IUE esa

NEWSLETTER

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(SPECIAL ISSUE)

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EDITORIAL

As was announced in ESA IUE Newsletter N° 13 a considerably improved version of the high resolution extraction software has now been installed at VILSPA. Together with the earlier release of the new low resolution software (ESA IUE Newsletter N° 10 and N° 11), this represents a major improvement in the general processing of IUE data (IUESIPS).

No major modifications are expected to be made to IUESIPS in the near future, therefore we present in this issue a detailed time history of IUESIPS (Part 1) and a number of suggested methods for improving IUE data reduced with earlier versions of IUESIPS (Part II). Minor changes, which are likely to occur, will be documented regularly in the Newsletters.

We hope that the present document will facilitate the use of data retrieved from the archive and will provide a better understanding of the effects to be expected when comparing IUE data reduced with different versions of IUE-SIPS. The two parts included here have also been published in NASA IUE Newsletters N° 16 and N° 17.

The Editor

ESA IUE Newsletter

Editor : W. Wamsteker
Published by : The ESA IUE Observatory
Apartado 54065, Madrid, Spain
Telephone: (1) 401-9661 Telex: 42555 VILS E
Typing : C. Ramirez Palacios
Drawings : J. Garcia Palacios

PART 1 - TIME HISTORY OF IUESIPS CONFIGURATIONS

B.E. Turnrose, C.A. Harvel

ABSTRACT

This document presents basic information needed by International Ultraviolet Explorer (IUE) Guest Observers and Archive Users to understand the evolution of the IUE Spectral Image Processing System (IUESIPS) and its products from April 1978 to March 1981. Data on the status of IUE-SIPS as a function of time are presented in a format intended to facilitate rapid indexing of the changes which have been made to correct deficiencies or errors and to enhance the capabilities of the system. It is expected that the collected information will be of particular utility to users of the IUE Regional Data Analysis Facilities and others wishing to assess the homogeneity of IUE data reduced at various times at either the U.S. or European IUE ground stations.

With the exception of a correction to VILSPA information for configuration number 23, this document represents a reprinting of CSC/TM-81/6117, issued in October 1981 under the same title.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. K.J.E. Northover of the European IUE ground station at Villafranca del Castillo, Spain (VILSPA) for reviewing a preliminary version of this document and providing a significant amount of data pertaining to the history of IUESIPS at VILSPA. The authors also thank Dr. F.H. Schiffer, III of the CSC IUE Science Operations staff for many useful discussions and suggestions regarding the format and contents of this document.

SECTION 1 - INTRODUCTION

1.1 BACKGROUND

The International Ultraviolet Explorer (IUE) satellite has been in operation as a Guest Observer facility since 3 April 1978. The software system used by the IUE Observatory ground stations at GSFC and Villafranca del Castillo, Spain (VILSPA) to perform the standard IUE data reduction operations and generate the standard output products, the IUE Spectral Image Processing System (IUESIPS), has undergone a continual evolution since April 1978 in order to enhance the quality of the data processing and remove various software deficiencies and errors as they were discovered. As a result of the various changes made to IUESIPS, there is necessarily an inhomogeneity between data as it would be processed currently and the same data as it might have been processed at prior times. Existing documentation (International Ultraviolet Explorer Image Processing Information Manual, Version 1.0, CSC/TM-79/6301, and "Chronology of Modifications to IUESIPS Output Products," in NASA IUE Newsletter No. 12, and ESA IUE Newsletter No. 9, January 1981) provides summary data relating to the existence of the changes made to IUESIPS but does not contain sufficient detail to allow a quantitative assessment of each change, in most cases.

1.2 OBJECTIVES

The purpose of this document is to provide a means by which the evolution of IUESIPS since 3 April 1978 can be described in sufficient detail to allow full traceability of the system so that the degree of homogeneity of IUE data reduced at diverse times at either ground station (GSFC or VILSPA) may be adequately assessed. The goal is to provide documentation of each stage in the life of IUESIPS in a form which is convenient and also comprehensive enough to allow the specification of the exact manner in which data reduced at the various stages differs from data reduced with the current system. Wherever possible, we have striven to facilitate the task of the user who wishes to devise correction procedures to remove reduction inhomogeneities. A collection of actual algorithms/procedures to perform meaningful transformation of earlier data is being prepared as a separate document.

1.3 SCOPE

This document describes all known changes relating to the contents or format of the tape output products (GO and archive tapes) from standard IUESIPS processing. Changes which pertain only to the other output products included in GO data packages (CalComp plots, Photowrite hardcopy images, and/or computer printouts) are not treated.

The emphasis in cataloging the changes to IUESIPS herein is on providing an accurate record of the time-history of the evolution of processing conditions, and wherever possible the exact times of implementation of the various changes, at GSFC and VILSPA separately, are given. The types of IUE images affected by each condition catalogued are indicated by camera and dispersion and processing option. Estimates of the actual number of images affected by each condition are made whenever possible. Cross references to available GSFC and VILSPA IUE Observatory software configuration documentation are made when pertinent, and a detailed description of each condition under discussion and its consequences in terms of the character of the data reduced under it, is provided. Finally, as many alternative means of identifying data processed under each configuration (in addition to the date and time of processing included in the headers of all but the very earliest images) as could be determined were included.

The period of time covered by the present document extends from 3 April 1978 to 31 March 1981 (GSFC changes), and 17 April 1978 to 31 March 1981 (VILSPA changes).

SECTION 2 - IUESIPS CONFIGURATIONS

2.1 GENERAL DESCRIPTION OF THE DOCUMENTATION

2.1.1 Sources of Data

Changes to the production version of IUESIPS have, with few exceptions, been effected through a configuration control process which provides documentation sufficient to identify the nature of and the time of implementation of each modification. At GSFC, such documentation takes the form of Science Operations Center Anomaly Reports (SOCARs) and Scheme Modification Reports (SMRs). SOCARs are used to justify and document the changes that are made to the IUESIPS software per se, i.e., applications programs, utilities, and IUESIPS systems software. SMRs are used to justify and document changes made to the production schemes of IUESIPS--those collections of standardized calls to the various IUESIPS applications programs needed to reduce images and generate specific output products for each image type. Although both SOCARs and SMRs carry information describing the scope of the changes they document, the detail included is generally insufficient to fully describe the ramifications of each change from a Guest Observer's point of view. Indeed, for this very reason, and also because many of the SOCARs and SMRs describe system-oriented changes which are transparent to the end recipient of the data, this document is being prepared with the user's interest in mind.

At VILSPA, similar documentation items (Image Processing Software Modification Reports and Scheme Modification Reports) are used to control changes. The GSFC and VILSPA documentation together were used to generate the short-form IUESIPS chronology appearing in NASA IUE Newsletter No. 12 and ESA IUE Newsletter No. 9. These combined resources as well as any available more informal notes and records were used to generate the data compiled herein.

In many cases, supplementary and quite detailed explanatory information is contained in articles published in the IUE Newsletter. Notable here are articles in the continuing series "IUE Data Reduction" of which twenty three have so far been published in the NASA IUE Newsletter. Data from these articles and, more generally, from any relevant contribution in the Newsletter or elsewhere have been assimilated for the present document.

2.1.2 Contents and Use of This Document

As mentioned in section 1.3, only those IUESIPS changes effecting the contents or format of the tape output products are catalogued in this document. The data are presented here as descriptions of each unique configuration of IUESIPS as defined by start and end dates representing the times at which relevant changes to the system were implemented. Such dates are recorded separately for the IUESIPS production systems at GSFC and at VILSPA. This approach is necessary since the effective times at which modifications were implemented at each ground station are in general different. Although functional equivalence of the two IUESIPS systems has been the overall operational goal, certain modifications at one station are not appropriate to the other; notable in this regard, for example, are most of the changes at GSFC dealing with calibration images, which are not acquired and analyzed as extensively at VILSPA.

The configurations are described in three separate but complementary ways: 1) bar-graph timelines showing start and end date (with a resolution of one week) for each configuration (referenced by number), 2) an index of configurations by number and title, and 3) a detailed description of each configuration by number, title, effective dates, etc. The first task of a user wishing to relate data reduced in the past to present-day data is to identify all past configurations appropriate to the old data, since the existence of a configuration with an end date at some point in the past indicates a difference between the system as it was prior to the end date and as it is now. This is accomplished, as a function of processing date (with 1-week resolution), with the configuration timelines in section 2.2. From the timelines, the user identifies the number of each prior configuration in effect on the date of processing. From the index of configurations in section 2.3, the user can then ascertain, by title, which configurations are relevant to his data. The user can then refer to section 2.4 for the detailed writeup of each configuration, including the exact start and end dates (when known), data types affected, relevant documentation, means of recognizing affected data (other than processing date), and the ramifications of each configuration. The user would also refer to section 2.4 for those cases in which the resolution of the timelines in section 2.2 was insufficient.

2.2 CONFIGURATION TIMELINES

In this section a set of bar-graph timelines is presented showing the start and end dates, at GSFC and at VILSPA separately, for each of the configurations catalogued. Figure 2-1 contains the timelines. Processing date is displayed along the vertical axis, at a scale of one week per small division, beginning with the start of the Guest Observer period on 3 April 1978. The first week in each new month is marked. Each configuration is identified by a sequential number, ordered by GSFC end date (or VILSPA end date if no GSFC end date exists). In Figure 2-1 the bar connecting the GSFC start and end dates appears to the left of each major division; the bar connecting the VILSPA start and end dates appears adjacent to the GSFC mark, to the right of each major division. In cases where the VILSPA dates are not known, a bar is not drawn.

Note that the configuration number is not necessarily an integer. Because a preliminary version of this document had been circulated at the IUE ground stations in May 1981 and some cross-referencing of configurations by number had occurred, it was decided to retain the original seventy configuration numbers as they appeared in the preliminary version. This means that several additional configurations subsequently identified as falling by date between original configurations are assigned decimal numbers, such as 14.1, and inserted in the proper sequence. With this system of numbering, the configurations are still in chronological order by end date. The timelines allow the user to determine quickly which past configurations affect the data in question, on the basis of processing date. In case of borderline processing dates, the user may refer directly to the precise start and end dates in section 2.4.

2.3 INDEX OF CATALOGUED CONFIGURATIONS

In this section each past configuration is listed by sequential number and title (Table 2-1). From this index, the user then can determine the general nature of each past configuration selected from the timelines in section 2.2. This index should simplify the user's task by allowing him to weed out configurations which, although in effect at the time of processing, are of no relevance to his data. An example would be a configuration pertinent only to high dispersion data which a user with only low dispersion data could ignore. On the other hand, those configurations which bear further investigation in section 2.4 are easily highlighted.

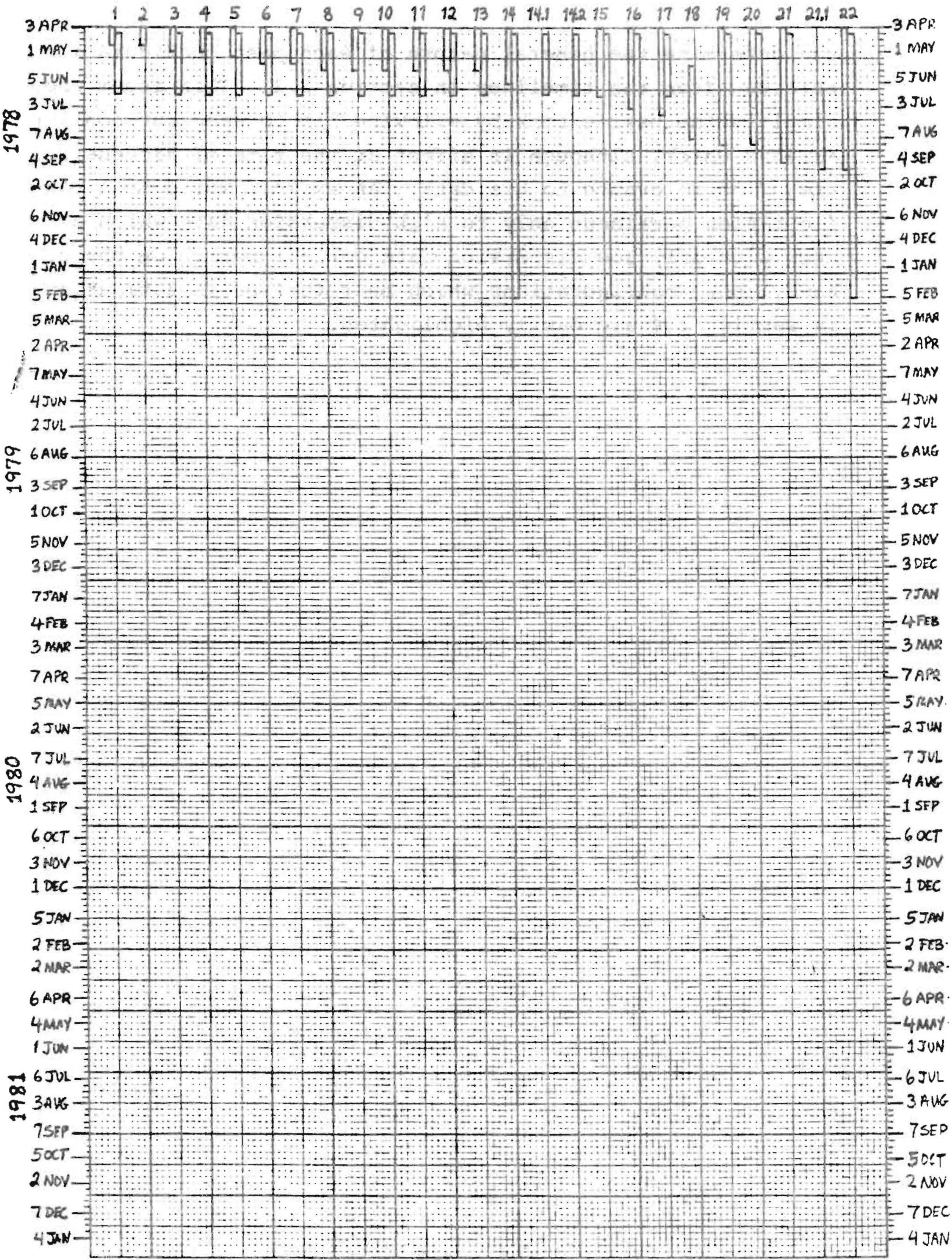


Figure 2-1. Configuration Timelines

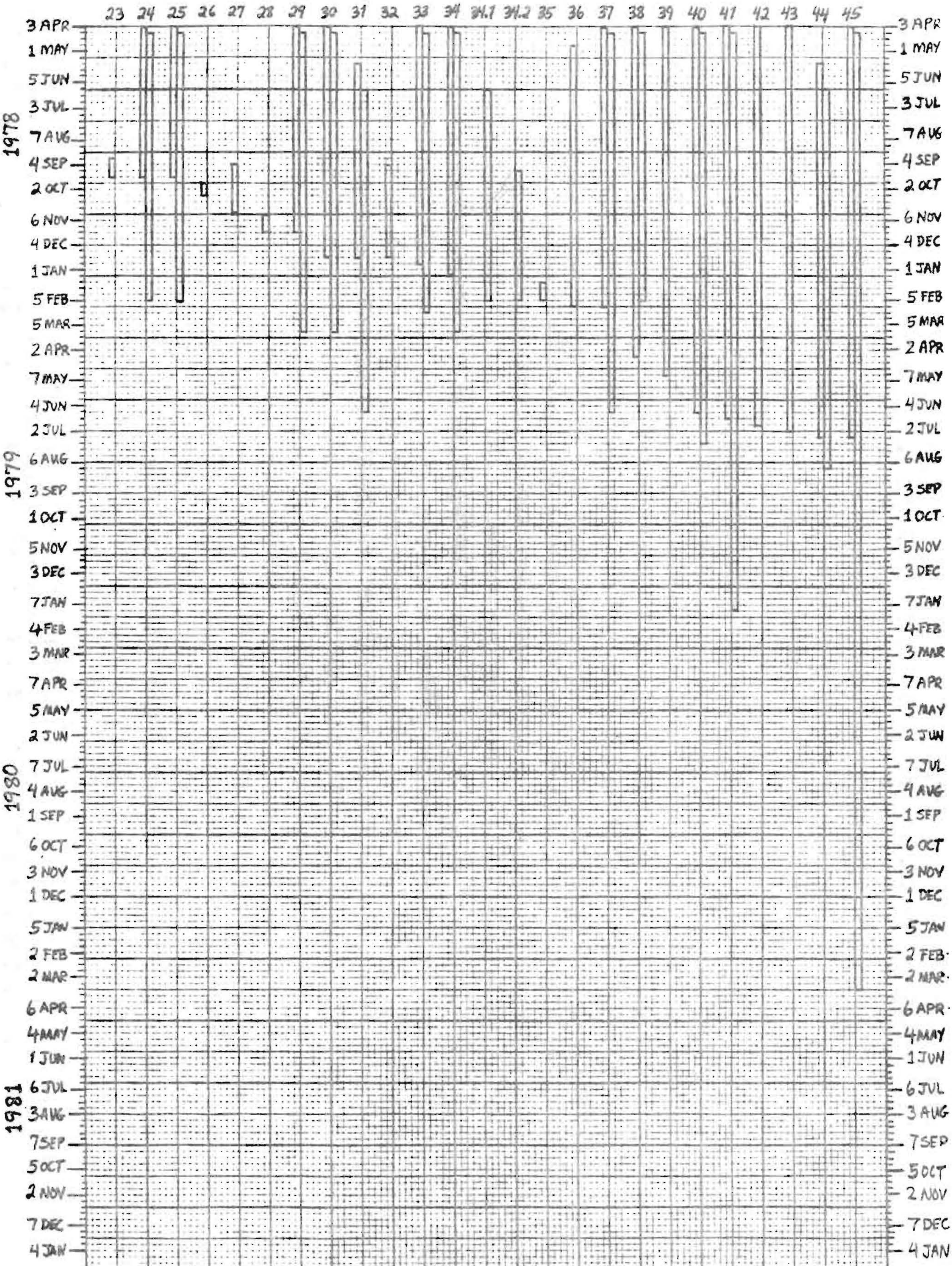


Figure 2-1. Configuration Timelines (continued)

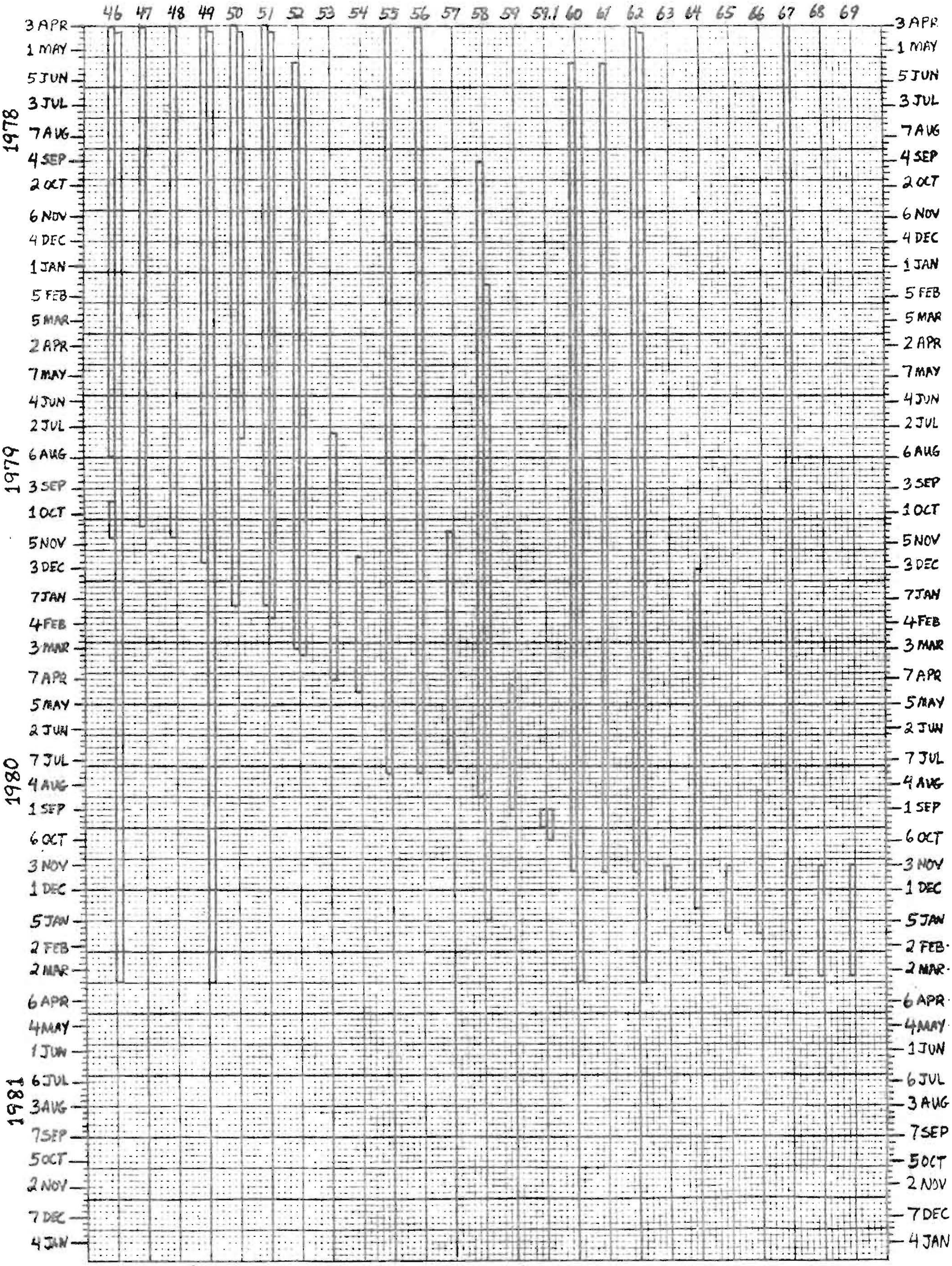


Figure 2-1. Configuration Timelines (continued)

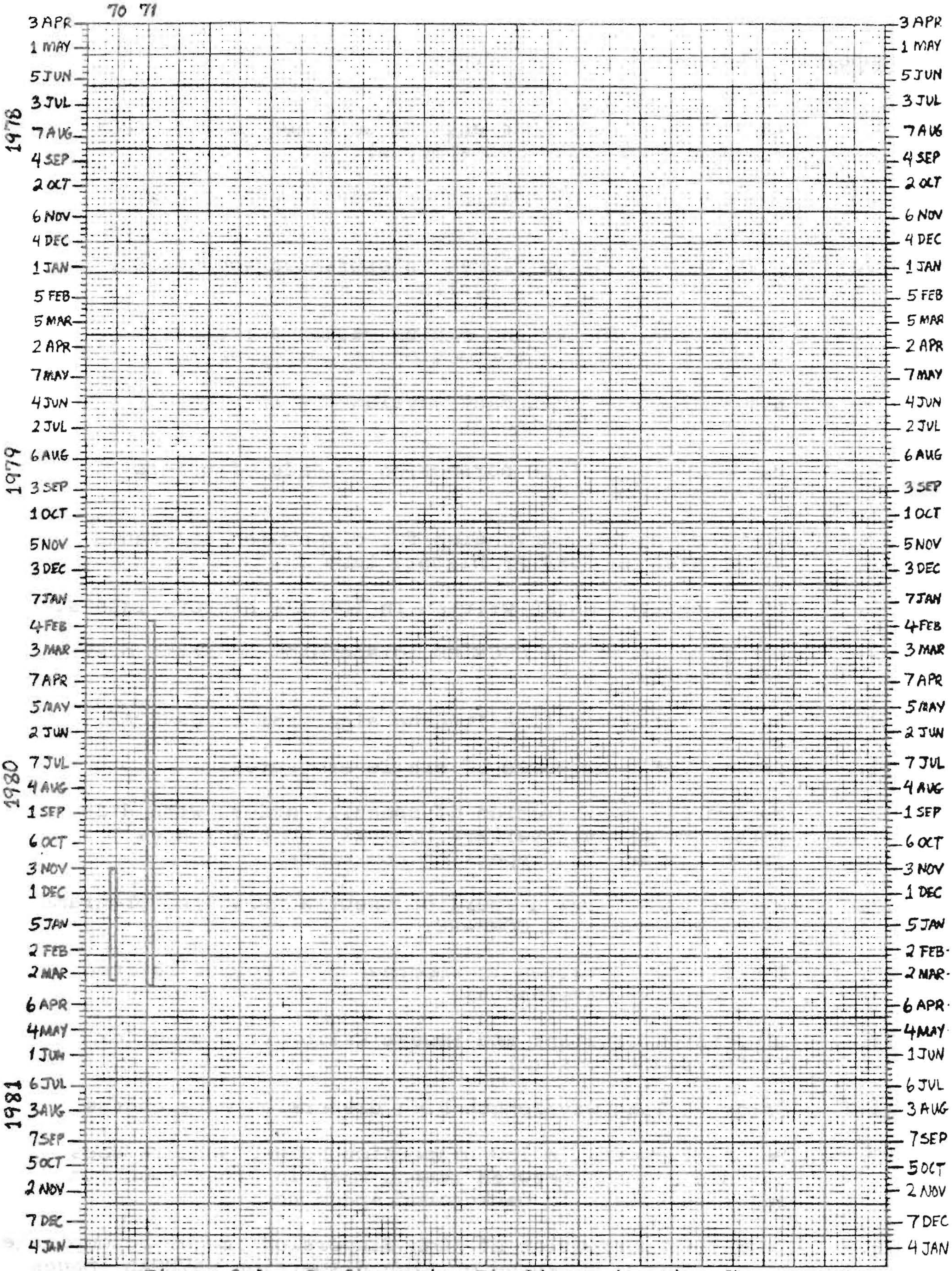


Figure 2-1. Configuration Timelines (continued)

Table 2-1. INDEX TO CATALOGED CONFIGURATIONS

Number	Title
1.	Corrupted data at the ends of smoothed background spectra (and hence net spectra).
2.	Restricted low dispersion SWP wavelength coverage (λ1000-1900Å).
3.	Erroneous negative fluxes in extracted spectra due to incorrect integer scaling of Fmax.
4.	Non-optimal center and radius values for circle in which geometric correction is performed.
5.	Suppression of redundant wavelengths in high dispersion processing.
6.	Unrestricted RIPPLE correction at ends of orders in high dispersion.
7.	Reversed naming convention for dispersion constants as written in IUESIPS history label.
8.	No processing dates written in IUESIPS history labels.
9.	One-pixel error in OSCRIBE (dispersion-constant overlay program).
10.	Nearest-neighbor line-finding algorithm in WAVECAL.
11.	Use of ITF's composed of single exposures.
12.	Accomplish registration of spectral orders with dispersion-constant overlays by shifting the images (rather than the dispersion constants).
13.	Extraction of low dispersion spectra using the programs SPIN, ROTATEH, and COMPARE.
14.	Epsilon-field values in smoothed backgrounds shifted to incorrect wavelengths.
14.1	Dispersion constant and reseau calibration used for VILSPA reductions (1).
14.2	Error in long wavelength high dispersion wavelengths.
15.	Reseau flagging in low dispersion merged spectra does not distinguish between reseau mark in gross spectrum and reseau mark in background spectrum.
16.	Geometric correction of high dispersion images accomplished using reseaux measured on high dispersion WAVECAL images.

Number	Title
17.	Use of non-optimal RIPPLE parameters for LWR.
18.	Extract low dispersion spectra (EXTLOW) with HT=9 and DISTANCE=8.0 (Will not properly extract spectra of aperture-filling objects).
19.	Image sequence number sometimes zeroed out in scale factor record of merged spectral file.
20.	Determine LWR low dispersion wavelength calibrations from preliminary version of line library.
21.	Use of incorrect offsets from small to large aperture in LWR.
21.1	Error in SWP low dispersion wavelength scale.
22.	Perform all registrations of spectral orders with dispersion-constant overlays manually.
23.	Camera number transmitted as true number plus 10 or 20 in scale factor record of merged spectral file.
24.	Determine SWP low dispersion wavelength calibrations from preliminary version of line library.
25.	Extract low dispersion large-aperture point-source spectra with DISTANCE=8.0.
26.	Improper truncation of area of image photometrically corrected.
27.	Automatic registration of spectral orders done using only 6 sampling areas in DSPCON.
28.	Omit vacuum-to-air correction for LWR low-dispersion single-aperture reduction.
29.	Photometrically correct entire 768 x 768 image (SWP high dispersion).
30.	Photometrically correct entire 768 x 768 image (low dispersion).
31.	No information on values of OMEGA, HBACK, or DISTANCE in IUESIPS history labels.
32.	No information on values of automatic registration shifts recorded in IUESIPS history labels.

Table 2-1 continued

Number	Title
33.	Process order 65 in SWP high dispersion.
34.	Photometrically correct entire 768 x 768 image (LWR high dispersion).
34.1	Dispersion constant and reseau calibration used for VILSPA reduction (2).
34.2	Dispersion constant and reseau calibration used for VILSPA reduction (3).
35.	Use incorrect version of ETOEM.
36.	High dispersion partial processing on S/360 (VICAR).
37.	Use original IUESIPS File Management System.
38.	No information on values of manual registration shifts recorded in IUESIPS history label.
39.	No output products generated for images designated "Do Not Process".
40.	Improperly convert certain spectral files with negative fluxes to GO-tape integer format.
41.	All high dispersion extractions due with HT=5.
42.	Write redundant raw-image tape files for wavelength calibration images.
43.	No short header file written at beginning of GO tape.
44.	Use of SWP ITF with incorrect 20% exposure level.
45.	Use of non-optimal pixel offsets from small to large aperture.
46.	Use of pixel offsets from small to large aperture which do not correspond to physical center of large aperture.
47.	Write geometrically-correct-image tape file for wavelength calibration images.
48.	Use biweekly dispersion-constant calibrations in low dispersion.
49.	Determine high dispersion wavelength calibrations from unrefined line libraries (version I libraries).
50.	Do not provide absolutely calibrated net spectrum in low dispersion.

