Calibration Product Review for the Faint Object Spectrograph

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FOS Instrument Science Report CAL/FOS-130
November 1994

Abstract

We present a complete discussion and a synopsis of the Cycle 4 calibration status of the FOS to date. A chronology and summary is provided of recent communications to the observer community concerning important FOS calibration issues including recommended re-processing procedures for certain photometric and flat field calibrations and discussions of pipeline processing errors affecting polarimetry and background subtraction. Complete reference guide tabulations of *all recommended* FOS reference files and reference tables for Cycle 4 ***AS OF 10 NOVEMBER 1994*** are given. Equivalent tabulations for pre-COSTAR observations may be found in cited references. Comprehensive calibration file and table delivery histories since launch are described and referenced. ASCII-text and Postscript versions of these tabulations and histories, which are updated on a continuing basis, may be found on STEIS in the instrument_news/fos/recommended_reference_files directory and in the "Instrument Status: Calibration Products and Tools" section of the WWW STScI FOS Homepage.

I. Introduction

Table 1 lists the six reference file types and eleven reference table types that are used in FOS calibration (CALFOS). Two additional reference file types which are included in Table 1, Point Spread Function and Line Spread Function, are not used in CALFOS. Figure 1 is a flowchart of the entire CALFOS process, which indicates the reference files and tables that are used, the keyword switches that are set, and the output products that are produced in each calibration step. Figure 2 is an extraction from a sample FOS Science Header (.c1h file) that shows the final settings of all calibration switches and the names of all reference files and tables used in the processing of a flux-calibrated RAPID mode observation.

Determination of the correct files for calibration use can be a daunting task, as there are literally thousands of FOS reference files. This report will discuss the status of the calibration operation associated with each reference file and table type. We also provide an appendix (Tables 3-19) in which *all Cycle 4 recommended reference files and tables* for each type of calibration as a function (where appropriate) of the applicable detector, disperser, aperture, and observation date are listed in a convenient matrix tabular format. Additionally, we note that the appendix is derived from four important guides, updated versions of which are *always available* on the World Wide

Web (WWW) STScI FOS Homepage (*http://marvel.stsci.edu/ftp/instrument_news/FOS/topfos.html*) in both the "Instrument Status: Calibration Products and Tools" and "Instrument-related Documentation" sections as well as on the text-oriented Space Telescope Electronic Information System (STEIS) in the instrument_news/fos/recommended_reference_files directory. Separate guides are provided for 1) flat fields, 2) inverse sensitivity (IVS), 3) dead diodes, and 4) all remaining reference files and tables. Two additional guides covering pre-COSTAR flat fields and inverse sensitivity are also in the same locations. The most recent series of guide updates (Keyes and Taylor, August, 1994) remains current at this writing. For more information see the reference guide paragraph near the end of section III of this report.

While the IRAF/STSDAS task **getreffile** and the Calibration Reference screens in StarView will list the recommended reference files and tables for any particular observation, it is always a good idea to double check the latest versions of the WWW or STEIS recommendation lists.

In addition, Instrument Science Report (ISR) CAL/FOS-113 (Taylor and Keyes, August, 1994) presents a comprehensive compilation and descriptive history of all reference files ever delivered to CDBS since HST launch *including all superseded, redundant, and erroneous deliveries.* The latter compilation is not intended for routine use by general observers, but is an invaluable reference for the serious student of FOS calibration history.

In the near future there will be one new reference file type and four new reference table types, which will be applicable *only* to the forthcoming revision of the pre-servicing non-polarimetric inverse sensitivity calibration. The reference file will be for Average Inverse Sensitivity (not to be confused with the current Inverse Sensitivity reference file). The four new reference tables will be: HST Focus History, Relative Aperture Throughput, Relative Aperture Throughput Versus Focus, and Time Changes in Inverse Sensitivity. An upcoming ISR, CAL/FOS-129 (Bushouse, 1994), will explain the new file and tables, and no discussion of either this new methodology or its associated reference files is included herein. Future updates to the WWW and STEIS recommendation lists will contain these new files when they become available. A general notice to the entire FOS user community will announce the availability of the new flux calibration method.

Table 1: FOS Reference File and Table Types

File Format	CDBS relation	CALFOS Header Keyword	Filename Extension	Contents	Selection Criteria
FILES	cybacr	BACHFILE	.r0h & .r0d	Default background file (count rate)	a,b
	cyfltr	FL*n*HFILE	.r1h & .r1d	Flat field file (multiplicative)	a,b,c,d,e,f,g
	cyivsr	IV*n*HFILE	.r2h & .r2d	Inverse Sensitivity file (ergs cm^{-2} $Å^{-1}$)	a,b,c,d,e,f,g
	cyretr	RETHFILE	.r3h & .r3d	Retardation file for polarimetry data	a,b,e,f
	cyddtr	DDTHFILE	.r4h & .r4d	Dead (Disabled) Diode file	a
	cyqinr	DQ*n*HFILE	.r5h & .r5d	Data Quality Initialization file	a,b,c,d,e,f,g
	cypsf	N/A	.r6h & .r6d	Point Spread Function files	a,h
	cylsf	N/A	.r7h & .r7d	Line Spread Function files	a,c,h
TABLES	cyccs0r	CCS0	.cy0	Aperture areas	a,c,d
	cyccs1r	CCS1	.cy1	Aperture positions	a,e
	cyccs2r	CCS2	.cy2	Sky emission line position	a,e,i
	cyccs3r	CCS3	.cy3	Sky/background filter widths	a
	cyccs4r	CCS4	.cy4	Wollaston/waveplate parameters (Polarimetry)	a,f
	cyccs5r	CCS5	.cy5	Sky shift parameters	a,c,d,e,i
	cyccs6r	CCS6	.cy6	Wavelength parameters	a,b,c,d,e,f,g
	cyccs7r	CCS7	.cy7	GIM scale factors	a
	cyccs8r	CCS8	.cy8	Mean background count rate	a,j,k
	cyccs9r	CCS9	.cy9	Scattered light correction	a,e
	coccg2r	CCG2	.cmg	Paired-pulse parameters (with GHRS)	a,l

Selection Criteria Key: a=detector; b=overscan *(always 5 currently)*; c=aperture id; d=aperture position; e=filter grating wheel id; f=polarizer id; g=pass direction; h=wavelength; i=NXSTEPS; j=geomagnetic latitude; k=geomagnetic longitude; l=instrument

