SECTION 3
OPERATIONS POLICY AND GUIDELINES

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3.1 DATA STORAGE, ENGINEERING DATA ANALYSIS

The IUE control centers at GSFC and VILSPA will not store indefinitely every bit of data transmitted by IUE. However, a history tape will be written which stores major frame telemetry data on a I/N sample basis plus commands sent and other events. These tapes will be stored in a rotating queue which will keep the most recent 30 days of spacecraft data available. A Flight Operations Directive is provided in Section 4 regarding disposition of history tapes. A sizable body of data is appended to each image acquired. This data includes engineering information, operations history pertaining to this image, preplanned finder fields, and observer comments. (For a detailed definition of the IUE Image Header Format, see document IUE-513-77-106.) Thus, every image taken by IUE is automatically annotated with all relevant information that may be needed to interpret the image or diagnose flight instrument or procedural malfunctions.

3.2 SCIENTIFIC DATA ARCHIVAL, ACCESS

Raw and processed images and reduced flux (λ) tabulations will be archived in the Scientific Operations Center for a period of at least 6 months and in the National Space Science Data Center at GSFC permanently. Access to archive data while held in the SOC will be limited to the guest observer who acquired the data, and to persons authorized by the guest observer. Six months following delivery of data to the guest observers, access is unrestricted.

The OCC will write a backup raw image archive tape which duplicates images placed on the shared disk. These tapes will be delivered to the SOC on a daily basis.

3.3 IUE OPERATIONAL STATES

The normal IUE operational state exists when the spacecraft subsystems are in their normal configurations, the subsystems are operating properly, a positive-power situation exists, the attitude is known, and all systems are capable of supporting scientific operations.

The normal operational state does not exist when a spacecraft emergency condition exists, the attitude is unknown, the three-axis control is lost, or the three-axis control is being maintained by other than the OBC hold-slew algorithm using gyros and wheels.

Additional operational states are defined which preclude normal scientific operations:

a. Orbit adjustment maneuvers.

b. Engineering tests or calibrations.

There is a requirement for GSFC to obtain range and range-rate measurements with the spacecraft in the form of several minute samples distributed over the full orbital period. This must be accomplished once per week, although not all samples need be obtained in a single orbit. A typical ranging plan is 5 minutes ranging data every hour. It is planned to interleave ranging measurements with other spacecraft operations on a noninterference basis by tolerating up to ±15 minutes deviation from planned to actual ranging time. Ranging requires temporary loss of the command link and hence is restricted to inactive spacecraft periods such as camera exposures. During the VILSPA operational shift, ranging will still be performed by GSFC and voice coordination with VILSPA will be required for each ranging measurement. VILSPA must drop their command carrier during each ranging measurement.

The nominal operational shift periods are 16 hours/day at NASA, and 8 hours/day at VILSPA.

3.4 U.S.-ESA/UK SPACECRAFT HANDOVER

The objective of the spacecraft handover is to ensure safe, efficient, and coordinated transfer of control of the IUE spacecraft from one ground system to the other. A voice link will be established 30 minutes prior to handover to VILSPA and retained throughout the VILSPA shift. Transfer to VILSPA will not take place as scheduled when the following conditions are in effect:

a. VILSPA cannot process telemetry or send commands.

b. The spacecraft is not in the normal operational state.

c. Spacecraft attitude is unknown.

The releasing station uplinks an ID code "0" to the OBC and turns off the command transmitter upon verification. The receiving station turns on the command transmitter and selects a polarization for the highest S/C command receiver Automatic Gain Control (AGC) reading. Then the receiving station uplinks the station ID code to OBC.

ID Codes: 0 = no station in control.
1 = GSFC in control.
2 = VILSPA in control.

The scheduled VILSPA operational period will shift in increments of 2 hours every 30 days to compensate for the 4 minutes per day difference between solar and sideral time.

Spacecraft attitude knowledge is essential to conduct IUE observations, and it may take as long as 12 hours to recover it when lost. For this reason, it is extremely important that the operators of both ground stations be very cautious when updating the attitude mode or in attempting to recover from an unrecognized telescope pointing.