Table 2-1 continued

Number	Title
51.	Truncation of ITF at upper limit.
52.	Incorrect units for DISTANCE parameter in EXTLOW.
53.	Use original Astron. Astrophys. absolute calibration.
54.	Determine high dispersion wavelength calibrations from partially refined line libraries (version II libraries).
55.	Use biweekly reseau calibrations.
56.	Use biweekly dispersion constant calibrations in high dispersion.
57.	Use preliminary mean dispersion constants for low dispersion.
58.	Inaccurate automatic registration programs.
59.	Determine high dispersion wavelength calibrations from further refinements to line libraries (version III libraries).
59.1	Incorrectly transmit 5-digit image sequence numbers to scale-factor record of extracted spectral files.
60.	Processing of low dispersion spectra using the programs GEOM, FICOR, and EXTLOW.
61.	Non-perpendicular manual shifts (REGISTER).
62.	Label lacks scheme name and auto/manual message.
63.	Incorrect manual shift for SWP images (REG).
64.	VBBLK without label processing.
65.	Incorrect entries in label by SPECLO (negative declination and zero shift).
66.	Inaccurate automatic registration (LWR-LOW, SWP-HIGH and all Trailed).
67.	Calibration files without temperature corrections (low dispersion).

Table 2-1 continued

Number	Title
68.	Use of preliminary parameters to specify the region to be processed by the program PHOTOM.
69.	Use positional information to determine the bounds of the area to be extracted (SPECLO).
70.	Unused lines of header label not blank-filled by POSTLO.
71.	Dispersion constant and reseau calibration used for VILSPA reductions (4).

2.4 DETAILED CONFIGURATION DATA

In this section the fully-detailed discussion of each cataloged IUESIPS configuration is found. To facilitate the use of this section as a reference tool, a standard format for the data presentation has been adopted. Each configuration begins on a new page and has the title and sequence number at the top of the page. The entries under "Data Affected" are used to specify the types of data pertinent to the configuration described. The "Camera" and "Dispersion" entries are self-evident. "Processing" means the specific type of file affected by the configuration - for example, a change in the photometric correction affects both the geometrically and photometrically corrected image itself and the spectra extracted from it, whereas a change in wavelength scales affects only the extracted spectra. The file mnemonic conventions defined in CSC/TM-79/6301 and "IUE Data Reduction XVIII, Implementation of New Low Dispersion Software: Summary of Output Format Changes" in NASA IUE Newsletter No. 12 are used often here (GPI, ESSR, ESHI, etc.). The terminology "merged spectra" refers to the file of merged gross, background and various net spectra (ESHI, ESLO or MELO), whereas in low dispersion the terminology "extracted spectra" would include both the line-by-line (ESSR or LBLS) and merged spectra.

The start and end dates (GMT) for each configuration are given, separately for GSFC and VILSPA, with the greatest precision possible. (An entry of N/A means that the configuration is not applicable at that particular ground station.) Where an exact time of day is available, it is given in GMT hours and minutes (hh:mm). In certain cases where exact times of changes were not recorded originally, a limit on the time of the change is set by the existence of a program or scheme listing evidencing the change (and which bears a time of day). In such cases the time of the listing becomes an "upper limit" to the time of the change and is preceded by the symbol "<".

When the start or end date is left totally blank, no information is currently available on the change date (certain VILSPA dates only). Certain VILSPA dates which are uncertain but supported by strong indirect evidence are enclosed within exclamation marks, e.g. !14 June 1978!

The entry "Media" reflects the output product media affected by the configuration. The entry "Estimated Fraction of Processed Images Affected" is an estimated proportion of images actually affected by the configuration out of the images potentially affected (i.e., the estimated fraction of affected data out of total data of the type specified above). The "Estimated Number of Images Affected" is an estimate of all affected data (GSFC and VILSPA). Both of the above estimates are rough and should not be relied upon for detailed statistics.

Under "Pertinent Documentation" are included cross references to all relevant documentation, including GSFC SOCAR and SMR numbers, IUE Newsletter articles, and other sources.

The "Description" section contains the discussion of the nature of each configuration, with equations, tables, and figures included where applicable. The attempt was made to provide sufficient detail without excessive length. Those descriptions or parts thereof provided by Dr. K.J.E. Northover of VILSPA are enclosed within brackets "< >".

Under "Means of Identifying Affected Data" we have provided, where possible, means of recognizing data affected by each configuration which are alternative to the date of processing. Where it was not possible to specify any such alternative identification methods, this section was omitted.

The set of detailed descriptions follows according to the format outlined above.

TITLE: Corrupted data at the ends of smoothed background spectra (and hence net spectra).

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted Spectra

MEDIA: Tape, CalComp

DATES:	BEGIN	3 April 1978	END	14 April 1978 20 April 1978	(GSFC)
	BEGIN	17 April 1978	END	!14 June 1978!	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 50

PERTINENT DOCUMENTATION: GSFC SOCAR 91, SOCAR 95

DESCRIPTION: Flux points at ends of orders which had been processed with SMOOTH (the running-average smoothing done on background spectra) were either incorrectly calculated or dropped because of an indexing problem in the code. The result was corrupted data at the ends of orders (smoothed background and net files) in high and low dispersion. The number of points that were handled incorrectly was TBD.

The program SMOOTH was modified to correct the problem; existing documentation indicates changes were made on 14 April 1978 and 20 April 1978 but is insufficient to fully specify the time and nature of the fixes.

TITLE: Restricted low dispersion SWP wavelength coverage (λ1000-1900Å)

DATA AFFECTED:

CAMERA: SWP DISPERSION: Low PROCESSING: Extracted Spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END <19:47 20 April 1978(GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 20

PERTINENT DOCUMENTATION: GSFC SMR 4

DESCRIPTION: The SWP low dispersion extraction scheme cut off at λ=1900Å. By modifying the size field in call to COMPARE so as to read (1, 81, 32, 1200) instead of (1, 183, 32, 1200) and by extending the call to SMOOTH with NAVG=1 to an LMAX of 2000.0 instead of 1900.0, spectral extraction was extended to λ=2000Å. Plots were similarly modified to show the extended spectral region.

MEANS OF IDENTIFYING AFFECTED DATA:

- Absence of extracted data at wavelengths longer than 1900 Å in SWP low dispersion.

TITLE: Erroneous negative fluxes in extracted spectra due to incorrect integer scaling of Fmax.

DATA AFFECTED:

CAMERA: All   DISPERSION: Both   PROCESSING: Extracted Spectra

MEDIA: Tape

DATES:	BEGIN	3 April 1978	END	26 April 1978	(GSFC)
	BEGIN	17 April 1978	END	!14 June 1978!	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 20%

ESTIMATED NUMBER OF IMAGES AFFECTED: 20

PERTINENT DOCUMENTATION: GSFC SOCAR 78, SOCAR 86, SOCAR 98, SOCAR 107, SOCAR 125

DESCRIPTION: The program ITOE which performs the scaling of floating-point internal-format fluxes scaled the fluxes so that the integer Fmax value was 32767 (± roundoff). When positive roundoff occurred, the 16-bit format overflowed, causing Fmax to be interpreted as a large negative number. Thus, any point extracted with flux equal to Fmax would be incorrectly encoded as negative numbers on the tape. In general, only a small number of points would be involved. Furthermore, the sudden jump to large negative numbers is easily identified.

A safety margin for roundoff error was therefore built in so that instead of scaling Fmax to 32767, Fmax + 1 is scaled to 32760.

MEANS OF IDENTIFYING AFFECTED DATA:

- Presence of sudden jumps to large negative fluxes amidst positive fluxes near 32767.

TITLE: Non-optimal center and radius values for circle in which geometric correction is performed.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: GPI, extracted spectra

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN 3 April 1978 END 27 April 1978 (GSFC)

BEGIN 17 April 1978 END !14 June 1978! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 100

PERTINENT DOCUMENTATION: GSFC SOCAR 109

DESCRIPTION: The program GEOMF, which geometrically corrects a raw image, only operates within a circle (in raw-image space) of radius RAD and centered at sample = CENS and line = CENL. Pixels in the output image which correspond to positions in the input image outside of this circle are set to zero DN. This is done both to save execution time and to remove as much of the unwanted target ring as possible.

Prior to end date, the values for these parameters had been:

CENS = 384.0
CENL = 384.0
RAD = 370.0

After this date, the new values are:

CENS = 390.0
CENL = 390.0
RAD = 358.0

That is, the circular area over which the geometric correction (and hence all further meaningful photometric correction and extraction) is performed is moved "down to the right" and made slightly smaller. The primary effect of this change is to remove a larger portion of the target ring from the corrected image and hence provide a cleaner extraction of data.

MEANS OF IDENTIFYING AFFECTED DATA:

- Examination of geometrically and photometrically corrected image (GPI).

TITLE: Suppression of redundant wavelengths in high dispersion processing

DATA AFFECTED:

CAMERA: All DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, Calcomp

DATES:	BEGIN	3 April 1978	END	<21:44	08 May 1978	(GSFC)
	BEGIN	17 April 1978	END		14 June 1978	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 100

PERTINENT DOCUMENTATION: GSFC SOCAR 99, SMR 8

DESCRIPTION: The program CUTMERGE, which restricted the extracted wavelengths for each order to the range $\frac{2K}{2M+1} < \lambda < \frac{2K^*}{2M-1}$, was used in order to produce properly merged gross, interorder, net, and net-ripple-corrected spectra on tape. Because of a bug in the program COMBINE (used to subtract interorder spectrum from gross to obtain net) which dropped data points from the end of the net spectrum, CUTMERGE had been used to cut all four spectra to equal length for merging in GO-tape format. When COMBINE was fixed to alleviate that problem (SOCAR 99), CUTMERGE was dropped as of the end dates shown.

As a result, there is no overlap of redundant wavelengths between most orders, so that coincidence of features can be used to better judge their reality in many cases.

* $K = \begin{matrix} 231{,}342 \text{ for LWR} \\ 137{,}600 \text{ for SWP} \end{matrix}$ (Note: not the same as K values for RIPPLE).

MEANS OF IDENTIFYING AFFECTED DATA:

- o Complete lack of wavelength redundancy in data on GO tape.
- o Program step CUTMERGE appears in I. P. history portion of label.

TITLE: Unrestricted RIPPLE correction at ends of orders in high dispersion

DATA AFFECTED:

CAMERA: All DISPERSION: High PROCESSING: Extracted spectrum

MEDIA: Tape, Calcomp

DATES: BEGIN 3 April 1978 END 13:24 11 May 1978 (GSFC)

BEGIN 17 April 1978 END !14 June 1978! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 100

PERTINENT DOCUMENTATION: GSFC SOCAR 119

DESCRIPTION: The program RIPPLE calculates a flux Fcorr(λ) corrected for the echelle blaze ("ripple") function with the formula:

$$\mathrm{Fcorr}\ (\lambda) = \frac{F(\lambda)}{R(\lambda)}$$

where $F(\lambda)$ is the uncorrected net flux

$$R(\lambda) \equiv \frac{\sin^2 X}{X^2}\ (1 + aX^2)$$

$$X = \frac{\pi m^2\ (\lambda - \lambda_c)}{K}$$

$$\lambda_c = \frac{K}{m}$$

m = order number

and K = 137,725, a = 0.10 } SWP

and K = 231,300, a = 0.08 } LWR at GSFC prior to 7 July 1978 (see also the change as of that date)

With this formula, the correction factor at the ends of the orders (large X) are large, resulting in the amplification of noise.

On the end date above, a limit of 2.61 was placed on the value of X, resulting in a maximum multiplicative flux correction factor $\frac{1}{R(\lambda)}$ of 15.77 in SWP and 17.16 (prior to 7 July 1978) for LWR.

TITLE: Reversed naming convention for dispersion constants as printed in IUESIPS history label.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END 11 May 1978 (GSFC)

BEGIN 17 April 1978 END !14 June 1978! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 250

PERTINENT DOCUMENTATION: GSFC SOCAR 113

DESCRIPTION: The naming convention for the A_i and B_i values of dispersion constants was reversed in the labels written by the programs DATEXTH2 and COMPARE. Both programs named the A_i as the line-coordinate constants, and the B_i as the sample-coordinate constants.

As of the end date above, the A_i refer to the sample coordinate constants and the B_i to the line-coordinate constants.

TITLE: No processing dates written in IUESIPS history labels.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: All files

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN 3 April 1978 END 04:40 18 May 1978 (GSFC)

BEGIN 17 April 1978 END 14 June 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 350

PERTINENT DOCUMENTATION: GSFC SOCAR 112

DESCRIPTION: The date and time of processing was not included in the IUESIPS history labels until the end date above. This is a serious deficiency, since the processing date provides the basic traceability parameter for the processing.

As of the end date, the IUESIPS Control Executive was modified to write the GMT time and date of processing, in the sample format 04:40Z May 18, 1978, in the history portion of the IUESIPS label (lines 101 on) for each applications program executed.

MEANS OF IDENTIFYING AFFECTED DATA:

- Lack of dates in IUESIPS history portion of label.

NO. 9

TITLE: One-pixel error in OSCRIBE2 (dispersion-constant overlay program).

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN 3 April 1978 END <17:08 18 May 1978 (GSFC)

BEGIN 17 April 1978 END 14 June 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 350

PERTINENT DOCUMENTATION: GSFC SOCAR 120, SMR 11

DESCRIPTION: The program OSCRIBE2 generated the overlays of the trajectories followed by the dispersion relations. It was found that a 1-pixel error (in the sample direction) was being introduced in generating the overlays, such that the generated overlays were situated at too large a sample number (i.e., too far "to the right") by 1 pixel. The effect of this would be change the positioning of the extraction slit with respect to the spectral orders, in as much as the (incorrect) overlays were registered with the orders by shifting the image prior to the spectral extraction step. For example, if no shift were in fact necessary, the error in OSCRIBE2 would have caused an offset to appear which would result in a shift leading to a spectral order which was not centered in the extraction slit. The effects of this on extracted flux would be small in low dispersion where the slit is relatively long, but could be measurable in high dispersion where the shorter slit and closer interorder spacing could result in both a reduced gross flux and an increased background flux. The effects on assigned wavelengths are small ($\leq .7$ pixel along dispersion) but variable, depending on the direction in which the compensating image shift was applied by the processing operator.

The program OSCRIBE replaced OSCRIBE2 and corrected the problem.

continued - No. 9

MEANS OF IDENTIFYING AFFECTED DATA:

- Program name OSCRIBE2 (instead of OSCRIBE) written in label of photowrite image with dispersion - constant overlay.

NO. 10

TITLE: Nearest-neighbor line-finding algorithm in WAVECAL.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted Spectra

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN 3 April 1978	END 18 May 1978 (LWR high) 19 May 1978 (SWP low) 21 May 1978 (LWR low & SWP high)	(GSFC)
	BEGIN 17 April 1978	END 14 June 1978	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 400

PERTINENT DOCUMENTATION: GSFC SMR 10

DESCRIPTION:

The program WAVECAL (which finds the coordinates of individual platinum lines in the geometrically-corrected calibration images) used a nearest-neighbor result from the cross-correlation search algorithm.

A modified version of the program (WAVECAL2) was installed (at GSFC on 15 May 1978) to interpolate smoothly the inferred coordinates of maximum correlation (i.e., the platinum-line positions) which are in general not integer pixel values. The resulting dispersion constants are hence slightly more accurate. Note that the effective end dates for this condition depend on when the next calibration image for each camera and dispersion mode was processed.

TITLE: Use of ITF's composed of single exposures

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: GPI, extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 3 April 1978 END 20:30 22 May 1978 (GSFC)

BEGIN 17 April 1978 END 14 June 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: GSFC SMR 12, CSC/TM-79/6301

DESCRIPTION:

Prior to the end dates shown, the Intensity Transfer Functions (ITFs) used were comprised of single flat-field images at each exposure level. The ITFs installed as of the end dates are comprised of averages of at least 2 (usually 3 or 4) images at each exposure level. In addition, the new LWR ITF was extended to a higher exposure level (nominal 200% exposure). The new SWP ITF was reduced to 11 levels instead of 12, but still covers approximately the same exposure range (up to nominal 160% level). CAUTION: The new SWP ITF installed on end date also contained the famous error in the 20% exposure level (see NASA IUE Newsletter No. 7, Nov. 1979 see also change of 07 July 1979)

Summary of characteristics of the changes made on ending dates

ITF CHARACTERISTIC	LWR		SWP	
	OLD	NEW	OLD	NEW*
Number of exposure levels	12	12	12	11
Nominal highest exposure level	140%	200%	160%	160%
Maximum unsaturated flux number †	18000	25219	18003	17740

† See 8 Jan. 1980 change to extrapolate the ITFs.
* New SWP ITF had large photometric errors for 1084<FN<4291. (See NASA IUE Newsletter No. 7.)

MEANS OF IDENTIFYING AFFECTED DATA:

- The tables of T values printed in the IUESIPS history labels of photometrically corrected images (see IUE Image Processing Information Manual, Version 1.0, CSC/TM-79/6301) These values are the effective exposure times, in units of 0.01 seconds, assigned to the various levels of the ITF. These values are:

Old ITFs

SWP:	0	1800	3600	5500	7300	9100
	10900	12700	14500	18200	21800	29100
LWR:	0	1800	3700	5600	7500	9400
	11200	15000	18800	22500	26300	30000

NEW ITFs

SWP:	0	1753	3461	6936	9000	10575
	14299	17709	21546	25156	28674	
LWR:	0	2303	4069	8008	10073	11878
	15883	20149	24471	29391	34333	42032

TITLE: Accomplish registration of spectral orders with dispersion-constant overlays by shifting the images (rather than the dispersion constants)

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 3 April 1978 END 20:30 22 May 1978 (GSFC)

BEGIN 17 April 1978 END 14 June 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: GSFC SMR 14

DESCRIPTION:

The registration of the spectral orders with the dispersion relations (which dictate the trajectory of the extraction slit) was accomplished by holding the dispersion constants fixed and actually moving the geometrically and photometrically corrected image by the small number of pixels required. The disadvantages of this procedure were that

1). only integer-pixel shifts were allowed (i.e., no resampling was done)

2). when the image is shifted, the reseau marks move with the image, and the reseau flagging algorithm which works on the expectation of fixed reseau positions will not work correctly.

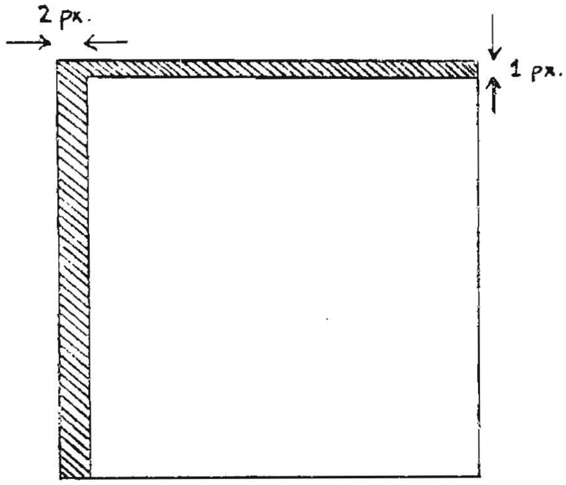
On the end dates shown, a change was made so that the image is held fixed and the registration is done by shifting the zero-point terms in the dispersion relations. Since the zero-point shift need not be an integer-pixel value, disadvantage 1 is removed, and since the image and reseaux are fixed in position, disadvantage 2 is also removed. Note the following changes to the data are involved in this procedural change:

a). The geometrically and photometrically corrected image written on the tape is now unshifted (previously, the shifted image had been written to tape, with zeroes filled in the samples (or lines) that were brought into the 768 x 768 pixel array during the shift step)

b). The dispersion constants written in the IUESIPS label are the <u>shifted</u> constants used to do the data extraction. They would be a slightly more accurate representation of the order location because of the fractional-pixel shifting allowed.

<u>MEANS OF IDENTIFYING AFFECTED DATA</u>:

- Geometrically and photometrically corrected images on tape (GPI) will have a border of zero-filled pixels representing the lines (or samples) shifted into the 768 x 768 array by the shifting process



e.g. an image shifted +2 pixels and +1 line would have zero values in the bytes corresponding to the pixels shown in shaded area above.

- IUESIPS history label of geometrically and photometrically corrected image shows that program SHIFT was executed.
- Reduced photowrite image with OSCRIBE overlay has information in label showing that the program SHIFT was executed, and it contains a line of text which reads **** OSCRIBED SHIFTED IMAGE ****

TITLE: Extraction of low dispersion spectra using the programs SPIN, ROTATEH, and COMPARE.

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN 3 April 1978 END 20:30 22 May 1978(GSFC)

BEGIN 17 April 1978 END 14 Jun 1978(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 300

PERTINENT DOCUMENTATION: GSFC SMR 15

DESCRIPTION: The use of the programs SPIN, ROTATEH, and COMPARE to extract low dispersion spectra was accompanied by several drawbacks and/or conditions which were eliminated by the introduction of the program EXTLOW for extracting low dispersion spectra. These conditions were:

1). No flagging of reseaux or saturated pixels. All quality-measure ε values set to 100.

2). Spectra extracted from a "rectified image segment", being a geometrically reshuffled portion of the geometrically and photometrically corrected image aligned parallel to the dispersion line.

3). The line-by-line or spatially-resolved spectra (NL=32, NS=1204) were extracted from the rectified image segment using a 1-pixel slit and were assigned "pseudo order" numbers 1-32. The 2000-FN-per-pixel offset added to the photometrically corrected image was included in the line-by-line flux values.

4). The merged slit-integrated spectra (NL=7, NS=1204) were extracted from the rectified image segment using a summation of line-by-line fluxes representing a slit 1 pixel wide and 10 pixels long. Gross spectrum from sum of lines 12-21, and background spectrum from sum of lines 7-11 and 22-26. The 2000-FN-per-pixel offset was included in both the gross and background fluxes (total 20,000 FN in each because of 10-pixel total slit area). Apart from the offset, which cancels out in the net spectrum, the net slit-integrated FN values were smaller than those subsequently obtained using EXTLOW, due to the geometric projection effects inherent in the extraction method. The ratios of EXTLOW net FN to COMPARE net FN are 1.78 for LWR and 1.83 for SWP.

With the introduction of EXTLOW, the following changes occurred:

1). ε values computed similarly to high dispersion case

$$\varepsilon = 0.264 \times d + \varepsilon_r + \varepsilon_s$$

where d = distance from center of tube in pixels

$$\varepsilon_r = \begin{cases} -800 & \text{if any pixel within the slit defining flux (gross or background) is within 2 pixels of the fixed reseau marks.} \\ 0 & \text{otherwise} \end{cases}$$

$$\varepsilon_s = \begin{cases} -1600 & \text{if any pixel in slit is saturated (DN=255)} \\ 0 & \text{otherwise} \end{cases}$$

2). Spectra extracted directly from the geometrically and photometrically corrected image, in a manner similar to high dispersion.

3). The line-by-line spectra (NL=55, NS=1204) extracted with an effective slit area of $\sqrt{2} \times \sqrt{2}$ pixels, each sampling slit being oriented at an angle of 45° to the line and sample directions. Each of the spectra are assigned a pseudo-order number from 73-127, with order numbers increasing from the large aperture toward the small. All 2000-FN offsets removed.

4). The merged spectra (NL=7, NS=1204) extracted with a slit of effective width $\sqrt{2}$ pixels and area of 17 pixels (i.e., the slit is $9\sqrt{2}$ pixel-widths long). The background spectra are extracted from the sum of 5 pixels on either side of the gross extraction slit, centered at a nominal distance of $8\sqrt{2}$ pixels from the dispersion line (but see change to EXTLOW2 on 01 March 1980) and normalized to a total area of 17 pixels. All 2000-FN offsets removed. Net FN differ from COMPARE values by the projection factors cited above.

MEANS OF IDENTIFYING AFFECTED DATA:

- Line-by-line file only 32 lines
- All $\varepsilon \equiv 100$
- Program names in IUESIPS history label

TITLE: Epsilon-field values in smoothed backgrounds shifted to incorrect wavelength.

DATA AFFECTED:

CAMERA: All DISPERSION: All PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END <14:10 01 June 1978 (GSFC)

BEGIN 17 April 1978 END 17:00 01 Feb 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 700

PERTINENT DOCUMENTATION: GSFC SOCAR 126, SMR 8, SMR 25

DESCRIPTION: The quality-measure ε field in smoothed background spectra was displaced by + NAVG/2 points each time SMOOTH was executed. NAVG is the width of the running-average filter used (≡15) so that ε values were displaced by +7 extraction points in each pass of SMOOTH. Since a double-pass smoothing is employed, the ε values were displaced by 14 points from their correct positions in smoothed background spectra; i.e., the wrong wavelengths were flagged for reseaux or saturation.

This misplacement is evident in the net spectrum defined as the gross minus the smoothed background, since the flags are combined. The ε values from the smoothed background appeared displaced from their correct positions, although those ε conditions arising from the gross spectrum were correct. Hence, the ε values in merged spectra prior to end date should be regarded with caution--only those reseaux or saturated-pixel flags arising from the gross spectrum would be correctly placed.

MEANS OF IDENTIFYING AFFECTED DATA:

- Points in net spectrum marked with distinguishing ε values (i.e., reseaux or saturation) whereas the same wavelengths do not have those values in either the gross or unsmoothed background. (This method is applicable only if the original CalComp plots are available, since the ε in merged spectral file on tape is a combined value).

NO. 14.1

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (1).

DATA AFFECTED:

CAMERA: All   DISPERSION: Both   PROCESSING: All except RAW.

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN N/A   END N/A   (GSFC)

BEGIN 17 April 1978   END 14 June 1978   (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 250

PERTINENT DOCUMENTATION: VILSPA TN/2002 - 00/AS/780417 (Release Ø 9 File)

DESCRIPTION: <During this period the wavelength and geometry calibrations used for the reduction of all data at VILSPA were based on images acquired between 18 March 1978 and 24 March 1978.

It is believed that these calibrations were used throughout. Evidence exists that another calibration, for LWR, dated 05 May 1978 and using images 27 April 1978 to 09 May 1978 was available by May 18, 1978. No specific evidence of its use is known.>

TITLE: Error in long wavelength high dispersion wavelengths.

DATA AFFECTED:

CAMERA: LWR DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN N/A END N/A (GSFC)

BEGIN 17 April 1978 END 15 June 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 30

PERTINENT DOCUMENTATION: VILSPA memos: MP/cr - 065 (17 May 1978) and MP/al - 065 (23 June 1978)

DESCRIPTION: < Derived wavelengths were approximately 0.7 Å too short. Error arose because scheme and calibration structure was such that the vacuum to air wavelength conversion was effectively performed twice.>

TITLE: Reseau flagging in low dispersion merged spectra does not distinguish between reseau mark in gross spectrum and reseau mark in background spectrum.

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged Spectra

MEDIA: Tape, CalComp

DATES: BEGIN 20:30 22 May 1978 END 16 Jun 1978 (GSFC)

BEGIN 17 April 1978 END !17:00 01 Feb 1979! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: GSFC SOCAR 127, SOCAR 134

DESCRIPTION: The version of EXTLOW in use between the dates above used identical flagging for reseau presence in both gross and background spectra, viz.,-800. When these spectra were combined to form the merged file, it was not possible from the merged data alone to tell which spectrum the reseau affected. Since the background spectrum is smoothed, reseaux there are generally of less significance than reseaux in the gross spectrum and it is therefore desireable to identify the point of origin of the reseau flag in the merged file.

The fix made was to flag reseaux in the background spectrum with the value -400 so that a differentiation could be made in the merged spectra as to the origin of the reseau contamination.

Thus $\varepsilon = 0.264 \times d + \varepsilon_r + \varepsilon_s$

where d = distance from center of tube in pixels

$$\varepsilon_r = \begin{cases} -800 \text{ if any pixel within the gross extraction slit is within 2 pixels of reseau} \\ -400 \text{ if any pixel within the background extraction slit is within 2 pixels of reseau (low disp. only)} \\ 0 \quad \text{otherwise} \end{cases}$$

$$\varepsilon_s = \begin{cases} -1600 & \text{if any pixel in slit is saturated (DN=255)} \\ 0 & \text{otherwise} \end{cases}$$

MEANS OF IDENTIFYING AFFECTED DATA:

- No ε values in the range $-400 < \varepsilon < -300$

NO. 16

TITLE: Geometric correction of high dispersion images accomplished using reseaux measured on high dispersion WAVECAL images.

DATA AFFECTED:

CAMERA: All DISPERSION: High PROCESSING: GPI, Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN 3 April 1978	END	11:00 9 Jun. 1978 (SWP) 23:00 1 Jul. 1978 (LWR)	(GSFC)
	BEGIN 17 April 1978	END	!17:00 01 Feb 1979!	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION:

DESCRIPTION: Prior to the end dates shown above, the reseau positions used to generate the geometric correction parameters for reducing high dispersion images were measured directly from high dispersion WAVECAL images. The difficulty is that the presence of many platinum emission lines on such images has the potential for contaminating the cross-correlation search for reseau positions. Such contamination was a considerably more significant problem in SWP than in LWR, and in particular in a region near the lower left of the SWP tube where a number of neighboring reseaux lie near platinum lines.

< At VILSPA a single set of geometric parameters has always been used for both high and low dispersion. It is strongly suspected, but not proven, that in this period these were derived from the high dispersion WAVECAL images appropriate to each installed calibration.>

The problem at its worst manifests itself by a poor geometric correction giving rise to distortions in the corrected image. It is believed that all instances of such serious contaminations (i.e., distortion readily apparent to the eye) were corrected by reprocessing, and that instances of less serious contamination were filtered out by the reseau-smoothing algorithm which generated the geometric parameters. (The smoothing algorithm failed when too many reseaux in a given row or column were contaminated).

The permanent solution to this problem was the procedural change of using only low dispersion calibration frames (on which contamination of smoothed reseaux is insignificant) to generate the geometric correction parameters for all images.

MEANS OF IDENTIFYING AFFECTED DATA:

- Distortions in geometrically and photometrically corrected image (GPI file).

TITLE: Use of non-optimal RIPPLE parameters for LWR:

K = 231,300 A = 0.08 (GSFC)

K = 231,075 A = 0.09 (VILSPA) *

DATA AFFECTED:

CAMERA: LWR DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END <06:07 7 Jul 1978 (GSFC)

BEGIN 17 April 1978 END 14 Jun 1978 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 400

PERTINENT DOCUMENTATION: GSFC SMR 38

DESCRIPTION: The RIPPLE correction constants K and A for LWR (see change of 11 May 1978) were initially set to the non-optimal values shown above at the two ground stations. Evaluation of spectra processed with those parameters indicated that the following values:

K = 231,150

A = 0.09,

were more appropriate, and the two ground stations adopted these values on the respective end dates shown above. With these new values, the limiting LWR ripple correction factor becomes 16.43.