Figure 1: Pipeline Processing by CALFOS

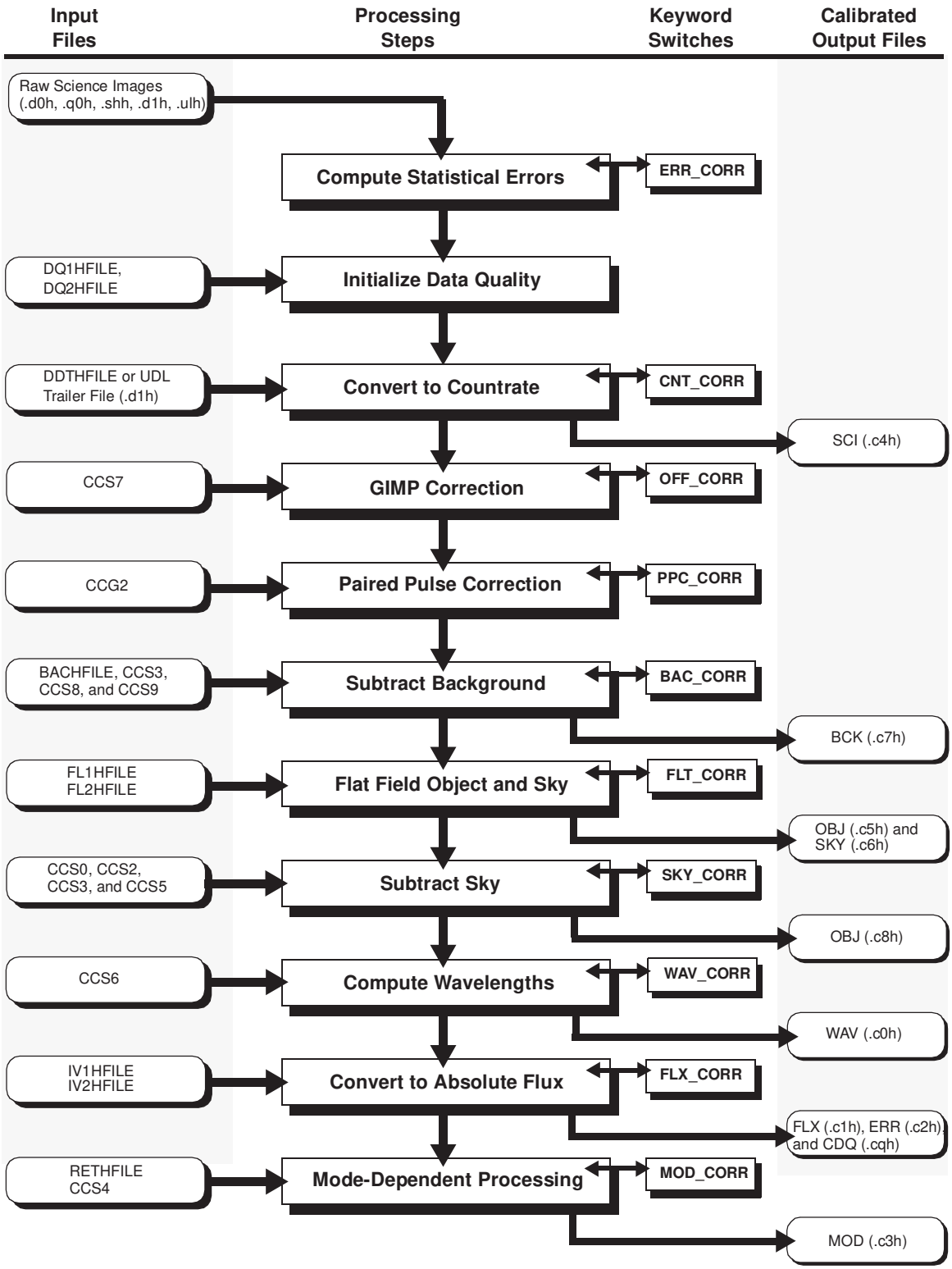

Figure 2: Sample FOS Science Header Extraction for POST-COSTAR RAPID Mode Data

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                / CALIBRATION FLAGS AND INDICATORS
GRNDMODE= 'RAPID-READOUT     ' / ground software mode
DETECTOR= 'BLUE              ' / detector in use: amber(red), blue
APER_ID = 'A-1               ' / aperture id
POLAR_ID= 'C                 ' / polarizer id
POLANG  =                  0.0 / initial angular position of polarizer
FGWA_ID = 'H13               ' / FGWA id
FCHNL   =                    0 / first channel
NCHNLS  =                  512 / number of channels
OVERSCAN=                    5 / overscan number
NXSTEPS =                    4 / number of x steps
YFGIMPEN=                    T / onboard GIMP correction enabled (T/F)
YFGIMPER= 'NO                ' / error in onboard GIMP correction (YES/NO)

                / CALIBRATION REFERENCE FILES AND TABLES
DEFDDTBL=                    F / UDL disabled diode table used
BACHFILE= 'yref$b3m1128my.r0h' / background header file
FL1HFILE= 'yref$e7813577y.r1h' / first flat-field header file
FL2HFILE= 'N/A               ' / second flat-field header file
IV1HFILE= 'yref$e3h1449qy.r2h' / first inverse sensitivity header file
IV2HFILE= 'N/A               ' / second inverse sensitivity header file
RETHFILE= 'N/A               ' / waveplate retardation header file
DDTHFILE= 'yref$d9h1244ay.r4h' / disabled diode table header file
DQ1HFILE= 'yref$b2f1306ry.r5h' / first data quality initialization header file
DQ2HFILE= 'N/A               ' / second data quality initialization header
file
CCG2    = 'mtab$a3d1145ly.cmg' / paired pulse correction parameters
CCS0    = 'ytab$a3d1145dy.cy0' / aperture parameters
CCS1    = 'ytab$aaj0732ay.cy1' / aperture position parameters
CCS2    = 'ytab$a3d1145fy.cy2' / sky emission line regions
CCS3    = 'ytab$a3d1145gy.cy3' / bkg and sky filter widths
CCS4    = 'ytab$e5v13262y.cy4' / polarimetry parameters
CCS5    = 'ytab$a3d1145jy.cy5' / sky shifts
CCS6    = 'ytab$e5v11576y.cy6' / wavelength coefficients
CCS7    = 'ytab$ba910502y.cy7' / GIMP correction scale factors
CCS8    = 'ytab$ba31407ly.cy8' / predicted background count rates
CCS9    = 'ytab$e3i09491y.cy9' / scattered light parameters

