DATE AND AGENDA		
10.	SELECTION OF NEW AWG MEMBERS		25
11.	DATE OF NEXT AWG MEETING		26

APPENDIX C (Concluded)

AGENDA

IUE ASTRONOMY WORKING GROUP MEETING

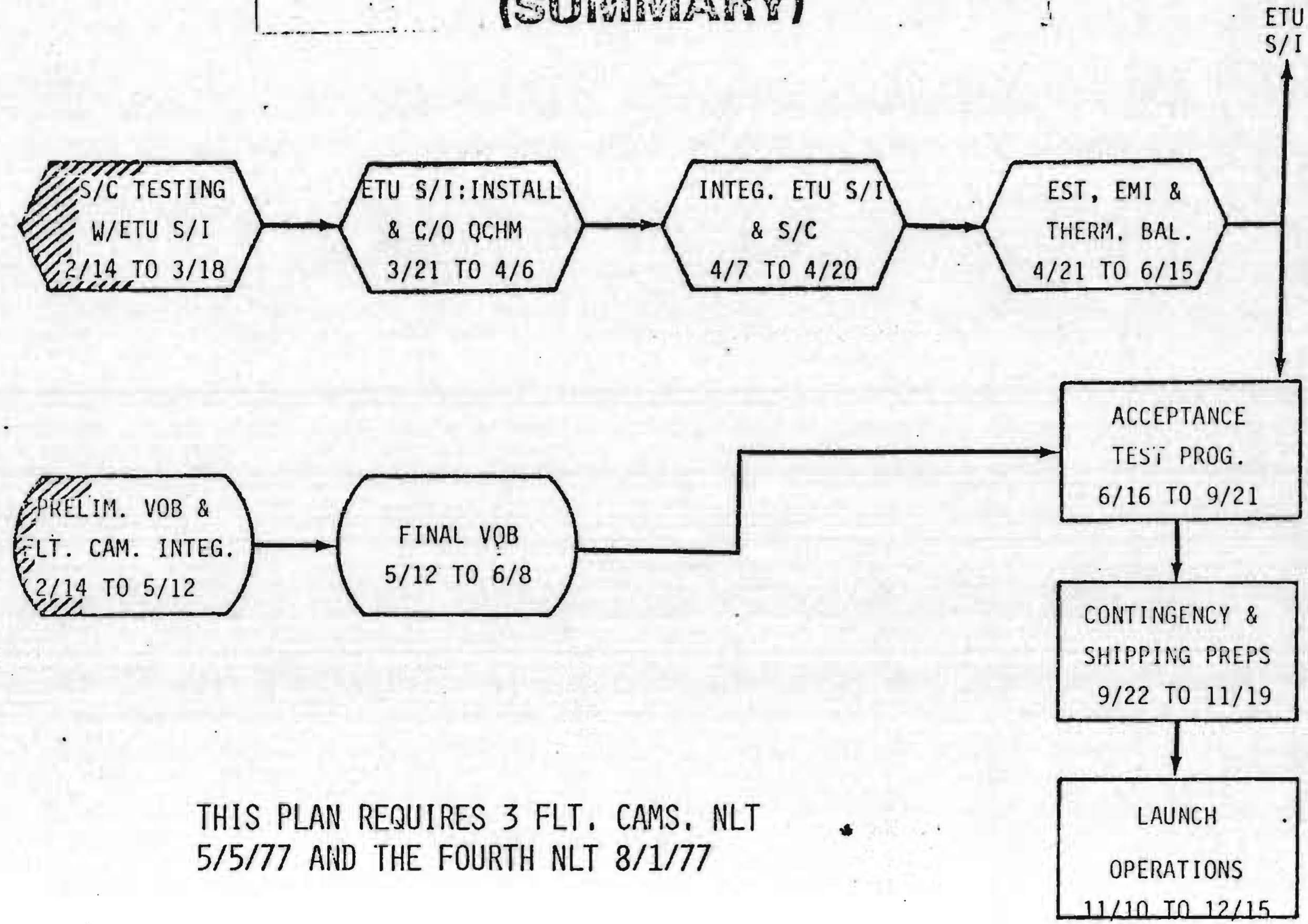
March 3

- -

OTHER SPEAKERS

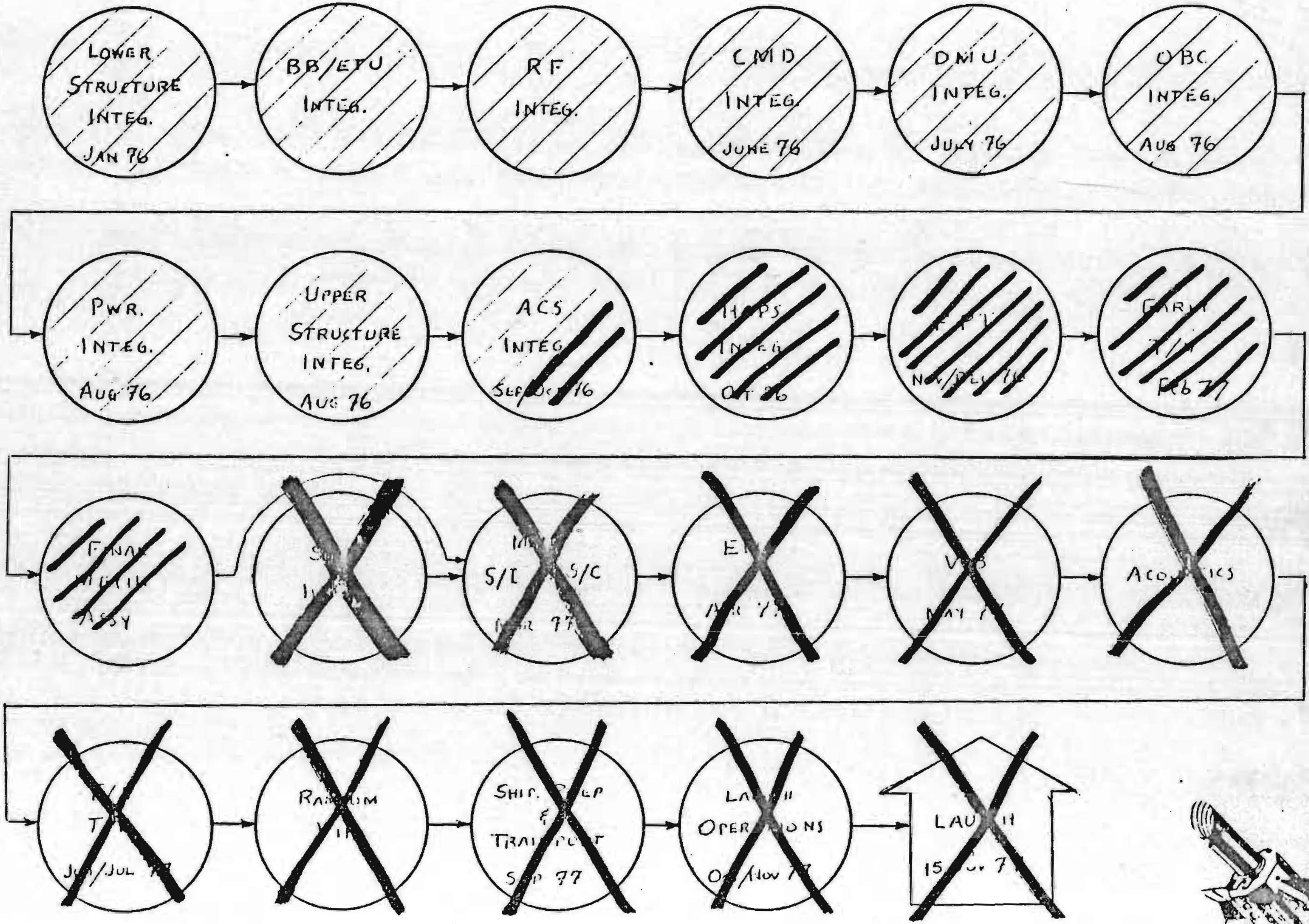
F-1 (Longanecker)

IUE INTEGRATION AND TEST PLAN (SUMMARY)



THIS PLAN REQUIRES 3 FLT. CAMS. NLT 5/5/77 AND THE FOURTH NLT 8/1/77

INTEG./TESTING SCHEDULE



ETU VIBRATION (#5)

FORMAT SHIFT

SW Prime 0.10 mm

SW Redundant 0.25 mm

LW Prime 0.60 mm

LW Redundant 0.50 mm

GOAL 0.25 mm

REQUIRED 1.00 mm

FLIGHT TELESCOPE

⊕ PROVISIONALLY ACCEPTABLE FOR FLIGHT

TEST DATA (80% ENERGY UNLESS SPECIFIED OTHERWISE)

		ENCIRCLED ENERGY	KNIFE EDGE *
A. UNMOUNTED OPTICS		75mμ = 76%	48μm
B. PRIMARY MOUNTED SECONDARY FREE		—	54μm
C. FLIGHT STRUCTURE (B&C STAR)		100μm = 83%	65μm
D. LTOF TEST RESULTS			
TEST #1	+20°C	100μm (72%) 200μm (92%)	90μm
	-10°C	100μm (36%) 200μm (74%)	136 μm
TEST #2	+20°C	—	79μm
	-10°C	—	128μm

MODIFY TANGENT BARS - REINSTALL - RETEST

TEST #3	+20°C	—	78μm
	-10°C		103μm

WORKING SCHEDULE

VOB CALIBRATION : NOW - 15 APRIL
LTOF (VOB CRANE MODS): 15 APRIL - 15 MAY

VOB (FINAL CALIB.) : 15 MAY - 8 JUNE