* There is some uncertainty in the VILSPA records. The old GSFC values for LWR K and A may have been in use at VILSPA until approximately 3 May 1978 when the values K=231,075 and A=0.09 were adopted. What is more certain is that the optimal values K=231,150 and A=0.09 were in fact installed on the respective end dates shown above.

TITLE: Extract low dispersion spectra (EXTLOW) with HT=9 and DISTANCE=8.0. (Will not properly extract spectra of aperture-filling objects.).

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged spectrum (extended objects in large aperture)

MEDIA: Tape, CalComp

DATES:	BEGIN 20:30 22 May 1978	END 01 Aug 1978	(GSFC)
	BEGIN N/A	END 14 June 1978	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 50

PERTINENT DOCUMENTATION: GSFC SMR 42, CSC/TM-79/6301

DESCRIPTION: All low dispersion spectra processed with EXTLOW prior to the end date above were extracted using a slit height HT=9 (9 pixels on a diagonal) and with the background sampled at DISTANCE=8.0. While these parameters are appropriate for a point source, aperture-filling objects such as extended sources or trailed exposures require a longer slit to measure all of the flux in the large aperture and a more distant background sampling to avoid contamination from the aperture itself. Therefore, aperture-filling sources extracted before the end date would suffer too small a gross flux and too large a background flux. The amount of the error depends on the flux distribution within the aperture.

On the end date, an optional processing scheme for extended sources was defined, using HT=15 (longer than the large-aperture) and DISTANCE=11.0. The old parameters were also retained for use with point sources. Caution: See the change to EXTLOW on 1 March 1980 for information on the units of measure for DISTANCE.

Note: <At VILSPA the extended source option was provided earlier. Prior to EXTLOW installation date at VILSPA (14 June 1978) an equivalent extended source reduction scheme was provided using COMPARE (refer configuration #13).>

MEANS OF IDENTIFYING AFFECTED DATA:

- HT=9 written in IUESIPS history label by EXTLOW.

TITLE: Image sequence number sometimes zeroed out in scale factor record of merged spectral file.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape

DATES: BEGIN 3 April 1978 END 08 Aug 1978 (GSFC)

BEGIN 17 April 1978 END !17:00 01 Feb 1979! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 20%

ESTIMATED NUMBER OF IMAGES AFFECTED: 300

PERTINENT DOCUMENTATION: GSFC SOCAR 141, SOCAR 145, SOCAR 150

DESCRIPTION: The program ETOEM which merges the gross, background, net, and absolutely-calibrated net spectra for tape output also creates the scale-factor record for that file. Bytes 13 and 14 of the scale record are supposed to contain the image sequence number in I*2 format. Until the end date shown, ETOEM was referencing the observer's comments section in line 4 of the IUE image label to obtain the image number. Although the image number was usually present in that location, it was not always there because it was manually keyed in at the time of observation. As a result, on those occasions when the area in the label searched was blank, a zero was transmitted to the merged-spectrum scale factor record in place of the correct image sequence number.

As of the change date above, ETOEM was modified to read the image sequence number from the system-generated bytes 53-56 of line 1 of the image label. These bytes contain the most reliable data in the image label pertaining to image number.

<VILSPA has a different format convention for the observers comments and all images will probably be affected.>

MEANS OF IDENTIFYING AFFECTED DATA:

- Image sequence number zero in merged-spectrum scale-factor record.

TITLE: Determine LWR low dispersion wavelength calibrations from preliminary version of line library.

DATA AFFECTED:

CAMERA: LWR DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END 11 Aug 1978 (GSFC)

BEGIN 17 April 1978 END 17:00 01 Feb 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 400

PERTINENT DOCUMENTATION: "IUE Data Reduction III. Accuracy of Low Dispersion Wavelengths," NASA IUE NEWSLETTER No. 5, July 1979.

DESCRIPTION: The line library used to perform LWR low dispersion wavelength calibrations was found to contain several emission lines which were either misidentified, blended, or too faint. A new line library omitting such lines (see reference documentation above) was adopted as of 09 August 1978, but not used to generate a production calibration file until 11 August 1978.

There were no known ill effects associated with the use of the old line libraries. The use of the new line libraries is documented here only for completeness.

TITLE: Use of incorrect offsets from small to large aperture in LWR.

DATA AFFECTED:

CAMERA: LWR DISPERSION: Both PROCESSING: Extracted spectra (large aperture)

MEDIA: Tape, CalComp

DATES: BEGIN	3 April 1978	END	16:00 30 August 1978 (low)	(GSFC)
			18:00 31 August 1978 (high)	
BEGIN	17 April 1978	END	17:00 01 Feb 1979	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 600

PERTINENT DOCUMENTATION: GSFC SMR 46; "IUE Data Reduction V. Wavelength assignments for Large Aperture Spectra," NASA IUE Newsletter No. 6, Sept. 1979.

DESCRIPTION: Large-aperture dispersion constants are derived from the directly-measured small-aperture values by adding an offset to the zero-point terms (A1 and B1) corresponding to the separation of the apertures in samples and lines. (See reference documentation above) In the case of LWR, the offsets used in the wavelength-calibration schemes until 11 August 1978 were preliminary values:

$$\Delta S = -21.1$$
$$\Delta L = +25.1$$

Subsequent more accurate measurements made on geometrically-corrected calibration images with both apertures illuminated showed that better values* were

$$\Delta S = -17.5$$
$$\Delta L + +19.5$$

The effect of having used the older offsets was primarily to introduce a velocity-like shift of approximately -50 km/sec in the zero-point of LWR high dispersion extracted spectra. This arises because the vector between the old and the new offsets lies chiefly along the high dispersion orders and is approximately 6.7 pixels in length. There is little wavelength offset in low dispersion because the shift is nearly perpendicular to the dispersion and hence corrected by the registration step.

The new offset values were incorporated into the GSFC wavelength calibration schemes on 11 August 1978 and first used to generate calibration files on the respective end and dates shown above for low and high dispersion.

* See also the change documented as of 08 July 1979.

NO. 21.1

TITLE: Error in SWP dispersion wavelength scale

DATA AFFECTED:

CAMERA: SWP DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN	N/A*	END	N/A*	(GSFC)
	BEGIN	15 June 1978	END	07 September 1978	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 150

PERTINENT DOCUMENTATION: ESA IUE Newsletter No. 3 (July 1979); VILSPA

internal memos: {MP/cr-097 16 Aug 1978)
JB/bm 6 Sep 1978)

DESCRIPTION: <All VILSPA SWP low dispersion data in the period were processed with dispersion constants which resulted in a noticeable systematic wavelength error. The computed scale is correct around 1250 Å and gives wavelengths too short by 10 Å near 1950 Å.

A suitable correction formula is:

$$\lambda_{corrected} = -20.00 + (1.0158 \pm 0.0002) * \lambda_{tape}$$

The calibration used was in use on 23 May 1978 at GSFC.>

* See also the discussion of the GSFC configuration ending 21 September 1978.

TITLE: Perform all registrations of spectral orders with dispersion-constant overlays manually

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 3 April 1978 END <02:00 10 Sept. 1978 (GSFC)

BEGIN 17 April 1978 END 17:00 01 Feb 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 3000

PERTINENT DOCUMENTATION: GSFC SMR 48

DESCRIPTION: Until the end dates shown above, the registration of spectral format with dispersion-constant overlays could only be performed by manual inspection of the images and overlays on the Experiment Display System (EDS) screen. The characteristics of shifts determined by this procedure are:

1) they are measured by eye and depend on an operator's judgment, and
2) they may be decomposed into arbitrary line and sample direction components yielding a net shift such that the spectrum coincides with the overlay. This is prone to being highly operator-dependent.

Operator guidelines were established to make all derived shifts in a direction perpendicular to the dispersion, on the theory that in the absence of specific knowledge to the contrary, the safest procedure is to apply a shift so as not to alter the wavelength assignments, i.e., a shift perpendicular to the dispersion. The strict adherence to such guidelines is operator-dependent, however, and it cannot be ruled out that arbitrary shifts in the wavelength scale (which would mimic velocity shifts in high dispersion, and would be constant-wavelength shifts in low dispersion) were induced by the registration step, with a magnitude corresponding to up to several pixels.

On the end dates above, a program with an automatic order-finding algorithm was implemented to calculate the perpendicular registration shifts * without operator intervention in most cases. Implementation of this software (the program DSPCON) eliminates the undesirable characteristics (1) and (2) listed above. As implemented in production on the dates shown, DSPCON was not used for trailed or extended-source spectra, or for spectra which were either too intense (at least 4 of the 6 sampling areas saturated), too faint (insufficient contrast in at least 4 of the 6 sampling areas), or for cases in which the r.m.s. deviation from the mean of the shifts measured in the various sampling areas exceeded 1.0 pixel. In addition, DSPCON was limited to total shifts of 2.8 pixels because of the size of the sampling areas used.

* In some cases, the nominally perpendicular shifts calculated by DSPCON were not precisely perpendicular; see the change made on 18 August 1980.

TITLE: Camera number transmitted as true number plus 10 or 20 in scale factor record of merged spectral file.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape

DATES: BEGIN ≥ 2 Sept. 1978 END 20 Sept. 1978 (GSFC)

BEGIN ! N/A ! END ! N/A ! (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: > 20

PERTINENT DOCUMENTATION: GSFC SOCAR 151, CSC/TM-79/6301, OCC SIR 5355

DESCRIPTION: The program ETOEM accessed bytes 49 and 50 of record 1 of the IUESIPS label (see CSC/TM-79 6301) to obtain the camera number for the scale factor record of the merged spectral file. Until 2 September 1978, the OCC software which wrote record 1 of the label used the value 0 for the station flag in byte 49 for both NASA and ESA images, so that the camera number read by ETOEM was effectively correct. When the correct station flag values (1=NASA, 2=ESA) were put into the label beginning on 2 September 1978 with OCC software system 7 (see OCC SIR 5355), however, the 1 or 2 in byte 49 was included by ETOEM as part of the camera number passed to the merged spectral file.

The program ETOEM was modified on the end date above to access only byte 50 for the camera number. Therefore, all images acquired on or after 2 Sept. 1978 and processed prior to 20 Sept. 1978 will have incorrect camera numbers in the merged spectrum scale factor record. Because processing did not always follow the strict chronological order of image acquisition, a unique processing start date for the incorrect camera numbers is difficult to determine; the start date shown above is therefore indicated as ≥ 2 Sept. 1978.

<At VILSPA, BEGIN ≥ 06 Nov 1978, END! 17:00 01 Feb 1979! >

MEANS OF IDENTIFYING AFFECTED DATA:

- Incorrect camera number in merged-spectrum scale factor record
- Acquisition date ≥ 2 Sept. 1978, processing date < 20 Sept. 1978. (GSFC)

NO. 24

TITLE: Determine SWP low dispersion wavelength calibrations from preliminary version of line library

DATA AFFECTED:

CAMERA: SWP DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN	3 April 1978	END	07:00	21 Sept. 1978	(GSFC)
BEGIN	17 April 1978	END	17:00	01 Feb. 1979	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 700

PERTINENT DOCUMENTATION: "IUE Data Reduction III. Accuracy of Low Dispersion Wavelengths," NASA IUE Newsletter No. 5, July 1979

DESCRIPTION: The line library used to perform SWP low dispersion wavelength calibrations was found to contain several emission lines which were either misidentified, blended, too faint, or contaminated by a reseau mark. The presence of these lines caused the calculated dispersion relations to vary from solution to solution (a new solution was obtained every several weeks) in a more or less random fashion. The worst problem associated with the use of this version of the line library was that the scale-factor terms of the dispersion relations (the A2 and B2 terms) exhibited spurious solution-to-solution excursions of up to ± 2%. As a result, wavelength scale errors of as much as ± 20 Å over the range from 1000 Å to 2000 Å were propagated to extracted spectra in those instances when the "bad" library entries were included in the dispersion solutions. In those instances when few (or no) "bad" entries were used in the solution, considerably smaller scale errors resulted, and in some cases quite accurate scales resulted.

The problem was eliminated with the adoption of a new SWP low dispersion line library which omitted the problem entries (see reference documentation above). The new library was adopted 09 August 1978 but not used to generate a production calibration file until 21 September 1978. However, the calibration in use from 13:00 27 July 1978 until 21 September 1978 was reasonably accurate even though it was derived from the old line library. Its scale terms differ by less than 0.2% from the scale terms of the mean dispersion constants adopted at GSFC on 18 July 1980, for example.

MEANS OF IDENTIFYING AFFECTED DATA:

- Values for the A2 and B2 scale terms of dispersion relations found in the IUESIPS history portion of label, which differ significantly from accurate values. This may be judged by comparison to the modern mean values, for example. The mean scale terms adopted on 18 July 1980 for SWP low dispersion are

  A2 = -.46657 pixels/Å (sample direction)

  B2 = .37616 pixels/Å (line direction).

TITLE: Extract low dispersion large aperture point-source spectra with DISTANCE = 8.0

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged spectra (point-source, large-aperture)

MEDIA: Tape, CalComp

DATES:	BEGIN	3 April 1978	END	<15:57	25 Sept. 1978	(GSFC)
	BEGIN	17 April 1978	END	17:00	01 Feb. 1979	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 800

PERTINENT DOCUMENTATION: GSFC SMR 49, CSC/TM-79/6301

DESCRIPTION: Large-aperture low dispersion spectra extracted as point sources (HT=9) had background sampled at DISTANCE = 8.0 (see CSC/TM-79/6301). This has the disadvantage of measuring background levels with a slit partially inside the large aperture, which although safe at most wavelengths, presents a problem for SWP exposures with substantial geocoronal Lyman-alpha signal. In such cases, the geocoronal Lyman-alpha contaminates the smoothed background near λ = 1216 Å (±50 Å).

On the end dates indicated, the DISTANCE parameter was changed to 11.0 (same as for large-aperture extended-source reduction), nominally putting background sampling outside of large aperture*.

* See, however, the changes to EXTLOW made on 01 March 1980 at GSFC.

TITLE: Improper truncation of area of image photometrically corrected.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: GPI, extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN	02 Oct. 1978	END	19:00 06 Oct. 1978	(GSFC)
BEGIN	N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 50

PERTINENT DOCUMENTATION: GSFC SMR 51, SMR 52

DESCRIPTION: A version of the photometric correction program which was intended to apply the photometric correction only within a circle of specified center and radius was introduced at GSFC and withdrawn 4 days later after it was determined that the program was not selecting the circular area properly. The short-lived version, called FICOR5, was found to be truncating useful data from the ends of certain orders (most severely in high dispersion) and was replaced with the former program, FICOR, which applies the photometric correction to the whole 768 x 768 image.

MEANS OF IDENTIFYING AFFECTED DATA:

- Program name FICOR5 (instead of FICOR) in IUESIPS history label during the 02 Oct.-06 Oct. 1978 time frame. (A corrected version of FICOR5 was eventually installed in December 1978 so only October 1978 FICOR5 results would be suspect.)
- Less than normal wavelength coverage in some orders.

TITLE: Automatic registration of spectral orders done using only 6 sampling areas in DSPCON

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 10 Sept. 1978 END 17:00 25 Oct. 1978 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: GSFC SMR 60

DESCRIPTION: The initial version of DSPCON used to perform automatic registration of spectral orders sampled only 6 areas of the image to do its cross-correlation order-finding calculation. On the date shown above, an updated version of DSPCON which extended the search to 6 additional areas was implemented. The wavelengths at which the new version samples the image to determine the shift are given in the following table.

SWP			LWR		
LOW	HIGH		LOW	HIGH	
λ	λ	m	λ	λ	m
1300	1465	94	2100	2360	98
1350	1475	94	2200	2370	98
1400	1530	90	2300	2460	94
1450	1540	90	2400	2470	94
1500	1600	86	2500	2570	90
1550	1610	86	2600	2580	90
1600	1680	82	2700	2690	86
1650	1690	82	2800	2700	86
1700	1765	78	2900	2820	82
1750	1775	78	3000	2830	82
1800	1860	74	3100	2960	78
1850	1870	74	3200	2970	78

TITLE: Omit vacuum-to-air correction for LWR low-dispersion single-aperture reduction

DATA AFFECTED:

CAMERA: LWR DISPERSION: Low (single aperture only) PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES:	BEGIN	04 Nov. 1978	END	5:30 15 Nov. 1978	(GSFC)
	BEGIN	N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 20

PERTINENT DOCUMENTATION: GSFC SMR 63, SMR 65

DESCRIPTION: The vacuum-to-air wavelength correction normally performed on LWR spectra at $\lambda > 2000$ Å was inadvertantly left out of the processing of single-aperture LWR low dispersion spectra during the period designated, due to a clerical error in creating a more efficient processing scheme.

It is believed that all affected spectra were subsequently reprocessed correctly.

MEANS OF IDENTIFYING AFFECTED DATA:

- No discontinuity in assigned wavelengths at 2000 Å. (vacuum-to-air correction introduces a discontinuity of approximately 0.65 Å at 2000 Å.)

TITLE: Photometrically correct entire 768 x 768 image

DATA AFFECTED:

CAMERA: SWP DISPERSION: High PROCESSING: GPI

MEDIA: Tape, Photowrite

DATES: BEGIN 03 April 1978 END 20:50 10 Dec. 1978 (GSFC)

BEGIN 17 April 1978 END 7 March 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1500

PERTINENT DOCUMENTATION: GSFC SMR 67

DESCRIPTION: With the exception at GSFC of the 4-day period ending 06 October 1978 (see change on that date), the entire 768 x 768 geometrically corrected image was photometrically corrected by the program FICOR. This was unnecessary and inefficient since the area outside of the target ring contains no image information. On the end date shown, the high dispersion SWP processing schemes were changed to use the program FICOR5, which photometrically corrects only the portion of the image within a circle of radius "RADIUS" and center line and sample coordinates CL and CS, where

RADIUS = 395.0

CL = 390.0

CS = 390.0

Outside of the area, the pixel values are set to the photometric offset value of 2000. This limitation increases the speed of execution without limiting the data actually extracted from the spectral orders.

MEANS OF IDENTIFYING DATA:

- Program name FICOR in image processing history portion of label
- Appearance of the GPI image

TITLE: Photometrically correct entire 768 x 768 image

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: GPI

MEDIA: Tape, Photowrite

DATES: BEGIN 03 April 1978 END 13 Dec. 1978 (GSFC)

BEGIN 17 April 1978 END 7 March 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 2500

PERTINENT DOCUMENTATION: GSFC SMR 68

DESCRIPTION: With the exception at GSFC of the 4-day period ending 06 October 1978 (see change on that date), the entire 768 x 768 geometrically corrected image was photometrically corrected by the program FICOR. This was unnecessary and inefficient since the area outside of the target ring contains no image information. On the end date shown, the low dispersion processing schemes for both SWP and LWR were changed to use the program FICOR5, which photometrically corrects only the portion of the image within a circle of radius "RADIUS" and center line and sample coordinates CL and CS, where

	SWP		LWR
RADIUS	= 395.0	RADIUS	= 390.0
CL	= 405.0	CL	= 400.0
CS	= 370.0	CS	= 405.0

Outside of these areas, the pixel values are set to the photometric offset value of 2000. This limitation increases the speed of execution without limiting the data actually extracted from the spectral orders.

MEANS OF IDENTIFYING AFFECTED DATA:

- Program name FICOR in image processing history portion of label
- Appearance of the GPI image

TITLE: No information on values of OMEGA, HBACK, or DISTANCE in IUESIPS history labels.

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Extracted Spectra

MEDIA: Tape, CalComp

DATES: BEGIN 20:30 22 May 1978 END 13 December 1978 (GSFC)

BEGIN 14 June 1978 END 11:00 05 June 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 3000

PERTINENT DOCUMENTATION: GSFC SOCAR 155, CSC/TM-79/6301

DESCRIPTION: The extraction parameters OMEGA, HBACK, and DISTANCE (see CSC/TM-79/6301) pertinent to low dispersion processing with the program EXTLOW are selectable according to processing-scheme options. In practice, with EXTLOW the angle OMEGA was always set to 90.0, and the height of the background slits HBACK to 5.0, but the DISTANCE parameter describing the distance from the order to the center of background slit varied according to aperture selection and point-source/extended-source reduction selection. Full documentation of the extraction parameters actually used, therefore, requires these parameters in the IUESIPS label.

On the end dates shown, a revised version of EXTLOW which enters the OMEGA, HBACK, and DISTANCE values into the IUESIPS label was implemented.

MEANS OF IDENTIFYING AFFECTED DATA:

- No information on OMEGA, HBACK, or DISTANCE written in IUESIPS label.

TITLE: No information on values of automatic registration shifts recorded in IUESIPS history label

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extended spectra

MEDIA: Tape, CalComp

DATES: BEGIN 10 Sept. 1978 END 13 Dec. 1978 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: GSFC SOCAR 156

DESCRIPTION: The values of the line and sample shifts calculated and applied to the zero-point term of the dispersion constants by the program DSPCON were not recorded in the IUESIPS history label. Since these values indicate the magnitude of the shift applied to correct for thermal misregistration of the spectral format perpendicular to the orders, they also offer some indication of the possible uncertainties to be expected in the assigned wavelengths due to the (uncorrected) thermal misregistration along the orders.

Revised versions of the programs DATEXTH2 (for high dispersion) and EXTLOW (for low dispersion) were implemented on the end dates above so as to write the line and sample shift values into the IUESIPS history labels. (At VILSPA, this corresponds with the implementation of automatic registration software itself.) This change affects only those images shifted automatically; images shifted manually were given dummy line and sample shifts of "YY.YYY" and "XX.XX" respectively, for the label. The presence of the dummy values is thus an indicator that an image was registered manually. (Actual manual shifts were eventually recorded correctly in the label; see change of 05 April 1979).

MEANS OF IDENTIFYING AFFECTED DATA:

- No shift values in IUESIPS label

TITLE: Process order 65 in SWP high dispersion

DATA AFFECTED:

CAMERA: SWP DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 3 April 1978 END 17:46 19 Dec 1978 (GSFC)

BEGIN 17 April 1978 END 14 Feb 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: GSFC SMR 69

DESCRIPTION: In SWP high dispersion, echelle order 65 lies at the very edge of the tube and is generally difficult even to detect except after the (large) photometric correction is applied. The extracted spectrum for order 65 was extremely noisy and covered so small a wavelength range, that on the end dates shown, the SWP high dispersion processing schemes were altered to terminate the extraction procedure with order 66 (i.e., orders 125 - 66 extracted).

MEANS OF IDENTIFYING AFFECTED DATA:

- Extracted spectrum for order 65 present.

TITLE: Photometrically correct entire 768 x 768 image

DATA AFFECTED:

CAMERA: LWR DISPERSION: High PROCESSING: GPI

MEDIA: Tape, Photowrite

DATES: BEGIN 3 April 1978 END <5:07 04 Jan. 1979 (GSFC)

BEGIN 17 April 1978 END 07 Mar. 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1500

PERTINENT DOCUMENTATION: GSFC SMR 70

DESCRIPTION: With the exception at GSFC of the 4-day period ending 06 October 1978, (see change on that date), the entire 768 x 768 geometrically corrected image was photometrically corrected by the program FICOR. This was unnecessary and inefficient since the area outside of the target ring contains no image information. On the end date shown, the high dispersion LWR processing schemes were changed to use the program FICOR5, which photometrically corrects only the portion of the image within a circle of radius "RADIUS" and center line and sample coordinates CL and CS, where

RADIUS = 390.0

CL = 395.0

CS = 390.0

Outside of this area, the pixel values are set to the photometric offset value of 2000. This limitation increases the speed of execution without limiting the data actually extracted from the spectral orders.

MEANS OF IDENTIFYING AFFECTED DATA:

- Program name FICOR in image processing history portion of label
- Appearance of the GPI image

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (2)

DATA AFFECTED:

CAMERA: All DISPERSION: LWR-Both PROCESSING: All Except RAW
SWP-High

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN N/A END N/A (GSFC)

BEGIN 15 June 1978 END 17:00 01 Feb 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: VILSPA TN/2003 - 00/AS/780614 (Release 10 File)

DESCRIPTION: <During this period the wavelength and geometry calibrations used for the reduction of all data acquired at VILSPA was that in use at GSFC on 23 May 1978.>

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (3)

DATA AFFECTED:

CAMERA: SWP DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN	N/A	END	N/A	(GSFC)
BEGIN	07 Sept. 1978	END	17:00 01 Feb. 1979	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 300

PERTINENT DOCUMENTATION: VILSPA internal memo JB/bm 6 Sept. 78 VILSPA TN/2003-00/AS/780614 (Release 10 file)

DESCRIPTION: <The dispersion constant calibration file for SWP low dispersion data was based on image SWP 2244 acquired on 08 August 1978. This corrected error described in the VILSPA configuration ending 07 September 1978.>

TITLE: Use incorrect version of ETOEM

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: ESSR

MEDIA: Tape

DATES:	BEGIN	19 Jan. 1979	END	19:30 1 Feb. 1979	(GSFC)
	BEGIN	N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 50

PERTINENT DOCUMENTATION: GSFC SOCAR 157

DESCRIPTION: During the affected time period, an incorrect version of the program ETOEM, which formats extracted spectra for the GO tape, was used. This version was implemented in an attempt incorporate further information into the IUESIPS history portion of the image label of merged spectra. This version, however, did not function properly in the special case where only one spectral file is to be merged for tape (as is the case for the line-by-line spectral file, ESSR, in low dispersion).

On the end date, the original version of ETOEM was restored, and all known affected images were subsequently reprocessed. This change is documented here only for completeness.

TITLE: High dispersion partial processing on S/360 (VICAR)

DATA AFFECTED:

CAMERA: All DISPERSION: High PROCESSING: All

MEDIA: Tape, CalComp

DATES: BEGIN	3:00 25 Apr. 1978	END	6 Feb. 1979	(GSFC)
BEGIN	N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 75%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1500

PERTINENT DOCUMENTATION: GSFC SMR 5, SMR 56

DESCRIPTION: During the affected period defined above, a number of high dispersion images were processed in part on the GSFC S/360 computers, under the VICAR system, as well as on the Sigma 9 computer under IUESIPS. In such cases, the geometric and photometric corrections, as well as the spectral registration step, were performed on the Sigma 9 and then further high dispersion processing (spectral extraction, manipulation, and plotting) was completed on the S/360. A requirement of processing on the S/360 under VICAR is that the image labels not exceed a limited size. As a result of this limitation, certain lines of the IUESIPS label were excised on the S/360: label lines 11-35, 38-45, 47-82, and 84-85 are missing from all image files processed on the S/360. These lines contain records of camera and SI procedures as well as various engineering data.

The partial processing on the S/360 was utilized in order to offload some of the large volume of data during the first year of operation and thus alleviate the significant backlogs which accrued. This capability was used primarily in 2 periods between the start and end dates shown above: 25 April 1978 to 10 July 1978 (period I) and 21 October 1978 to 6 February 1979 (period II). During period I, the raw and photometrically-corrected image files were written to tape on the Sigma 9 and hence only the extracted spectra have a truncated label. During period II, the raw and photometrically-corrected images were passed on an intermediate tape to the S/360 and were written to tape, along with the extracted spectra, in final form on the S/360 and hence all files have the truncated labels.

Subtle differences in the processing performed by the VICAR S/360 system and the Sigma 9 IUESIPS system may have existed, although benchmark reductions on both machines verified that no gross differences existed. The most serious difference was the loss of the label lines in the truncation process. Note also that the naming convention for the line and sample dispersion constants entered into the EBCDIC image labels of extracted spectra is reversed for spectra processed as the S/360, compared to most of the spectra processed on the Sigma 9: after 11 May 1978 (see change on that date) the naming convention adopted in CSC/TM-79/6301 is used on the Sigma 9. That is, the A_i coefficients are for the sample coordinates and the B_i coefficients are for the line coordinates. In the labels of spectra processed on the S/360, however, the A_i refer to the line coordinates and the B_i to the sample coordinates.

MEANS OF IDENTIFYING AFFECTED DATA:

- Abbreviated image-header labels (missing lines 11-35, 38-45, 47-82, 84-85) in extracted spectra. Note that for images processed during period II (see above), even the raw and photometrically-corrected image files have abbreviated labels although only the spectral extraction step is actually computed on the S/360.

TITLE: Use original IUESIPS File Management software

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: All

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 3 April 1978 END 9:00 09 Feb. 1979 (GSFC)

BEGIN 17 April 1978 END 11:00 05 June 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 5000

PERTINENT DOCUMENTATION:

DESCRIPTION: The original IUESIPS File Management software (the subsystem of IUESIPS which accesses, reads, and writes data files) was used until the end dates shown above (with the exception of the programs FICOR5, DATEXTH2, and EXTLOW at GSFC which were converted at 18:00 on 13 Feb. 1979). A new File Management subsystem was implemented to speed up IUESIPS production by eliminating the explicit zeroing-out of all output files prior to filling with true data. Extensive testing was performed to assure that this change had no effect on the final output products, and indeed the 4-day delay in converting the 3 programs mentioned above resulted from the need to modify their label-processing routines to function properly with unzeroed arrays. There are no known instances where use of the new File Management system changed any delivered output products; the existence of the change, however, is documented herein for completeness.

TITLE: No information on values of manual registration shifts recorded in IUESIPS history label

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 03 April 1978 END 15:15 05 April 1979 (GSFC)

BEGIN 17 April 1978 END 17:00 01 Feb. 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 75%

ESTIMATED NUMBER OF IMAGES AFFECTED: 5000

PERTINENT DOCUMENTATION: GSFC SOCAR 158

DESCRIPTION: The values of the line and sample thermal registration shifts determined manually by operators were not recorded in the IUESIPS history label. For the same reasons cited in the discussion of the recording of automatically-determined shifts (see the 13 December 1978 change), such a situation was not advantageous.