                / CALIBRATION SWITCHES
CNT_CORR= 'COMPLETE'           / count to count rate conversion
OFF_CORR= 'OMIT              ' / GIMP correction
PPC_CORR= 'COMPLETE'           / paired pulse correction
BAC_CORR= 'COMPLETE'           / background subtraction
GMF_CORR= 'COMPLETE'           / scale reference background
SCT_CORR= 'COMPLETE'           / scattered light correction
FLT_CORR= 'COMPLETE'           / flat-fielding
SKY_CORR= 'SKIPPED '           / sky subtraction
WAV_CORR= 'COMPLETE'           / wavelength scale generation
FLX_CORR= 'COMPLETE'           / flux scale generation
ERR_CORR= 'COMPLETE'           / propagated error computation
MOD_CORR= 'PERFORM           ' / ground software mode dependent reductions
```

II. Discussion of Calibration Status for each Reference File and Table Type

This section contains a brief description of the purpose of each reference file or table, the selection criteria used by CDBS (except USEAFTER) to choose the correct file, a discussion of the status of the instrumental calibration associated with each reference file or table, and direction to the appropriate table of the appendix for locating the currently recommended reference file or table. The selection criteria, which are also included in Table 1, are from the Calibration Data Base Design, Version 6.0 (April, 1994). For those reference files or tables that have overscan specified as a CDBS selection criterion, *only overscan=5 is supported by current FOS calibration*.

II.1 Background Reference File:

This reference file contains the default background specified in count rate units. This file is scaled by the appropriate value from the Mean Background Count Rates Reference Table (see below) to produce the predicted detector background vector for the geomagnetic position of an observation. The CDBS selection criteria are detector and overscan.

Status: Table 4 of the appendix gives the current recommendations. The current reference files derive from SV observation and analysis. The pipeline correction may be approximately *30% too small*. The error affects dayside observations and high geomagnetic latitude observations predominantly; nightside observations at geomagnetic latitudes between +30 degrees and -30 degrees are not seriously affected. An analysis by M. Rosa (HST Calibration Workshop and CAL/FOS-114) initially reported this discrepancy and recommended that the current geomagnetic field model be refined. Further investigation by the STScI FOS team has recently (September, 1994) revealed that a serious error was made in the SV analysis (Lyons et al, CAL/FOS-080). All "burst" background events (those producing more than one count) were eliminated from the SV dataset on which the reference file is based. Although the precise magnitude of this error has yet to be determined, the 30% discrepancy reported by Rosa is of the correct order.

We have a substantial baseline of new dark measures obtained in Cycles 2 through 4. Analysis of all FOS darks is now underway by J. Hayes under the supervision of A. Koratkar. The possible need for a more accurate geomagnetic field model will be addressed after the new dark analysis is completed.

Mean background count rates are .007 counts/sec/diode for FOS/BLUE and .010 counts/sec/diode for FOS/RED. Consequently, only observations of very faint sources (count rates of the order of the mean background rates) will be affected by this problem. Our interim recommendation is that observers and archive researchers of faint sources, for which the Science Header Calibration Switch `SCT_CORR` is either not present or set to `'SKIPPED'` (see scattered light section II.18 below), should contact an FOS Instrument Scientist. A STEIS announcement concerning this situation is in preparation.

II.2 Flat Field Reference File:

FOS flat fields remove pixel-to-pixel sensitivity variations and photocathode granularity on scales of approximately 10 diodes or less. The CALFOS flat field correction is performed as a multiplicative operation, hence the reference files contain inverse flat fields. The CDBS selection criteria are: detector, overscan, aperture id, aperture position, filter grating wheel id, polarizer id, and pass direction.

Status: Re-calibrate all Cycle 4 single aperture high-dispersion observations obtained prior to 13 July 1994 with flat field reference files listed in Tables 8-11 of the Appendix.

FOS policy for post-servicing pipeline reduction always has been to utilize the best-available flat fields at the time of observation . Post-servicing observationally-derived flat field reference files were installed in the pipeline on 13 July 1994 for all high-dispersion spectral elements with all single apertures except the two barred apertures and the 0.1-PAIR apertures. These flat fields are derived from 4.3 aperture "superflat" observations made in SMOV and early in Cycle 4. Observations obtained prior to 13 July 1994 were corrected with the best-available pre-servicing flat fields. In some circumstances the new flats remove granularity features that appeared as absorptions in data corrected with the pre-servicing flats. A general notice to the FOS user community, which was posted on STEIS on 15 July 1994, recommended that all post-servicing observations obtained prior to 13 July 1994 be re-processed with the new reference files. Users were directed to contact either the FOS Instrument Scientists or the Analysis Hot Line or to refer to the Post-COSTAR Flat Field Reference Guide file on STEIS, which is found in both the instrument_news/fos/recommended_reference _files and instrument_news./fos/flat_field STEIS directories. Low-dispersion flat fields are nearly completed and will be released shortly. Unity flat fields are in place for the barred apertures and the 0.1-PAIR apertures as no flat field observations have ever been made for these apertures. We plan to use 0.25-PAIR flats for the 0.10-PAIR case after aperture-specific flat observations are made in Cycle 4. We have consulted personally with the only post-servicing user of a barred aperture.

Lastly, we note that in addition to the 4.3 flat observations mentioned, aperture-specific Cycle 4 flat field observations will be made for all spectral elements with the 1.0 aperture, and for certain other highly utilized apertures or known pathological instrumental configurations. Initial analysis of SMOV observations, however, indicates that the worrisome aperture-dependence seen in pre-servicing FOS flats is either not present or dramatically reduced in post-servicing spectra.

II.3 Inverse Sensitivity (IVS) Reference File (absolute spectrophotometry):

The IVS is used to convert observed count rates to fluxes (F-lambda). The CDBS selection criteria are: detector, overscan, aperture id, aperture position, filter grating wheel id, polarizer id, and pass direction.

Status: Re-calibrate all Cycle 4 observations obtained prior to 21 March 1994 with IVS reference files listed in Tables 14-17 of the Appendix.

Initially, unity post-servicing IVS reference files were installed in the pipeline. On 21 March 1994 observationally-derived IVS reference files were installed for all detector/disperser combinations with the 4.3 and 1.0 apertures. Theoretical predictions for all other apertures, except the barred

apertures and the 0.1-PAIR apertures, were installed on the same date. Three observing programs were affected by calibration with the unity IVS files. On 25 March 1994 all three PIs were sent personal e-mail messages that described the problem and which directed the observers to contact either the FOS Instrument Scientists or the Analysis Hot Line. A general notice to the FOS user community was also posted on STEIS on 25 March 1994, with essentially the same admonitions and recommendations.