The following handover policy was adopted at the three-agency meeting on March 23, 1979:

a. When the ground stations are under normal operating conditions:

(1) At handover, the sun shutter must be open with the FES tracking on a star which gives reliable star presence.

(2) At handover, both cameras should be in standby mode with each camera either read down or prepared. To achieve this end, exposure should terminate at least 13 minutes before handover and the last image read should be initiated at least 10 minutes before handover.

(3) During handover, the telemetry should be in format 2A and at 20 Kb.

(4) At handover, spacecraft attitude shall be $15^{\circ} < B < 135^{\circ}$.

(5) At handover, the spacecraft shall be pointing at a stationary target with all gyro drift rates for a moving target zeroed (Earth is a moving target).

(6) Unless permission is granted by the receiving station prior to handover, the current attitude stored on the spacecraft must be that of the target.

(7) HAPS heater No. 1 shall be turned on at least 30 minutes prior to handover.

(8) The following information will be relayed by voice link to the receiving station:

(a) The most common name of the target which will include the name of the catalogue if it is not obvious.

(b) The visual magnitude of the target. It should be clearly stated if FES magnitude is used.

(c) 1950 right ascension and declination of the target.

(d) FES location of the target.

(e) The camera image numbers at handover.

(f) The state of each camera when not obvious from telemetry (i.e. exposed, read down, SPREP ed) which will include the degree of overexposure on the most recent images from each camera.

(g) If the tracker will not be left tracking on the target, the FES location of the object being tracked along with any other information which might aid the receiving station in identifying the field.

(h) Any spacecraft housekeeping status information that might be helpful to operations as requested, e.g. SI heater status, operations difficulties experienced, etc.

(9) To facilitate in an orderly transition, the commanding station should advise the receiving station of the expected time of handover as early as possible.

(10) If the receiving station should be dissatisfied with the attitude as defined by the commanding station, they may request the commanding station to confirm the attitude by

maneuvering to a nearby catalogue star with well defined coordinates. If the maneuver verifies the attitude reference, handover will be counted as if it had occurred at the time the releasing station was originally ready for handover.

b. When the spacecraft and/or the ground station experience difficulties:

(1) When station A experiences ground system failure shortly before handover, station B will be required to read down the image(s) and the length of time spent after the scheduled handover will be charged to station A.

(2) When station A experiences ground system failure and is not able to accept handover or is not able to command the spacecraft any time in its shift, they will advise station B of the expected downtime of its ground system. With the concurrence of station A, station B may then assume command of the spacecraft and make efficient use of the telescope time. However, any time station A can accept handover, station B is required to prepare for handover immediately. An ongoing exposure will be terminated immediately and the image read down. An ongoing maneuver must be allowed to finish and star field identified. The time between station A's request for handover and the actual handover will be charged to station B. But station B will not be charged for the time that A spends to slew back to its original target or any other target. Station B is not required to repay station A for the time used.

(3) If a station loses spacecraft attitude during observations and the spacecraft attitude is unknown at handover time, the length of time after the scheduled handover that is required to recover the attitude and achieve handover will be charged to that station.

(4) Operational impact that is a result of a spacecraft engineering test, spacecraft failure, stationkeeping maneuver, ground software systems failure, or any other condition(s) which led the Mission Operation Manager, Project Operations

Director, or VILSPA Operations Engineer to declare a spacecraft emergency, or to stop science operations for diagnostics, will be absorbed by the station normally scheduled for that time. This operational impact will be credited to that station's "Spacecraft Calibration and Engineering Test" time.

c. Operational Impact Time Accounting:

(1) Each station's Spacecraft Calibration and Engineering Test time, including that covered by paragraph b (4) above, will be summarized and reported monthly.

(2) Time charged and credited to the respective stations as described in paragraphs a (2), b (1), b (2), and b (3), will be maintained by the stations' Resident Astronomers and reported monthly, as a separate item from the Spacecraft and Engineering Test time.