The implementation of the new program REGISTER (an exact manual-shift analogue of the automatic-shift program DSPCON) on the end dates shown made it possible to insert the actual manual-shift values into the IUESIPS history label. This change thus replaced the dummy YY.YYY and XX.XX shift values that had appeared in manually-shifted image labels since 13 December 1978 at GSFC and 01 February 1979 at VILSPA; prior to those times, no value whatsoever appeared in image labels.

MEANS OF IDENTIFYING AFFECTED DATA:

- No true shift values (i.e., either blank or dummy values) in IUESIPS label.

NO. 39

TITLE: No output products generated for images designated "Do Not Process"

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: All

MEDIA: Tape

DATES:	BEGIN	03 April 1978	END	30 April 1979	(GSFC)
	BEGIN	17 April 1978	END		(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 2%

ESTIMATED NUMBER OF IMAGES AFFECTED: 120

PERTINENT DOCUMENTATION: GSFC SMR 77

DESCRIPTION: Prior to the end date, all images designated by the original Guest Observer as "Do Not Process" were entirely disregarded. The disadvantage of this procedure is that images regarded as useless by the original Guest Observer may indeed have some value to other investigators and should at least be preserved in raw form for archival purposes. On the end date, a new processing scheme was implemented to copy to tape the raw data for any images marked "Do Not Process" (DNP) on the observing scripts, and at the same time to enter a comment into the image label indicating its disposition as an unprocessed image.

Retroactively, and at a relatively low priority, a program was initiated at GSFC to go back and recover from the operations raw-image archive tapes as many of the "DNP" images as possible, copying them in raw form to GO and NSSDC archive tapes. As of April 1981, approximately 30 such DNP images remained to be recovered.

<A similar program is to be carried out at VILSPA.>

TITLE: Improperly convert certain spectral files with negative fluxes to GO tape integer format.

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted Spectra

MEDIA: Tape

DATES:	BEGIN	03 April 1978	END 19:00	07 June 1979	(GSFC)
	BEGIN	17 April 1978	END	12 July 1979	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: <5%

ESTIMATED NUMBER OF IMAGES AFFECTED: <300

PERTINENT DOCUMENTATION: GSFC SOCAR 176; "Improper Scaling of Certain IUE Spectral Files," NASA IUE Newsletter No. 7, Nov., 1979, p. 45; CSC/TM-79/6301.

DESCRIPTION: The program ITOE, which converts the IUE spectra extracted as floating-point FN values to scaled integers in preparation for writing to tape, incorrectly scaled spectra with negative extracted fluxes for which $|f_{min}| > |f_{max}|$ where f_{min} is the algebraic minimum flux value and f_{max} is the algebraic maximum flux value (see NASA IUE Newsletter No. 7, p.45). Typically, such a condition is most likely to be encountered in the background spectra of images with a low level radiation or halation background superposed on an abnormally low null pedestal. Since it is the low null level which leads to negative IUE fluxes (because of the manner in which the intensity transfer function is extrapolated at the low-intensity end), most images subject to the scaling problem were short exposures from the SWP camera, in which significant drifts of the null level were observed during the period in which the ITOE problem existed.

In cases where the extracted flux values are all negative, the incorrect scaling algorithm returned zero values for all integer fluxes and the J and K scale factors (see CSC/TM-79/6301, p. 8-37). In cases where some extracted flux values are positive but $|f_{min}| > |f_{max}|$ still applies, those negative fluxes algebraically less than $-f_{max}$ were incorrectly converted to integers, whereas all other fluxes were correctly scaled. A modified version of ITOE was implemented on the end dates shown to properly scale all spectra.

MEANS OF IDENTIFYING AFFECTED DATA:

- J,K and scaled flux values all set to zero; or more generally,
- Background on tape, when smoothed twice by a 15-point running-average filter, does not equal the background calculated by subtracting the net spectrum from the gross spectrum.

TITLE: All high dispersion extractions done with HT=5.

DATA AFFECTED:

CAMERA: All DISPERSION: High, large aperture PROCESSING: Extracted Spectra

MEDIA: Tape, CalComp

DATES: BEGIN 03 April 1978 END 15:10 15 June 1979 (GSFC)

BEGIN 17 April 1978 END 16:00 10 Jan. 1980 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 700

PERTINENT DOCUMENTATION: GSFC SMR 82, CSC/TM-79/6301

DESCRIPTION: Prior to the end dates shown, all high dispersion spectral extractions were performed using the fixed parameter HT=5 (see CSC/TM-79/6301). Extended sources (such as planets and comets) sometimes yield order widths which exceed this slit height of 5-pixels on a diagonal, and hence for such sources not all gross flux was being extracted.

On the end dates shown, an "extended-source" option supporting a choice of HT=7 (which yields a slit which closely approximates the extent of the large aperture perpendicular to the dispersion) was made available in high dispersion, (manual-shift only). Note that with this change, although most of the gross flux is included in the extraction slit, there is more of a contamination problem for short wavelengths where the orders are close together.

MEANS OF IDENTIFYING AFFECTED DATA:

- HT value in IUESIPS history label

TITLE: Write redundant raw-image tape files for wavelength calibration images.

DATA AFFECTED:

CAMERA: All DISPERSION: Both (Wavecal only) PROCESSING: Raw image

MEDIA: Tape

DATES: BEGIN 03 April 1978 END 19 June 1979 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 150

PERTINENT DOCUMENTATION: GSFC SMR 81

DESCRIPTION: Wavelength calibration images were previously processed using several independent processing schemes which both wrote the raw image file to tape. On the end date, a set of streamlined calibration schemes was adopted which combined several steps into one and which further suppressed the writing of the raw file completely, since all wavelength calibration images were as of that date extracted as if they were normal spectral images.

In particular, for a low dispersion wavelength calibration image, the standard file sequence on tape changed from 1) raw image, 2) found reseau positions, 3) raw image, and 4) geometrically-corrected image, to 1) found reseau positions, 2) geometrically corrected image, followed by the standard set of normal-image tape files (RI, GPI, GPIS, ESSR, ESLO). For a high dispersion wavelength calibration image, the file sequence 1) raw image, and 2) geometrically-corrected image was changed to 1) geometrically corrected image followed by the normal-image tape files (RI, GPI, ESHI).

TITLE: No short header file written at beginning of GO tape

DATA AFFECTED:

CAMERA: All   DISPERSION: Both   PROCESSING: All

MEDIA: Tape

DATES: BEGIN 03 April 1978   END 02 July 1979   (GSFC)

BEGIN N/A   END N/A   (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 6000

PERTINENT DOCUMENTATION: CSC/TM-79/6301

DESCRIPTION: Prior to the end date above, no short header file was written at the beginning of each GO tape. This means that the first file on the tape is an actual data file, usually the raw image file for the first data set contained on the tape.

As of the end date, at GSFC only, a 1-record file of 360 bytes is written to each GO tape as it is mounted on the tape drive. This file precedes all actual data files on the tape and is an identifier used in the automated IUE Observatory accounting system. The format of this tape header file is shown in CSC/TM-79/6301, p. 8-11. It contains one line of EBCDIC text identifying the tape as a GO tape and giving the 7-character GSFC inventory number for that tape. Most GO's find it convenient to simply skip over this file when reading their tapes.

Note that as the tape header file is a GSFC IUE Observatory accounting device, it appears only on GO tapes originating at the GSFC IUE Observatory. In particular, tapes originating at VILSPA or produced from archives at the NSSDC would not contain the tape header file.

MEANS OF IDENTIFYING AFFECTED DATA:

- Lack of tape header file at beginning of tape.

TITLE: Use of SWP ITF with incorrect 20% exposure level

DATA AFFECTED:

CAMERA: SWP DISPERSION: Both PROCESSING: GPI, extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 20:30 22 May 1978 END 19:40 07 Jul 1979 (GSFC)

BEGIN 14 Jun 1978 END 07 Aug 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 2000

PERTINENT DOCUMENTATION: GSFC SMR 85; "An Alert to IUE Users Regarding an Error in the SWP Photometric Correction," and "An Update on the SWP ITF Problem", both in NASA IUE Newsletter No. 7, November, 1979; CSC/TM-79/6301; "A Correction Algorithm for Low Dispersion SWP Spectra", "Correction of Data Affected by the SWP ITF Error", and "A Comparative Study of Five SWP Low-Dispersion Correction Algorithms", all in NASA IUE Newsletter No. 8, February, 1980. (ESA IUE Newsletters Nos. 4,5 and SRC IUE Newsletter No. 4).

DESCRIPTION: The 11-level SWP Intensity Transfer Function (ITF) installed at GSFC on 22 May 1978 contained a serious error in the 20% exposure level. This error was publicized in the "Alert to IUE Users Regarding an Error in the SWP Photometric Correction" mentioned above. It was caused when a blank image was accidentally averaged in with three valid 20% exposure images in constructing a mean 20% level for the ITF. As a result of this, the DN values assigned to each pixel in the 20% level of the ITF are only 0.75 times the correct value, which means that the FN value assigned in the photometric correction process to image pixels falling between the 10% and 40% exposure levels will be too large. Since FN=1084 is assigned to pixels at the 10% level and FN=4291 is assigned to pixels at the 40% level, any intermediate FN will be systematically too large, with the greatest error (63%) occurring at FN=2141. The "Update on the SWP ITF Problem" in

NASA IUE Newsletter No. 7 contained a table listing the percentage error in FN per pixel (defined as $FN_{old}/FN_{true}-1$) as a function of FN per pixel. This table is repeated here to serve as a guide to users in determining what data might be affected by this problem.

FN/pixel	% Error
1080	4%
1500	30%
2141	63%
2500	41%
2750	31%
3000	23%
3500	11%
4290	1%

Depending on whether the background or gross spectrum is within the susceptable range of FN per pixel, the net spectrum FN values may be too low or too high. The two references cited contain further details and discussion of the errors induced by the ITF problem.

A new SWP ITF with a correctly-generated 20% level (and slightly more accurate assigned effective exposure times*) was installed to correct the problem on the end dates shown above. Because of the seriousness of the problem, a considerable effort went into defining an after-the-fact correction algorithm that could be applied to rectify low dispersion SWP spectra processed with the bad ITF (see the last three documents listed above). Since a comparable correction algorithm could not be devised for high dispersion spectra, all high dispersion SWP spectra processed with the bad ITF were reprocessed at the originating ground station.

* As a result of the redefined exposure times, the maximum unsaturated flux number in SWP changed from 17740 to 17632.

MEANS OF IDENTIFYING AFFECTED DATA:

- The tables of T values printed in the IUESIPS history labels of photometrically corrected images (see CSC/TM-79/6301) represent the effective exposures, in units of 0.01 seconds, assigned to each level of the ITF. Since these values were refined at the same time the error in the 20% level was corrected, they may be used to discriminate which ITF version was used to process a given image. These values are:

Bad SWP ITF

0	1753	3461	6936	9000	10575
14299	17709	21546	25156	28674	

New SWP ITF

0	1684	3374	6873	9091	10586
14371	17745	21524	25105	28500	

TITLE: Use of non-optimal pixel offsets from small to large aperture

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra (large aperture)

MEDIA: Tape, CalComp

DATES: BEGIN 03 April 1978 END 08 July 1979 (GSFC)

BEGIN 17 April 1978 END 16:00 10 Mar 1981 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 4000

PERTINENT DOCUMENTATION: GSFC SMR 84; "IUE Data Reduction V. Wavelength assignments for Large Aperture Spectra", NASA IUE Newsletter No. 6, Sept. 1979.

DESCRIPTION: On the basis of studies performed in 1979 it was determined that the ΔL and ΔS pixel offsets used to tie down the zero-points for large-aperture wavelength scales (see the IUE Newsletter report above) did not correspond precisely to the points within the large aperture of each camera at which telescope operations procedures normally placed objects. Because of this fact, there is implicit in all large-aperture spectra processed prior to 08 July 1979 at GSFC a small but systematic wavelength error. The magnitude and sign of this error depend on the camera and dispersion mode, as described in the above IUE Newsletter report. The table below lists the offsets in use prior to 08 July 1979 and compares them to the offsets to the actual object-placement points.

	SWP			LWR		
	Δ L px.	Δ S px.	R px.	Δ L px.	Δ S px.	R px.
OLD OFFSETS*	-20.0	-17.0	26.3	+19.5	-17.5	26.2
OFFSETS TO OBJECT PLACEMENT POINT	-19.9	-17.1	26.3	+20.4	-19.0	27.9

$$R = [(\Delta L)^2 + (\Delta S)^2]^{1/2}$$

* For LWR, the "old offset values" were used beginning August 30-31, 1978. See the change documented as of that date for the earlier values.

The difference between the two sets of offsets is converted below to induced wavelength errors (or for high dispersion, velocity-like errors) in the following sense:

$$\lambda_{old} = \lambda_{correct} + \Delta\lambda$$

$$\text{or} \quad \text{velocity}_{old} = \text{velocity}_{correct} + \Delta v$$

	SWP	LWR
Low Dispersion $\Delta\lambda$	+0.23 Å	-1.76 Å
High dispersion Δv	+0.13 km s^{-1}	+11.8 km s^{-1}

TITLE: Use pixel offsets from small to large aperture which do not correspond to physical center of large aperture

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra (large aperture)

MEDIA: Tape, CalComp

DATES: BEGIN {03 April 1978, 20 Sept. 1979} END {06 August 1979, 29 October 1979} (GSFC)
BEGIN 17 April 1978 END 16:00 10 Mar 1981 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 4200

PERTINENT DOCUMENTATION: GSFC SMR 86; "IUE Data Reduction V. Wavelength Assignments for Large Aperture Spectra; NASA IUE Newsletter No. 6, Sept. 1979; GSFC SMR 106.

DESCRIPTION: As described in the Newsletter documentation above, prior to 1 August 1979 at GSFC, telescope operations procedures did not place point sources at the physical center of the large aperture during the acquisition process. When an operations change was made on that date to place objects at the physical center, a corresponding change was made to the ΔL and ΔS pixel offsets used by IUESIPS in establishing large-aperture wavelength scales so that all spectra acquired as of 1 August 1979 would be reduced using the correct offsets. This change was implemented in IUESIPS on 6 August 1979 at GSFC. The new offsets used are (in pixels):

SWP			LWR		
ΔL	ΔS	R	ΔL	ΔS	R
-19.7	-17.4	26.3	+19.4	-18.6	26.9

$$R = \left[(\Delta L)^2 + (\Delta S)^2\right]^{1/2}$$

These values may be compared to previous offsets as documented in the changes of 08 July 1979.

Due to a clerical error, the old offsets were inadvertantly reintroduced (for LWR low dispersion only) during the short period 20 September - 29 October 1979.

TITLE: Write geometrically-corrected-image tape file for wavelength calibration images.

DATA AFFECTED:

CAMERA: All DISPERSION: Both (Wavecal only) PROCESSING: Geometrically corrected image

MEDIA: Tape

DATES: BEGIN 03 April 1978 END 9 October 1979 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 175

PERTINENT DOCUMENTATION: GSFC SMR 93

DESCRIPTION: Wavelength calibration images were previously processed so as to write the geometrically-corrected image file to tape. Since the geometrically-and-photometrically-corrected image file (GPI) is also written to tape as part of the standard spectral-extraction processing now done on wavelength calibration images, the geometrically-corrected file is largely redundant data. On the end date, the writing of the geometrically-corrected file was suppressed.

With this change, for a low dispersion wavelength calibration image, the standard file sequence on tape goes from 1) found reseau positions, and 2) geometrically-corrected image, followed by the standard set of tape files (RI, GPI, GPIS, ESSR, ESLO), to 1) found reseau positions, followed by the standard set (RI, GPI, GPIS, ESSR, ESLO). For a high dispersion wavelength calibration image, the file sequence changes from 1) geometrically-corrected image, followed by standard set (RI, GPI, ESHI), to just the standard set of files (RI, GPI, ESHI).

TITLE: Use biweekly dispersion-constant calibrations in low dispersion

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 03 April 1978 END 23:00 29 October 1979 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 4000

PERTINENT DOCUMENTATION: GSFC SOCAR 194, SMR 91, "IUE Data Reduction XI. Mean Dispersion Relations for Low Dispersion Spectra," NASA IUE Newsletter No. 7, Nov. 1979; "IUE Data Reduction XXI."

DESCRIPTION: As described in the above Newsletter article, prior to the end date shown the dispersion relations used to reduce IUE images were determined from new Pt-Ne lamp calibration images obtained approximately every two weeks. Although that procedure does insure that any long-term changes in the true dispersion relations are monitored, short-term changes due to thermal effects (which have timescales on the order of hours) are insufficiently sampled, and in particular one runs the risk of using an atypical calibration to reduce several weeks worth of subsequent images if an extreme thermal condition happened to exist at the time the calibration image was obtained. This is an important consideration since although long-term trends are now known to exist (see "IUE Data Reduction XXI"), short-term thermal effects are of major significance to the observed variations in spectral format, having an amplitude of up to several pixels. In low dispersion, thermal motions of the spectral format tend to be in the direction perpendicular to the dispersion (see "IUE Data Reduction XXI"), so that while the use of the biweekly calibrations may lead, on the average, to larger registration shifts, little wavelength error is introduced because the component of thermal motion along the low dispersion orders is small.

On the end date, mean dispersion relations were adopted (for low dispersion only) in all standard production schemes for current processing and reprocessing. The calibrations averaged together to form the means spanned the time period from GMT day 221, 1978 to GMT day 274, 1979. The adopted values are given in the table below (small aperture values),

	SWP	LWR
A_1	981.37	-298.22
A_2	- 0.46657	0.30242
B_1	- 263.68	-266.66
B_2	0.37618	0.22577

$$\text{where sample} = A_1 + A_2\ \lambda$$

$$\text{line} = B_1 + B_2\ \lambda$$

Note: For use of mean calibration files in high dispersion, see change as of 18 July 1980.

MEANS OF IDENTIFYING AFFECTED DATA:

- Values for the A_2 and B_2 dispersion-constant scale factors which are not equal to the mean values adopted on end date.

TITLE: Determine high dispersion wavelength calibrations from unrefined line libraries (version I libraries)

DATA AFFECTED:

CAMERA: SWP,LWR DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 03 April 1978 END 14:00 23 Nov. 1979 (GSFC)

BEGIN 17 April 1978 END 16:00 10 Mar. 1981 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 4500

PERTINENT DOCUMENTATION: GSFC SMR 92, "IUE Data Reduction XX: High Dispersion Libraries", NASA IUE Newsletter No. 13, January 1981

DESCRIPTION: The line libraries used to determine the high dispersion wavelength scales prior to the end date were unrefined compilations of Pt-Ne emission line lists (version I libraries). These libraries were examined in 1979 in order to understand why many of the lines were chronically rejected during the regression analysis used by the program WAVECAL2 to determine dispersion relations (see IUE Data Reduction XX, above). It was found that many of the lines were either incorrect or inappropriate (lines with incorrect wavelength assignments; lines which are too faint, too bright, or blended; lines which fall near reseau marks; lines with close companions; lines which fall too near the edge of the tube). Such lines were deleted from the line libraries in three phases, the first of which was implemented on the end date shown above. (Also, see the changes as of 18 April 1980 and 29 August 1980).

The original SWP line library contained 243 lines; the original LWR library contained 219. The edited libraries implemented on the end date (version II libraries) contained 179 lines and 181 lines for SWP and LWR, respectively. The benefits realized by the use of the new libraries relate to a higher internal accuracy and incorporation of a greater fraction of the available lines into the final solutions (see IUE Data Reduction XX). The actual dispersion relations resulting from the modified libraries are such that the pixel locations corresponding to a given wavelength would be identical (i.e., to better than 0.1 pixels) to those obtained from dispersion relations resulting from the original libraries. That is, there is no practical difference in the wavelength assignment for extracted spectra.

TITLE: Do not provide absolutely-calibrated net spectrum in low dispersion

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged spectra

MEDIA: Tape, CalComp

DATES: BEGIN 03 April 1978 END 5:00 9 Jan. 1980 (GSFC)

BEGIN 17 April 1978 END 12 July 1979 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 5500

PERTINENT DOCUMENTATION: GSFC SMR 96; "IUE Data Reduction XII: Absolute Calibration of Low Dispersion Spectra," NASA IUE Newsletter No. 8, Feb. 1980; CSC/TM-79/6301; "Photometric Calibration of the International Ultraviolet Explorer (IUE): Low Dispersion," Astron. Astrophys. 85, 1980; Photometric Calibration of the IUE VII: Joint US/UK/ESA Revision to the IUE Absolute Calibration", NASA IUE Newsletter, No. 8, Feb. 1980. (ESA IUE Newsletter, No. 6.)

DESCRIPTION: Low dispersion spectra processed prior to the end dates shown did not include the absolutely-calibrated net signal: the "ABNET" portion of the merged spectral file (see CSC/TM-79/6301) was identical to the "NET" portion, being expressed as time-integrated, slit-integrated FN values. On the end dates above, the inverse sensitivity functions S_λ^{-1} for each camera were applied before writing the ABNET data:

$$ABNET \equiv S_\lambda^{-1} \times FN(NET) \qquad (erg\ cm^{-2}\ Å^{-1})$$

Note that the exposure time is not divided out, so that ABNET data are still time integrated.

Note also the following GSFC/VILSPA difference: On 12 July 1979 VILSPA began use of the S_λ^{-1} functions as originally published in Astron. Astrophys. as referenced above. On 9 January 1980 GSFC began use of the S_λ^{-1} functions modified at 1850 Å and 1900 Å as described in "Photometric Calibration of the IUE, VII," and interpolated as described in "IUE DATA Reduction, XII". (See also the change of 02 April 1980).

MEANS OF IDENTIFYING AFFECTED DATA:

- Magnitude of the uncalibrated ABNET data, when rescaled to floating-point values, will be large (i.e., typically 10^2-10^5 FN units), whereas the absolutely-calibrated ABNET spectral values will typically lie in the range 10^{-11} - 10^{-8} erg cm^{-2} $Å^{-1}$

TITLE: Truncation of ITF at upper limit

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Photometrically corrected image, extracted spectra.

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 3 April 1978 END 16:55 8 Jan. 1980 (GSFC)

BEGIN 17 April 1978 END 16:00 1 Feb. 1980 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 11000

PERTINENT DOCUMENTATION: GSFC SMR's 98, 96 and SOCAR 201. "IUE Data Reduction XIII: Modification of Photometric Correction to Extrapolate the Intensity Transfer Function", NASA IUE Newsletter, No. 8, Feb. 1980.

DESCRIPTION: During this period FN values were determined by linear interpolation within the ITF table and linear extrapolation at the lower end of the table. In those cases where the observed DN value was greater than the largest DN in the ITF table the FN value of the largest DN in the table was assigned. After the end date of this period a new program (FICOR6) was implemented which differs from the old program in that it performs a linear extrapolation for DN's greater than the last unsaturated (saturation DN = 255) point in the ITF. The program uses the last two unsaturated points in the ITF to determine the slope for the extrapolation. If the extrapolated FN exceeds 32767 it is set equal to 32767; therefore, an FN of 32767 can indicate either an input DN of 255 (saturation) or an extrapolated FN limited by the 16 bit (halfword) integer format. All FN values of 32767 are flagged the same way by the ϵ field and appear on plots with a "+" symbol as either "saturated or limited extrapolation".

MEANS OF IDENTIFYING AFFECTED DATA: Spectra processed during this period were processed by a version of FICOR other than FICOR6. If FICOR6 is not listed in the history label some other version of photometric conversion was used.

TITLE: Incorrect units for the DISTANCE parameter in EXTLOW

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged spectra

MEDIA: Tape, CalComp

DATES: BEGIN 20:30 22 May 1978 END 21:49 1 March 1980 GSFC

BEGIN 14 June 1978 END 12:30 6 March 1980 VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 7000

PERTINENT DOCUMENTATION: GSFC SMR 99 and SOCAR 204. "Low Dispersion Background Extraction Error", NASA IUE Newsletter No. 9, April 1980.

DESCRIPTION: During this period the parameter, "DISTANCE", input to the extraction program EXTLOW to specify the distance between the dispersion line (center of on-order extraction) and the center of the background extraction slit specified this distance in PIXELS. Because of this, the background extraction slit was very close to or in many cases overlapping the gross extraction slit and/or the large aperture. After the end of this period the program EXTLOW was replaced by the program EXTLOW2 which takes the parameter "DISTANCE" in units of "diagonal pixels" where one diagonal pixel is equal to ($1 \times \sqrt{2}$) pixels. After this change the values assigned to the parameters input to EXTLOW2 remained the same as those previously used by EXTLOW. Therefore, the effect of the change was to move the background away from the spectrum by a factor of the square root of two ($\sqrt{2}$).

Throughout this period the small aperture gross extraction slit overlapped the background by $1.3\sqrt{2}$ pixels. After the end of the period it was separated from the background by $\sqrt{2}$ pixels.

For the large aperture point source mode the error has varied with time at GSFC as follows: (1) between 22 May 1978 and and 25 Sept. 1978 the background extended into the gross extraction slit by $1.3\sqrt{2}$ pixels (almost 1/2 the area of the background) (2) After 25 Sept. 1978 (See Configuration No. 25) there was a small gap of $0.78\sqrt{2}$ pixels between the gross extraction slit and the end of the background slit, and the background slit extended into the large aperture by about

0.2 $\sqrt{2}$ pixels, and (3) after 1 March 1980 the gap between the large aperture and the background slit became 3$\sqrt{2}$ pixels and the gap between the background and the gross 4 $\sqrt{2}$ pixels.

In the large aperture <u>extended source</u> mode (this mode was not created until 1 Aug. 1978) the overlap throughout the period at GSFC was 2.2 $\sqrt{2}$ pixels between the background slit and the gross extraction slit and 0.2$\sqrt{2}$ pixels between the large aperture and the background. After the end of this period the background slit was 3$\sqrt{2}$ pixels from the large aperture and 1$\sqrt{2}$ pixels from the gross extraction slit.

< For VILSPA data, the relevant dates are as follows:

(1) From 14 June 1978 to 31 Jan 1979
(2) After 01 Feb 1979
(3) After 06 Mar 1980

The extended source extraction mode was affected from 14 June 1978 until 06 Mar 1980 at VILSPA. >

MEANS OF IDENTIFYING AFFECTED DATA:

- After the end of this period the label for the extracted spectrum will contain the program name EXTLOW2. During the affected period the label will indicate EXTLOW.

TITLE: Use original *Astron. Astrophys.* absolute calibration

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: Merged Spectra

MEDIA: Tape, CalComp

DATES: BEGIN N/A END N/A (GSFC)

BEGIN 12 July 1979 END 14:00 02 April 1980 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: "Photometric Calibration of the International Ultraviolet Explorer (IUE): Low Dispersion," *Astron. Astrophys.* 85, 1980; "IUE Data Reduction XII: Absolute Calibration of Low Dispersion Spectra," *NASA IUE Newsletter* No. 8, Feb. 1980. (*ESA IUE Newsletter* #6).

DESCRIPTION: During the affected time period, at VILSPA only, the original low dispersion S_λ^{-1} functions as described in "Photometric Calibration of the International Ultraviolet Explorer (IUE): Low Dispersion" were utilized to provide the absolutely-calibrated spectrum. As of the end date, the modified S_λ^{-1} as described in "IUE Data Reduction XII" was adopted. These modifications involve a 14% reduction in S_λ^{-1} at 1850Å and a 6% reduction at 1900Å, a smooth interpolation to points on a 10Å grid in LWR and a 5Å grid in SWP, and the truncation of S_λ^{-1} to zero at the extremes of wavelength in each camera. With these changes, the S_λ^{-1} used at both GSFC and VILSPA are the same.

TITLE: Determine high dispersion wavelength calibrations from partially refined line libraries (version II libraries).

DATA AFFECTED:

CAMERA: SWP,LWR DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 14:00 23 Nov. 1979 END 18 Apr. 1980 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 800

PERTINENT DOCUMENTATION: GSFC SMR 100, "IUE Data Reduction XX: High Dispersion Line Libraries", NASA IUE Newsletter No. 13, January 1981.

DESCRIPTION: The high dispersion line libraries used during the period shown above were partially-refined (version II) listings of Pt-Ne emission lines (see "IUE Data Reduction XX" and the changes of 23 November 1979). A further refinement was made on the end date above which resulted in new libraries (version III) containing 172 lines for SWP and 164 lines for LWR. As noted in the changes of 23 November 1979, the effects of this change relate principally to the internal consistency of the dispersion-constant solutions--no practical changes to the assigned wavelength scales of extracted spectra are realized.

TITLE: Use biweekly reseau calibrations

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Both PROCESSING: All but raw image

MEDIA: Tape, CalComp, Photowrite,

DATES: BEGIN 03 Apr. 1978 END 10:00 18 July 1980 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 11000

PERTINENT DOCUMENTATION: GSFC SMR 107, 103, 104; "IUE Data Reduction XVII., NASA IUE Newsletter No. 11, Oct. 1980.

DESCRIPTION: Prior to the end date shown the reseaux positions used to correct the geometry of the IUE images were determined from new WAVECAL + TFLOOD calibration images taken approximately every two weeks. After the above end date a set of mean reseaux positions were implemented based on 16 LWR 60% or 77% UVITF images exposed between day 73 of 1978 and day 204 of 1979 and 20 SWP 60% or 77% UVITF images exposed between day 85 of 1978 and day 334 of 1979. As noted in the above Newsletter article the chief advantage of mean files over the usual biweekly calibrations is that short term fluctuations are averaged out, yielding calibrations more appropriate to the "typical" IUE image. UVITF images were used instead of WAVECAL + TFLOOD images since the former provide a flatter and less contaminated area for the FNDRES (reseaux finding) program to search.

Several improvements were made in the details of the FNDRES program in order to get the highest possible accuracy. An improved template for the large reseau in row 11, column 11 was used and three more reseaux in SWP and two more in LWR near the tube edges were added so as to reduce the amount of extrapolation needed to achieve the full 13-by-13 grid of reseaux used in the geometric correction process (see SMR 103 & 104). Furthermore, the average positions found on the UVITF images with the improved FNDRES were calculated without the row-and-column smoothing procedure usually applied to reseaux measured on a single image. This smoothing was found to introduce errors.

TITLE: Use biweekly dispersion constant calibrations in high dispersion

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES:	BEGIN	03 Apr. 1978	END	10:00 18 July 1980	(GSFC)
	BEGIN	N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 5000

PERTINENT DOCUMENTATION: GSFC SMR 107, 103 and 104, "IUE Data Reduction XVII, NASA IUE Newsletter, No. 11, Oct. 1980, "IUE Data Reduction XI, NASA IUE Newsletter, No. 7, Nov. 1979.