Subsequent Cycle 4 photometric monitor and aperture throughput observations have confirmed the theoretical predictions for apertures smaller than 1.0 with uncertainties of 3-10 percent; the largest differences are for the smallest apertures and shortest wavelengths (Bohlin, private communication, August, 1994). No further reference file updates will be made until additional Cycle 4 calibration observations have been acquired. We note that the substantial "dip" in sensitivity between 1500-2500 Å relative to ground-based COSTAR mirror component measures remains present in all observations with FOS/BLUE.

II.4 Retardation Reference Files (polarimetry):

The retardation files are used during polarimetry calibration to create the observation matrix *f(w)*. The CDBS selection criteria are: detector, overscan, polarizer id, and filter grating wheel id.

Status: Tables 6 and 7 of the appendix give the current recommendations. The pipeline files are derived from Cycle 3 calibrations and were created by Richard Allen. Analysis of Cycle 4 observations is nearing completion; currently no GO programs are scheduled. The Cycle 4 analysis (Allen, private communication, October, 1994) indicates that FOS polarimetry with gratings G190H and G270H will be feasible post-COSTAR, but utilization of G130H will NOT be possible. Instrumental polarization is less than 2.5% and position angle varies with wavelength. Polarimetric calibration accuracy limits will be approximately 0.3% for FOS/BLUE and 0.6% for FOS/RED.

All polarimetric observations with NREAD=2 have been incorrectly calibrated by the pipeline. A general announcement of this problem was posted on STEIS in late May, 1994. All five affected proposers were personally contacted and informed of the problem by an Instrument Scientist. The CALFOS error was corrected by 1 July 1994, all affected observations have been re-processed by FOS team personnel, and all observers have been contacted concerning arrangements for re-distribution of the corrected data. Discussions are in progress concerning placement of the corrected data in the STScI archive.

An error of 2 Å in the FOS/RED G190H polarimetric wavelength calibration zero-point was discovered in late September, 1994. The problem will be corrected by mid-November, 1994. Two Cycle 3 proposals, both associated with members of the FOS team, are affected.

II.5 Dead (Disabled) Diode Reference Files:

The CDBS selection criterion is detector.

Status: Table 5 of the appendix gives the current recommendations.The FOS Dead Diode (DD) Reference Files are correct and current. Of course, due to the nature of the phenomenon being corrected, some pipeline-calibrated observations, obtained in the interval between discovery of a dead or noisy diode and the arrival of a new DD file in the pipeline, may contain diminished or

noisy calibrated pixels in the output data products. These incompletely corrected files will be in the archive, as well. Therefore, all observers and archival researchers are reminded to always check the current Dead Diode Reference File guide in the instrument_news/fos/recommended_reference_files directory on STEIS or to contact the FOS Instrument Scientists or the Analysis Hot Line.

II.6 Quality Initialization Reference File:

The CDBS selection criteria are: detector, overscan, aperture id, aperture position, filter grating wheel id, polarizer id, and pass direction.

Status: There are almost 1800 different recommended quality initialization files. Therefore, no tabular summary is provided in this document. Tables of recommended files are posted on STEIS in the /instrument_news/fos/recommended_reference_files directory in an ASCII-text document, fos_qin_recommend.txt. In addition to a variety of other data quality issues, the quality initialization files can be used to flag intermittent or noisy diodes, however this aspect of their function *has not been kept up to date* since current lists of intermittent and noisy diodes are included in the recommended list of dead diode reference files mentioned in the dead diode section II.5 above.

II.7 Point Spread Function Reference File:

The CDBS selection criteria are: detector and wavelength.

Status: FOS point spread function (PSF) reference files are not used in CALFOS calibration. They have been delivered to CDBS for reference. The PSFs currently available are for the pre-COSTAR period only. The PSFs are given at 200 Å intervals from 1200 Å to 5400 Å for FOS/BLUE and from 1600 Å to 8400 Å for FOS/RED. No tabular summary of these files is provided in this document, rather please refer to Table 7 of CAL/FOS-113 (Taylor and Keyes, 1994). A detailed description of the PSF modeling is found in CAL/FOS-104 (Evans, 1993).

II.8 Line Spread Function Reference File:

The CDBS criteria are: detector, wavelength, and aperture id.

Status: FOS line spread function (LSF) reference files are not used in CALFOS calibration. They have been delivered to CDBS for reference. The LSFs currently available are for the pre-COSTAR period only. Refer to CAL/FOS-104 (Evans, 1993) for more details. There are 513 Line spread function (LSF) reference files, which are posted on STEIS in the /instrument_news/fos/lsf_psf directory in an ASCII-text document, fos_lsf_recommend.txt, hence no tabular summary of these files is provided in this document.

II.9 Aperture Areas Reference Table:

This reference table contains the areas of the FOS entrance apertures and is used to scale the sky spectrum to the object spectrum. The appropriate table entry is determined by: detector, aperture id, and aperture position.

Status: Table 3 of the appendix gives the current recommendation. Areas were determined from SV measures and are considered accurate to approximately 5 percent. No sky-subtracted observations have ever been performed.

II.10 Aperture Positions Reference Table :

This reference table is used *only* for determination of which aperture (UPPER or LOWER) of a paired aperture was used. The appropriate table entry is determined by: detector and filter grating wheel id.

Status: Table 3 of the appendix gives the current recommendation. Values were determined in SV and are sufficiently accurate to accomplish their fiduciary purpose.

II.11 Sky Emission Line Position Reference Table:

This reference table specifies spectral regions in a sky spectrum known to have emission lines. The regions are not smoothed before the sky is subtracted from the object spectrum. The appropriate table entry is determined by: detector, filter grating wheel id, first channel (diode), and NXSTEPS.

Status: Table 3 of the appendix gives the current recommendation. These are the pre-launch values. The Science Verification data have never been confirmed due to poor table design. *No sky-subtracted observations have ever been performed.*

II.12 Sky/Background Filter Widths Reference Table:

This reference table specifies the mean and median filter widths for smoothing the background and sky spectra. The appropriate table entry is determined by detector.

Status: Table 3 of the appendix gives the current recommendation. Table contains pre-launch values, which have never been used.

II.13 Wollaston/Waveplate Parameters Reference Table:

This reference table is used in the polarimetry calibration. It contains the angles of each of the two pass directions with respect to the Q=1 coordinate axis of the polarization reference frame. The appropriate table entry is determined by: detector and polarizer id.

Status: Table 3 of the appendix gives the current recommendation. Values have been updated as a result of Cycle 3 calibration for all supported detector/disperser combinations. Cycle 4 updates will be made for verified post-servicing polarimetry modes (see comments in Retardation Reference File section II.4 above).

II.14 Sky Shift Parameters Reference Table:

This reference table gives the shift (in pixels) needed to align the sky spectrum with the object spectrum before subtracting. The appropriate table entry is determined by: detector, aperture id, aperture position, filter grating wheel id, and NXSTEPS.