S/L: S/I MATE (COMPLETE) : 30 JUNE

TESTING

ELECTRICAL BASELINE; OPTICAL REF.; VIBRATION; ACOUSTICS; BLOWDOWN; ARRAY DEPLOYMENT; POST CHECK.

— 16 AUGUST —

FLT. CAM #4 INST/FOCUS or QUAL.

— 1 SEPTEMBER

THERMAL VACUUM; EMI/RFI

SHIP 10 NOV 1977

LRD 15 DEC 1977

IUE GROUND SYSTEM - ACTIVITIES SINCE SEPTEMBER 1976

1. IUESIPS INITIAL DELIVERY TO VILSPA: NOVEMBER 1976
2. FIRST TEST OF IUEOCC WITH FLIGHT SPACECRAFT: NOVEMBER 1976
3. FIRST EXPERIMENT DISPLAY SYSTEM DELIVERED: DECEMBER 1976
4. IUE IMAGE HEADER - REVISED BY INCORPORATION OF UK RECOMMENDATIONS - FEBRUARY 1977
5. CALL FOR ENGINEERING DATA ANALYSIS REQUIREMENTS PUBLISHED: - FEBRUARY 1977
6. SOC-OCC CABLE PULLS COMPLETED: FEBRUARY 1977
7. SUPPORT CONTRACT AWARDED FOR SIMULATOR VALIDATION SIMULATION PLAN DEVELOPMENT
8. FLIGHT OPERATIONS MANUAL - STARTED

IUE GROUND SYSTEM - STATUS AS OF MARCH 1977

1. ALMOST ALL HARDWARE DELIVERIES ACCOMPLISHED.
   OUTSTANDING ITEMS: (BOTH DUE MARCH 1977)
   - EDS UNITS 2 AND 3, FINAL SOFTWARE

   12-METER ANTENNA WAVEGUIDE

2. OCC SOFTWARE: SYSTEM 2.0 DELIVERED
   REMAINING DELIVERIES:
   - BASIC SYSTEM - APRIL 1977
   - LAUNCH SYSTEM - JULY 1977
   - FINAL SYSTEM - OCT. 1977