DESCRIPTION: During this period the dispersion relations used to reduce the IUE images were determined from new Pt-Ne lamp calibration images taken approximately every two weeks. As noted in the above Newsletter articles (see the change for 29 Oct. 1979 as well), the chief advantage of mean files over the usual biweekly calibrations is that thermal fluctuations are averaged out yielding calibrations more appropriate to the "typical" IUE image. As of the end date above, a set of mean dispersion constants for high dispersion was implemented. This set was based on 24 SWP and 24 LWR standard TFLOOD + WAVECAL high dispersion images acquired between 1 June 1979 and 1 June 1980. The dispersion relations determined from each of these images were averaged together term by term to define the set of mean high resolution dispersion constants given below:

(next page)

	SWP		LWR	
A_1	.787841752597664	D+3	-.512112131218370	D+4
A_2	-.174827009628957	D Ø	.149474938164753	D Ø
A_3	.128250164013606	D-5	-.557131203376991	D-6
A_4	Ø		.128677678460013	D-2
A_5	-.464346927595875	D Ø	.279988588392915	D Ø
A_6	Ø		Ø	
A_7	-.245917585466073	D-7	.964982411024015	D-7
B_1	-.624447811047980	D+4	.151718662770336	D+5
B_2	-.131942801615998	D Ø	-.275447072458253	D Ø
B_3	.127355792121042	D-5	.903443905778614	D-6
B_4	Ø		.661594536973941	D-1
B_5	.414873420270391	D Ø	.222497232868056	D Ø
B_6	.293871562110805	D-7	.225207671516958	D-7
B_7	-.286833642560946	D-6	.227041512913941	D-7

MEANS OF IDENTIFYING AFFECTED DATA:

- Values of the dispersion constants (given in image label) which differ from the above mean constants (aside from the A_1 and B_1 terms).

TITLE: Use of preliminary mean dispersion constants for low dispersion

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 23:00 29 Oct. 1979 END 10:00 18 July 1980 GSFC

BEGIN N/A END N/A VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 2000

PERTINENT DOCUMENTATION: GSFC SMR 107,103, and 104, "IUE Data Reduction XVII., NASA IUE Newsletter No. 11, Oct. 1980.

DESCRIPTION: During the period 29 Oct. 1979 to 18 July 1980 a set of preliminary mean dispersion relations were used (see change for 29 Oct. 1979) which were based on data obtained during the first year of IUE operation (GMT day 221 1978 to GMT day 274 1979). As noted in the above Newsletter article, studies of temporal and thermal variability of dispersion relations have shown that dispersion relations obtained during the first year of IUE operation may not be appropriate to use for current data. Therefore, at the end of the period a new set of dispersion constants was implemented, based on 24 SWP and 24 LWR standard TFLOOD + WAVECAL low dispersion images taken between 1 June 1979 and 1 June 1980. These new mean constants differ from the means reported in the change for 29 Oct. chiefly in the zero-point terms where the largest difference is +0.86 pixels. The largest difference in the scale term is 0.00002 pixels/Å.

The mean dispersion constants adopted for low dispersion on 18 July 1980 are given below:

Camera	Aperture	A_1	A_2	B_1	B_2
SWP	Small	982.21	-.46657	-263.44	.37616
LWR	Small	-298.63	.30244	-265.80	.22579

TITLE: Inaccurate automatic registration programs

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 09 Sept. 1978 END 11:30 18 Aug. 1980 (GSFC)

BEGIN 25 Jan. 1979 END 22:00 30 Dec. 1980 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50% (Automatic only)

ESTIMATED NUMBER OF IMAGES AFFECTED: 7000

PERTINENT DOCUMENTATION: GSFC SOCAR 211

DESCRIPTION: During the period indicated two errors existed in the automatic registration programs DSPCON and DCSHIFT: (1) the line and sample shift components calculated did not represent a shift perpendicular to the spectrum (the equations used to calculate the shift were incorrect), and (2) when the required shift was large (shift greater than 3.0 pixels perpendicular to the spectrum) the program would sometimes give a shift that was a gross underestimate (as much as 1.0 pixel too small) of the correct shift. At the end of this period these errors were corrected (note that an additional error was subsequently found in the corrected programs - see GSFC change for 19 Jan. 1981).

The errors caused by the first of these two problems vary in magnitude as a function of camera and dispersion. The following table lists the errors to be expected for the data reduced during this period (the values in the table can be added to the erroneous shifts, S_o and L_o, to get the correct shifts):

	Sample	Line
LWR - HIGH	S_o*(0.27) - .28	L_o*(-0.26) -0.20
LWR - LOW	S_o*(0.03) -0.21	L_o* (0.02) -0.28
SWP - HIGH	S_o*(0.24) -0.28	L_o*(-0.22) +0.22
SWP - LOW	S_o*(0.008) -0.22	L_o*(-0.004)-0.27

The magnitude of the error caused by the second problem above can be as large as ± 1.0 pixel in low dispersion and somewhat smaller in high dispersion.

Neither of these errors affected spectra which were trailed; during the affected time period all trailed spectra were manually registered.

MEANS OF IDENTIFYING AFFECTED DATA:

- If the line shift divided by the sample shift is exactly equal to (+ or -) the arctangent of 51°, the data were processed during this period and need correction (note that for SWP-Low, data processed after the end date will yield the arctangent of $51^\circ.12$).

TITLE: Determine high dispersion wavelength calibrations from further refinements to line libraries (version III libraries)

DATA AFFECTED:

CAMERA: SWP,LWR DISPERSION: High PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN 18 April 1980 END 29 August 1980 (GSFC)

BEGIN N/A END N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 600

PERTINENT DOCUMENTATION: GSFC SMR 112, "IUE Data Reduction XX: High Dispersion Line Libraries".

DESCRIPTION: The high dispersion line libraries used during the period shown above were further-refined (version III) libraries (see "IUE Data Reduction XX", and the changes of 23 November 1979 and 18 April 1980). A final refinement, involving the deletion of marginally faint lines and lines with close companions, was made on the end date shown above, resulting in a final SWP library of 146 lines and a final LWR library of 145 lines (version IV libraries). As with the earlier changes, no practical effects on the assigned wavelength scales of extracted spectra are realized by this change.

TITLE: Incorrectly transmit 5-digit image sequence numbers to scale-factor record of extracted spectral files.

DATA AFFECTED:

CAMERA: SWP DISPERSION: Both PROCESSING: Extracted Spectra

MEDIA: Tape

DATES: BEGIN 03 Sept. 1980 END 18 Sept. 1980 (GSFC)

BEGIN 03 Sept. 1980 END 30 Sept. 1980 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 200

PERTINENT DOCUMENTATION: GSFC SOCAR 215

DESCRIPTION: For the SWP camera, 5-digit image sequence numbers were reached on 03 September 1980. The version of the program ETOEM in use at both ground stations at that time accessed only the right-most 4 digits of the image sequence number, so that SWP 10001 was transmitted to the scale-factor record of extracted spectral files as SWP 0001, SWP 10002 as SWP 0002, etc. The corrections to ETOEM allowing all 5 digits to be transmitted were made on the respective dates shown above.

MEANS OF IDENTIFYING AFFECTED DATA:

- SWP image numbers in the range 0000 to ~0250 written into the scale factor record of SWP imates acquired during September 1980.

TITLE: **Processing of low dispersion spectra using the programs GEOM, FICOR and EXTLOW.**

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Low PROCESSING: All but Raw image

MEDIA: Tape, CalComp, Photowrite, Printout

DATES:	BEGIN 20:30	22 May 1978	END	00:11	04 Nov. 1980	GSFC
	BEGIN	14 June 1978	END	16:00	10 Mar. 1981	VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 10000

PERTINENT DOCUMENTATION: GSFC SMR 116; "Photometric Calibration of the IUE, VIII. Comprehensive Revision to the IUE Absolute Calibration in Low Dispersion", NASA IUE Newsletter No. 10, June 1980; "IUE DATA REDUCTION XVIII & XIX" NASA IUE Newsletter No. 12, Jan. 1981; "INTERNATIONAL ULTRAVIOLET EXPLORER IMAGE PROCESSING INFORMATION MANUAL, VERSION 1.0", CSC/TM-79/6301, 1979.

DESCRIPTION: A detailed description of the processing procedures used during the indicated period can be found in Version 1.0 of the Information Manual referred to above, and the two Newsletter articles listed can be consulted for the processing details in effect as of the end date for this period.

The output products produced during this period and those produced immediately after the end date differed in the manner shown by the following table:

During Period	After End Date
Photometrically and Geometrically corrected image provided. The entire image out to the edge of the roughly circular vidicon target is corrected.	Photometrically corrected image provided (same geometry as raw image). A band 160 pixels wide, centered between the large and small apertures, and parallel to the dispersion is the only part of the image corrected. Pixels outside this band are left as raw DN values.

During Period	After End Date
For the Photometrically and Geometrically corrected image the halfword pixel values are coded in a simple manner such that the relative flux (FN) equals the scaled value given unless the scaled value is 32767, in which case the pixel is saturated or extrapolated to the halfword limit (32767 is the largest FN possible).	The coding of the halfword pixels of the photometrically corrected image is designed to accommodate an extensive flagging system for exceptional pixels. The following conditions are flagged: (a) $-32767 \leq$ Scaled value ≤ -2049; Saturation (DN=255) or excessive extrapolation of ITF (b) $-2048 \leq$ Scaled Value < 0; Extrapolatin of upper end of ITF up to FN=65536 (c) $0 \leq$ Scaled Value ≤ 255; (No photometric correction raw DN outside of band) (d) $256 \leq$ Scaled Value < 32767; Normal interpolation of ITF up to FN=61534 or extrapolation to negative FN down to FN=-3488. For case (d) the relation between FN and the Scaled Value is FN=2*(Scaled Value - 2000). For cases (a)-(c), see IUE Data Reduction XVIII.
A 55-line Image Segment file was provided which consisted of the fluxes given in the line-by-line file. Each line was ~ 836 bytes long.	The Image Segment is not provided since the same information is in the line-by-line file.
The extracted spectrum files (line-by-line and merged spectra) have a data record length of 1204 bytes (up to 602 points per order). The scale factor record (record zero) does not contain target or engineering data.	Extracted spectrum files have a data record length of 2048 bytes, accommodating a total of 1022 points per order. The scale factor record contains such things as RA & DEC of target, camera temperatures and time of observation.

During Period	After End Date
Merged spectrum extracted from the photometrically and geometrically corrected image at an omega angle (see version 1.0 of IUE Information Manual for definition of omega angle) of 90° for all cameras, both apertures and all modes (Point source, Extended source, Trailed).	Merged spectrum derived directly from a summation at the correct omega angle of fluxes in the line-by-line spectrum. Different omega angles are used for each of the cameras, apertures and modes (a distinction <u>is</u> made between extended source and trailed).
The background spectrum is smoothed twice using a 15-point running average (this caused narrow defects such as reseaux, bright spots, and cosmic ray hits to be smoothed into the background).	The background is processed by a median filter (width 63 pixels) before a double mean filter of width 31 is applied (this rejects all narrow features including reseaux).
The data quality measure values (epsilons) are calculated using a formula that includes a term proportional to the distance of a pixel from the tube center. For the net spectrum the epsilons include a term for background reseaux.	There are only six possible values of epsilon (data quality measure) which signal six conditions (if more than one of the conditions occurs at that point the value for the worst case is given).
The order of the files for a double aperture image has the data for small aperture <u>first</u>.	The order of the files for a double aperture image has the data for small aperture <u>last</u>.
The absolute calibration of January 1980 is used (see GSFC change for 08 Jan. 1980).	The absolute calibration of May 1980 is used (see <u>NASA IUE Newsletter</u> No. 10).
Spectral data is extracted at an interval of 1.4 pixels from the resampled (smoothed) photometrically and geometrically corrected image.	Spectral data is extracted at an interval of 0.7 pixels from the raw image. The resulting spectral resolution is better than with the older method.

During Period	After End Date
The header at the beginning of the data files gives the names of the reduction programs in use (FICOR, GEOM, EXTLOW(2)).	The header at the beginning of the data files gives the names of the new reduction programs (PHOTOM, SPECLO, POSTLO) and in addition gives the time of the midpoint of the observation, the target coordinates, and a statement noting that either an automatic or a Manual Shift was used.

Data quality during this period was different from that after the end date as follows:

(1) The spectral resolution was not as good.

(2) Because of the broader extraction slit used there was less noise in the spectra (the same noise figure can be obtained for data extracted after the end date by binning the data).

(3) Reseaux and noise spikes are smoothed into the background spectrum and when it is then subtracted from the gross to produce the net erroneous broad dips or rises are produced.

(4) The well-corrected region of the SWP net spectrum ended at 1955 Å (after the end date it was extended to 1990 Å).

(5) The absolute calibration is slightly poorer (the improved calibration installed at the end date differed from the old calibration by as much as 10% in SWP and 6.3% in LWR).

Aside from the change in the absolute calibration, the changes made of the end of this period did not appreciably modify the photometric properties of the system (changes were less than 2%).

TITLE: Non-perpendicular manual shifts (REGISTER)

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Both PROCESSING: Extracted

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN	20:30	22 May 1978	END	00:11, 04 Nov. 1980	GSFC
	BEGIN		14 June 1978	END		VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50%

ESTIMATED NUMBER OF IMAGES AFFECTED: 9000

PERTINENT DOCUMENTATION: GSFC SMR 116, SOCAR 216

DESCRIPTION: During this period, whenever it was necessary to register an image manually, the image processing specialist would display the image on the Experiment Display System (EDS) and estimate the shift in the sample direction and the line direction necessary to place the wavelength overlay (produced by the program OSCRIBE using the dispersion relation and displayed along with the image) on top of the spectrum. Misregistration of the image and the overlay is caused by thermal motion of the entire spectral format and will have components perpendicular to the dispersion direction and along the dispersion direction. Since the component along the dispersion was unknown, moving a given wavelength on the overlay along the dispersion is just as likely to increase the error as decrease it; therefore, every effort was made to estimate a shift that was perpendicular to the dispersion direction.

The shifts estimated were only approximately perpendicular to the dispersion so they could introduce arbitrary displacements along the dispersion of up to 3 pixels. After the end date a new program REG was implemented to replace the program REGISTER. This new program uses the line and sample shift supplied by the image processing specialist (this need not represent a shift perpendicular to the dispersion) to determine the correct components of an exactly perpendicular shift.

MEANS OF IDENTIFYING AFFECTED DATA:

- Erroneous shifts were usually integer values (see label). After the end date a message was added to the label noting that either an automatic or manual shift was made.

  <At VILSPA an extra label message was added before the original REGISTER program was withdrawn. The date of processing should always be used to identify affected VILSPA data.>

NO. 62

TITLE: Label lacks scheme name and AUTO/MANUAL message

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN 03 Apr. 1978	END 00:11, 04 Nov. 1980		(GSFC)
	BEGIN 17 Apr. 1978	END 16:42	30 Jan. 1981	(VILSPA)
		16:00	10 Mar. 1981	

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 19000

PERTINENT DOCUMENTATION: GSFC SMR 116, SOCAR's 216, 223, 224.

DESCRIPTION: During this period the image labels did not contain the name of the processing procedure ("Scheme") used or a notation indicating the type of registration shift applied (manual, automatic, or none). The registration shift information was not contained in the scale factor record ("record Ø") of the extracted files. After the end date the scheme name and shift information were added to the label and a flag was placed in word 62 of record Ø to indicate the type of shift used (Ø=no shift, 1=auto shift, 2=manual shift).

At VILSPA, these changes were implemented in two phases. On 30 Jan. 1981 the AUTO/MANUAL message was added to high dispersion labels; on 10 March 1981, the same was done for low dispersion and the scheme name was added for both dispersions.

NO. 63

TITLE: Incorrect manual shift for SWP images (REG)

DATA AFFECTED:

CAMERA: SWP DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 00:11, 04 Nov. END 05:00 26 Nov. 1980 (GSFC)

BEGIN N/A N/A (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50% (manual only)

ESTIMATED NUMBER OF IMAGES AFFECTED: 200

PERTINENT DOCUMENTATION: GSFC SOCAR 228

DESCRIPTION: During this period there was an error in the program REG such that it calculated shifts which were not perpendicular to the dispersion direction whenever it was used for an SWP image (LWR was done correctly). The error caused was equivalent to using the old program REGISTER, i.e., arbitrary displacements of the overlay and the dispersion relation along the spectrum (up to 3 pixels in the worst cases).

MEANS OF IDENTIFYING AFFECTED DATA: The label will note that a Manual shift was used and the entire shift will be in either the Sample direction or the Line direction.

TITLE: VBBLK without label processing

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: Raw image (NSSDC tapes only)

MEDIA: Tape

DATES:	BEGIN 10 Dec. 1979	END	22 Dec. 1980	(GSFC)
	BEGIN N/A	END	N/A	(VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 4500

PERTINENT DOCUMENTATION: GSFC SMR 94; SOCAR 205

DESCRIPTION: This problem affected only those tapes sent to the National Space Science Data Center (NSSDC). Regular Guest Observer tapes were not affected.

During this period the IUESIPS program VBBLK created raw images with starting line (SL) and starting sample (SS) fields in the first line of the header label reading "0895" and "0895" instead of "0001" and "0001". After the end date this problem was corrected.

TITLE: Incorrect entries in label by SPECLO (Declination and Zero Shift).

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: All but raw image

MEDIA: Tape, CalComp

DATES: BEGIN 00:11 04 Nov. 1980 END 20:00 16 Jan. 1981 GSFC

BEGIN END VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50%

ESTIMATED NUMBER OF IMAGES AFFECTED: 300 (only Negative DEC and unshifted cases)

PERTINENT DOCUMENTATION: GSFC SOCARs 231, 232; SMR 116

DESCRIPTION: During this period the declination of an object listed in the processing label on the line starting "TARGET COORD. (1950):" had the correct magnitude but the wrong sign for objects south of the Equator. In addition the line of the label giving the line and sample shift did not list the shifts as 0.0 when a shift was not used, but instead looked like the following: "LINE SHIFT=YY.YYY SAMPLE SHIFT=XX.XXX" After the end date these two errors were corrected.

TITLE: Inaccurate automatic registration (LWR-LOW, SWP-HIGH and all Trailed)

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Both PROCESSING: Extracted spectra

MEDIA: Tape, CalComp, Photowrite

DATES:						
BEGIN	11:30	18 Aug. 1980	END	14:00	19 Jan. 1981	GSFC
BEGIN	22:00	30 Dec. 1980	END			VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 50% (automatic only)

ESTIMATED NUMBER OF IMAGES AFFECTED: 500

PERTINENT DOCUMENTATION: GSFC SOCAR 233

DESCRIPTION: During this period LWR-Low dispersion, SWP high dispersion and all trailed images were mis-registered by about 0.4 pixels. Since this is less than 10 percent of the length of the shortest slit used the photometric error caused should be very small (in most cases the entire spectrum was still in the slit). The error in the dispersion direction would, in general, be less than this total error.

TITLE: Calibration Files without temperature corrections (low dispersion)

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Low PROCESSING: All But Raw Image

MEDIA: Tape, CalComp, Photowrite

DATES: BEGIN 03 Apr. 1978 END 05:00 3 Mar. 1981 (GSFC)

BEGIN 17 Apr. 1978 END (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 12000

PERTINENT DOCUMENTATION: GSFC SMR 118, and SOCAR's 238, 241, 240, 242; "IUE Data Reduction XXI, NASA IUE Newsletter No.15.

DESCRIPTION: The IUESIPS processing software uses a set of displacements (determined from the reseaux on the tube faceplate) for each camera to correct each data image for geometric distortion, and a set of dispersion constants for each camera and dispersion mode (high, low) to determine the location of the spectrum for extraction and wavelength assignment. Primarily because of variations in spacecraft temperature at the time of observation the geometry of the image and the location of the spectral format on the camera faceplate change from image to image. Before the end date, no explicit thermal correction was applied to the calibration files.

During this period several changes were made to the processing software in an effort to use the best set of reseaux and dispersion constants for each image (see GSFC changes for: 22 May '78, 09 Jun. '78, 01 Jul. '78, 11 Aug. '78, 10 Sept. '78, 23 Nov. '79, 18 Apr. '80, 22 Apr. '80, 31 May '80, 18 Jul. '80, 18 Aug. '80, 29 Aug. '80, 04 Nov. '80 -- underlined dates are the most significant).

As of the end date for this change the displacement set used and the dispersion constants used were a function of the temperature at the time of the observation and the time of observation (the temperature used is referred to as the THDA and is usually available in the binary part of the image header). Before this change if an image was taken at a temperature which differed significantly from the temperature of the calibration files used, the wavelength assigned to a point on the spectrum would be incorrect. As an example, if the temperature of the image and the calibration file differed by 9° C for an SWP low dispersion image a wavelength error of over 2 Å would result.

Those images processed during the period when bi-weekly calibrations were used are likely to show larger errors than images processed after the mean calibrations were implemented (the effective temperatures for the mean calibrations were approximately 8° C for SWP and 13° C for LWR). The average (one standard deviation) wavelength error caused by using the mean calibrations (specifically the mean dispersion constants implemented on the end date of this change) instead of the temperature corrected calibrations is 0.16 Å for LWR-Low and 0.30 Å for SWP-Low (this corresponds to 0.06 pixels in LWR and 0.18 pixels in SWP along the spectrum).

Some of the bi-weekly calibrations were taken at temperatures very different from both the mean temperatures and the temperatures of the images processed using them; therefore, it would be possible to greatly improve the accuracy of the wavelengths of images taken during the bi-weekly calibration era.

The photometric quality of data processed before and after the end date differed very little. The data after the end date may be marginally less noisy (~5%), due to the use of the temperature corrected reseaux for the SWP camera. The reseaux motion is greatest for the SWP camera (it is at most ~0.9 pixels from the mean). For LWR the motion is so small (about 0.2 pixels from the mean) that the mean values were still used after the end date.

In those cases where the date of observation or the temperature cannot be obtained from the label (all images prior to March 1979 lack the temperature and the date of observation) they will be entered manually (a comment in the processing label will say "MANUAL OVERIDE") or mean calibrations will be used (a message in the label will note this). The mean dispersion constants to be used in such cases were implemented on the end date of this change. These new dispersion constants are slightly better than the July, 1980 set. The processing label for all images taken after the end date will contain the lines:

```
THDA FOR RESEAU MOTION =
THDA FOR SPECTRUM MOTION =
THERMAL SHIFTS:  LINE = SAMPLE =
```

Any further shifting necessary to register the image, either manual or automatic, is recorded in the label under the name REGISTRATION SHIFTS: LINE = SAMPLE =

MEANS OF IDENTIFYING AFFECTED DATA:

- The messages to specify the temperatures used will not appear in the label.

TITLE: Use of preliminary parameters to specify the region to be processed by the program PHOTOM

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Low PROCESSING: All but raw image

MEDIA: Tape, CalComp, Photowrite

DATES:	BEGIN 00:11 4 Nov. 1980	END 05:00 03 Mar. 1981	GSFC
	BEGIN 16:00 10 Mar. 1981	END	VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: GSFC SOCAR 247

DESCRIPTION: During this period the 160-pixel-wide band of the raw image which was photometrically corrected was slightly larger (roughly 2 pixels and 15 pixels longer in the direction of dispersion for SWP and LWR respectively) than it was after the end date and displaced as a whole by several pixels (29 pixels for SWP and 10 for LWR). The affect of this on the extracted data is to change slightly the end points (smallest wavelength, largest wavelength) of the spectrum. Immediately after the end date (3 Mar. to 5 Mar.) the new smaller corrected area caused an error which is described in the GSFC change for 5 Mar. 1981.

TITLE: Use positional information to determine the bounds of the area to be extracted (SPECLO)

DATA AFFECTED:

CAMERA: LWR & SWP DISPERSION: Low PROCESSING: Extracted spectra

MEDIA: Tape, CalComp

DATES: BEGIN	00:11	04 Nov. 1980	END	05:00	5 Mar. 1981	GSFC
BEGIN	16:00	10 Mar. 1981	END			VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: GSFC SOCAR 245

DESCRIPTION: During this period the program SPECLO extracted that part of the spectrum lying between two nominal (coded into the program) end point wavelengths as long as the center of the extraction slits for these wavelengths fell within a designated area of the image. If the sample and line position of the endpoint wavelengths slit center fell outside these bounds SPECLO substituted for that endpoint a new wavelength having a slit center just inside the area. Between 05:00 GMT, 3 Mar. 1981 and 05:00 GMT, 5 Mar. 1981 the area of the image which was photometrically corrected did not coincide with the area designated by SPECLO for extraction. Therefore, during this two day period pixels outside the photometrically corrected area could be included in the gross flux extracted.

After the end date for this change SPECLO was modified so that it no longer used positional information to determine the starting and ending wavelengths of the spectrum to be extracted. Starting at one of two nominal endpoints supplied in the program and continuing to the other, the new version of SPECLO extracts the flux in slits spaced along the spectrum at an interval of 0.707 pixels. If any of the pixels in an extraction slit are flagged as raw data pixels (the area of raw data outside the photometrically corrected area is coded by the program PHOTOM to flag it as raw data - see GSFC changes for 4 Nov. 1980) the flux from that slit and its corresponding wavelength are excluded from the extracted spectrum. The result of this is that SPECLO extracts all the data lying between the two nominal wavelenths and <u>completely</u> (in the sense that every pixel is checked) inside of the photometrically corrected area.

TITLE: Unused lines of header label not blank-filled by POSTLO

DATA AFFECTED:

CAMERA: All DISPERSION: Low PROCESSING: All but raw image

MEDIA: Tape, CalComp, Printout

DATES: BEGIN 00:11 04 Nov. 1980 END 14:30 6 Mar. 1981 GSFC

BEGIN 16:00 10 Mar. 1981 END VILSPA

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: 100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 1000

PERTINENT DOCUMENTATION: GSFC SOCAR 246

DESCRIPTION: During this period the program POSTLO did not fill unused lines of the header label or unused portions of lines with blanks (these parts of the label contained core-garbage). Therefore, if the label is printed as an EBCDIC string some lines will contain arbitary characters. After the end date these lines were blank filled (i.e., the EBCDIC character, blank, was placed in each byte).

NO. 71

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (4)

DATA AFFECTED:

CAMERA: All DISPERSION: Both PROCESSING: All Except Raw

MEDIA: Tape, Calcomp, Photowrite

DATES: BEGIN N/A END N/A (GSFC)

BEGIN 17:00 01 Feb 1979 END 16:00 10 Mar 1981 (VILSPA)

ESTIMATED FRACTION OF PROCESSED IMAGES AFFECTED: ~100%

ESTIMATED NUMBER OF IMAGES AFFECTED: 2500

PERTINENT DOCUMENTATION:

VILSPA TN/2005 - 00/JB/790125 Release 12 file
TN/2006 - 00/JB/790605 Release 12B file
TN/2007 - 00/KN/800201 Release 12C file
TN/2008 - 00/KN/801230 Release 12D file
memo:

DESCRIPTION: <During this period almost all, if not all, data acquired at VILSPA was reduced using dispersion constant and reseau position calibrations dated 13 Nov. 1978 by GSFC. Data not reduced with these calibrations (if any) will have been reduced using a second "special" calibration optionally available to Guest Observers.

After 10 March 1981, the mean dispersion constants and reseau calibration described under configurations 55, 56, and 57 was installed for production use at VILSPA. (Since 30 Sept. 1980 they had been available as special calibrations).

The "special" calibration changed several times during this period. Relevant dates and cross references for the calibrations made available as "special" calibrations are:

i) Reseau files and high dispersion constants.

BEGIN 17:00 01 Feb. 1979 END 14:00 30 Sep. 1980

LWR - The 18 March 1978 calibration (refer to configuration (14.1))
SWP - The 23 May 1978 calibration (refer to configuration (34.1))
BEGIN 14:00 30 Sept. 1980 END 16:00 10 March 1981
The mean calibrations were available. (refer to configurations 55, 56)

ii) Low dispersion

BEGIN 17:00 01 Feb. 1979 END 18 Dec. 1979
LWR - The 18 March 1978 calibration (refer configuration (14.1))
SWP - The 23 May 1978 calibration (refer configuration (34.1))
BEGIN 18 Dec 1979 END 14:00 30 Sept. 1980
The preliminary mean low dispersion constants were available (configuration 57)
BEGIN 14:00 30 Sept. 1980 END 16:00 10 March 1981
The mean dispersion constants were available (refer to configuration No. 57)

iii) After 16:00 10 March 1981 the 13 Nov. 1978 calibration was installed as the "special" calibration>.

MEANS OF IDENTIFYING AFFECTED DATA:

Comparison of dispersion constants in label with the mean calibration values given in configuration descriptions 56, 57.

SECTION 3 - LIMITATIONS AND WARNINGS

Every attempt has been made to provide correct and complete information in this document. The degree to which such efforts have succeeded is not uniform, depending on a number of circumstances, most of which relate to the state of the available records used as sources. The limitations imposed by such shortcomings are discussed below.

3.1 UNAVAILABLE DATA

A certain fraction of the relevant data for this documentation effort is not presently available. Most often, such data pertain to the configuration start and end dates. In some cases, the exact hour of implementation was not recorded and so only the GMT date is provided. In other cases, even the day of implementation is not presently known. In such instances, the date fields are left blank.

3.2 UNCERTAIN DATA

Some of the data required for the complete description of each configuration are uncertain. Such situations can arise when the available documentation sources are sketchy or imprecise; such situations can also arise when the configuration is by nature too complicated for simple exposition in the format adopted here (an example would be the complete description of "special calibrations"--reseau-position and/or wavelength calibrations taken by the original Guest Observer for application to his own data).

In cases where dates are uncertain, exclamation marks are used to set them off. In cases where other specific information is uncertain, a "TBD" ("To Be Determined") entry is made. Some such entries might be resolved by further research with considerable additional effort; others may not be resolved at all. In general, the unresolved issues left because of conflicting or unclear data are of minor significance.

Those areas in which there is known particular uncertainty include:

1) Background-smoothing program SMOOTH during the first two months of operation. There is ambiguity as to which program versions incorporating which changes were used in production during this time period. (See Configuration number 1).