Status: Table 3 of the appendix gives the current recommendation. *This capability has never been used or tested on orbit; values are pre-launch estimates.*

II.15 Wavelength Parameters Reference Table:

This reference table gives the dispersion relation used to compute the wavelength of each pixel. The appropriate table entry is determined by: detector, filter grating wheel id, aperture id, aperture position, polarizer id, and pass direction.

Status: Table 3 of the appendix gives the current recommendation. Wavelength table has not been updated since the Cycle 1 inclusion of internal/external wavelength offsets except for inclusion of FOS/RED polarimetric dispersion relations in Cycle 3. The polarimetric update includes a recently discovered, soon-to-be-corrected error for FOS/RED G190H (see discussion in Retardation Reference File section II.4 above). FOS wavelength calibration accuracy is dominated by Filter/Grating Wheel (FGW) position non-repeatability, such that for any observation requiring one sigma wavelength accuracies better than 0.3 diode (approximately 80 km/sec with high-dispersion gratings), the FOS team has always recommended that observers obtain a wavelength calibration spectrum contiguous with the science observation. Instructions that describe this procedure are found in the FOS Instrument Handbook.

II.16 GIM Scale Factors Reference Table:

This reference table contains the scale factors used for scaling the model geomagnetic field strength calculations in CALFOS. These calculations are used to correct the geomagnetically induced image motion (GIM) if onboard correction has not been enabled. The appropriate table entry is determined by detector.

Status: Table 3 of the appendix gives the current recommendation. Starting in April, 1993 the GIM has been corrected onboard by default in both X- and Y-directions. Typical GIM excursions are of the order of 0.5 pixels and there may be errors of the order of 10 percent in the onboard model correction algorithm. If the science header keyword YFGIMPEN is set to FALSE, then the onboard correction was not performed and the GIM Scale Factors Reference Table is used in the pipeline reduction to correct only in X-direction.

II.17 Mean Background Count Rates Reference Table:

This reference table contains the predicted mean background count rates as a function of geomagnetic latitude and longitude. The mean background count rate at the position and time of the observation is interpolated from the table and the background reference file is scaled by this factor. The appropriate table entry is determined by: detector, geomagnetic latitude, and geomagnetic longitude.

Status: Table 3 of the appendix gives the current recommendation. See discussion concerning background underestimation error in section II.1 above.

II.18 Scattered Light Correction Reference Table:

This reference table contains the beginning and ending diode ranges for particular detector/

disperser combinations which define the region of the spectrum in which the mean amplitude of *scattered light plus background* will be measured. These regions correspond to spectral ranges in which the detector has no sensitivity. Some gratings have no regions of zero sensitivity and therefore entries of zero for the range specification in this reference table. The correction is performed only for those gratings with non-zero range entries in this table. The appropriate table entry is determined by: detector and filter grating wheel id.

Status: Re-process all observations obtained prior to 19 April 1994 for which the Science Header Calibration Switch `SCT_CORR` is not present with entry in Table 3 of the appendix.

Note: Due to the nature of the pipeline scattered light correction algorithm, all observations for which the Science Header Calibration Switch `SCT_CORR` is set to `'COMPLETED'` should not be re-processed for the detector background calibration error mentioned in section II.1 above.

This pipeline algorithm, introduced in April, 1994, allows a correction for a wavelength-independent constant component of scattered light plus background only in certain FOS configurations. Recently M. Rosa (CAL/FOS-127, September, 1994) has provided a working tool for FOS scattered light prediction based entirely upon optical principles. This extremely promising new modeling code is appropriate for utilization in post-observation analysis by the observer rather than as a pipeline algorithm. Details are available from the FOS Instrument Scientists or the STSDAS Hot Line.

II.19 Paired-Pulse Parameters Reference Table:

This reference table contains the paired-pulse parameters used to correct for non-linearity at high count rates. This table is shared with GHRS. The appropriate table entry is determined by: instrument and detector.

Status: Table 3 of the appendix gives the current recommendation. This correction algorithm is based upon pre-flight tests. No correction is applied to count rates of less than 10 counts/sec. A pixel is flagged as poorly corrected in the data quality file for count rates greater than 52,000 counts/sec and is flagged as saturated for rates in excess of 57,000 counts/sec.

III. Brief Synopsis of Current (10 November 1994) Cycle 4 Calibration Status

This section provides a brief summary of potential problems or inaccuracies in the current calibration of the FOS. Where appropriate, a time table for correction or improvement is provided. Also, the location of the FOS Reference File and Reference Table Guides is given.

In all cases, please contact the FOS Instrument Scientists or the Analysis Hotline at the addresses listed in Table 2 below for additional information.

Background correction:

FOS background corrections may be approximately 30 percent too small. Naturally, this affects only observations of faint sources. Approximate mean background count rates are 0.010 counts/sec/diode for FOS/RED and 0.007 counts/sec/diode for FOS/BLUE. Currently, we recommend re-calibration of low count rate observations for which the Science Header Calibration Switch

SCT_CORR is either not present or set to 'SKIPPED' with a background reference file arbitrarily increased by 30 percent. The FOS team is presently analyzing all available background measures in order to derive corrected reference files and tables.

Flat Fields:

Since 13 July 1994 post-servicing observationally-derived superflats have been available for single aperture high-dispersion observations. The new flats were obtained with the 4.3 aperture, but the strong aperture dependence seen in pre-servicing flats is not present in post-servicing observations. *All single aperture high-dispersion Cycle 4 observations obtained prior to 13 July 1994 should be re-calibrated with new reference files as some features will be removed by the new flats*. Please refer to the post_costar_flat_field_announcement file in the instrument_news/fos directory on STEIS. Complete lists of recommended reference files are found in both the STEIS instrument_news/fos/recommended_reference_files and instrument_news/fos/flat_field directories. Post-servicing flats for low-dispersion gratings are not yet available, but should be released around 1 December 1994. Please note that aperture-specific flat fields for the 1.0 and some other small apertures will be available later in Cycle 4 - announcements will be placed on STEIS. Currently no pipeline flat field correction is applied to observations made with the barred apertures or the 0.1-PAIR apertures - please contact an Instrument Scientist for these cases.

Inverse Sensitivity (IVS):