3. IUESIPS: BUILD 13 COMPLETE - PROVIDES SCHEME PROCESSING FROM TERMINALS.

   ALL APPLICATIONS PROGRAMS CONVERTED EXCEPT:
   - WAVELENGTH CALIBRATION
   - DATA EXTRACTION
   - FFT2

4. FLIGHT DYNAMICS SOFTWARE -
   - ATTITUDE + ORBIT MANEUVER PROGRAM DELIVERED
   - ATTITUDE DETERMINATION PROGRAM IN DEVELOPMENT

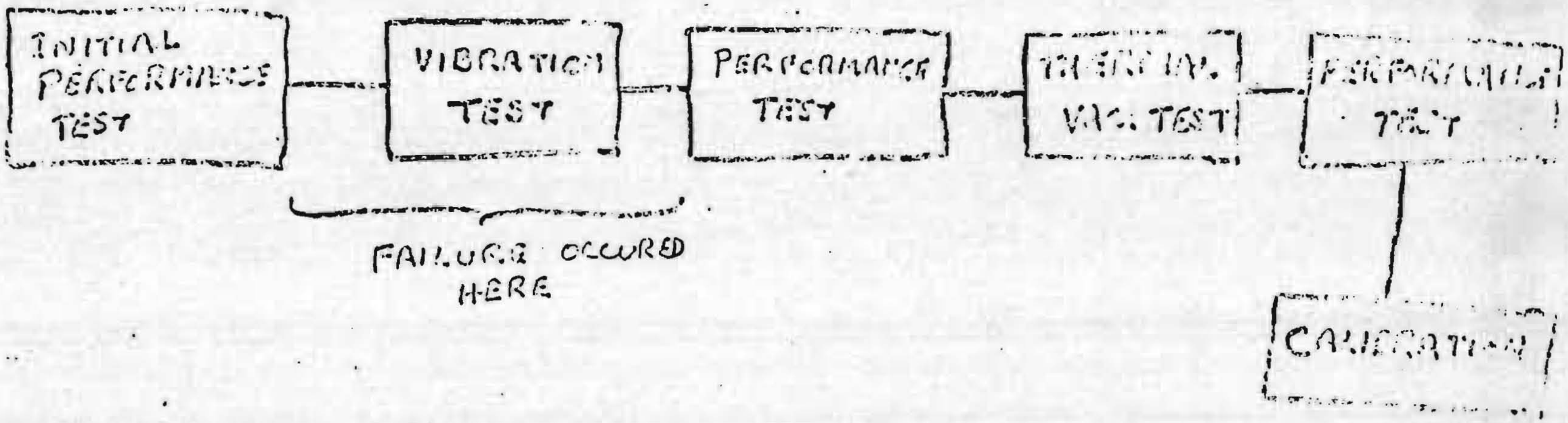
CAMERA 07

BACKGROUND PROBLEM

- ENHANCED BACKGROUND : CRESCENT SHAPE
  INTENSITY ≡ M_v 8 B0 STAR (HMA DISP)
- VARIATION OF INTRINSIC INTENSITY WITH E.H.T.
  DEPENDS ON OVERALL EHT
  INDEPENDENT OF CONVERTER EHT
- POSITION OF CRESCENT : CAUSED BY SHADOWING OF MgF_2/Potting/Air
  Interface at edge of the face plate
- IONISATION TEST : No Discharges Detected. (< 10pC)
- SEARCH WITH PMT : Light pulses detected irregular ~ 2pps.
  Consistent with light generation within potting
- FURTHER WORK : Identify cause of light
  Reclaim SEC/converter bonded pair.

CAMERA OG : FAILURE

CAMERA ENVIRONMENTAL TEST PROGRAM:



FAILURE ANALYSIS : TARGET BROKEN

POSSIBLE CAUSES : VIBRATION DAMAGE; BUT TUBE AND MOUNT HAVE BEEN QUALIFIED AS A TYPE.

EACH SEC TUBE HAD VIBRATION TEST AT WESTINGHOUSE.