(3) Unless accepted by the SOC of the receiving station, an early handover of 10 minutes or more will be counted only as 10 minutes.

(4) Late handover due to the inability of the receiving station to accept handover shall be counted as on time.

3.5 DETERMINATION OF OPERATIONAL STATE OF SPACECRAFT

The IUE MOM is responsible for determining the operational readiness of the spacecraft and the NASA and ESA ground systems to support normal scientific operations. This determination may be delegated to the POD for day-to-day handover operations, but not for the initial transition from the engineering checkout state to scientific operational readiness.

The criteria for initial scientific operation readiness are that the spacecraft must be on station and under three-axis control on gyros and wheels, and the attitude reference known by a position identification of a star field.

3.6 DELEGATION OF SPACECRAFT CONTROL FOR SCIENTIFIC OPERATIONS

Immediately upon receiving control of the spacecraft from the releasing station, the POD (or Operations Engineer), at the station receiving control, will confirm that the spacecraft configuration is nominal, the ground system fully operational, that no anomalous conditions exist, and that no prior-scheduled stationkeeping operations or engineering tests are to be performed. If and when these conditions are all true (i.e., the spacecraft is in its "normal operational state"), the POD will delegate control of the spacecraft to the Telescope Operator manning the telescope operations console in the SOC.

At this point, the Telescope Operator is in direct control of the spacecraft through the ability to execute a subset of the operational procedure library and the maneuver processor. This procedure set is designed to allow the Telescope Operator full use of the scientific instrument, spacecraft, and ground system capabilities while relieving him of the need to send direct commands to the spacecraft. (The procedures have necessary safety checks and interlocks coded into them to positively preclude misuse which could be hazardous to the spacecraft.) Certain routinely required operations, such as momentum wheel unloading, will not be directly available to the Telescope Operator because of the inherent risk or need to control the frequency of such operations. These operations will be performed for the Telescope Operator on request to the OD, and they will be executed by spacecraft control personnel as needed.

3.6.1 TABULATION OF ALLOWED TELESCOPE OPERATOR OPERATIONS

A tabulation of the Allowed Telescope Operator operations follows:

a. Operation of camera select, dispersion select, and aperture-select mechanisms.

b. Operation of sun-shutter, tungsten, and fiducial "star" lamps.

c. Operation of the single FES unit which has been designated as the operational FES.

d. Operation of any of two cameras which has been designated as the operational cameras, using standard options for prepare, expose, and read procedures.

e. Execution of the maneuver processor to perform unconstrained maneuvers to any target on the present observer's target list or to other targets upon authorization of the Project Scientist. Maneuvers into or through constained regions require constraint-override approval by the OD.

f. Operation of the UV flood lamp or wavelength calibration lamp only with the prior approval of the resident astronomer for operations.

g. Inspection and annotation of acquired images.

h. Modification of the state of the scientific instrument heater configuration.

3.6.2 TABULATION OF DISALLOWED TELESCOPE OPERATION FUNCTIONS

A tabulation of disallowed Telescope Operator functions (generally precluded by software) follows:

a. The sending of any command outside the context of SOC-available procedures.

b. Operation or activation of the focus drive mechanism or electronics. (Telescope focusing is considered an engineering test.)

c. Modification of the configuration or operational mode of any spacecraft subsystem.

d. Execution of contrained maneuvers without prior approval by the OD.

3.7 ABNORMAL OPERATIONAL SITUATIONS

Upon the detection of any spacecraft anomaly, the POD is responsible for ascertaining whether or not scientific operations (if in progress) will be suspended. If, in the opinion of the POD, an anomaly or apparent malfunction is sufficiently severe or hazardous, the POD has the authority to unilaterally suspend science operations. Examples of such cases are loss of attitude control, loss of spacecraft electrical power, catastrophic failure of a vital subsystem, or failure of ground systems.

The POD has the authority to declare a spacecraft emergency state when appropriate, and to initiate whatever spacecraft safety and fault-diagnostic procedures are deemed necessary in the interest of preserving the mission and restoring the spacecraft to an operational state. Fault-diagnostic procedures will usually involve the appropriate GSFC subsystem engineers or UK camera engineers.