Effective 21 March 1994, observationally-derived IVS reference files for the 4.3 and 1.0 apertures were installed in the pipeline. Additionally, theoretically-based aperture throughputs for all other apertures (except the barred apertures and the 0.1-PAIR apertures) were installed. Subsequent observations have indicated that the theoretical throughputs are accurate at the 2-3 percent level. No further change is planned in any IVS reference files until additional Cycle 4 calibration observations are obtained. Post-servicing observations made prior to 21 March 1994 were flux-calibrated with unity reference files, such that the output .r1* files contained values in count-rate units, although calibration switches in the header indicated the units were fluxes. *All Cycle 4 observations obtained prior to 21 March 1994 should be re-calibrated with new reference files.* Barred and 0.1-PAIR aperture IVS reference files remain as unity. All observers affected by unity files have been personally notified.

Wavelengths:

The dominant uncertainty in FOS wavelength scales is the positional accuracy with which the Filter/Grating Wheel (FGW) repeats. As a result, any observer requiring wavelength accuracies corresponding to 0.3 diodes or smaller (approximately 80 km/sec at high-dispersion) should obtain WAVEcal observations contiguous with science exposures without moving the FGW. See FOS Instrument Handbook, version 5, or contact an FOS Instrument Scientist for details.

An error of 2 Å in the FOS/RED polarimetric G190H wavelength calibration zero-point has been discovered in September, 1994. It will be corrected by mid-November 1994.

Polarimetry:

Cycle 4 calibration results indicate that FOS/BLUE G130H polarimetry observation will not be feasible. Gratings G190H and G270H will be usable with both FOS detectors; contact an FOS Instrument Scientist for current detailed recommendations.

Reference File Guide locations:

Periodically updated ASCII text and Postscript versions of all Reference File and Table Reference Guides mentioned in this document are maintained both in the WWW STScI FOS Homepage "Instrument Status: Calibration Products and Tools" section and in the /instrument_news/fos/recommended_reference_files directory on STEIS and will be available for viewing or anonymous ftp from *stsci.edu*. On STEIS the files are given self-explanatory names, such as "ref_files_tables_*mmmyy*.ps" and "ref_files_tables_*mmmyy*.txt", where *mmmyy* is the posting date in month and year, the extension ".ps" denotes the Postscript version, and ".txt" denotes the ASCII-text version. For example, the current set of files are named "ref_files_tables_aug94.ps" and "ref_files_tables_aug94.ps" (these particular files are for all reference files and tables except flat fields, IVS, and dead diodes which have their own recommended lists (post_costar_flat_fields_*mmmyy*.*,post_costar_ivs_*mmmyy*.*, and dead_diodes_*mmmyy*.* - where * is ".txt" or ".ps").

Table 2: FOS Instrument Contacts

Contact	Telephone	E-mail
Tony Keyes	(410) 338-4975	*keyes@stsci.edu*
Anuradha Koratkar	(410) 338-4470	*koratkar@stsci.edu*
Analysis Hot Line	(410) 338-1082	*analysis@stsci.edu*

IV. Warnings/Alerts to the General and Specifically-affected User Community

25 March 1994: Posted notice on STEIS for general community and sent personally worded e-mails to the three affected GOs announcing removal of unity IVS reference files and pipeline installation of observationally-derived post-servicing IVS reference files. Asked affected GOs to contact Instrument Scientists or Analysis Hot Line for details of re-calibration including distribution of new reference files. The general community version of this message is in the STEIS instrument_news/fos directory and in the instrument_news/fos/absolute_photometry directory, as well.

26 May 1994: Posted general community notice on STEIS announcing and describing polarimetry calibration error for the relatively small subset of polarimetry observations with multiple readouts per exposure (NREAD=2). This notice is in the STEIS instrument_news/fos/polarimetry directory.

1 July 1994 (and later): Conducted personal communications with the five GOs affected by the NREAD=2 polarimetry error. Announced CALFOS software fix for the problem and informed GOs that FOS team will re-process their data. Subsequently, made arrangements for distribution of re-processed data (this process continues in some cases).

15 July 1994: Posted notice on STEIS for general community announcing the availability of post-servicing, observationally-derived flat field reference files and their installation in the PODPS pipeline. Asked GOs to contact Instrument Scientists or Analysis Hot Line for details of re-calibration including distribution of new reference files. This message is in the STEIS instrument_news/fos directory and in the instrument_news/fos/flat_field directory.

6-11 Aug 1994 : Installed new versions of all Reference File Guides on STEIS (flat field, IVS, dead diode tables, and all others). Postscript and ASCII-text versions of the guides are in the instrument_news/fos/recommended_reference_files directory.

26 Sep 1994: Sent e-mail to all Cycle 4 PIs noting that beginning with Cycle 4 all observations are flux calibrated on a new absolute reference scale. Post-servicing calibrations use a theoretical model for the white dwarf G191B2B as the absolute reference, which is different from the previous system in several wavelength regions, notably in the ultraviolet. This message is also in the STEIS instrument_news/fos/absolute_photometry directory.

30 Sep 1994: Re-organized single confusing STEIS directory into topically named sub-directories (e.g., flat_field, recommended_reference_files, polarimetry) with an easy-to-read set of instructions, a new WHATS_NEW file containing directions to recent important alerts, and a table of contents in the top level. Informed entire FOS user community (all cycles) of the change via e-mail to list of all PIs. Also included in this message an appeal for addresses of additional contacts and for address corrections (numerous responses have been received).

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APPENDIX: Cycle 4 Recommended FOS Reference Files and Tables

Notes for Table Interpretation:

"*": wildcard
yyyymmdd: USEAFTER date (4 digit year A.D., 2-digit month, 2-digit day) {in Tables 3-18}
*abcdefghi.r*h*,(*.r*d*): rootname of reference file and extensions for header (and data) files
*abcdefghi.cy** or *.cm**: rootname and extension of reference table
The letter "l" in rootnames is italicized ("*l*") for legibility in the tables.

Table 3: RECOMMENDED FOS REFERENCE TABLES

Table Description	Keyword	USEAFTER and Filename
Aperture areas	CCS0	19900101 a3d1145dy.cy0
Aperture positions	CCS1	19900101 aaj0732ay.cy1
Sky emission line position	CCS2	19900101 a3d1145fy.cy2
Sky/background filter widths	CCS3	19900101 a3d1145gy.cy3
Wollaston/waveplate parameters (polarimetry)	CCS4	19930608 e5v13262y.cy4
Sky shift parameters	CCS5	19900101 a3d1145jy.cy5
Wavelength parameters	CCS6	19930608 e5v11576y.cy6
GIMP scale factors	CCS7	19900101 ba910502y.cy7
Mean background count rates	CCS8	19900101 ba31407*l*y.cy8
Scattered light correction	CCS9	19900101 e3i09491y.cy9
Paired-pulse parameters	CCG2	19900101 a3d1145*l*y.cmg

Table 4: RECOMMEDNED FOS BACKGROUND REFERENCE FILES

Detector	USEAFTER and FILE
RED	19900101 b3m1128fy.r0h,.r0d
BLUE	19900101 b3m1128my.r0h,.r0d

Table 5: FOS DEAD DIODE REFERENCE FILES

Detector	Filename	Begin Date (USEAFTER)	End Date
RED	dap1024ay.r4h,.r4d	12 Oct 1993	present
BLUE	d9h1244ay.r4h,.r4d	17 Sep 1993	present

Table 6: RED RECOMMENDED FOS RETARDATION REFERENCE FILES for SUPPORTED CONFIGURATIONS

Grating	Pol A	Pol B
H19	Not supported	19930608 e5v1122ry.r3h,.r3d
H27	Not supported	19930608 e5v1122sy.r3h,.r3d
H40	19930608 e5v1122ty.r3h,.r3d	Not supported

Table 7: BLUE RECOMMENDED FOS RETARDATION REFERENCE FILES for SUPPORTED CONFIGURATIONS

Grating	Pol A	Pol B
H13	Not supported	19930608 e5v11230y.r3h,.r3d
H19	Not supported	19930608 e5v11231y.r3h,.r3d
H27	Not supported	19930608 e5v11232y.r3h,.r3d

Table 8: RED RECOMMENDED H19,H27,L15,H40 FLAT FIELD REFERENCE FILES

Aperture	H19	H27	L15	H40
A-1 (4.3)	19940201 e781357cy.r1h,.r1d	19940201 e781357dy.r1h,.r1d	19920915 d2315487y.r1h,.r1d	19940201 e781357ey.r1h,.r1d