4 CAMERAS TESTED WITHOUT DAMAGE

HANDLING SHOCK

EXTERNAL ELECTRICAL DISCHARGE TO TARGET LEAD

READ BEAM TURNED FULL ON

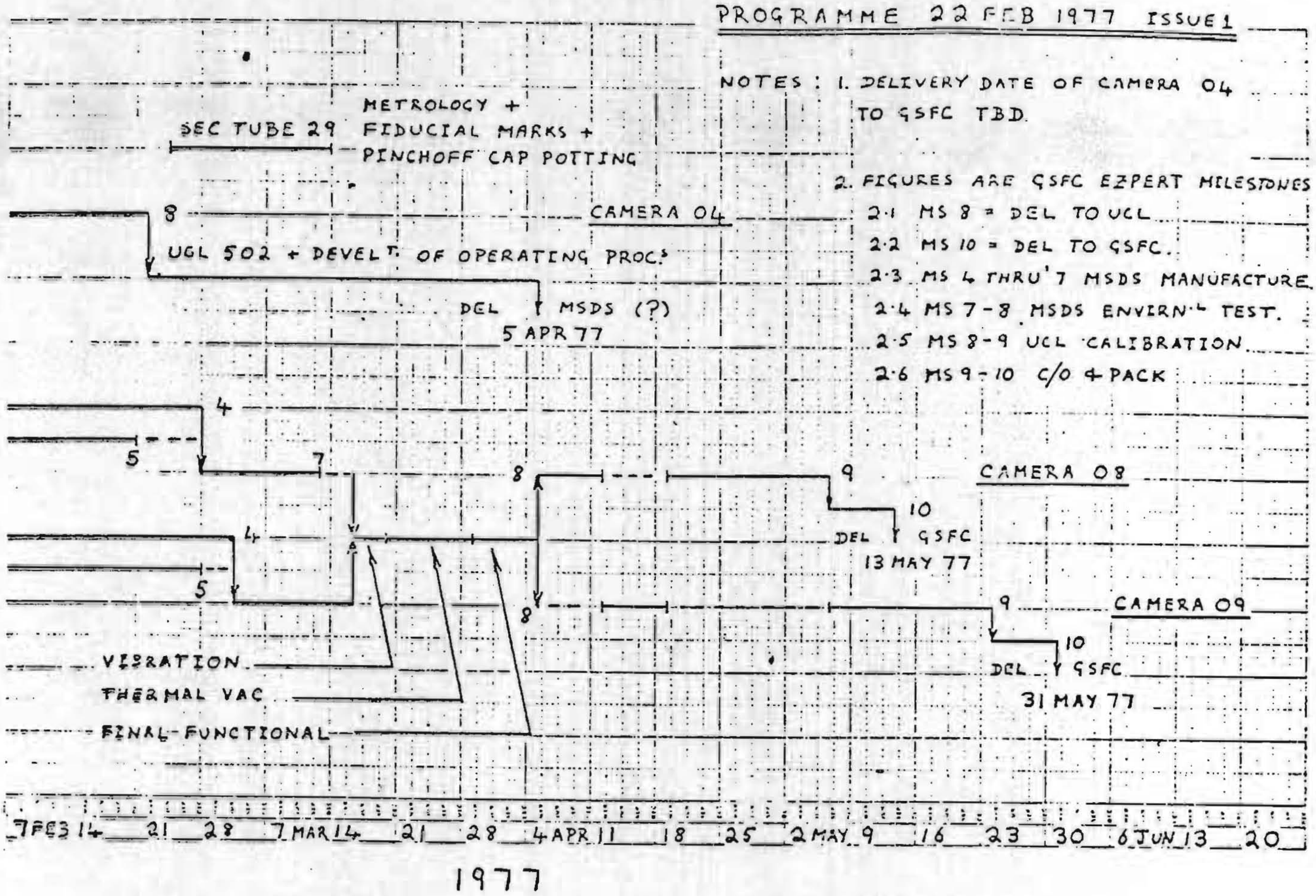
} DO NOT SEEM LIKELY

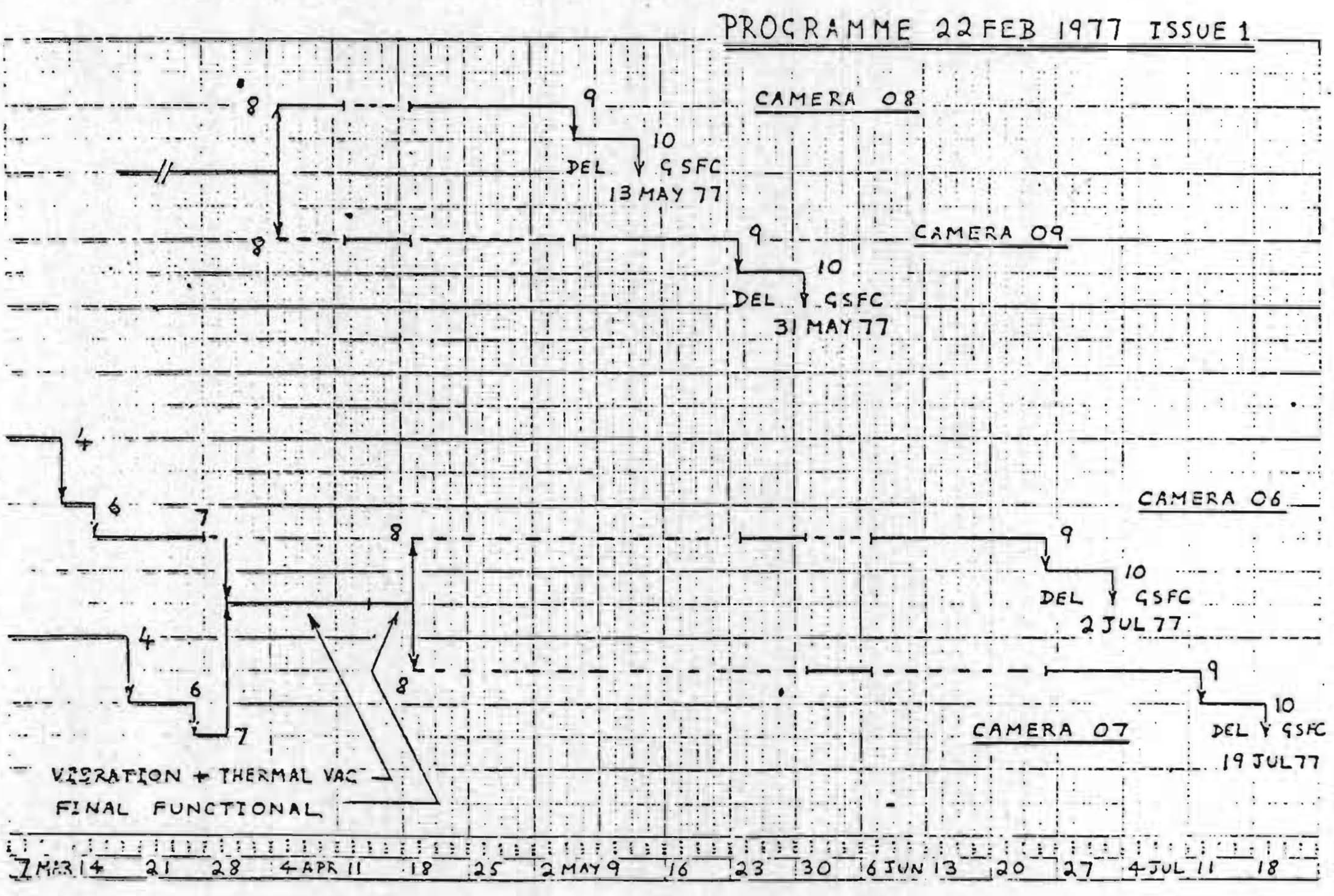
F-10 (Wilson)