2) Special calibrations (particularly prior to March 1981). The details of what effect special calibrations have on data are difficult to quantify because of the varying purposes for which the calibrations were obtained and the varying circumstances under which they were applied. For example, some high dispersion special calibrations were executed using reseaux found on high dispersion Pt-Ne images, even after July 1978 (see Configuration number 15) in order to satisfy the needs of the particular Guest Observer. It is also difficult to tell which images were reduced under special calibrations without an image-by-image check of processing logs, since prior to March 1981 no information identifying the calibration files used was put into the labels of images.

3) LWR ripple correction parameters in use at VILSPA prior to 14 June 1978. There is ambiguity as to the values of the K and A parameters used in production from 17 April 1978 to 14 June 1978. (See Configuration number 17).

PART 2 - METHODS FOR IMPROVING PREVIOUS IUESIPS PRODUCTS,

B.E. Turnrose, C.A. Harvel, A.D. Mallama

ABSTRACT

This document presents a compilation of methods of correcting for the inhomogeneity of International Ultraviolet Explorer(IUE) reduced data products on tape. It is a companion volume to CSC/TM-81/6117, Techniques of Reduction of IUE Data: Time History of IUESIPS Configurations, which contains a detailed description of the evolution of the IUE Spectral Image Processing System (IUESIPS). The present document describes, wherever it is feasible to do so, the algorithms which may be applied to IUE data reduced under the various configurations catalogues in CSC/TM-81/6117 in order to bring older data up to current IUESIPS standards. It is expected that this information will be of particular utility to the designers and users of the IUE Regional Data Analysis Facilities.

This document is a reprint of CSC/TM-81/6136, issued in October 1981 under the same title.

SECTION 1 - INTRODUCTION

1.1 BACKGROUND

The International Ultraviolet Explorer (IUE) satellite has been in operation as a Guest Observer facility since April 3, 1978. The software system used by the IUE Observatory ground stations at GSFC and Villafranca del Castillo, Spain (VILSPA) to perform the standard IUE data reduction operations and generate the standard output products, the IUE Spectral Image Processing System (IUESIPS), has undergone a continual evolution since April 1978 in order to enhance the quality of the data processing and remove various software deficiencies and errors as they were discovered. As a result of the various changes made to IUESIPS, there is necessarily an inhomogeneity between data as it would be processed currently and the same data as it might have been processed at prior times. The document CSC/TM-81/6117, Techniques of Reduction of IUE Data: Time History of IUESIPS Configurations, describes in considerable detail this evolution of IUESIPS and its ramifications. Emphasis in that document is placed on allowing the Guest Observer or archive user to assess the inhomogeneity of IUE data reduced at diverse times at either ground station (GSFC or VILSPA) between April 3, 1978 and March 31, 1981; this is achieved by presenting detailed descriptions of the IUESIPS configurations in place at both ground stations during this period.

1.2 OBJECTIVES

The purpose of this document is to complement CSC/TM-81/6117 by providing instructions, in the form of explicit algorithms wherever possible, for correcting or enhancing previously-processed IUE data in order to bring those data up to the standards currently (April 1981) achieved by IUESIPS. The time history of IUESIPS configurations presented in CSC/TM-81/6117 provides the framework for the correction methodologies contained herein. The primary goal is to provide sufficient information to allow a programmer to implement corrective software which can be applied to reduced data products generated under each configuration discussed in CSC/TM-81/6117. A secondary but nearly as important goal is to identify those past configurations for which algorithmic corrections are either inappropriate or infeasible.

1.3 SCOPE

This document addresses each IUESIPS production configuration cataloged in CSC/TM-81/6117. As such, it relates to IUE data on magnetic tape processed between April 3, 1978 and March 31, 1981 at either ground station and obtained from either ground station as original Guest Observer data or from one of the various international data centers as archive data.

Because the primary goal of this document is to provide instructions to programmers for coding correction algorithms, as much explicitly detailed information as was deemed useful has been included in the discussion of the methods of upgrading data processed under each configuration. Such information takes the form of equations, detailed explanations, and cross references to easily available existing pertinent documentation wherever possible.

Those configurations for which it is not possible or advisable to define <u>ex post facto</u> corrections for extracted spectral data are so identified. In some instances, re-extraction of spectral data from the existing photometrically corrected image is the only suitable means of upgrading the data; in other instances, complete reprocessing from the raw-image stage is the only suitable means of correction. In such cases, our discussion is limited to a presentation of pertinent considerations and cautions (for example, array sizes, special requirements and the like) which would apply to any attempt to code and implement software to perform these large calculations.

Since such large-scale computational tasks are beyond the planned scope of the IUE Regional Data Analysis Facilities and most individual users' institutional facilities, this limitation is appropriate. Finally, certain instances in which corrections are not applicable are so identified.

SECTION 2 - CORRECTION METHODOLOGY

2.1 GENERAL CONSIDERATIONS AND OVERVIEW

The approach taken in this document is to simplify the user's task of applying corrective algorithms to previously reduced data by modularizing the presentation of those algorithms. In so doing we have isolated particular procedures or methods of general applicability and presented them once in Appendix A. Thereafter, in discussing specialized procedures unique to given IUESIPS configurations, the general-purpose methods are invoked, as needed, by reference to the Appendix. Such an approach eliminates much unnecessary repetition and streamlines the presentation.

Furthermore, emphasis is placed on algorithms by which extracted spectra may be made compatible with current data, since such algorithms are generally within the reach of modest computational facilities. Instances where the entire two-dimensional image data arrays (either raw or photometrically corrected) must be manipulated to correct a problem (as in complete reprocessing or spectral re-extraction), are, as mentioned in section 1.3, treated only in general terms. In section 2.2 an index is provided in tabular form to allow quick review of the recommended correction methods for each of the IUESIPS configurations addressed in CSC/TM-81/6117. Only those configurations identified in section 2.2 as having relevant algorithmic corrections or otherwise requiring special instructions are discussed in section 2.3.

Several general remarks are in order about assumptions that have been made regarding the use of the correction procedures presented in this document. It is first of all assumed that the user has familiarized himself with existing documentation on IUE data and data reduction techniques and has a reasonable knowledge of the major steps in the reduction of IUE data and their logical connection. Useful references in this regard are Perry and Turnrose (1977), Klinglesmith, Perry, and Turnrose (1979), Lindler (1979a,b), Turnrose and Harvel (1980), the series of articles on IUE Data Reduction in the NASA IUE Newsletter (see Appendix B), and of course the companion document to this volume, CSC/TM-81/6117.

In the actual correction procedures themselves, it is assumed that data read in from tape are already converted to real-number format and that conversion back to the scaled-integer tape format will be done when the data manipulations are completed; algorithm 12 of Appendix A addresses this format conversion but is not explicitly invoked in each correction procedure.

It is also to be understood that the user must decide which aspects of the general-purpose methods presented in Appendix A are pertinent to the application at hand. For example, if the smoothing algorithm (algorithm 7) is invoked, the user must determine whether to use a double running average filter or a median-plus-double-running-average filter, depending on the particular situation (namely the date of original processing and the user's wishes). In the same way, it should be understood that the corrections bulleted out in each configuration-unique procedure in section 2.3, by nature, do not necessarily lead to an output product equivalent to that produced by the current IUESIPS software, since the correction addresses a particular configuration only, and several further stages of correction may be necessary to reach current standards. That is, the configurations are in a sense cumulative and the corrections should be considered sequentially to arrive at current standards.

2.2 INDEX TO CONFIGURATION CORRECTIONS

Each of the IUESIPS configurations cataloged in CSC/TM-81/6117 is listed by number and title in Table 2-1, where the various

Table 2-1. INDEX TO CONFIGURATION CORRECTIONS

Number	Title	Alg.	Re-ext.	Repro.	N/A
1.	Corrupted data at the ends of smoothed background spectra (and hence net spectra).	X			
2.	Restricted low dispersion SWP wavelength coverage (λ1000-1900Å).		X		
3.	Erroneous negative fluxes in extracted spectra due to incorrect integer scaling of Fmax.	X			
4.	Non-optimal center and radius values for circle in which geometric correction is performed.			X	
5.	Suppression of redundant wavelengths in high dispersion processing.		X		
6.	Unrestricted RIPPLE correction at ends of orders in high dispersion.	X			
7.	Reversed naming convention for dispersion constants as written in IUESIPS history label.				X
8.	No processing dates written in IUESIPS history labels.				X
9.	One-pixel error in OSCRIBE (dispersion-constant overlay program).	X	X		
10.	Nearest-neighbor line-finding algorithm in WAVECAL.		X		
11.	Use of ITF's composed of single exposures.			X	
12.	Accomplish registration of spectral orders with dispersion-constant overlays by shifting the images (rather than the dispersion constants).		X		
13.	Extraction of low dispersion spectra using the programs SPIN, ROTATEH, and COMPARE.		X		
14.	Epsilon-field values in smoothed backgrounds shifted to incorrect wavelengths.	X	X		
14.1	Dispersion constant and reseau calibrations used for VILSPA reductions (1).	X	X	X	
14.2	Error in long wavelength high dispersion wavelengths.	X			
15.	Reseau flagging in low dispersion merged spectra does not distinguish between reseau mark in gross spectrum and reseau mark in background spectrum.	X	X		
16.	Geometric correction of high dispersion images accomplished using reseaux measured on high dispersion WAVECAL images.			X	

Table 2-1 continued

Number	Title	Alg.	Re-ext.	Repro.	N/A
17.	Use of non-optimal RIPPLE parameters for LWR.	X			
18.	Extract low dispersion spectra (EXTLOW) with HT=9 and DISTANCE=8.0 (Will not properly extract spectra of aperture-filling objects).	X	X		
19.	Image sequence number sometimes zeroed out in scale factor record of merged spectral file.	X			
20.	Determine LWR low dispersion wavelength calibrations from preliminary version of line library.				X
21.	Use of incorrect offsets from small to large aperture in LWR.	X			
21.1	Error in SWP low dispersion wavelength scale.	X			
22.	Perform all registrations of spectral orders with dispersion-constant overlays manually.		X		
23.	Camera number transmitted as true number plus 10 or 20 in scale factor record of merged spectral file.	X			
24.	Determine SWP low dispersion wavelength calibrations from preliminary version of line library.	X			
25.	Extract low dispersion large-aperture point-source spectra with DISTANCE=8.0.	X	X		
26.	Improper truncation of area of image photometrically corrected.			X	
27.	Automatic registration of spectral orders done using only 6 sampling areas in DSPCON.		X		
28.	Omit vacuum-to-air correction for LWR low-dispersion single-aperture reduction.	X			
29.	Photometrically correct entire 768 x 768 image (SWP high dispersion).				X
30.	Photometrically correct entire 768 x 768 image (low dispersion).				X
31.	No information on values of OMEGA, HBACK, or DISTANCE in IUESIPS history labels.				X
32.	No information on values of automatic registration shifts recorded in IUESIPS history labels.				X

Number	Title	Alg.	Re-ext.	Repro.	N/A
33.	Process order 65 in SWP high dispersion.				X
34.	Photometrically correct entire 768 x 768 image (LWR high dispersion).				X
34.1	Dispersion constant and reseau calibrations used for VILSPA reductions (2).	X	X	X	
34.2	Dispersion constant and reseau calibration used for VILSPA reductions (3).	X		X	
35.	Use incorrect version of ETOEM.		X		
36.	High dispersion partial processing on S/360 (VICAR).				X
37.	Use original IUESIPS File Management System.				X
38.	No information on values of manual registration shifts recorded in IUESIPS history label.				X
39.	No output products generated for images designated "Do Not Process".				X
40.	Improperly convert certain spectral files with negative fluxes to GO-tape integer format.	X	X		
41.	All high dispersion extractions done with HT=5.		X		
42.	Write redundant raw-image tape files for wavelength calibration images.				X
43.	No short header file written at beginning of GO tape.				X
44.	Use of SWP ITF with incorrect 20% exposure level.	X		X	
45.	Use of non-optimal pixel offsets from small to large aperture.	X			
46.	Use of pixel offsets from small to large aperture which do not correspond to physical center of large aperture.				X
47.	Write geometrically-correct-image tape file for wavelength calibration images.				X
48.	Use biweekly dispersion-constant calibrations in low dispersion.	X			
49.	Determine high dispersion wavelength calibrations from unrefined line libraries (version I Libraries).				X
50.	Do not provide absolutely calibrated net spectrum in low dispersion.	X			
51.	Truncation of ITF at upper limit.			X	

Number	Title	Alg.	Re-ext.	Repro.	N/A
52.	Incorrect units for DISTANCE parameter in EXTLOW.	X	X		
53.	Use original Astron. Astrophys. absolute calibration.	X			
54.	Determine high dispersion wavelength calibrations from partially refined line libraries (version II libraries).				X
55.	Use biweekly reseau calibrations.			X	
56.	Use biweekly dispersion constant calibrations in high dispersion.		X		
57.	Use preliminary mean dispersion constants for low dispersion.	X			
58.	Inaccurate automatic registration programs.	X	X		
59.	Determine high dispersion wavelength calibrations from further refinements to line libraries (version III libraries).				X
59.1	Incorrectly transmit 5-digit image sequence numbers to scale-factor record of extracted spectral files.	X			
60.	Processing of low dispersion spectra using the programs GEOM, FICOR, and EXTLOW.	X		X	
61.	Non-perpendicular manual shifts (REGISTER).	X			
62.	Label lacks scheme name and auto/manual message.				X
63.	Incorrect manual shift for SWP images (REG).	X			
64.	VBBLK without label processing.	X			
65.	Incorrect entries in label by SPECLO (negative declination and zero shift).	X			
66.	Inaccurate automatic registration (LWR-LOW, SWP-HIGH and all Trailed)		X		
67.	Calibration files without temperature corrections (low dispersion).	X	X	X	
68.	Use of preliminary parameters to specify the region to be processed by the program PHOTOM.			X	
69.	Use positional information to determine the bounds of the area to be extracted (SPECLO).				X
70.	Unused lines of header label not blank-filled by POSTLO.				X
71.	Dispersion constant and reseau calibrations used for VILSPA reductions (4).	X	X	X	

applicable approaches to correcting each configuration are indicated by an "X" in one or more of the appropriate columns headed "Alg.", "Re-ext.", "Repro.", and "N/A". A mark in the "Alg." column indicates that an algorithm has been defined to correct the extracted spectral data and is included in section 2.3. A mark in the "Re-ext." column indicates that re-extraction of spectral data from the photometrically corrected image is required and that the user is referred to algorithm 2 of Appendix A for further information. A mark in the "Repro." column indicates that complete reprocessing of the image from its raw form is required and that the user is referred to algorithm 1 of Appendix A. A mark in the "N/A" column indicates that a correction procedure is not applicable for the particular configuration so marked.

Note that it is possible for a configuration to carry a mark in more than one column of Table 2-1, which means either that two alternative approaches to the correction have been identified or that certain aspects of the data can be corrected in one manner while other aspects require a different method. In such instances, further explanation is provided in Section 2.3. Note again that only those configurations marked in the "Alg." column of Table 2-1, or those for which special instructions for re-extraction/reprocessing are required, are addressed in section 2.3.

2.3 CORRECTION PROCEDURES

2.3.1 General-Purpose Procedures

A total of 14 general-purpose data manipulation/correction methods have been defined. These methods are outlined by number and title in Table 2-2 and represent procedures which must be invoked by many of the individual configuration-unique correction procedures to be presented in section 2.3.2. Because of their general and repeated usage, these procedures are presented separately in Appendix A and simply cross-referenced elsewhere in the document by number as necessary.

Table 2-2 General-Purpose Correction Procedures

Algorithm Number	Title
1	Complete reprocessing
2	Spectral extraction from photometrically corrected image
3	Pseudo-slit extractions from line-by-line spectra
4	Wavelength assignments via dispersion constants
5	Low-dispersion wavelength corrections
6	Wavelength corrections for zero-point shifts
7	Background smoothing
8	Ripple correction
9	Vacuum-to-air wavelength correction
10	Absolute calibration
11	Scaling fluxes and wavelengths from integer to real format and vice versa
12	Updating scale-factor record of extracted spectra
13	Updating IUESIPS history labels
14	Reading THDA values from IUESIPS label

2.3.2 Configuration - Unique Procedures

In this section the correction procedures for each of the configurations marked in the "Alg." column of Table 2-1 are presented. Additionally, in this section are included entries for configurations whose correction procedures require special instructions or information prior to re-extraction or reprocessing, even though a true algorithmic correction method has not been identified in Table 2-1.

Attempts have been made to keep the description of these procedures as concise as possible, and so certain "understood" procedures such as integer-to-real-number and real-number-to-integer conversion are not invoked explicitly (see section 2.1). References to any of the general-purpose algorithms mentioned in section 2.3.1 and detailed in Appendix A are made by algorithm number.

The user is reminded that the application of the steps comprising any one of these procedures may not by themselves yield outputs equivalent to those produced by the current IUESIPS. Instead, the resulting data may represent an intermediate stage, inasmuch as the corrections effected refer to a particular system configuration. Several successive corrections may be required, depending on the circumstances, to reach current output standards. We have attempted to provide the user with the necessary tools and information to perform each correction and have left it up to each user to decide when corrections should be combined, concatenated serially, or just considered individually, according to that user's own needs.

As an aid to the user, the configurations listed in Table 2-1 have been categorized by generic tape in Table 2-3. With this cross reference, the user may more easily decide which configurations (and hence corrections) concern various major aspects of the data. In certain cases, configurations are listed under more than one topic when it was felt important to highlight more than a single aspect. Table 2-3 should also assist users in identifying the cumulative or serial nature of the configurations.

Table 2-3 Cross-Reference of Configurations by Major Topic

	Topic	Configuration Numbers
1.	Absolute calibration	50,53
2.	Dispersion constants/reseaux (i.e., wavelengths and geometric correction)	10,14.1,14.2,16,20,21,21.1,24,34.1, 34.2,45,46,48,49,54,55,56,57, 59,67,71
3.	Extraction slit geometry	13,18,25,52,60 (low dispersion) 41 (high dispersion)
4.	Integer flux scaling on tape	3,35,40
5.	Intensity Transfer Functions (ITF)	11,44,51
6.	Label/scale record	7,8,19,23,31,32,36,38,59.1,62, 64,65,70
7.	Registration of spectral orders	9,12,22,27,32,38,58,61,63,66
8.	Ripple correction	6,17
9.	Other	1,2,4,5,14,15,26,28,29,30,33,34, 36,37,39,42,43,47,68,69

<u>TITLE</u>: Corrupted data of the ends of smoothed background spectra (and hence net spectra).

Since the unsmoothed background and the gross spectra are available in the merged file of the GO tape, net spectra produced during this period can be replaced by the correct net spectra using the following procedure:

- Apply the smoothing algorithm (No. 7) to the unsmoothed background (double-pass mean filter).
- Subtract the smoothed background from the gross to produce the net.
- Note that for high dispersion data a correction must be made for the echelle blaze (see algorithm 8). The earliest version of this ripple correction was used during this period (see configuration number 6 in CSC/TM-81/6117).
- Update the scale factor record (see algorithm 12).

TITLE: Erroneous negative fluxes in extracted spectra due to incorrect integer scaling of F_{max}

In general, only a small number of points in any spectrum should be affected by this error. The affected points can be easily identified since they will appear as large negative values in a part of the spectrum where most of the fluxes are large positive values. The alternative courses of action possible are:

A. • Display the extracted files and check for large negative values as described above (an automatic program could be used to make this check). If erroneous large negative fluxes are found they should be corrected by adding 65535 ($=2^{16}-1$). If the user is limited to 16-bit signed integers, such corrected fluxes could be limited to +32767 with little error.

B. • Using the procedure above it is possible that a correct flux that was large and negative might be interpreted incorrectly. To avoid this very unlikely situation re-extract the spectrum from the photometrically corrected image (see algorithm 2).

TITLE: Unrestricted RIPPLE correction at ends of orders in high dispersion.

The ripple-corrected net spectra produced during this period had a very large correction factor applied to the end of the order (a region with little or no data) resulting in the amplification of noise (when plotted, the spectra look very messy).

- To correct this use restricted ripple correction algorithm 8.

TITLE: One-pixel error in OSCRIBE (dispersion-constant over-lay program).

The effects on assigned wavelength caused by this error are small ($\leq$ 0.7 pixel along dispersion) but variable in detail, depending on the direction in which the registration shift was applied by the processing operator. The flux error caused will be greatest for high dispersion at shorter wavelengths where the orders are close together.

- In order to correct the flux error induced by this configuration, in general the spectrum must be re-extracted from the geometrically and photometrically corrected image (see algorithm 2).
- The best approach would be for the user to start from the mean dispersion constants (see CSC/TM-81/6117, configuration numbers 56 and 57), determine any necessary registration shifts, and then use the shifted dispersion constants for the re-extraction. This method will also correct any wavelength errors.
- If the user does not have a method of determining the necessary registration shifts required by the approach given above the spectrum can be re-extracted using a modified version of the dispersion relations used for the original extraction. The original extraction was made with a set of dispersion constants defining a line parallel to the spectral order but displaced from it by one pixel in the sample direction. The change needed in the dispersion relation to make it properly overlay the spectrum could be made by incrementing the sample-direction zero-point term in the dispersion relation by +1.0 (this will move the dispersion line toward the right on a photowrite); however, since the registration shift applied by the processing operator

is unknown (e.g.; it is also possible to register the spectrum and dispersion relation by changing the line-direction zero-point term) the wavelengths derived will still be in error.

A somewhat better approach would be to modify both the line and sample zero point terms such that the required registration shift is in a direction perpendicular to the spectrum (see algorithm 6 for the information needed to do this). The wavelengths obtained in this case will probably still be incorrect but on the average the error will be less than for a sample-direction-only correction.

TITLE: Accomplish registration of spectral orders with dispersion-constant overlays by shifting the images (rather than the dispersion constants).

The geometrically and photometrically corrected image (GPI) given on the GO tape has been shifted for extraction registration (this caused errors in reseaux flagging and allowed only integer pixel shifts). In order to correct these problems the following procedure should be followed:

- Shift the GPI back to its nominal position (the amount to shift it can be determined by noting the number of rows and columns of zeroes at the image margin).
- Re-extract the data from the GPI file using suitable dispersion constants (see algorithm 2).

TITLE: Epsilon-field values in smoothed background shifted to incorrect wavelengths.

It is possible to correct for this error in both high and low dispersion by using the procedures given below.

- High dispersion. (1) Using the dispersion relations given in algorithm 4 determine the position (sample and line) of each of the reseaux flagged wavelengths in the merged file (given the wavelength assigned to a pixel, the dispersion relations will provide the sample and line position of that pixel); (2) compare the position found with all the possible positions of reseaux; (3) if there is not a reseau within seven pixels of the position found in (1) above, the wavelength was flagged erroneously and the flagging should be removed. Any flagged wavelength that does lie within seven pixels of a reseau was correctly flagged. For information on the positions of the reseaux for the SWP and LWR camera see algorithm 2.

- For low dispersion re-extract the data from the line-by-line file as per algorithm 3.

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (1)

The effects of using the reseau-displacement file adopted by VILSPA during this period depend on the details of the particular calibration image used to generate those displacements. Although it is likely that all ill effects resulting from the displacements are small, some problems of the sort described in Configuration number 16 of CSC/TM-81/6117 may be encountered, in which case the safest and most complete procedure would be to reprocess the images in question using the mean reseau positions, for example (Configuration number 55), to define the geometric correction step.

For high dispersion images, the effects of using a given set of dispersion constants may be removed by re-extracting the spectrum from the geometrically and photometrically corrected image, using the mean dispersion relations (see Configuration number 56 of CSC/TM-81/6117).

For low dispersion images, the only significant effect of using the old dispersion constants is a possible wavelength error. The assigned wavelengths in the merged file of the GO tape can be corrected by applying the generalized correction algorithm (Algorithm 5). In this case, the primed (original) dispersion constants are those found in the processing label, and the desired (new) dispersion constants may be logically taken to be the mean relations described in Configuration number 57 of CSC/TM-81/6117).

TITLE: Error in long wavelength high dispersion wavelengths

Since the error is that the vacuum-to-air correction was applied twice, a single air-to-vacuum correction should be applied by restating the equations provided in algorithm 9. By rewriting equation (A-15),

$$\lambda_{vac} = \lambda_{air} * f(\lambda_{vac})$$

where the function $f(\lambda)$ is defined by equation (A-16) in algorithm 9. It is sufficiently accurate here (to within ~0.0001 Å in final answer) to evaluate the function $f(\lambda_{vac})$ as $f(\lambda_{air})$, so that

$$\lambda_{corrected}\ (\text{Å}) = \lambda_{tape}\ (\text{Å}) * f(\lambda_{tape}).$$

TITLE: **Reseau flagging in low dispersion merged spectra does not distinguish between reseau mark in gross spectrum and reseau mark in background spectrum.**

The line-by-line (spatially resolved) file contains the information needed to distinguish between the two types of reseau.

- Re-extract the spectrum from the line-by-line file as per algorithm 3.

TITLE: Use of non-optimal RIPPLE parameters for LWR

Since the net spectrum before ripple correction is available in the merged file of the Guest Observer tape it is possible to completely correct for this error.

- Apply the technique of algorithm 8 to the Net spectrum of the GO tape merged file using the following ripple parameters: K = 231,150 and A = 0.09.

TITLE: Extract low dispersion spectra (EXTLOW) with HT=9 and DISTANCE=8.0 (will not properly extract spectra of aperture-filling objects)

Depending on the accuracy desired the user has two options for the correction of data extracted during this period:

- Complete correction. Re-extract the data as per algorithm 2. For the extraction use the best available dispersion constants (generally the mean values - see configurations No. 56 and 57), and set HT = 15 and DISTANCE = 11.0 (see configuration No. 52 for units of DISTANCE parameter).
- Very accurate approximate solution. Extract data from the line-by-line (spatially resolved) file as per algorithm 3. Note that algorithm 3 also corrects for the error described in configuration No. 52.

No. 19

TITLE: Image sequence number sometimes zeroed out in scale factor record of merged spectral file

- If the image number in bytes 13 and 14 of the scale factor record (the first record of the merged file) is zero read the correct number from bytes 53-56 of the first line of the raw image file (see Turnrose, B.E., and Harvel, C.A., 1980 for information on formats for image labels and the scale factor record).

TITLE: Use of incorrect offsets from small to large aperture in LWR.

Since the vector between the incorrect and the correct offset positions lies chiefly along the high dispersion orders (it is therefore almost perpendicular to the low dispersion order) this is primarily a high dispersion problem. The only errors are wavelength errors.

- High dispersion. Red shift all high dispersion wavelengths by 48.6 km/sec; that is,

  $$\lambda_{correct} = (1.000162)\ \lambda_{incorrect}$$

- Low dispersion. The errors involved are not significant (~ 1 Å).

- Alternatively, the formalism of algorithm 6 may be used to derive the precise parallel and perpendicular components of the difference between the correct and the incorrect small-to-large aperture offsets in either dispersion mode. From CSC/TM-81/6117 (configuration 21) it is seen that the line and sample components of the difference between the offsets to be entered in algorithm 6 are:

  $$\Delta L = 19.5 - 25.1 = -5.6$$
  $$\Delta S = -17.5 + 21.1 = 3.6$$

  The parallel component $\Delta \|$ from algorithm 6 is then related directly to the wavelength or velocity error incurred.

TITLE: Error in SWP low dispersion wavelength scale

The wavelength in the merged file of the GO tape can be corrected by one of the two alternative methods below. The first is a general method (see also configuration No. 24) and the second has been empirically derived by VILSPA specifically for this error.

A. • Obtain the incorrect dispersion constants used for the extraction from the processing label and use these and a set of good dispersion constants (the means would be the best--see configuration number 57) as input to the low dispersion wavelength correction algorithm (algorithm 5).

B. • Correct the wavelengths λ_{tape} obtained from the GO tape by the VILSPA formula:

$$\lambda_{corrected}\ (A^{o}) = (1.0158 \pm 0.0002) * \lambda_{tape}\ (\text{Å}) - 20.00$$

Note that the correction formula published in ESA IUE Newsletter No. 3, p. 6, has an incorrect sign for the -20.00 term.

TITLE: Camera number transmitted as true number plus 10 or 20 in scale factor record of merged spectral file.

For images extracted during this period use the following procedure.

- Read camera number from scale factor record (see Turnrose, B.E., and Harvel, C.A., 1980 for information on image labels and scale factor record) and set it equal to CAM. Then use this FORTRAN procedure:

```
 99 IF (CAM.LE.4)  GO TO 100
    CAM = CAM -10
    GO TO 99
100 CONTINUE
```

When this section of code is completed the value of CAM will be the correct camera number.

TITLE: Determine SWP low dispersion wavelength calibrations from preliminary version of line library.

The wavelengths in the merged file of the GO tape can be corrected by the following procedure:

- Obtain the incorrect dispersion constants used for the extraction from the processing label and use these and a set of good dispersion constants (the means would be the best - see configurations No. 56 and 57) as input to the low dispersion wavelength correction algorithm (algorithm 5).

TITLE: Extract low dispersion large-aperture point-source spectra with DISTANCE = 8.0

Depending on the accuracy desired the user has two options for correction of data extracted during this period:

- Complete correction. Re-extract the data as per algorithm 2. For the extraction use the best available dispersion constants (generally the means--see configurations No. 56 and 57) and set DISTANCE = 11.0 (see configuration No. 52 for units of DISTANCE parameter).
- Very accurate approximate solution. Extract data from the line-by-line (spatially resolved) file as per algorithm 3. Note that algorithm 3 also corrects for the error described in configuration No. 52.

TITLE: Omit vacuum-to-air correction for LWR low-dispersion single-aperture reduction.

To correct data reduced during this period proceed as follows:

- Check the wavelengths in the extracted spectrum for a 0.65 Å discontinuity at 2000 Å; if such a discontinuity is found the data do not need to be corrected.
- If the discontinuity is not there correct the data as per algorithm 9.

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (2).

Same as configuration No. 14.1.

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (3).

Same as configuration No. 14.1, with the exception of the discussion of high dispersion re-extraction, which is not relevant to low dispersion.