The role of the ESA Operations Engineer (OE) is parallel to that of the POD for situations developing during the ESA operational shift. However, the actions of the ESA OE will be mainly one of securing spacecraft safety and notifying the POD of the spacecraft situation. The ESA OE may undertake some fault-diagnosis if the spacecraft is clearly not in jeopardy or if requested to do so by the POD.

In the event of ground computer failure or loss of spacecraft communications, the POD or ESA OE must quickly determine how long the spacecraft can safely remain in its present state without ground action. If the time is less than 15 minutes, action should begin immediately to bring up the backup computer and put the spacecraft into an indefinitely safe condition. If the spacecraft is not in any immediate danger, the POD may elect to pursue some degree of ground troubleshooting prior to calling upon backup hardware.

In the event of loss or suspected loss of the spacecraft attitude reference, the POD will confer with the RA for operations to develop a plan or recovery.

NOTE

> It is incumbent upon the telescope operator to be alert to recognize this situation early so that haphazard searching does not confuse the history of maneuvers to the extent that the inverse maneuver can no longer be performed and recovery becomes hopeless.

Upon occasion, IUE may be subject to, or the cause of, radio interference with other spacecraft. Under such conditions, the POD is responsible for undertaking appropriate actions to eliminate the problem. If a worthwhile exposure is being stored in one or more of the cameras, one should not attempt to read the image as long as an interference condition exists with the IUE downlink. An example of such a case would be interference from a Landsat passing within the IUE ground antenna beamwidth at ETC. Such a case is indeed possible, but its effect will be short-lived (minutes), and perhaps no action is the best way to handle this problem. In the event that IUE interferes with another spacecraft, the POD will not act on requests by other projects or agencies in shutting down IUE RF transmissions without first consulting with the IUE MOM or Project Manager.

3.8 ENGINEERING TESTS

Spacecraft operations which do not fall in one of the following categories will be classified as engineering tests:

a. Scientific observations

b. Calibration observations/exposures.

c. Stationkeeping maneuvers.

d. Attitude determination.

e. Standby.

By definition, engineering tests are experimental in nature and are usually motivated by the desire to improve or evaluate spacecraft performance and to develop new operations techniques. By their nature, engineering test operations frequently require short turnaround between conception and execution. Therefore, a small amount of spacecraft time is deliberately withheld from scheduled science operations to accommodate engineering test needs should they arise. This is necessary because guest observer telescope time is allocated months in advance whereas engineering test requirements become known only a day or so before the fact. Reserved time that is not needed will be made available to scientific operations.

3.8.1 ENGINEERING TEST APPROVAL

Engineering test proposals must be submitted in writing to the MOM or POD for approval before the test will be scheduled. The POD will consult with the system engineer, subsystem engineers, and Project Scientist as appropriate before granting approval to perform the test. Engineering test proposals may be informal (handwritten) but must explicitly state the purpose, objectives, detailed procedure to be followed, and identify all known or suspected hazards associated with performing the test.

Upon approval, engineering tests will be scheduled for execution with the POD serving as test conductor.

3.8.2 CONDUCT OF ENGINEERING TESTS AT VILSPA

The ESA OE has the same authority as the MOM to approve and conduct engineering tests during the ESA-UK operational periods.

Engineering tests involving the use of cameras in modes or with Digital-to-Analog Converter (DAC) values differing from those used by the approved operations procedures shall not be conducted without prior consultation with the UK camera subsystem engineer. Engineering tests which would subject the spacecraft or any components thereof to substantial risk of damage or impairment of performance shall not be approved unless the Project Managers of the U.S., UK, and ESA have jointly agreed that the conduct of the test is in the best interest of all concerned. Enforcement of this policy is the joint responsibility of the MOM and the ESA Operations Engineer.