Designation in SIPL. 76	UEDS Control No.	Scheduled Delivery to UCL ACD : 22 FEB. 1977	Scheduled Delivery to GSFC ACD : 22 FEB. 1977	Status ACD : 22 FEB. 1977
Qual.	03	Delivered 28 AUG. 1976	Delivered 20 OCT. 1976	In SI spectrograph in long wavelength prime position, operating in VCB in air.
FLT 1	05	Delivered 11 NOV. 1976	Delivered 7 JAN. 1977	In SI spectrograph in short wavelength prime position. Replacement modules incorporating 2N3742's and dynamic refocus improvements, in manufacture for possible retrofit.
FLT 2	07	19 APR 1977	19 JUL. 1977	Fault observed; UVC-SEC tube assembly removed for fault diagnosis. Camera in rework; replacement tube in potting process. 2N3439 transistors being replaced by 2N3742's. Dynamic refocus improvements also incorporated at same time.
FLT 3	06	19 APR. 1977	2 JUL. 1977	SEC tube failed, target found to be ruptured. Camera in rework; replacement tube in potting process. 2N3439 transistors being replaced by 2N3742's. Dynamic refocus improvements also being incorporated at same time.
FLT 4	04	Delivered 22 FEB. 1977	TBD	Camera in operation at UCL for development of operating procedures. Replacement modules incorporating 2N3742's and dynamic refocus improvements in manufacture for possible retrofit.
FLTSP 1	08	5 APR. 1977	13 MAY 1977	Camera manufacture well advanced; 2N3742's and dynamic refocus improvements being incorporated.
FLTSP 2	09	5 APR. 1977	31 MAY 1977	

2N3439-Westinghouse transistor part no.

2N3742-Motorola transistor part no. (also batch 2)


PROGRAMME 22 FEB 1977 ISSUE 1
NOTES: 1. DELIVERY DATE OF CAMERA 04 TO GSFC TBD.
2. FIGURES ARE GSFC EXPERT MILESTONES
2·1 MS 8 = DEL TO UCL
2·2 MS 10 = DEL TO GSFC.
2·3 MS 4 THRU' 7 MSDS MANUFACTURE
2·4 MS 7-8 MSDS ENVIRN.L TEST.
2·5 MS 8-9 UCL CALIBRATION
2·6 MS 9-10 C/O + PACK
SEC TUBE 29
METROLOGY + FIDUCIAL MARKS + PINCHOFF CAP POTTING
CAMERA 04
UCL 502 + DEVEL.T OF OPERATING PROC.S
DEL MSDS (?)
5 APR 77
CAMERA 08
DEL GSFC
13 MAY 77
CAMERA 09
DEL GSFC
31 MAY 77
VIBRATION
THERMAL VAC
FINAL FUNCTIONAL
7 FEB 14 21 28 7 MAR 14 21 28 4 APR 11 18 25 2 MAY 9 16 23 30 6 JUN 13 20
1977


PROGRAMME 22 FEB 1977 ISSUE 1
CAMERA 08
DEL GSFC
13 MAY 77
CAMERA 09
DEL GSFC
31 MAY 77
CAMERA 06
DEL GSFC
2 JUL 77
CAMERA 07
DEL GSFC
19 JUL 77
VIBRATION + THERMAL VAC
FINAL FUNCTIONAL
7 MAR 14 21 28 4 APR 11 18 25 2 MAY 9 16 23 30 6 JUN 13 20 27 4 JUL 11 18
1977

OVERALL SOFTWARE TASKS

A. PRE-LAUNCH CAMERA CALIBRATION — U.K.

B. POST-LAUNCH DATA PROCESSING

1. ERROR AND NOISE REMOVAL — CAMERA: UK; OTHER: US

2. GEOMETRIC DISTORTION. MEASUREMENT AND REMOVAL — UK

3. PHOTOMETRIC TRANSFER FUNCTION. MEASUREMENT AND CORRECTION — UK

4. BACKGROUND REMOVAL — CAMERA: UK; SI: US

5. WAVELENGTH DETERMINATION — US

6. DATA EXTRACTION — US

7. QUANTUM EFFICIENCY CORRECTION — US

C. POST-LAUNCH CALIBRATIONS — US

UK PRE-LAUNCH CAMERA CALIBRATION TASKS

TASK	DATE AVAILABLE
1. HOUSEKEEPING	AUG. '73
2. UTILITY PROGRAMS DISPLAYS, STATISTICS ETC.	OCT '75 – JUN '76
3. PHOTOMETRY ITF QUANTUM EFFICIENCY	INITIAL VERSION FEB '75 FINAL VERSION MAR '77
4. GEOMETRY	VARIOUS DEC '74 – AUG '76
5. RESOLUTION MTF'S HALATION	DEC '74
RESEAU DEPTHS	NOV '76
6. NOISE S/N	JUN '76
HEAD AMP. CORRECTION	SEPT '76