A-2 (0.5 pair) UPPER	19920915 d231548hy.r1h,.r1d	19920915 d231548sy.r1h,.r1d	19920915 d2315497y.r1h,.r1d	19900101 9be1438oy.r1h,.r1d
A-2 (0.5 pair) LOWER	19920915 d231548ny.r1h,.r1d	19920915 d2315493y.r1h,.r1d	19920915 d231549cy.r1h,.r1d	19900101 9be1439ey.r1h,.r1d
A-3 (0.25 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-3(0.25 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
A-4 (0.1 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-4 (0.1 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
B-1 (0.5)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-2 (0.3)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-3 (1.0)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-4 (BLANK)	19920915 d3t1050by.r1h,.r1d	19920915 d3t1050fy.r1h,.r1d	19920915 d3t1050iy.r1h,.r1d	19900101 d3t11065y.r1h,.r1d
C-1 (1.0 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
C-1 (1.0 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
C-2 (0.25x2.0 slit)	SAME AS A-1	SAME AS A-1	19920915 d241317ny.r1h,.r1d	SAME AS A-1
C-3 (2.0-BAR)	19920915 d3t1050cy.r1h,.r1d	19920915 d3t1050gy.r1h,.r1d	19920915 d3t1050jy.r1h,.r1d	19900101 d3t11066y.r1h,.r1d
C-4 (0.7x2.0-BAR)	19920915 d3t1050ey.r1h,.r1d	19920915 d3t1050hy.r1h,.r1d	19920915 d3t1050ky.r1h,.r1d	19900101 d3t11067y.r1h,.r1d

Table 9: RED RECOMMENDED H57,H78,L65,PRI FLAT FIELD REFERENCE FILES

Aperture	H57	H78	L65	PRISM
A-1 (4.3)	19940201 e781357fy.r1h,.r1d	19940201 e781357hy.r1h,.r1d	19900101 baf13104y.r1h,.r1d	19900101 baf13105y.r1h,.r1d
A-2 (0.5 pair) UPPER	19900101 9be1438oy.r1h,.r1d	19900101 9be1438oy.r1h,.r1d	19900101 9be1438oy.r1h,.r1d	19900101 9be1438oy.r1h,.r1d
A-2 (0.5 pair) LOWER	19900101 9be1439ey.r1h,.r1d	19900101 9be1439ey.r1h,.r1d	19900101 9be1439ey.r1h,.r1d	19900101 9be1439ey.r1h,.r1d
A-3 (0.25 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-3(0.25 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
A-4 (0.1 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-4 (0.1 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
B-1 (0.5)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-2 (0.3)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-3 (1.0)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-4 (BLANK)	19900101 d3t11065y.r1h,.r1d	19900101 d3t11065y.r1h,.r1d	19900101 d3t11065y.r1h,.r1d	19900101 d3t11065y.r1h,.r1d
C-1 (1.0 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
C-1 (1.0 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
C-2 (0.25x2.0 slit)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
C-3 (2.0-BAR)	19900101 d3t11066y.r1h,.r1d	19900101 d3t11066y.r1h,.r1d	19900101 d3t11066y.r1h,.r1d	19900101 d3t11066y.r1h,.r1d
C-4 (0.7x2.0-BAR)	19900101 d3t11067y.r1h,.r1d	19900101 d3t11067y.r1h,.r1d	19900101 d3t11067y.r1h,.r1d	19900101 d3t11067y.r1h,.r1d

Table 10: BLUE RECOMMENDED H13,H19,H27,H40 FLAT FIELD REFERENCE FILES

Aperture	H13	H19	H27	H40
A-1 (4.3)	19940201 e7813577y.r1h,.r1d	19940201 e7813578y.r1h,.r1d	19940201 e7813579y.r1h,.r1d	19940201 e781357ay.r1h,.r1d
A-2 (0.5 pair) UPPER	19920101 d2f13334y.r1h,.r1d	19920101 d2f13336y.r1h,.r1d	19920101 d2f13338y.r1h,.r1d	19920101 d2f1333ay.r1h,.r1d
A-2 (0.5 pair) LOWER	19920101 d2f1333dy.r1h,.r1d	19920101 d2f1333gy.r1h,.r1d	19920101 d2f1333iy.r1h,.r1d	19920101 d2f1333jy.r1h,.r1d
A-3 (0.25 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-3(0.25 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
A-4 (0.1 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-4 (0.1 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
B-1 (0.5)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-2 (0.3)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-3 (1.0)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-4 (BLANK)	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d
C-1 (1.0 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
C-1 (1.0 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
C-2 (0.25x2.0 slit)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
C-3 (2.0-BAR)	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d
C-4 (0.7x2.0-BAR)	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d

Table 11: BLUE RECOMMENDED H57,L15,L65,PRI FLAT FIELD REFERENCE FILES

Aperture	H57	L15	L65	PRISM
A-1 (4.3)	19900101 9ba0959jy.r1h,.r1d	19920101 d2f1332ry.r1h,.r1d	19900101 9ba0959jy.r1h,.r1d	19920101 d2f13332y.r1h,.r1d
A-2 (0.5 pair) UPPER	19900101 9be14405y.r1h,.r1d	19920101 d2f13335y.r1h,.r1d	19900101 9be14405y.r1h,.r1d	19920101 d2f1333cy.r1h,.r1d
A-2 (0.5 pair) LOWER	19900101 9be1440iy.r1h,.r1d	19920101 d2f1333fy.r1h,.r1d	19900101 9be1440iy.r1h,.r1d	19920101 d2f1333*l*y.r1h,.r1d
A-3 (0.25 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-3(0.25 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
A-4 (0.1 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
A-4 (0.1 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
B-1 (0.5)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-2 (0.3)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-3 (1.0)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
B-4 (BLANK)	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d	19920101 d3t1117dy.r1h,.r1d
C-1 (1.0 pair) UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER	SAME AS A-2 UPPER
C-1 (1.0 pair) LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER	SAME AS A-2 LOWER
C-2 (0.25x2.0 slit)	SAME AS A-1	SAME AS A-1	SAME AS A-1	SAME AS A-1
C-3 (2.0-BAR)	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d	19920101 d3t1117ey.r1h,.r1d
C-4 (0.7x2.0-BAR)	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d	19920101 d3t1117gy.r1h,.r1d

Table 12: BLUE RECOMMENDED H13,H19,H27 POLARIZER FLAT FIELD REFERENCE FILES

Aperture	H13-POL B	H19-POL B	H27-POL B
A-1 (4.3) PASS 1	19930608 e5v11159y.r1h,.r1d	19930608 e5v1115dy.r1h,.r1d	19930608 e5v1115iy.r1h,.r1d
A-1 (4.3) PASS 2	19930608 e5v1115ay.r1h,.r1d	19930608 e5v1115ey.r1h,.r1d	19930608 e5v1115jy.r1h,.r1d
B-1 (0.5) PASS 1	19900101 cbj11439y.r1h,.r1d	19900101 cbj1143dy.r1h,.r1d	19900101 cbj1143hy.r1h,.r1d
B-1 (0.5) PASS 2	19900101 cbj1143cy.r1h,.r1d	19900101 cbj1143fy.r1h,.r1d	19900101 cbj1143iy.r1h,.r1d
B-3 (1.0) PASS 1	19930608 e5v1115by.r1h,.r1d	19930608 e5v1115gy.r1h,.r1d	19930608 e5v1115ky.r1h,.r1d
B-3 (1.0) PASS 2	19930608 e5v1115cy.r1h,.r1d	19930608 e5v1115hy.r1h,.r1d	19930608 e5v1115my.r1h,.r1d

Table 13: RED RECOMMENDED H19,H27,H40 POLARIZER FLAT FIELD REFERENCE FILES

Aperture	H19-POL B	H27-POL B	H40-POL A
A-1 (4.3) PASS 1	19930608 e5v11151y.r1h,.r1d	19930608 e5v11154y.r1h,.r1d	19930608 e5v11156y.r1h,.r1d
A-1 (4.3) PASS 2	19930608 e5v11153y.r1h,.r1d	19930608 e5v11155y.r1h,.r1d	19930608 e5v11157y.r1h,.r1d
B-1 (0.5) PASS 1	19900101 9ba09578y.r1h,.r1d	19900101 9ba09578y.r1h,.r1d	19900101 94616585y.r1h,.r1d
B-1 (0.5) PASS 2	19900101 9ba0957jy.r1h,.r1d	19900101 9ba0957jy.r1h,.r1d	19900101 9ba0955sy.r1h,.r1d
B-3 (1.0) PASS 1	19900101 9ba09578y.r1h,.r1d	19900101 9ba09578y.r1h,.r1d	19900101 94616585y.r1h,.r1d
B-3 (1.0) PASS 2	19900101 9ba0957jy.r1h,.r1d	19900101 9ba0957jy.r1h,.r1d	19900101 9ba0955sy.r1h,.r1d

Table 14: RED RECOMMENDED H19,H27,H40,H57 INVERSE SENSITIVITY REFERENCE FILES

Aperture	H19	H27	H40	H57
A-1 (4.3)	19940201 e3h1446by.r2h,.r2d	19940201 e3h1446oy.r2h,.r2d	19940201 e3h14475y.r2h,.r2d	19940201 e3h1447hy.r2h,.r2d
A-2 (0.5 pair) UPPER	19940201 e3h1446dy.r2h,.r2d	19940201 e3h1446qy.r2h,.r2d	19940201 e3h14477y.r2h,.r2d	19940201 e3h1447jy.r2h,.r2d
A-2 (0.5 pair) LOWER	19940201 e3h1446cy.r2h,.r2d	19940201 e3h1446py.r2h,.r2d	19940201 e3h14476y.r2h,.r2d	19940201 e3h1447iy.r2h,.r2d
A-3 (0.25 pair) UPPER	19940201 e3h1446gy.r2h,.r2d	19940201 e3h1446sy.r2h,.r2d	19940201 e3h14479y.r2h,.r2d	19940201 e3h1447my.r2h,.r2d
A-3(0.25 pair) LOWER	19940201 e3h1446ey.r2h,.r2d	19940201 e3h1446ry.r2h,.r2d	19940201 e3h14478y.r2h,.r2d	19940201 e3h1447*l*y.r2h,.r2d
A-4 (0.1 pair) UPPER	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d
A-4 (0.1 pair) LOWER	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d
B-1 (0.5)	19940201 e3h1446hy.r2h,.r2d	19940201 e3h1446ty.r2h,.r2d	19940201 e3h1447ay.r2h,.r2d	19940201 e3h1447ny.r2h,.r2d