3.9 DATA PROCESSING

3.9.1 PROCESSING TURNAROUND REQUIREMENT

A design goal of IUE is to provide processed output data products to guest observers within 24 hours of the associated observation. As a matter of policy, this goal will be achieved to the fullest possible extent within the allotted resources. The ability of the ground system to meet this goal is, of course, dependent upon the daily volume of data to be processed and, in particular, the volume of output data products which are to be generated. It should be noted that in arriving at the 24-hour turnaround goal it was projected that on the average no more than nine high-resolution and nine low-resolution images would be gathered in a single day, and that 8 hours of Sigma 9 time would be adequate to perform the necessary image processing.

It is clear, however, that individual observing programs may occasionally exceed this volume to the extent that the 24-hour turnaround goal cannot be maintained. In such cases, the Project Scientist for Operations may find it necessary to impose data processing volume limitations or establish processing priority guides to prevent an individual user from impacting the processing turnaround of other users. As a policy matter this is left to the discretion of the Project Scientist for Operations.

3.9.2 CALIBRATION OPERATIONS

It is anticipated that periodic calibration checks of the flight scientific instrument will be required throughout the IUE Mission lifetime. These will take the form of camera exposures with on-board sources as well as observations of standard stellar objects. Such operations use the same procedures that are used with routine scientific operations, and will be scheduled and conducted by the RA's as needed during normal scientific operations periods.

Another class of calibration operation is camera reoptimization which differs from ordinary calibration checks in that the procedures used allow specification of DAC reference parameters. This quality places camera reoptimization in the category of engineering tests requiring MOM approval to execute. The MOM will ascertain that the three-agency committee, charged with scientific instrument maintenance and calibration, has initiated or endorsed such tests prior to scheduling them for execution.

3.10 SPACECRAFT REPORTING PROCEDURES

The following lists the IUE reporting procedures:

a. Spacecraft subsystem anomalies will be documented (logged) according to the time (GMT) of occurrence, the subsystem affected, and a brief description of the anomaly. This log will be maintained in the IUEOCC at GSFC for later analysis by the appropriate S/C subsystem engineers. VILSPA will maintain a duplicate log.

b. Any S/C subsystem failure and/or emergency shall be referred to the IUE MOM or POD, as soon as practicable, by the IUEOCC Lead Analyst.

c. In the event of a spacecraft subsystem failure and/or emergency, the operating station shall take the appropriate action to:

   (1) Take necessary action to ensure safety of the S/C, if necessary.

   (2) Switch to a backup system, if available.

   (3) Proceed with science operations, provided observations may be continued.

   (4) Retain all history tapes which might provide information on the failure and what corrective actions were taken.

d. Generally, if any S/C system failure and/or emergency are experienced during VILSPA operations VILSPA will:

   (1) Take necessary action to ensure safety of the S/C, if necessary.

(2) Notify the IUEOCC by the most rapid means available so the MOM or POD can be notified.

(3) Log the event and provide a copy to the IUEOCC by facsimile.

(4) Prepare to hand over the operations to the IUEOCC, if necessary, for S/C failure analysis. The decision to hand it over will be a joint decision between the two operating centers.

e. The operations history tape will contain, as a minimum:

(1) All commands transmitted to the S/C.

(2) S/C telemetry data.

(3) The operations event log.

(4) Alarm messages.

f. The IUEOCC will write and keep the operations history data at least 30 days in rotating queue.

NOTE

IUEOCC history data recorded during VILSPA operations will not contain command, event, and certain alarm data.

g. VILSPA will record history data during their operating periods. These history tapes will be retained for a period of 30 days so command, history, alarms, and the event log will be available, if needed, for S/C failure analysis.

h. In the event of a VILSPA ground system failure, which might prevent or significantly degrade VILSPA operation, the IUEOCC will be notified immediately to prepare to assume operations of the spacecraft.

i. In the event of ground system failure at GSFC, which might prevent or significantly degrade operations, the following actions will be taken:

(1) Switch to backup hardware, if available.

(2) If operations through ETC become impossible, operate through a STDN backup station, as long as STDN support capability is available.

(3) If backup hardware is not available at GSFC, contact VILSPA for possible backup to GSFC, providing VILSPA spacecraft contact is possible. If the VILSPA operations staff is not on station, the estimated time for arrival and support is about 1½ hours.