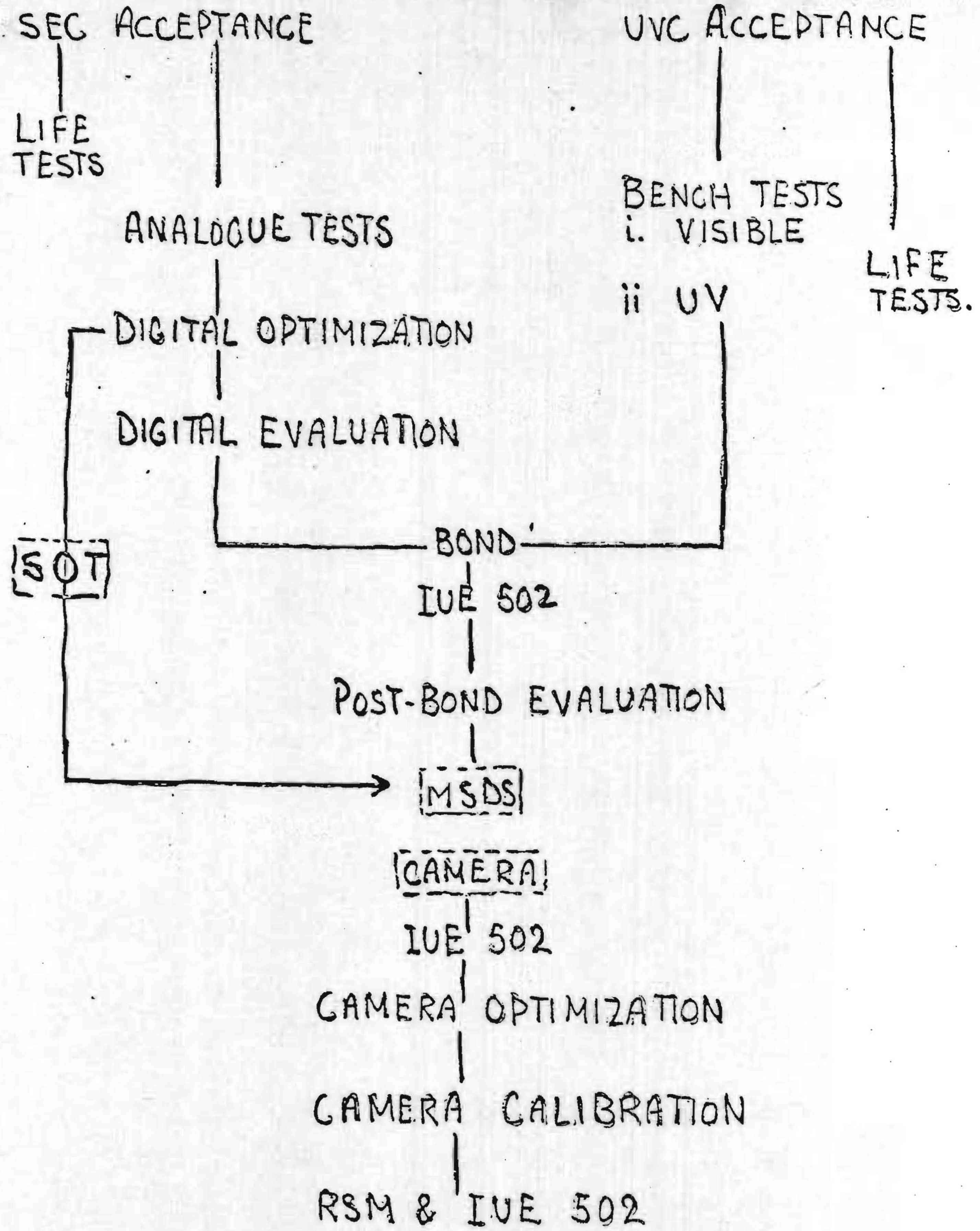
CALIBRATION DATA

CAMERA 03 CALIBRATIONS DELIVERED		12. NOV 1976
" 05 " "		2 FEB 1977

POST-LAUNCH DATA REDUCTION UK CONTRIBUTION

FUNCTION	DATA AVAILABLE	PRESENT STATUS
1. CAMERA INDUCED PERIODIC NOISE		
D/A GLITCHES	PRELIMINARY VERSION JUNE '76	FURTHER TESTS REQUIRED
MOIRÉ FRINGES	ELIMINATED BY HARDWARE	
HEAD AMPLIFIER	SEPT '76 (QUAL. ONLY) FOR FLIGHT : ELIMINATED BY HARDWARE	FINAL VERSION
2. GEOMETRIC DISTORTION		
MEASUREMENT USING RESEAUX	FIRST VERSION DEC '74 UPDATES TO AUG '76	FINAL VERSION
CORRECTION	DEC. '74	"
3. PHOTOMETRIC TRANSFER FUNCTION		
MEASUREMENT	FIRST VERSION DEC '74 UPDATES TO MAR '77	"
CORRECTION	" "	"
4. BACKGROUND REMOVAL		
CAMERA INDUCED BACKGROUND	PART OF 3 ABOVE	"

ACTIVITY CHART



SEC ACCEPTANCE

SEC TUBE
- VISUAL INSPECTION
- STATIC TESTS:
  - GAS RATIO
  - INTERELECTRODE RESISTANCE & CAPACITANCE
  - VISIBLE QE
  - VG_1 vs IG_2, IG_3

COIL
- SELECTED BY OPERATION WITH A STANDARD SEC TUBE

MATED

ANALOGUE TESTS:
- SEC/COIL MATED PAIR
- ALIGNMENT CURRENT
- FOCUS CURRENT
- REFOCUS POTENTIAL AT TWO SIG. LEVELS
- MODULATION AT 7.5 lp/mm
- LINE/FRAME DEFLN. CURRENT
- BLEMISH RECORD
- TARGET - G_4 RESONANCE AT 1600 c/s, 4000 c/s.

LIFE TESTS

SIMILAR TESTS + HEATER CYCLING
ENT CYCLING
ILLUMINATION AGEING.

UVG ACCEPTANCE

- UVG
- VISUAL INSPECTION
- STORE IN DRY N_2 FOR > 16 HRS
- SPURIOUS EMISSION TESTS
- BACKGROUND TESTS
- FLATNESS, BLEMISHES PINHOLES
- OPACITY
- PHOSPHORE LINEARITY
- GEOM. DISTORTION
- SCREEN GAIN
- UNIFORMITY
- HALATION
- MTF
- LONG WAVELENGTH QE
- UV WAVELENGTH QE.

LIFE TESTS.

SIMILAR TESTS + ENT AGEING
ILLUMINATION AGEING.

SEC TUBE OPTIMIZATION

- TARGET TRANSFER FUNCTION
- G1 ON VOLTAGE
- ALIGNMENT & ORENTATION CHECK
- CENTRE FOCUS CHECK
- G4 OPTIMIZATION
- G3 REFOCUS OPTIMIZATION
- ALIGNMENT CHECK
- G6 VOLTAGE & G6 INCREMENT
- G1 ON VOLTAGE CHECK
- ERASE CYCLE → (back to TARGET TRANSFER FUNCTION)
- LINE/FRAME DEFLECTION CURRENTS.