TITLE: Improperly convert certain spectral files with negative fluxes to GO-tape integer format

This problem principally affects background spectra extracted from images with low null levels (see CSC/TM-81/6117). In such cases, as long as the gross and net spectra are not also affected, a new smoothed background can be obtained by subtracting the net spectrum from the gross spectrum. If the gross and/or net spectra are also affected, or if the unsmoothed background is required, then re-extraction from the photometrically corrected image is necessary. The alternative courses of action are thus:

A.
- Display gross and net spectra from merged file and verify that fluxes behave as expected--i.e., that these spectra are not affected by this problem.
- Subtract net spectrum from the gross spectrum, point-by-point, to obtain the smoothed background spectrum.

B.
- Re-extract spectra from the photometrically corrected image (see algorithm 2).

No. 44

<u>TITLE</u>: Use of SWP ITF with incorrect 20% exposure level

The problem is addressed in two ways, depending on the dispersion mode of the images affected. Whereas for low dispersion, suitable correction techniques have been published and used successfully, for high dispersion a complete reprocessing is required.

A. Low Dispersion

- Apply the correction algorithm SWPFIX (Cassatella *et al*, 1980) or an alternative (Holm and Schiffer, 1980). These methods work on the extracted spectra (line-by-line or merged).

B. High Dispersion

- Reprocess the image from its raw form (see algorithm 1)

TITLE: Use of non-optimal pixel offsets from small to large aperture

The most important effect of using pixel offsets to the large aperture which do not correspond exactly to the point at which objects were normally placed in the aperture is that the assigned wavelengths will be slightly in error, as described in CSC/TM-81/6117. Any component of misplacement perpendicular to the dispersion direction would have already been compensated in the registration procedure done prior to the spectral extraction. The steps to be taken to correct the error are as follows:

A.

- In low dispersion,

$$\lambda_{correct} = \lambda_{old} + \Delta\lambda$$

where $\Delta\lambda = \begin{cases} -0.23\text{Å} & \text{in SWP} \\ +1.76\text{Å} & \text{in LWR} \end{cases}$

- In high dispersion,

$$\text{velocity}_{correct} = \text{velocity}_{old} + \Delta v$$

where $\Delta v = \begin{cases} -0.13 \text{ km s}^{-1} & \text{in SWP} \\ -11.8 \text{ km s}^{-1} & \text{in LWR} \end{cases}$

Here, velocity is the radial velocity assigned to a spectral feature based on a comparison of its observed wavelength to its rest wavelength, in km s^{-1}. The use of velocity, rather than wavelength, is convenient in high dispersion where a constant-pixel offset corresponds to a constant-velocity offset (rather than a constant-wavelength offset as in low dispersion).

Wavelength offsets are related to velocity offsets by

$$\Delta\lambda = \frac{\lambda \ \Delta v}{C}$$

where C = speed of light = 3×10^5 km s^{-1}. The offset values presented here are taken from "IUE Data Reduction V."

B.

- Alternatively, the formalism of algorithm 6 may be used to derive from scratch the parallel and perpendicular components of the difference between the correct and the incorrect small-to-large aperture offsets. The parallel component is then converted to wavelengths or velocities as further described in algorithm 6, yielding the same offset values as were presented in method A above.

TITLE: Use biweekly dispersion-constant calibrations in low dispersion

As is the case for configuration number 45, the most important effects in this situation are those relating to the assignment of wavelengths, since the effects of differing dispersion relations are already removed by the spectral registration step in the direction perpendicular to the dispersion. To change the low dispersion wavelengths to those corresponding to the mean dispersion relations, proceed in the following way:

- Apply the wavelength correction as described in algorithm 5, where the original dispersion relations are those used to do the spectral extraction and written in the IUESIPS image label (with registration shifts included), and the new dispersion relations are the mean values listed in CSC/TM-81/6117 under this configuration number. Note that for large-aperture data, the appropriate zero-point offsets to the large aperture (see CSC/TM-81/6117 configurations number 45 and 46) should be added to the mean values.

TITLE: Do not provide absolutely calibrated net spectrum in low dispersion

- Use algorithm 10 to apply absolute calibration to net spectrum. Note that on IUE output tapes, all extracted spectra are in time-integrated form, including the ABNET spectra provided after IUESIPS configuration number 50.

TITLE: Incorrect units for DISTANCE parameter in EXTLOW

Inasmuch as the line-by-line spectra produced by EXTLOW were unaffected by this problem (which pertained to the merged file of slit-integrated spectra), an adequate correction may be obtained by utilizing the line-by-line data. Thus two alternative methods of correction may be used:

A.
- Use line-by-line file ESSR (see Turnrose and Harvel, 1980) to emulate merged spectral data with background sampled at proper distance from dispersion line (see algorithm 3).

B.
- Re-extract background spectrum from photometrically corrected image at proper distance from order to redefine a corrected merged spectral file (see algorithm 2).

TITLE: Use original *Astron. Astrophysics* absolute calibration

- Use algorithm 10 to apply improved absolute calibration to net spectrum. Note that on IUE output tapes, all extracted spectra are in time-integrated form, including the ABNET spectra provided by IUESIPS.

TITLE: Use preliminary mean dispersion constants for low dispersion

Since the refined mean dispersion constants differed from the preliminary constants chiefly in the zero-point term, a reasonable correction to the extracted wavelengths may be obtained by considering the parallel component of the zero-point shift above. Alternatively, the small variation in scale may be considered explicitly. Note that in either case, only the effects of the changed dispersion relations on wavelength are relevant, since effects in the direction perpendicular to the dispersion would have already been removed by the spectral registration procedure.

A. • Ignoring the small difference in scale terms (A_2 and B_2) between the preliminary and refined dispersion constants, define ΔL and ΔS offsets as

$$\Delta L = B_1' - B_1$$

$$\Delta S = A_1' - A_1$$

where the primed quantities are the new zero-point terms (see CSC/TM-81/6117), and the unprimed quantities are the zero-point terms actually used in the extraction process (obtained from IUESIPS label). Use algorithm 6 to calculate the corresponding $\Delta ||$ and wavelength correction. Note that for large-aperture data, the appropriate small-to-large aperture offsets must be added to the new means used.

B. • Apply the full wavelength correction procedure in algorithm 5. Here, the new dispersion constants are the new mean values (with offset to large aperture added, if applicable) and the old dispersion constants are the actual values taken from the IUESIPS label, including registration shifts.

TITLE: Inaccurate automatic registration programs

Two types of correction may be made for this problem, corresponding to the two types of error introduced. A wavelength error caused by the slight non-perpendicularity of the applied registration shifts is correctable by an algorithm, whereas a flux error caused by the overall shift-magnitude error requires re-extraction.

A. • If the registration shift values are available from the IUESIPS label, correct the applied shifts by the amounts and in the sense shown in the discussion of configuration 58 in CSC/TM-81/6117.

• Then define ΔL and ΔS as the differences between the corrected and uncorrected line and sample shifts, respectively, and use algorithm 6 to calculate the corresponding $\Delta||$ and wavelength or velocity correction. This method provides no flux corrections.

B. • If the registration shifts are not written in the IUESIPS label, in low dispersion a reasonable alternative is to correct the assigned wavelengths with algorithm 5, using the mean dispersion constants as the "new" constants and the actual dispersion constants in the label (which include the unknown shifts) as the "original" constants. In high dispersion such an alternative is not defined.

C. • Provided that corrected dispersion relations are available (see A above), re-extract the spectrum from the photometrically corrected image (see algorithm 2). This method corrects both the wavelengths and the extracted fluxes.

No. 59.1

TITLE: Incorrectly transmit 5-digit image sequence numbers to scale-factor record of extracted spectral files.

Inasmuch as the problem for the affected SWP images is simply that the image number in binary integer format in bytes 13-14 of the scale-factor record (first record after IUESIPS label) is too small by 10,000, complete correction may be obtained by decoding the halfword integer, adding 10,000, and recoding the result to binary halfword integer form and storing in the scale-factor record.

TITLE: Processing of low dispersion spectra using the programs GEOM, FICOR, and EXTLOW

In general, the benefits and file formats of the new low dispersion data processing software which replaced the programs named above are attainable either exclusively or most conveniently by complete reprocessing (algorithm 1). One aspect of the new software, however, the increased sampling frequency and number of extracted points per order, may be emulated algorithmically as follows, although this technique has not actually been tried on IUE data.

- Interpolate the existing spectral samples with a suitable interpolation function such as the sinc function described by Lorre (1978). Applying Lorre's method to the one-dimensional case at hand, obtain

$$I(X) = \sum_{i=X-\Delta}^{X+\Delta} I(i) \frac{\sin(X-i)\pi}{(X-i)\pi}$$

where $I(X)$ is the interpolated intensity at intermediate wavelength location X, $I(i)$ is the sampled intensity at the ith wavelength, and Δ is the half-width of the interpolation filter. Note that the values of i at the summation limits are rounded to integer values. The sampling frequency of the new software may be emulated by choosing an X midway between every i (that is, nominal sampling interval $\sqrt{2}/2$ pixels instead of $\sqrt{2}$). Note that this is only an approximate procedure because the original sampling interval is not uniform. The user is referred to Pratt (1978) for further details and considerations relating to this and other possible interpolation techniques, including the choice of Δ.

TITLE: Non-perpendicular manual shifts (REGISTER)

The correction for non-perpendicularity of shifts here cannot be treated as exactly as in configuration number 58 since the applied shifts are manually determined and hence not exactly reproducible. However, straightforward procedures may be defined to correct wavelengths for the error which might have been introduced in the shifting process.

A.

- If the registration shifts ΔL and ΔS are available from the IUESIPS label, use algorithm 6 to calculate the corresponding parallel and perpendicular shifts, $\Delta||$ and $\Delta\perp$. If $\Delta||$ is non-zero, use it to compute the corresponding wavelength or velocity correction as in algorithm 6. All $\Delta||$ is zero, no correction is necessary.

B.

- If the registration shifts are not written in the IUESIPS label, just as in configuration number 58 a reasonable alternative in low dispersion is to correct the assigned wavelengths with algorithm 5 using the mean and the original dispersion constants. In high dispersion a similar alternative is not defined.

<u>TITLE</u>: Incorrect manual shift for SWP images (REG).

The correction for non-perpendicularity of shifts is the same as that discussed for configuration number 61.

TITLE: VBBLK without label processing

- Change the starting line (SL) and starting sample (SS) values in first record of IUESIPS image label from 0895 to 0001. See Turnrose and Harvel (1980) for label format details.

TITLE: Incorrect entries in label by SPECLO (negative declination and zero shift)

- For objects with negative declination, change sign of declination in the line of IUESIPS image label which reads "TARGET COORD. (1950):" . Declination should be correct already in line 37 of label (see Turnrose and Harvel, 1980, p. 8-15).
- For images in which the IUESIPS label reads "LINE SHIFT=YY.YYY SAMPLE SHIFT=XX.XXX", change YY.YYY and XX.XXX to 0.0

<u>TITLE</u>: Calibration files without temperature corrections (low dispersion)

In order to correct for the thermal motion of reseau marks, it is necessary to reprocess the image from its raw form (see algorithm 1). The correction of wavelengths for thermal and temporal spectral format motion, however, may be accomplished algorithmically or by re-extraction (algorithm 2). The algorithmic correction procedure is described below.

- Read the day and year (IDAY and IYR) of approximate image READ from the image label as discussed in algorithm 14, and calculate the elapsed GMT day number since 31 December 1977 (ignoring leap years) as

  LGMT = IDAY + (IYR-78) * 365.

  An alternative approach is to calculate this day number from data on the handwritten observing script.

- Read the camera head amplifier temperature (THDA) at the end of the exposure from the image label using algorithm 14, if the image was acquired after March 1979. An alternative source of the THDA is the handwritten observing script.

- Use the dispersion constants given in the IUESIPS image label to calculate the line and sample positions (L,S) corresponding to the arbitrary fiducial wavelength 1500 Å in SWP or 2600 Å in LWR. (see algorithm 4).

- Refer to Figure 2-1 for SWP and Figure 2-2 for LWR. These figures show the loci of pixel addresses, in the line and sample number plane, of the fiducial wavelengths 1500 Å (SWP) and 2600 Å (LWR), <u>in the small</u>

aperture, as functions of both time and THDA. The trajectories for constant time and constant temperature were constructed on the basis of the time and temperature correlation studies used to correct for spectral format motion in current production processing (see "IUE Data Reduction XXI"). By interpolating between the two types of loci drawn in the figures, the user may determine the predicted small-aperture line and sample coordinates (L_o, S_o) of the fiducial wavelengths at any relevant given time and temperature. Whereas these coordinates represent the best-guess temperature/time corrected positions, the coordinates (L,S) calculated above from the dispersion relations in the image label represent the uncorrected positions used in the wavelength assignment process during the spectral extraction. The difference between these positions can thus be used as shown below to infer and correct possible wavelength errors in the extracted spectrum.

- If spectra in question are in the large aperture, add the appropriate line and sample offsets to the (L_o, S_o) values interpolated from Figure 2-1 or 2-2 (see CSC/TM-81/6117, configurations number 45 and 46) to obtain (Lc, Sc).
- Define $\Delta L = L_c - L$
  $\Delta S = S_c - S$
- Use algorithm 6 to calculate the parallel shift $\Delta||$ and the resulting wavelength correction corresponding to ΔL and ΔS. This effectively reduces the wavelength scale to the temperature/time corrected system.

TITLE: Dispersion constant and reseau calibrations used for VILSPA reductions (4).

Same as configuration No. 14.1.

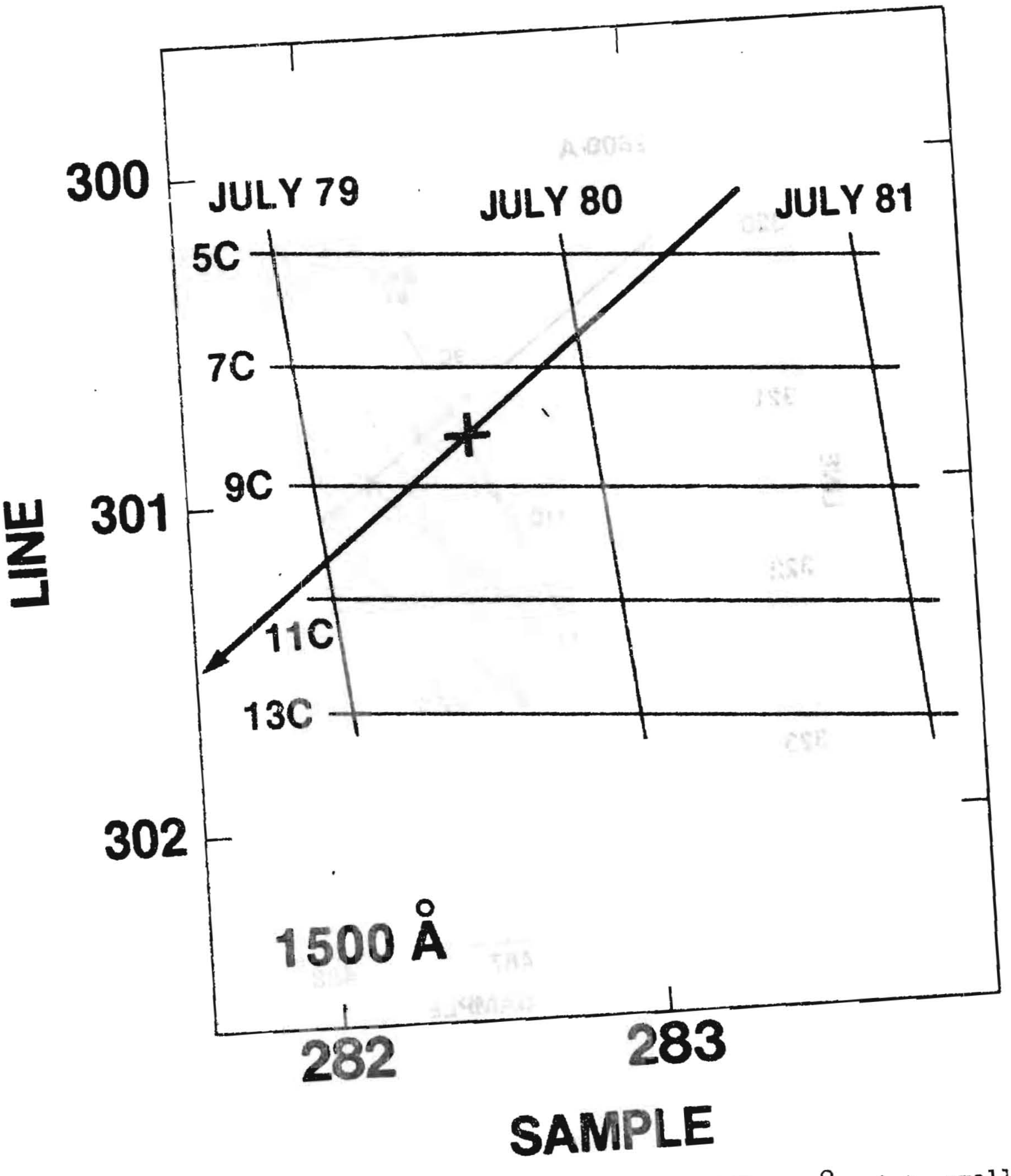


Figure 2-1 Loci of predicted trajectories of λ = 1500 Å point, small aperture, for various times (month and year marked) and THDA (degrees Celsius marked) in SWP low dispersion. Shown as a "+" is the position corresponding to the current mean dispersion relations; the direction of dispersion is also plotted as a vector passing through the mean point. Prepared by R.W. Thompson.

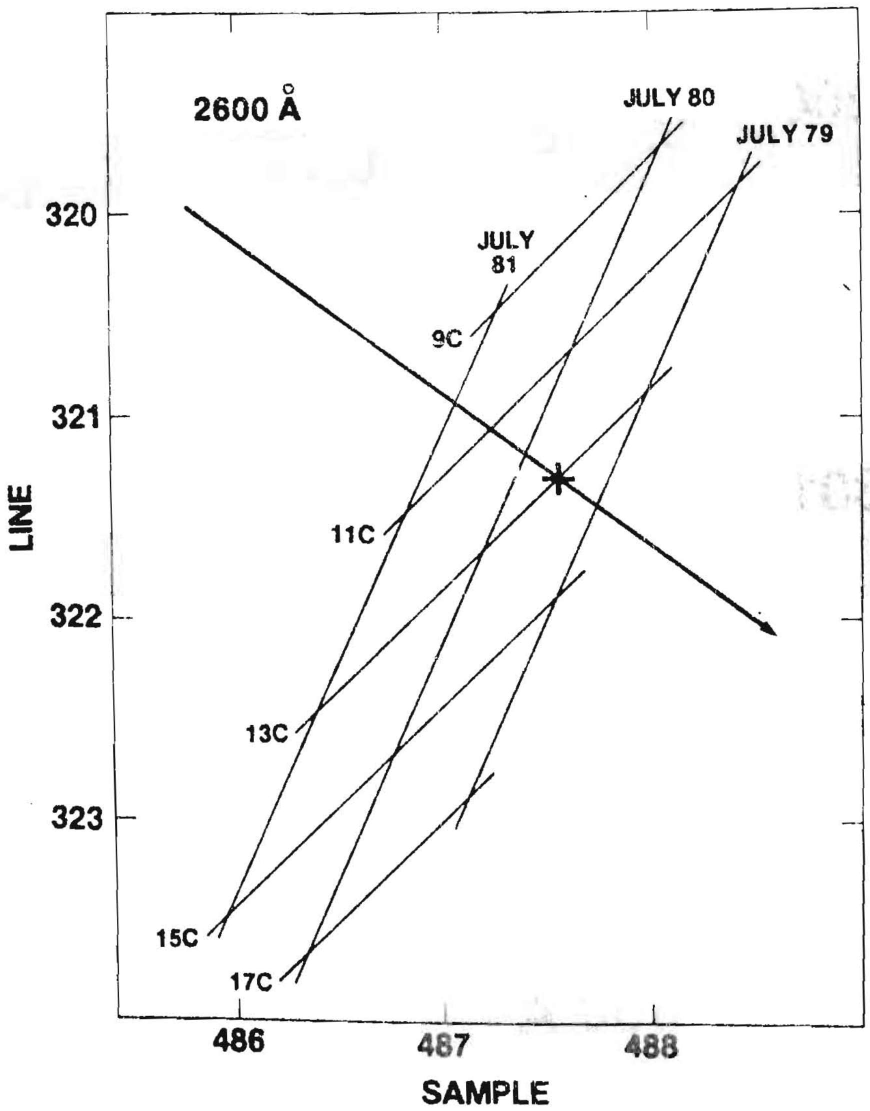


Figure 2-2 Loci of predicted trajectories of λ = 2600 Å point, small aperture, for various times (month and year marked) and THDA (degrees Celsius marked) in LWR low dispersion. Shown as a "+" is the position corresponding to the current mean dispersion relations; the direction of dispersion is also plotted as a vector passing through the mean point. Prepared by R.W. Thompson.

APPENDIX A

GENERAL - PURPOSE METHODS

Algorithm 1 - Complete reprocessing:

The requirements associated with the complete reprocessing of an IUE image are extensive. In this context, the reprocessing of an image is defined to be the sum of all calculational steps necessary to produce an extracted spectrum, starting from the raw 768 x 768 image. The many separate steps which constitute the processing, from dealing with the geometric distortion, correcting for the camera non-linearities and non-uniformities (photometric correction), applying dispersion relations, extracting spectral data, and finally, manipulating the extracted spectral data, have been described in several references (Perry and Turnrose, 1977; Klinglesmith, Perry, and Turnrose, 1979; Lindler, 1979a,b; Turnrose and Harvel, 1980). In addition, refinements and modifications to the processing procedures are addressed in many articles of the series IUE Data Reduction I-XX published in the NASA IUE Newsletter, Nos. 2-13 (see Appendix B).

From a computational standpoint, the steps placing the greatest demand on the processing system are those which handle the geometric distortion (either explicitly or implicitly; see IUE Data Reduction VI and XVIII), the photometric correction using the Intensity Transfer Function (ITF), and the actual spectral extraction from the photometrically-corrected image. These steps all involve the use of large, two-dimensional arrays (the image and ITF data) and in practice are designed so as to work with only several lines of an image at a time (Perry and Turnrose, 1977; Lindler, 1979a,b.). This is necessary since raw images contain 589,824 bytes, the ITF files contain 6,488,064 bytes (SWP) or 7,077,888 bytes (LWR), and photometrically corrected images contain 1,179,648 bytes.

The format and the use of these files are discussed in Perry and Turnrose (1977), and Turnrose and Harvel (1980). These references also contain explicit equations describing the geometric and photometric correction algorithms always used for high dispersion (see also IUE Data Reduction XIII for the ITF extrapolation techniques now incorporated), and Lindler (1979a,b) and IUE Data Reduction XVIII provide specific algorithms and discussion pertaining to the new implicit-geometric-correction software used for low dispersion since 3 November 1980 at GSFC and since 10 March 1981 at VILSPA.

Specific considerations relating to the extraction of spectral data from the photometrically corrected images and the subsequent manipulation of the extracted spectra are addressed in other general purpose algorithms in this Appendix.

Algorithm 2 - Spectral extraction from photometrically corrected image:

The ability to extract spectral data from a photometrically corrected image, while less of a computational burden than full reprocessing, places considerable demands on processing systems. The need to handle large amounts of data (1,179,648 bytes per photometrically corrected image), the need to extract data from orders positioned neither horizontally, vertically, nor along the diagonal, and the need to flag exceptional pixels (reseau-contaminated pixels, saturated pixels, extrapolated pixels) are significant factors. Many aspects of the extraction problem are addressed in detail in Turnrose and Harvel (1980) for the "old" software which extracts spectral data from photometrically and geometrically corrected images and in Lindler (1979a,b) for the "new" software which extracts spectral data from photometrically corrected images with raw geometry.

The use of analytic dispersion relations to define the locus of points in the image representing the nominal position of the spectral orders is discussed in Turnrose and Harvel (1980) and under a separate algorithm in this Appendix. The procedures for registering the nominal dispersion relations with the actual spectral orders are also discussed in Turnrose and Harvel (1980). The sampling algorithms for actually extracting spectral flux values are discussed in the above reference and in Lindler (1979a,b). The flagging mechanism by which extracted flux points affected by exceptional pixels are identified is discussed partially in several references and elaborated upon below.

Reseau flagging. As described in IUE Data Reduction XVII, the geometrically correct reseau grid (i.e., the reseau locations to which the geometric correction step -- either explicit or implicit -- maps the found reseau positions) for each camera consists of a 13 x 13 array of reseau marks laid out in a square pattern extending across and beyond the tube face. In every case, the "central" reseau mark - that lying in row 7, column 7 of the grid -- is positioned at line number 390, sample number 410 in the geometrically corrected frame of reference. In the LWP and LWR cameras, the spacing between adjacent reseau marks is 55 pixels in both the line and sample directions, implying that the reseau mark in row 1, column 1 of the grid is situated at line number 60, sample number 80. In the SWP camera, the spacing between adjacent reseau marks is 56 pixels in both the line and sample directions, implying that the reseau mark in row 1, column 1 of the grid is situated at line number 54, sample number 74. For the SWR camera, not used for Guest Observer science data, a suitable reseau grid has not been defined.

As flux values are sampled in the extraction process, (under either the "old" or the "new" software), reseau marks which are calculated to lie within 2 pixels of <u>any</u> pixel contributing to the measured flux are flagged by negative values of the quality-measure ε. (See the discussion of configuration number 15 in CSC/TM-81/6117). Note that the description on p. 6-9 of Turnrose and Harvel (1980) is incorrect in stating that only reseau within 2 pixels of the <u>center</u> of an extraction slit are flagged.

<u>Exceptional-flux-condition flagging</u>. In the "old" (explicit geometric correction) software, only saturated pixels (DN = 255) are flagged in extracted spectra (see Turnrose and Harvel, 1980). In the "new" (implicit geometric correction) software a considerably more extensive flagging system for exceptional flux conditions is built into the coding of pixel values in the photometrically corrected image itself (see IUE Data Reduction XVIII and CSC/TM-81/6117, configuration number 60).

This more extensive system allows for the flagging of saturated pixels and pixels whose fluxes are based on ITF extrapolations and in the future will also flag pixels affected by bright spots (radiation artifacts) and camera microphonic noise patterns.

Following the actual extraction of spectral data, including the conditional flagging discussed above, the gross and background fluxes are further manipulated (Turnrose and Harvel, 1980; IUE Data Reduction XVIII) to define net spectra which in low dispersion are also absolutely calibrated. The important aspects of the various manipulations done to the extracted spectra are individually discussed in the other general-purpose algorithms in this Appendix, as they have considerable application to many of the specific correction procedures addressed in the main text of this document.

Algorithm 3 - Psuedo-slit extractions from line-by-line spectra

In low dispersion, a line-by-line or spatially resolved spectrum is provided from which pseudo-slit extractions can be made on even small computers to correct, improve upon, or otherwise customize the equivalent of the IUE merged-spectral file. This is particularly convenient since the data are presented in relatively small arrays and since wavelengths and quality flags (ε) are already assigned to each flux point. With the "old" low dispersion software, the line-by-line spectra consist of 55 gross pseudo-orders extracted parallel to the direction of the dispersion with a square sampling area $\sqrt{2}$ pixels by $\sqrt{2}$ pixels oriented at an angle of 45 degrees to the line and sample directions. As Cassatella et al (1980) point out, each such line-by-line flux sample includes portions of between 4 and 7 pixels of the geometrically and photometrically corrected image. The line-by-line spectra are arranged as 55 pseudoorders which collectively extend completely across and between both spectrograph apertures and where the 28th line is nominally centered on the dispersion line and assigned an "order" number of 100. In all, "order" numbers 73 to 127 are assigned to the line-by-line extractions, with the order numbers increasing as one progresses from the large aperture towards the small aperture in each camera. The detailed format of the data on tape is discussed in Turnrose and Harvel (1980).

With the "new" low dispersion software, (IUE Data Reduction XVIII and XIX) the line-by-line spectra are extracted by a different technique but provide similarly-organized data, with a greater number of sampled flux points per order.

As indicated in Cassatella et al. (1980), the gross and background extractions performed by IUESIPS in calculating the standard merged spectral files may be emulated by summing flux points at constant wavelength from the appropriate corresponding lines of the line-by-line file. Table A-1 summarizes the range of lines to be summed for each of the several aperture/source-characteristic options in use currently. The Guest Observer or archive user may also wish

Table A-1. Range of line numbers to be summed in spatially-resolved file to emulate merged spectra.

	Small Aperture	Large Aperture	
		Point Source	Extended/Trailed Source
Gross	24 - 32	24 - 32	21 - 35
Background	18-22 plus 34-38	15-19 plus 37-41	15-19 plus 37-41

to define different "swaths" through the line-by-line array to optimize the flux measurements for a particular application: very faint point sources, for example, could be more profitably sampled with a shorter gross "slit" (i.e., fewer lines added together) to reduce the effects of extraneous noise from the underlying background.

Note that in all cases of pseudo-slit extraction, the effective pixel areas of the background and gross "slits" must be normalized before a net signal can be defined.

Algorithm 4 - Wavelength assignments via dispersion constants:

The relation between wavelength and nominal pixel location in IUE images is determined by analytical dispersion relations, as described in Turnrose and Harvel (1980). The analytical dispersion relations utilize a set of dispersion constants A_i and B_i which are determined by a multivariate regression analysis. The relations, which separately determine the line and sample numbers corresponding to a given wavelength λ (in Å) and echelle order number m, are the following:

$$\text{sample number} = A_1Z_1 + A_2Z_2 + A_3Z_3 + \ldots\ldots + A_7Z_7 \qquad \text{(A-1)}$$

$$\text{line number} = B_1Z_1 + B_2Z_2 + B_3Z_3 + \ldots\ldots + B_7Z_7 \qquad \text{(A-2)}$$

where

$$\begin{aligned} Z_1 &= 1 \\ Z_2 &= m\lambda \\ Z_3 &= (m\lambda)^2 \\ Z_4 &= m \\ Z_5 &= \lambda \\ Z_6 &= m^2\lambda \\ Z_7 &= m\lambda^2 \end{aligned} \qquad \text{(A-3)}$$

In the case of low dispersion, only the first two terms in equations (A-1) and (A-2) are used, and $m \equiv 1$.