3.11 IUE SPACECRAFT ANOMALY REPORT

IUE Spacecraft Anomaly Reports (IUESCAR) shall be written to describe anomalies as they are discovered during SC testing, calibration, and operations. These reports shall be recorded in the following format on the IUESCAR form shown in Figure 3-1. A complete report file shall be maintained both at GSFC and VILSPA. The report shall be generated as soon as possible after the anomaly is discovered. The shift shall complete all reports before leaving.

The following is a guide for completing the SCAR:

1. Brief statement of the anomaly which shall be used as a title.
2. Anomaly numbers shall be assigned consecutive numbers at each site.

V-XXXXX	VILSPA report No.	XXXXX
G-XXXXX	GSFC report No.	XXXXX

3. Originator.
4. Originator's phone No. (office).
5. Calendar date.
6. SC mode or configuration shall be recorded, e.g., hold/slew.
7. GMT including day, hr., min., at time of anomaly. This will be used to locate data on history tapes.
8. SC operation shall indicate operation at the time the anomaly was discovered, e.g., coarse slew, fine slew, FES track, SWR EXPOSE, camera LWP readout, etc.
9. Description of the anomaly in sufficient detail to identify the subsystems affected and an understanding of anomaly. (Use additional page(s) if required.)

IUE SPACECRAFT ANOMALY REPORT (IUESCAR)		
ANOMALY (1)		
ANOMALY NUMBER (2)	(3) ORIGINATOR	(4) PHONE NUMBER
DATE (5)	(6) SPACECRAFT MODE OR CONFIGURATION	GMT (7) Day Hr. Min.
(8) SPACECRAFT OPERATIONS DURING WHICH ANOMALY OCCURED		
DESCRIPTION OF ANOMALY (9)		
(10) IMMEDIATE CORRECTIVE ACTION TAKEN		
RESOLUTION OR DISPOSITION (11)		
REMARKS (12)		
RESPONSIBLE ENGINEER (13)	APPROVED BY (14) DATE	CLOSED BY DATE

Figure 3-1. Example of an IUE Spacecraft Anomaly Report

10. Immediate action(s) taken to safe the spacecraft and/or continue operations. Also include any immediate test results.

11. Resolution of the IUESCAR by the appropriate IUE Project Engineer.

12. Remarks shall include any general information that might be helpful in understanding the IUESCAR or its resolutions.

13. Signature of the responsible engineer, or other person, who specifies the resolution or disposition.

14. Approved by the IUE MOM, POD, or designated representative.

3.12 FLIGHT OPERATIONS DIRECTIVE

It is anticipated that during the operational life of IUE, operational changes or workaround solutions to flight equipment malfunctions may need to be created. The latter, of course, would be documented on a SCAR. The Flight Operations Directive (FOD) is the vehicle for ordering a permanent change in the operational routine. It is issued in closing out a SCAR in which an operational workaround is indicated. It is also issued in cases of significant operations errors with the intent of avoiding a repetition of those errors. The term "significant" should be taken to mean exposure of the spacecraft to a hazardous situation, or a loss in observing time in excess of a few minutes.

FOD's will be issued by the GSFC MOM, or POD and will be assigned sequential numbers, separated into three categories: normal, energency, or special. On a periodic basis, copies of FOD's will be sent to all registered FOM holders. FOD's will be provided immediately upon issue to both the GSFC and VILSPA control centers.

The VILSPA operations team is encouraged to contact the POD whenever they feel that a new FOD should be issued. Conversely, the VILSPA OE will be consulted prior to the issuance of new FOD's. The format of a blank FOD form is shown in Figure 3-2.

IUE FLIGHT OPERATIONS DIRECTIVE	DATE	NUMBER
1. APPLICATION: IMPLEMENTATION RESPONSIBILITY: SUPERCEDES PRIOR FODs: RESPONDS TO SCARs:		
2. DIRECTIVE		
3. APPROVAL		DATE

Figure 3-2. Example of an IUE Flight Operations Directive