DIGITAL EVALUATION

- INTENSITY TRANSFER FUNCTION
- MODULATION TRANSFER FUNCTION
- GEOMETRY CHECK
- TARGET LAG
- UNIFORMITY & BLEMISH CHECK
- GAIN VS ENT
- BACKGROUND

IUE 502

TARGET TRANSFER FUNCTION

MODULATION TRANSER FUNCTION
at 6.5 lp/mm

TARGET GAIN

RESIDUAL IMAGE

HEAD AMPLIFIER
NOISE

CAMERA OPTIMIZATION

PRELIMINARY ITF

PREP SEQUENCE

GI ON VOLTAGE

ALIGNMENT

REFOCUS CHECK

EVALUATION TESTS

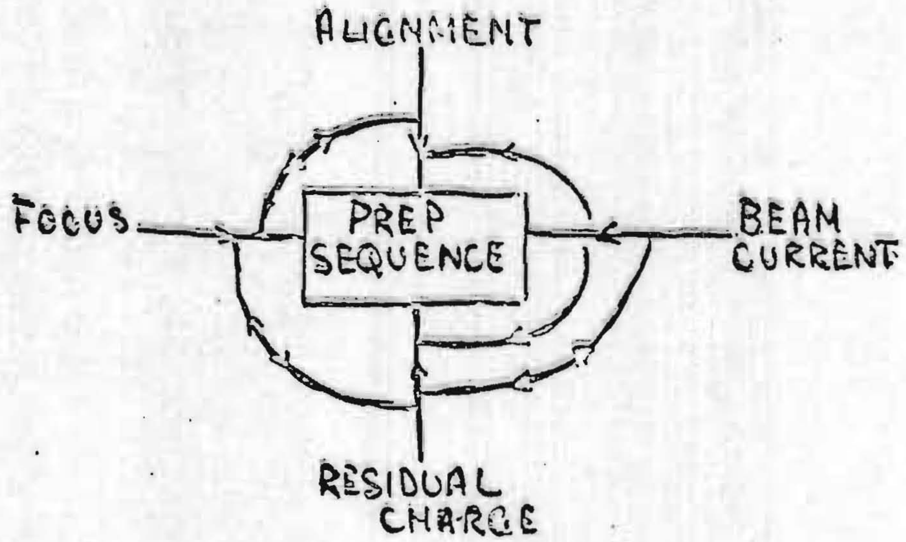
BEAM ACCEPTANCE.

TARGET GAIN

SIGNAL-TO-NOISE RATIO.

RESOLUTION.

PREP SEQUENCE



QUAL CAMERA	CAMERA # Φ5
200% FLOOD	200% FLOOD
3 DEFOCUSED FAST WIPES	1 FOCUSED READ RATE WIPE
20% FLOOD	20% FLOOD
1 READ RATE FOCUSED WIPE	1 FOCUSED READ RATE WIPE.

CAMERA CALIBRATION DATA

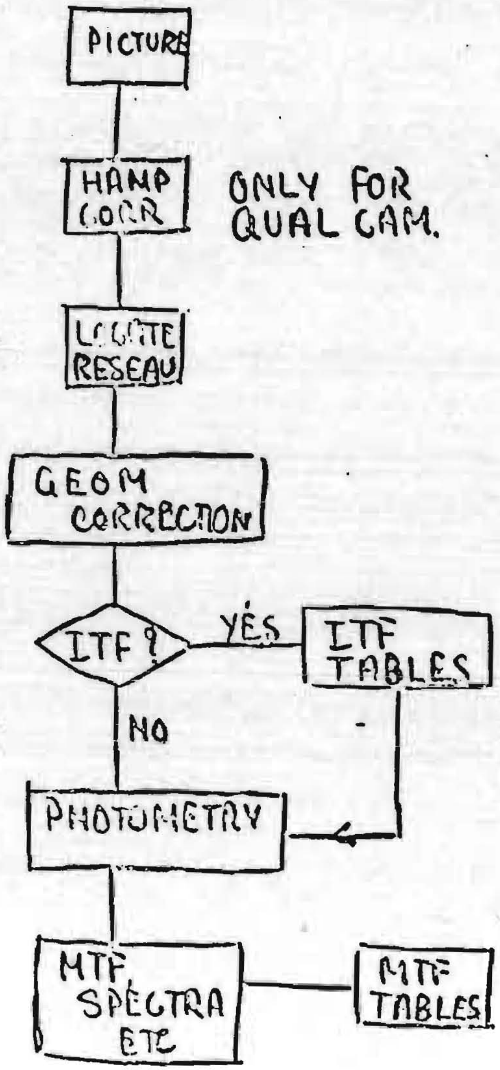
VOLTAGE: UVC 5 KV
SEC 6.1 KV 95% of Max Gain
3.75 " 30%
3.15 " 15%

DATA: FULL ITF (A) 12 DATA POINTS
FULL MTF (B) 0.1, 0.5, 1.5, 2.5, 4.5, 6.5, 8.5 lp/mm
PARTIAL ITF (C) 3 DATA POINTS
PARTIAL MTF (D) 2.5, 4.5, 6.5, 8.5 lp/mm.