A method of inverting dispersion relations of the form of equations (A-1) through (A-3) so as to, for example, solve for the sample and wavelength values at which a given order m crosses a particular line in the image is described on pages 4-31 and 4-32 of Perry and Turnrose (1977).

The values of the A_i and the B_i used to extract the spectral data of an IUE image are recorded in the IUESIPS history portion of the label (see Turnrose and Harvel, 1980, pages 8-19, 8-20) and for the "new" low dispersion software, also in the scale-factor record of the extracted data (IUE Data Reduction XVIII). Consequently, the Guest Observer or archive user wishing to use the standard dispersion formulae to assign wavelength values to image pixels (<u>in the geometrically correct frame of reference</u>) may utilize the A_i and B_i values and the methods described herein. Users are cautioned that in the case of images reduced under the "new" implicit-geometric-correction software, the pixel locations associated with the dispersion formulae must be referred back to the raw-image geometry according to the algorithm presented on p. 22 of Lindler (1979b). Mean values for the displacement data sets needed for Lindler's algorithm can be obtained from IUE Data Reduction XVII; the variation of instanteous displacements from these means due to thermal effects will in general be small (IUE Data Reduction XXI).

Algorithm 5 - Low dispersion wavelength corrections:

In "IUE Data Reduction III" in NASA IUE Newsletter, No. 5, a correction algorithm for low dispersion wavelengths is derived. This algorithm, while derived for the purpose of correcting SWP low dispersion wavelengths for the effects of the preliminary SWP low dispersion line library (see CSC/TM-81/6117, configuration number 24), is generally applicable to any low dispersion situation in which wavelengths generated from a given set of dispersion constants need to be transformed to the corresponding wavelengths that would be generated from a second set of dispersion constants. This algorithm would, therefore, be useful to users who wish, for example, to convert wavelengths assigned with biweekly dispersion constants to wavelengths assigned with mean dispersion constants.

Given that the original dispersion relations are

$$\text{sample number} = a_1' + a_2' \lambda_o \qquad (A - 4)$$

$$\text{line number} = b_1' + b_2' \lambda_o \qquad (A - 5)$$

and the desired (new) dispersion relations are

$$\text{sample number} = a_1 + a_2 \lambda \qquad (A - 6)$$

$$\text{line number} = b_1 + b_2 \lambda \qquad (A - 7)$$

then the relation between the original wavelength λ_o and the converted wavelength λ is

$$\lambda = d + m \lambda_o \qquad (A - 8)$$

where

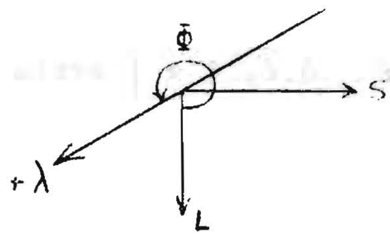
$$d = \frac{b_2 (b_1' - b_1) + a_2 (a_1' - a_1)}{b_2^2 + a_2^2} \qquad (A - 9)$$

$$m = \frac{b_2 b_2' + a_2 a_2'}{b_2^2 + a_2^2} \qquad (A - 10)$$

Algorithm 6 - Wavelength corrections for zero-point shifts:

For many applications it is useful to have a method by which assigned wavelengths can be transformed approximately, given a simple zero-point shift in the dispersion relations. Such a situation corresponds to deriving the effect of changing the A_1 and B_1 terms in equation (A-1) and (A-2) discussed in algorithm 4. The uses of such a method include estimating the effects of thermal shifts and non-perpendicular registration shifts, for example. The method shown below was developed by R. W. Thompson as part of the analysis of thermal shifts in IUE images in the SWP and LWR cameras and consists of decomposing line and sample direction shifts, ΔL and ΔS, into equivalent components parallel and perpendicular to the dispersion direction, $\Delta \parallel$ and $\Delta \perp$. In this formulation, $\Delta \parallel$ and $\Delta \perp$ are defined in a right-handed coordinate system such that positive $\Delta \parallel$ (the " + X axis") is in the direction of increasing wavelength.

First, we note that it is possible to define with little uncertainty an angle Φ which is the angle of the dispersion direction with respect to the direction of positive line number, thus:



In low dispersion, Φ is unique for each camera; in high dispersion, Φ varies slightly with order number (total variation ~ $0\overset{\circ}{.}7$ between orders 125 and 75). The whole-number values of Φ adopted here in Table A-2 are thus correct for all orders to within ~ $0\overset{\circ}{.}5$.

Table A-2 Dispersion-line angles (rounded to nearest degree)

Camera	Dispersion	Φ (in radians)
SWP	Low	$\frac{309 \times 2\pi}{360}$
	High	$\frac{38 \times 2\pi}{360}$
LWR	Low	$\frac{53 \times 2\pi}{360}$
	High	$\frac{324 \times 2\pi}{360}$

For a given line shift ΔL and sample shift ΔS, define

$$R = (\Delta L^2 + \Delta S^2)^{1/2} \qquad \text{(A - 11)}$$

If $\Delta L > 0.0$ and $\Delta S \geq 0.0$, $\theta = \arctan\left(\frac{\Delta S}{\Delta L}\right)$

If $\Delta L \leq 0.0$ and $\Delta S > 0.0$, $\theta = \left| \arctan\left(\frac{\Delta L}{\Delta S}\right)\right| + \pi/2$

If $\Delta L < 0.0$ and $\Delta S \leq 0.0$, $\theta = \arctan\left(\frac{\Delta S}{\Delta L}\right) + \pi$

If $\Delta L \geq 0.0$ and $\Delta S < 0.0$, $\theta = \left| \arctan\left(\frac{\Delta L}{\Delta S}\right)\right| + \frac{3\pi}{2}$

Then

$$\Delta\| = R \cos(\theta - \Phi) \qquad \text{(A - 12)}$$

$$\Delta\perp = R \sin(\theta - \Phi) \qquad \text{(A - 13)}$$

If $\Delta L = 0 = \Delta S$, $\Delta\| = 0 = \Delta\perp$.

The interpretation of $\Delta\parallel$, which is the only component of the shift pertinent to the wavelength scale, depends on the dispersion mode. In low dispersion, a motion of one pixel along the dispersion direction corresponds to a shift of 1.67 Å in SWP and 2.65 Å in LWR (see "IUE Data Reduction V"). In high dispersion, a motion of one pixel along the dispersion direction corresponds closely to a constant velocity (not wavelength) shift of 7.64 km s^{-1} in SWP and 7.32 km s^{-1} in LWR (see "IUE Data Reduction XXI").

Note that in relating a calculated $\Delta\parallel$ to a wavelength or a velocity shift, it is important to keep in mind whether motion of the object spectrum or of the dispersion relations is being addressed. A change in the A_1 and B_1 values in equations (A-1) and (A-2), for example, so as to move the dispersion relation zero-point in the positive wavelength (velocity) direction will result in assigned spectral wavelengths (velocities) which are smaller by the amount of the shift.

Algorithm 7 - Background smoothing:

IUE low dispersion background spectral fluxes are currently smoothed with a median filter, followed by a double-pass mean filter. A median filter replaces the central point within the filter "window" (the set of neighboring points falling within the filter width) by the median of the samples within the window; a mean filter replaces the central point of the window by the mean of the points within the window. (See "IUE Data Reduction X"). Under the former low dispersion software (pre-November 3, 1980 at GSFC and pre-March 10, 1981 at VILSPA), only the double-pass mean filter was used. Although the current (old) high dispersion software at GSFC uses the old-style double mean-only filtering, the median-plus-double-mean filter is used at VILSPA and will be part of the new high dispersion reduction system; it is therefore the recommended method.

A suitable median-filter algorithm is presented in Schiffer and Holm (1980). With the "new" extraction software with $\frac{\sqrt{2}}{2}$ spacing between adjacent spectral samples, a median filter width W_{median} of 63 points should be used; the mean filter width W_{mean} is 31 points. With the "old" extraction software with $\sqrt{2}$ spacing between adjacent spectral samples, $W_{median} = 31$ and $W_{mean} = 15$ should be used. As noted in Cassatella _et al._ (1980), filtering algorithms are preferred in which the effective filter window collapses in width once the filter is within W/2 points of the end of the data string. By keeping only valid data points within the filter windows, unwanted artifacts in the smoothed data are avoided.

Algorithm 8 - Ripple correction:

In high dispersion, the net spectrum is corrected for the echelle grating blaze function (the "ripple") with a simplified, semi-empirical formula. More suitable formulae may exist; recent studies suggest that the *effective* grating constants K (see below) may vary with order number (Ake, 1981; Benvenuti, 1981). This effective variability of K may in fact be due to other causes as yet not fully understood.

The extracted net spectrum $F(\lambda)$ is obtained from the fifth record of each 6-record data group for each order (Turnrose and Harvel, 1980, p. 8-41) and rescaled to floating point format (see algorithm number 10). The ripple-corrected net spectrum $F_{corr}(\lambda)$ is obtained as follows:

$$F_{corr}(\lambda) = \frac{F(\lambda)}{R(\lambda)} \qquad \text{(A - 14)}$$

where
$$R(\lambda) = \frac{\sin^2 X}{X^2}\,(1 + aX^2)$$

and
$$X = \min\left[\begin{array}{c} \dfrac{\pi\, m^2\, |\lambda - \lambda_c|}{K} \\ 2.61 \end{array}\right]$$

m = echelle order number

$\lambda_c = K/m$ = central wavelength for order m

a = adjustable parameter

K = echelle grating constant

Current values for K and a are given in Table A-3.

Historical variations in these values are found in CSC/TM-81/6117.

Table A-3. Ripple-correction parameters.

Camera	K	a
SWP	137725	0.10
LWR	231150	0.09

Algorithm 9 - Vacuum-to-air wavelength correction:

Since it is customary to catalog wavelengths as measured in air (λ_{air}) in the spectral region longward of 2000Å, IUESIPS makes a vacuum-to-air correction for the appropriate wavelengths measured in the LW spectrograph. These corrections are as follows (see Turnrose and Harvel, 1980).

1. All extracted wavelengths from the SW spectrograph are left uncorrected (vacuum wavelengths λ_{vac}, even for $\lambda_{vac} > 2000$ Å).

2. All extracted wavelengths from the LW spectrograph are corrected to air values if equal to or greater than 2000 Å; extracted wavelengths shorter than 2000 Å are left uncorrected (vacuum wavelengths). When the correction is applied, it is defined by

$$\lambda_{air} = \frac{\lambda_{vac}}{f(\lambda_{vac})} \tag{A - 15}$$

$$\text{where } f(\lambda) = 1.0 + 2.735182 \times 10^{-4} + \frac{131.4182}{\lambda^2} + \frac{2.76249 \times 10^8}{\lambda^4} \tag{A - 16}$$

Note that in high dispersion, the vacuum-to-air correction described by equations (A-15) and (A-16) is applied <u>after</u> the echelle blaze ("ripple") correction is made. Conversely, when LW spectra are read from tape and ripple-correction processing is to be made, all wavelengths must be transformed back to vacuum values first.

Algorithm 10 - Absolute calibration:

In low dispersion, an absolute calibration of the extracted time-integrated flux (FN) net spectra is obtained by applying the inverse sensitivity function S_{λ}^{-1} and dividing by the exposure time in seconds. "IUE Data Reduction XII" presents a detailed listing of the S_{λ}^{-1} function used at GSFC from 9 January 1980 until 3 November 1980; the report by Bohlin and Holm (1980) presents the revised absolute calibration now adopted at both GSFC and VILSPA. The interpolation technique described in "IUE Data Reduction XII" should be used to derive S_{λ}^{-1} values at intermediate wavelengths. The net flux $F(\lambda)$ is obtained from record 6 of the 7-record merged extracted spectra (Turnrose and Harvel, 1980) and rescaled to floating point format (see algorithm number 10). Alternatively, a new net spectrum could be obtained from a pseudo-slit extraction from the line-by-line spectra (see algorithm number 3). The absolutely-calibrated spectrum $F_{abs}(\lambda)$ is calculated as

$$F_{abs}(\lambda) = \frac{F(\lambda)\, S_{\lambda}^{-1}}{t_{sec}} \quad \text{erg cm}^{-2}\ \text{s}^{-1}\ \text{Å}^{-1} \tag{A-17}$$

where S_{λ}^{-1} is the inverse sensitivity function in erg cm^{-2} Å^{-1} FN^{-1} for the appropriate camera, and t is the exposure time in seconds.* The value of t may be obtained from logical record 2 of the IUESIPS label (see p. 8-15 of Turnrose and Harvel, 1980), although the value stored there is the sum of the commanded exposure times, and in the case of multiple exposures or multiple-aperture exposures, the appropriate decomposition of that value must be determined from other means. It is recommended that whenever possible, alternative records on the exposure times be consulted to verify or correct exposure times read from the image labels.

In high dispersion, an official absolute calibration is not in use. Recent work in this area is discussed in Cassatella, Ponz, and Selvelli (1981).

* Note: IUESIPS processing does not divide out by the exposure time. See "IUE Data Reduction XII".

Algorithm 11 - Scaling fluxes and wavelengths from integer to real format and vice versa:

Fluxes and wavelengths for IUE spectra are written to the standard Guest Observer (and archive) tape in a scaled integer form. Originally calculated internally as floating-point numbers, these quantities are written on tape as 16-bit integers (range: ± 32767) to facilitate decoding on different computers. The operations required to decode the integer values on tape are given here first. The reverse operations of converting the real values to the integer format are also given.

A. Integer-to-real number conversion

Let I_i be an integer flux value at point i read from tape. Then the corresponding real flux value F_i is obtained from

$$F_i = I_i * J * 2^{-K} \qquad (A - 18)$$

where the J and K scaling constants are read from the scale-factor record of the extracted spectrum being analyzed (see Turnrose and Harvel, 1980, pp. 8-37 ff). Note that each component (gross, background, net, etc.) of a merged spectral file has its own J and K values, pertaining to all orders of that component.

Let $L_i(m)$ be the integer wavelength value at point i in order m read from tape. Then the corrresponding real wavelength value λ in angstroms is obtained from

$$\lambda_i(m) = \lambda_o(m) + \text{UNIT} * L_i(m) \qquad (A - 19)$$

where the value of UNIT is 0.2Å in low dispersion and 0.002 Å in high dispersion, and where $\lambda_o(m) = 0$ for low dispersion and is equal to the largest integer less than or equal to the first wavelength in each order; $\lambda_o(m)$ is thus different for each order in high dispersion and is given in the scale-factor record (see Turnrose and Harvel, 1980, pp. 8-37 ff)

B. Real-number-to-integer conversion

With same notation as above,

$$I_i = [F_i/R + 0.5] \qquad (A - 20)$$

where $R = J * 2^{-K}$, and the bracket notation means the largest integer less than or equal to the value contained within the brackets. J and K may be determined as they are in IUESIPS, as shown below:

Let F_{max} be the maximum real flux in the spectrum involved.

Then

$$G = \log_{10}\left(\frac{F_{max} + 1}{32760}\right) \Big/ \log_{10} 2$$

$$L = [G + 0.5]$$

$$D = G - L$$

$$K = 15 - L$$

$$J = [2^{D+15} + 0.5]$$

Finally, for wavelengths $\lambda_i(m)$ in angstroms, in low dispersion $\lambda_o(m) = 0$ and

$$L_i(m) = [\lambda_i(m) * 5 + 0.5] \quad . \qquad (A - 21)$$

In high dispersion, for each order m

$$\lambda_o(m) = \left[\lambda_1(m)\right] \qquad (A - 22)$$

and

$$L_i(m) = \left[\left(\lambda_i(m) - \lambda_o(m)\right)*500 + 0.5\right] \qquad (A - 23)$$

Algorithm 12 - Updating scale-factor record of extracted spectra:

The first tape record after the IUESIPS label in all extracted-spectrum files is the so-called scale-factor record (or "record zero"). This record contains a variety of entries relating to the contents of the data records which follow it, including the various important scaling constants such as J,K, and λ_o (see algorithm 11) used to convert integer data on the tape to real numbers; see p. 8-38 of Turnrose and Harvel (1980). In addition, the contents of this record have recently been greatly expanded under the "new" low dispersion software (see "IUE Data Reduction XVIII").

Since this record has been established to hold data in a 16-bit integer format convenient for computer decoding, there are reasons for which the most important entries in the scale-factor record should be updated if the corresponding spectral data are changed as a result of operations the user may perform. These entries would include λ_{min} and λ_{max} values (the nearest-integer minimum and maximum wavelengths of the whole spectrum), the sets of I_{min}, I_{max}, J, and K values for each extracted spectrum where I_{min} and I_{max} are the minimum and maximum scaled-integer flux values, and J and K are the flux scaling constants (see algorithm 11), the λ_o wavelength offsets for each extracted order (again see algorithm 11), and the number of extracted points in each order. All such entries might logically be altered implicitly as a result of spectral manipulations performed by the user, who is, therefore, reminded that these constants should be explicitly updated in the scale-factor record if the user wishes to store the modified spectral data in the standard format for future use or manipulation. Table 8-6 of Turnrose and Harvel (1980) illustrates in explicit fashion the location of all data in the "old" format of the scale-factor record; "IUE Data Reduction XVIII" contains similarly explicit information on the "new" format scale-factor record. Users are directed to these sources to ascertain where the updated entries are to be made.

Algorithm 13 - Updating IUESIPS history labels:

The format of the IUESIPS labels is described in section 8 of Turnrose and Harvel (1980); Figure 8 - 14 of that reference is reproduced here as Figure A - 1. Normal IUESIPS file labels consist of between 20 and 30 physical tape records. Each physical record is 360 bytes in length (one byte = 8 binary bits), being a concatenation of 5 logical records each 72 bytes long. That is, lines in the image label are blocked 5 at a time to form 360-byte physical records (blocks) on tape.

Raw image labels start out 20 physical records (blocks) long. As the image proceeds through the processing system, additional label information is appended, one block at a time. Since the information added at any given step may or may not fill one or more entire block(s), a continuation character at the end of each logical record is used to flag the end of the label as follows. If any logical record is followed by at least one other, the EBCDIC character "C" is placed in byte no. 72 of that logical record to signify a continuation. The last logical record of the whole label contains the EBCDIC character "L" in byte no. 72. Note that the end-of-label flag need not occur on a block boundary; any logical records which appear after the "L" in the last block are undefined (they generally contain core garbage). This overall label-record structure is shown in Figure A-1.

The label records are in a mixture of EBCDIC and binary-integer formats (see Turnrose and Harvel, 1980). Observers using computers with non-EBCDIC printers (e.g., ASCII) are reminded that an input character format conversion will be required to display the EBCDIC portions correctly.

Two special types of files have nonstandard labels: (1) The Tape Header file which begins each GO tape has only 1 block, of which only the first logical record is filled. All information is in EBCDIC format. Note that the Tape Header File label has no "size parameters" field (see Turnrose, Harvel, 1980) as all other labels do. (Note further that the Tape Header File has no data records.) (2) Reseau-position files generated from calibration images have only 1 block in their labels. Unlike the Tape Header file labels, however, reseau-position labels do have the standard size parameters in the first logical record, and generally one or more other logical records are present containing free-form identification information for the source of the reseau data.

If a user wishes to update information within an existing label, he has merely to determine the physical record and byte(s) involved. Figures 8-3 through 8-11 of Turnrose and Harvel (1980) provide detailed format and contents information for normal IUESIPS labels. If a user wishes to add additional records to an existing IUESIPS label, he must first find the last logical record by searching for the EBCDIC "L" in byte 72 (Figure A-1), change the "L" to a "C", and then add additional logical records as necessary, with either continuation ("C") or last ("L") codes in byte 72 of each as appropriate.

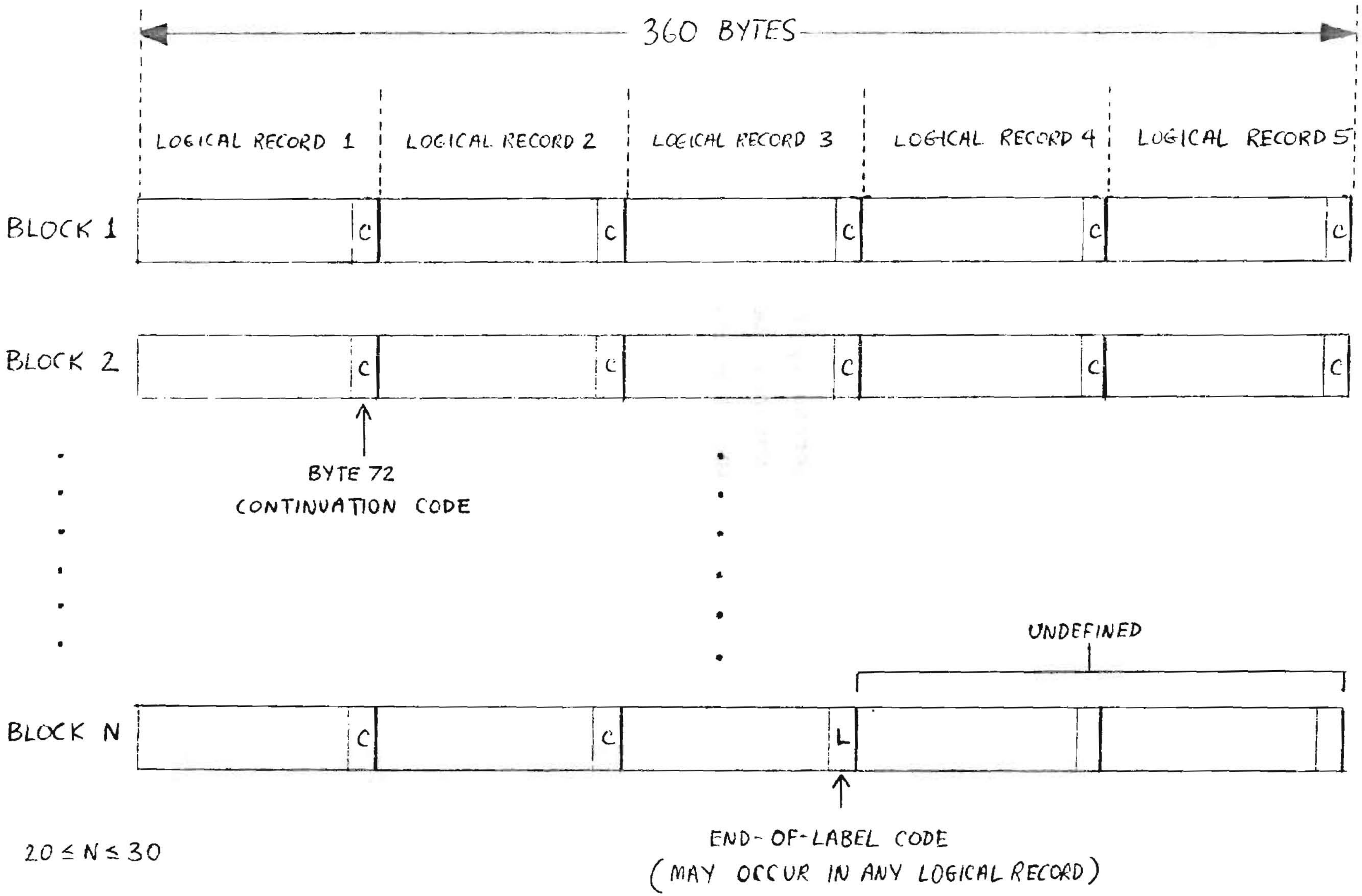


Figure A-1. Standard IUESIPS Label Record Structure

Algorithm 14 - Reading THDA values from IUESIPS label:

Data for the camera head amplifier temperature (THDA) are contained in the so-called "camera snapshot" portion of the IUE image label in binary form. Although prior to March 1979 at GSFC (and a somewhat later time at VILSPA) all of the data necessary to extract THDA usefully were not written in the label, images acquired since that time do contain reliable label entries and THDA is now routinely extracted from the image labels during production IUESIPS processing. In order to utilize the THDA information, one must determine which of a number of time-tagged camera snapshot entries contains the relevant data and then convert the raw telemetry to physical units. Procedures to perform the necessary data retrieval, correlation, and conversion operations have been developed by R.W. Thompson, who has kindly provided the following description of them.

The various data which are read from the IUE image label to determine THDA are listed in Table A-4. The data from logical records 1 and 10 of the label (see algorithm 13) determine the camera, image number, and approximate read time which are in turn used to find the correct entries from among the 15 possible camera snapshot entries in logical records 86-100.

To find THDA at time of READ: Search the camera snapshot entries in records 86-100 to find the entry for which the following three criteria are met:

1) ICAM = TBNO
2) PROC = 7
3) $|TREAD - TCSR| \leq 0.2$ hours, where

$$TREAD = IH + (IM/60.0) + (IS/3600.0) \quad \text{hours}$$

$$TCSR = HR + (MIN/60.0 \quad \text{hours}$$

Then extract the raw THDA telemetry value TLM from byte 41 of that entry, and convert to physical units as described below.

To find THDA at end of exposure: Search backwards through the entries (i.e., backwards in time) from the entry identified above as that pertaining to image READ, until the first entry is found in which:

1) ICAM = TBNO

and 2) PROC = 6

Then extract the raw THDA telemetry value TLM from byte 41 of that entry and convert to physical units as described below. If no such entry is found, then the THDA at end of exposure cannot be extracted from the label; in such cases, the THDA at ime of READ is generally used.

To convert raw THDA telemetry values (TLM) to physical units:

First convert TLM to actual thermistor voltage TV by the relation

$$TV = TLM * 0.02DO \qquad (A - 24)$$

Then convert TV to THDA in ^{o}C using the following polynominal function:

$$\begin{aligned} THDA = {} & 0.10913\ D03 - (0.13191\ D03)\ (TV) + (0.84903\ D02(TV)^2 \\ & - (0.30540\ D02)(TV)^3 + (0.53477\ D01)(TV)^4 \\ & - (0.36411\ D00)(TV)^5 \end{aligned} \qquad (A - 25)$$

Table A-4 Data read from IUE image label to determine THDA

Parameter Description	Parameter Name	Location		Format	Range of Proper Values
		Logical Record No.	Byte No.		
Camera number	TBNO	1	50	EBCDIC 1 character	1-4
Image sequence number	ISN	1	52-56	EBCDIC 5 characters	1000-99999
Approximate time of image READ:					
Year-1900	IYR	10	1-2	EBCDIC 2 characters	78-99
Day (GMT)	IDAY	10	3-5	EBCDIC 3 characters	0-364
Hour (GMT)	IH	10	6-7	EBCDIC 2 characters	0-23
Minute (GMT)	IM	10	8-9	EBCDIC 2 characters	0-59
Second (GMT)	IS	10	10-11	EBCDIC 2 characters	0-59
Camera snapshot entries, arranged in 15 logical records (86-100) of 72 bytes each, stored chronologically (with wraparound after 15th entry):					
Time of entry:					
Hour (GMT)	HR	86-100	1	I * 4	0-23
Minute (GMT)	MIN	86-100	2	I * 4	0-59
Raw THDA telemetry	TLM	86-100	41	I * 4	0-255
Camera number	ICAM	86-100	56	I * 4	1-4
Procedure number	PROC	86-100	57	I * 4	1-7

APPENDIX B

"IUE DATA REDUCTION" ARTICLES[1]

NUMBER	TITLE	NASA IUE NEWSLETTER *ESA* Number	DATE
I.	High Dispersion Data Extraction	2	November 1978
II.	Radial Velocities in High Dispersion Using the Small Aperture	2	November 1978
III.	Accuracy of Low Dispersion Wavelengths	5	July 1979
IV.	CalComp Plots of High Dispersion Net Ripple-Corrected Fluxes	5	July 1979
V.	Wavelength Assignments for Large Aperture Spectra	6	September 1979
VI.	An Outline for Basic Studies of IUE Data and Planned Improvements to the Processed Results	6	September 1979
VII.	Intrinsic Resolution and Planned Changes to the Extraction Slit	6	September 1979
VIII.	Planned Changes to High Dispersion Extraction Slit Height	6	September 1979
IX.	Planned Changes to the Order-Locating Software: DCSHIFT	7	November 1979
X.	Planned Changes to the Background Smoothing Algorithm	7	November 1979
XI.	Mean Dispersion Relations for Low Dispersion Spectra	7	November 1979
XII.	Absolute Calibration of Low Dispersion Spectra	8 *6* *11*	February 1980 *April 1980* *August 1981*
XIII.	Modification of Photometric Correction to Extrapolate the Intensity Transfer Function	8	February 1980
XIV.	Properties of the Upper Levels of the Intensity Transfer Functions: Extracted DN Values Relevant to Low Dispersion Spectra	9 *7*	April 1980 *July 1980*

APPENDIX B (Cont.)

NUMBER	TITLE	NASA IUE NEWSLETTER *ESA* Number	DATE
XV.	Systematic Errors in the SWP Wavelength Scale	10	June 1980
XVI.	Orbital Velocity Corrections	10	June 1980
XVII.	Mean Reseaux and Dispersion Constants	11	October 1980
XVIII.	Implementation of New Low Dispersion Software: Summary of Output Format Changes	12 *10*	January 1981 *May 1981*
XIX.	Results of Basic Improvements to the Extraction of Spectra from IUE Low Dispersion Images	12 *10*	January 1981 *May 1981*
XX.	High Dispersion Line Libraries	13	January 1981
XXI.	The Parameterization of the Motion of the IUE Reseau Grids and Spectral Formats as a Function of Time and Temperature	15[2]	September 1981
XXII.	Washburn Extraction Routine and the Width of the Point Spread Function in Low Dispersion non-GEOM IUE Images	15 *11*	September 1981 *August 1981*
XXIII.	Further Modifications to the Extrapolation of the Intensity Transfer Function	15	September 1981
XXIV.	Implementation of new High Resolution Software: Summary of output products	*13*	*June 1982*
XXV.	Implementation of basis improvements to extraction of High Dispersion spectra	*13*	*June 1982*
XXVI.	Automatic registration of the extraction Slit with the Spectral format	*13*	*June 1982*

1) Whenever applicable the corresponding ESA-IUE Newsletter publication is given in italics. For additional references we recommend to consult: IUE+VILSPA User's Guide vol III, Image processing, eds. L. Bianchi, K. Morthover, J. Clavel.

2) Astron. Astrophys. 107, 11, 1982

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