B-2 (0.3)	19940201 e3h1446iy.r2h,.r2d	19940201 e3h14470y.r2h,.r2d	19940201 e3h1447by.r2h,.r2d	19940201 e3h1447oy.r2h,.r2d
B-3 (1.0)	19940201 e3h1446jy.r2h,.r2d	19940201 e3h14471y.r2h,.r2d	19940201 e3h1447dy.r2h,.r2d	19940201 e3h1447py.r2h,.r2d
C-1 (1.0 pair) UPPER	19940201 e3h1446*l*y.r2h,.r2d	19940201 e3h14473y.r2h,.r2d	19940201 e3h1447fy.r2h,.r2d	19940201 e3h1447ry.r2h,.r2d
C-1 (1.0 pair) LOWER	19940201 e3h1446ky.r2h,.r2d	19940201 e3h1772y.r2h,.r2d	19940201 e3h1447ey.r2h,.r2d	19940201 e3h1447qy.r2h,.r2d
C-2 (0.25x2.0 slit)	19940201 e3h1446my.r2h,.r2d	19940201 e3h14474y.r2h,.r2d	19940201 e3h1447gy.r2h,.r2d	19940201 e3h1447sy.r2h,.r2d
C-3 (2.0-BAR)	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d
C-4 (0.7x2.0-BAR)	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d

Table 15: RED RECOMMENDED H78,L15,L65,PRI INVERSE SENSITIVITY REFERENCE FILES

Aperture	H78	L15	L65	PRISM
A-1 (4.3)	19940201 e3h1447ty.r2h,.r2d	19940201 e3h1448hy.r2h,.r2d	19940201 e3h14492y.r2h,.r2d	19940201 e3h1449ey.r2h,.r2d
A-2 (0.5 pair) UPPER	19940201 e3h14481y.r2h,.r2d	19940201 e3h1448ky.r2h,.r2d	19940201 e3h14495y.r2h,.r2d	19940201 e3h1449gy.r2h,.r2d
A-2 (0.5 pair) LOWER	19940201 e3h14480y.r2h,.r2d	19940201 e3h1448iy.r2h,.r2d	19940201 e3h14494y.r2h,.r2d	19940201 e3h1449fy.r2h,.r2d
A-3 (0.25 pair) UPPER	19940201 e3h14485y.r2h,.r2d	19940201 e3h1448ny.r2h,.r2d	19940201 e3h14497y.r2h,.r2d	19940201 e3h1449iy.r2h,.r2d
A-3(0.25 pair) LOWER	19940201 e3h14482y.r2h,.r2d	19940201 e3y1448*l*y.r2h,.r2d	19940201 e3h14496y.r2h,.r2d	19940201 e3h1449hy.r2h,.r2d
A-4 (0.1 pair) UPPER	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d	19900101 d3u13522y.r2h,.r2d
A-4 (0.1 pair) LOWER	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d	19900101 d3u13521y.r2h,.r2d
B-1 (0.5)	19940201 e3h14489y.r2h,.r2d	19940201 e3h1448oy.r2h,.r2d	19940201 e3h14498y.r2h,.r2d	19940201 e3h1449jy.r2h,.r2d
B-2 (0.3)	19940201 e3h1448ay.r2h,.r2d	19940201 e3h1448py.r2h,.r2d	19940201 e3h14499y.r2h,.r2d	19940201 e3h1449ky.r2h,.r2d
B-3 (1.0)	19940201 e3h1448cy.r2h,.r2d	19940201 e3h1448ry.r2h,.r2d	19940201 e3h1449ay.r2h,.r2d	19940201 e3h1449*l*y.r2h,.r2d
C-1 (1.0 pair) UPPER	19940201 e3h1448ey.r2h,.r2d	19940201 e3h1448ty.r2h,.r2d	19940201 e3h1449cy.r2h,.r2d	19940201 e3h1449oy.r2h,.r2d
C-1 (1.0 pair) LOWER	19940201 e3h1448dy.r2h,.r2d	19940201 e3h1448sy.r2h,.r2d	19940201 e3h1449by.r2h,.r2d	19940201 e3h1449my.r2h,.r2d
C-2 (0.25x2.0 slit)	19940201 e3h1448fy.r2h,.r2d	19940201 e3h14491y.r2h,.r2d	19940201 e3h1449dy.r2h,.r2d	19940201 e3h1449py.r2h,.r2d
C-3 (2.0-BAR)	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d
C-4 (0.7x2.0-BAR)	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d	19931226 e1p0834gy.r2h,.r2d

Table 16: BLUE RECOMMENDED H13,H19,H27,H40 INVERSE SENSITIVITY REFERENCE FILES

Aperture	H13	H19	H27	H40
A-1 (4.3)	19940201 e3h1449qy.r2h,.r2d	19940201 e3h14508y.r2h,.r2d	19940201 e3h1450ky.r2h,.r2d	19940201 e3h14512y.r2h,.r2d
A-2 (0.5 pair) UPPER	19940201 e3h1449sy.r2h,.r2d	19940201 e3h1450ay.r2h,.r2d	19940201 e3h1450my.r2h,.r2d	19940201 e3h14514y.r2h,.r2d
A-2 (0.5 pair) LOWER	19940201 e3h1449ry.r2h,.r2d	19940201 e3h14509y.r2h,.r2d	19940201 e3h1450*l*y.r2h,.r2d	19940201 e3h14513y.r2h,.r2d
A-3 (0.25 pair) UPPER	19940201 e3h14501y.r2h,.r2d	19940201 e3h1450cy.r2h,.r2d	19940201 d3h1450oy.r2h,.r2d	19940201 e3h14517y.r2h,.r2d
A-3(0.25 pair) LOWER	19940201 e3h1449ty.r2h,.r2d	19940201 e3h1450by.r2h,.r2d	19940201 e3h1450ny.r2h,.r2d	19940201 e3h14516y.r2h,.r2d
A-4 (0.1 pair) UPPER	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d
A-4 (0.1 pair) LOWER	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d
B-1 (0.5)	19940201 e3h14502y.r2h,.r2d	19940201 e3h1450ey.r2h,.r2d	19940201 e3h1450py.r2h,.r2d	19940201 e3h14518y.r2h,.r2d
B-2 (0.3)	19940201 e3h14503y.r2h,.r2d	19940201 e3h1450fy.r2h,.r2d	19940201 e3h1450qy.r2h,.r2d	19940201 e3h14519y.r2h,.r2d
B-3 (1.0)	19940201 e3h14504y.r2h,.r2d	19940201 e3h1450gy.r2h,.r2d	19940201 e3h1450ry.r2h,.r2d	19940201 e3h1451ay.r2h,.r2d
C-1 (1.0 pair) UPPER	19940201 e3h14506y.r2h,.r2d	19940201 e3h1450iy.r2h,.r2d	19940201 e3h14510y.r2h,.r2d	19940201 e3h1451cy.r2h,.r2d
C-1 (1.0 pair) LOWER	19940201 e3h14505y.r2h,.r2d	19940201 e3h1450hy.r2h,.r2d	19940201 e3h1450ty.r2h,.r2d	19940201 e3h1451by.r2h,.r2d
C-2 (0.25x2.0 slit)	19940201 e3h14507y.r2h,.r2d	19940201 e3h1450jy.r2h,.r2d	19940201 e3h14511y.r2h,.r2d	19940201 e3h1451dy.r2h,.r2d
C-3 (2.0-BAR)	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d
C-4 (0.7x2.0-BAR)	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d

Table 17: BLUE RECOMMENDED H57,L15,L65,PRI INVERSE SENSITIVITY REFERENCE FILES

Aperture	H57	L15	L65	PRISM
A-1 (4.3)	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451fy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451ty.r2h,.r2d
A-2 (0.5 pair) UPPER	19900101 d3u13528y.r2h,.r2d	19940201 e3h1451jy.r2h,.r2d	19900101 d3u13528y.r2h,.r2d	19940201 e3h14521y.r2h,.r2d
A-2 (0.5 pair) LOWER	19900101 d3u13527y.r2h,.r2d	19940201 e3h1451iy.r2h,.r2d	19900101 d3u13527y.r2h,.r2d	19940201 e3h14520y.r2h,.r2d
A-3 (0.25 pair) UPPER	19900101 d3u1352ay.r2h,.r2d	19940201 e3h1451*l*y.r2h,.r2d	19900101 d3u1352ay.r2h,.r2d	19940201 e3h14525y.r2h,.r2d
A-3 (0.25pair) LOWER	19900101 d3u13529y.r2h,.r2d	19940201 e3h1451ky.r2h,.r2d	19900101 d3u13529y.r2h,.r2d	19940201 e3h14522y.r2h,.r2d
A-4 (0.1 pair) UPPER	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d	19900101 d3u1352cy.r2h,.r2d
A-4 (0.1 pair) LOWER	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d	19900101 d3u1352by.r2h,.r2d
B-1 (0.5)	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451my.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19940201 e3h14526y.r2h,.r2d
B-2 (0.3)	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451ny.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19940201 e3h14527y.r2h,.r2d
B-3 (1.0)	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451oy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19940201 e3h14528y.r2h,.r2d
C-1 (1.0 pair) UPPER	19900101 d3u1352ey.r2h,.r2d	19940201 e3h1451qy.r2h,.r2d	19900101 d3u1352ey.r2h,.r2d	19940201 e3h1452by.r2h,.r2d
C-1 (1.0 pair) LOWER	19900101 d3u1352dy.r2h,.r2d	19940201 e3h1451py.r2h,.r2d	19900101 d3u1352dy.r2h,.r2d	19940201 e3h1452ay.r2h,.r2d
C-2 (0.25x2.0 slit)	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1451sy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19940201 e3h1452dy.r2h,.r2d
C-3 (2.0-BAR)	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d
C-4 (0.7x2.0-BAR)	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d	19931226 e1p0834hy.r2h,.r2d

Table 18: BLUE RECOMMENDED H13,H19,H27 POLARIZER INVERSE SENSITIVITY REFERENCE FILES

Aperture	H13-POL B	H19-POL B	H27-POL B
A-1 (4.3) PASS 1	19930608 e5r1452ky.r2h,.r2d	19930608 e5r1452oy.r2h,.r2d	19930608 e5r1452ty.r2h,.r2d
A-1 (4.3) PASS 2	19930608 e5r1452*l*y.r2h,.r2d	19930608 e5r1452py.r2h,.r2d	19930608 e5r14531y.r2h,.r2d
B-1 (0.5) PASS 1	19900101 d4s10346y.r2h,.r2d	19900101 d4s10348y.r2h,.r2d	19900101 d4s1034ay.r2h,.r2d
B-1 (0.5) PASS 2	19900101 d4s10347y.r2h,.r2d	19900101 d4s10349y.r2h,.r2d	19900101 d4s1034by.r2h,.r2d
B-3 (1.0) PASS 1	19930608 e5r1452my.r2h,.r2d	19930608 e5r1452qy.r2h,.r2d	19930608 e5r14532y.r2h,.r2d
B-3 (1.0) PASS 2	19930608 e5r1452ny.r2h,.r2d	19930608 e5r1452ry.r2h,.r2d	19930608 e5r14534y.r2h,.r2d

Table 19: RED RECOMMENDED H19,H27,H40 POLARIZER INVERSE SENSITIVITY REFERENCE FILES

Aperture	H19-POL B	H27-POL B	H40-POL A
A-1 (4.3) PASS 1	19930608 e5r1452cy.r2h,.r2d	19930608 e5r1452fy.r2h,.r2d	19930608 e5r1452hy.r2h,.r2d
A-1 (4.3) PASS 2	19930608 e5r1452dy.r2h,.r2d	19930608 e5r1452hy.r2h,.r2d	19930608 e5r1452jy.r2h,.r2d
B-1 (0.5) PASS 1	19900101 d4s1033ky.r2h,.r2d	19900101 d4s1033qy.r2h,.r2d	19900101 d4s10342y.r2h,.r2d
B-1 (0.5) PASS 2	19900101 d4s1033*l*y.r2h,.r2d	19900101 d4s1033ry.r2h,.r2d	19900101 d4s10343y.r2h,.r2d
B-3 (1.0) PASS 1	19900101 d4s1033my.r2h,.r2d	19900101 d4s1033sy.r2h,.r2d	19900101 d4s10344y.r2h,.r2d
B-3 (1.0) PASS 2	19900101 d4s1033ny.r2h,.r2d	19900101 d4s1033ty.r2h,.r2d	19900101 d4s10345y.r2h,.r2d