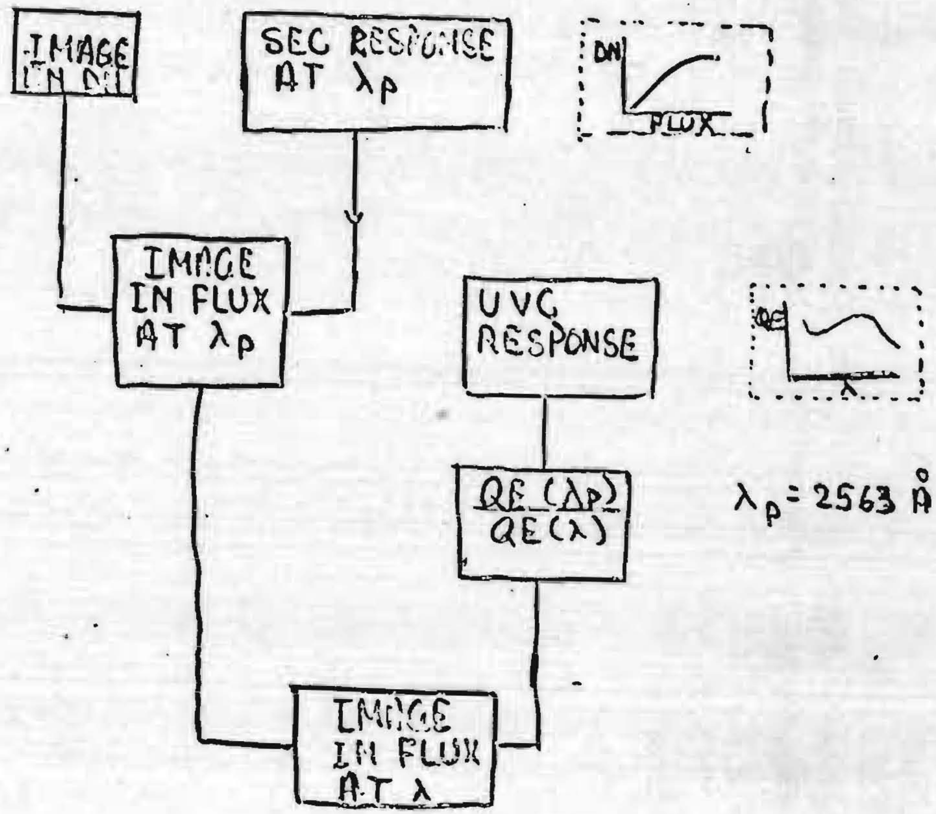
	WAVELENGTH Å	VOLTAGE V_1	V_2	V_3
IN AIR	3160	C, D		
	3000	C, D		
	2800	C, D		
	2536	A(2), B	A, D	A, D
	2400	C, D		
	2200	C, D		
	1940	C, D		
IN VAC	2536	A(2)		
	1800	C, D		
	1700	C, D		
	1600	C, D		
	1400	C, D		
	1216	A, B		

+ REPRODUCIBILITY, MTF AT DIFF. LIGHT BIAS, RECIPROCITY, BACKGROUND, ITF at 2x PIXEL

SOFTWARE OPERATIONS



PHOTOMETRY



CAMERA PERFORMANCE

	Qual Φ 3	Φ 5	
SIGNAL/NOISE	20-30	10-20	per pixel.
DYNAMIC RANGE #1	42	20	per pixel
for S/N>10 #2	20		
SENSITIVITY at 2536 Å	12	20	el/photon
RESOLUTION PSF at 2536 Å	70 center 100 edge	~70 100	microns
SPECTRAL RESOLUTION at 2536 Å	0.11 Å C 0.16 Å E	0.11 Å 0.16 Å	Å Å
BACKGROUND HiD		11	m_v
LoD.		14	m_v

F-23 (West)

Partial Star List

1*	2	3	4	5	6	7	8	9	10
001	H00120315	13 45 34	+49 34	B35	1.88	-0.18	1	1	1
002	H00120315	13 45 34	+49 34	B35	1.88	-0.18	2	1	1
003	H00120315	13 45 34	+49 34	B35	1.88	-0.18	1	2	1
004	H00120315	13 45 34	+49 34	B35	1.88	-0.18	2	2	1
005	H00044402	06 18 23	-30 02	B25	3.02	-0.19	1	1	1
006	H00044402	06 18 23	-30 02	B25	3.02	-0.19	2	1	1
007	H00044402	06 18 23	-30 02	B25	3.02	-0.19	1	2	1
008	H00044402	06 18 23	-30 02	B25	3.02	-0.19	2	2	1
009	H00038666	05 44 09	-32 20	O95	5.19	-0.27	1	1	1
010	H00038666	05 44 09	-32 20	O95	5.19	-0.27	2	1	1
011	H00038666	05 44 09	-32 20	O95	5.19	-0.27	1	2	1
012	H00038666	05 44 09	-32 20	O95	5.19	-0.27	2	2	1
013	H00214680	22 37 00	+38 48	O95	4.87	-0.20	1	1	1
014	H00214680	22 37 00	+38 48	O95	4.87	-0.20	2	1	1
015	H00214680	22 37 00	+38 48	O95	4.87	-0.20	1	2	1
016	H00214680	22 37 00	+38 48	O95	4.87	-0.20	2	2	1
017	H00149438	16 32 46	-28 07	B05	2.83	-0.25	1	1	1
018	H00149438	16 32 46	-28 07	B05	2.83	-0.25	2	1	1
019	H00149438	16 32 46	-28 07	B05	2.83	-0.25	1	2	1
020	H00149438	16 32 46	-28 07	B05	2.83	-0.25	2	2	1
021	H00036512	05 29 31	-07 21	B05	4.62	-0.26	1	1	1
022	H00036512	05 29 31	-07 21	B05	4.62	-0.26	2	1	1
023	H00036512	05 29 31	-07 21	B05	4.62	-0.26	1	2	1

* 1. Sequence No.
2. Henry Draper Catalog No.
3. Right Ascension
4. Declination
5. Spectral Type
6. Visual Magnitude
7. B-V Magnitude
8. Wavelength Mode
9. Resolution Mode
10. No. of Scans

F-24 (West)

REFERENCE OBSERVATIONS

O, WR STARS, OB SUPERGIANTS	P. CONTI
F,G,K, AND M STARS	E. BOHM-VITENSE
B&A STARS	M. PLAVEC
INTERSTELLAR LINE STARS	E. JENKINS
PLANET WAVELENGTH CALIBRATIONS	A. LANE
PHOTOMETRIC STANDARD STARS	B. OKE, B. SAVAGE, R. WILSON

OPERATION OF BONDED U.V. CONVERTER/SEC TUBE