

# **OPERATIONS MANUAL**

## **DAY-NIGHT WHOLE SKY IMAGER (E/O CAMERA SYSTEM 6)**

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**DRAFT OPERATIONS MANUAL  
(OCT 94)**

**DAY-NIGHT  
WHOLE SKY IMAGER**

(E/O Camera System 6)

This manual summarizes the basic support procedures required for the normal operation of the Day/Night Whole Sky Imager. It is intended as a checklist operational guide for the use of on-site host personnel in performing their periodic inspection and assessment of the system's performance. This draft version describes only the TWP version of the WSI as of 10/94.

System maintenance and trouble shooting instructions are not included in this draft summary note; they will be added to a later draft.

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(E/O Camera System 6)

**Table of Contents**

Points of Contact

1. System Description .....	1
2. Concept of Operations .....	1
3. System Diagram and Descriptions .....	2
4. Subsystem Diagram and Description .....	2
5. Instrument Power-up and Safety Considerations .....	2
6. Instrument Operation .....	8
6.1. Program Start-up and Operation .....	8
6.2. Program Input and Output.....	8
7. Host Personnel Responsibilities Overviews .....	14
8. WSI Operational Checklists .....	15
8.1. Daily Visual Inspections .....	15
8.2. Weekly Data Tape Replacements .....	16
8.3. Weekly Inspections of Solar Occultor .....	19
8.4. Monthly Inspection of Sensor Housing .....	19
8.5. Monthly Removal and Cleaning of Computer's External Air Filter .....	19
9. Maintenance and Troubleshooting Procedures .....	19
10. Packaging and Transport.....	19
11. Spare Parts and Supplies .....	19
12. Utility Programs .....	20
12.1 TESTWSI.....	20
12.2 RTGRAB .....	20
12.3 IMGVIEW .....	20
12.4 EXBACK .....	20
12.5 EXRCVR .....	21

## List of Illustrations

Fig. 3-1	WSI Hardware Block Diagram .....	3
Fig. 3-2	WSI Imager Assembly .....	4
Fig. 4-1	WSI Sensor Subassembly .....	5
Fig. 4-2	WSI Control Console Subassembly .....	6
Fig. 5-1	WSI Interconnection Diagram .....	7
Fig. 6-1	Runwsi24 Initial Screen .....	9
Fig. 6-2	Runwsi24 Display Before First Image Grab .....	10
Fig. 6-3	Runwsi24 Typical Display Format .....	11
Fig. 6-4	Input File for D/N WSI Acquisition Program.....	12
Fig. 8-1	Sample D/N WSI Status File .....	17
Fig. 8-2	Sample D/N WSI Header Table .....	18
Fig. 12-1	EXBACK Menu .....	22
Fig. 12-2	EXRCVR Menu .....	23

## Appendices

A	Program Interrupts for RUNWSI24.....	24
B	RUNWSI24 Input and Output .....	26
C	Changing System Date .....	28



**DAY/NIGHT  
WHOLE SKY IMAGER**  
(E/O Camera System 6)

## **1. System Description**

The Whole Sky Imager (WSI) consists of a computer controlled solid-state digital camera that provides calibrated, multi-spectral imagery suitable for the automatic extraction of local cloud cover, cloud location, and cloud motion information. The images are acquired through a fisheye lens, which images the full upper hemisphere, via spectral and neutral density filters, onto a CCD 16-bit camera.

The controller includes two Accessory Control Panels (ACP), which enable both computer and manual control of the components. A PC-AT clone computer is used for system control and data acquisition.

This version of the documentation describes Unit 3, which is being prepared for delivery to the ARM's TWP site.

## **2. Concept of Operations**

In the field, the WSI units are operated in fully automated mode, acquiring data continuously at 10 minute intervals, 24 hours per day. Raw data are archived continuously. Data processing and data transfer to other computers vary with the system and sponsor.

The system is controlled through an automated data acquisition program. This program is designed to acquire data at 10-minute intervals. Prior to each data acquisition, the program determines the required settings for the spectral and neutral density filters and for the exposure, based on the position of the sun and moon, and the phase and distance of the moon. This process is referred to as the flux control algorithm.

The program also positions the solar/lunar occulter, which is a sun shade to provide stray light protection. Images are grabbed through red and blue filters during the daylight, and open hole under starlight. In addition, a dark image, to characterize the camera dark noise level, is acquired whenever the exposure time is changed. Upon data acquisition, data are saved on tape, and also placed in a location for use by the data processing program.

Data are labeled with headers including information on the time, and the status of the instrument. A number of quality control checks are performed, and the results embedded in the header. In addition, the quality control checks provide yellow and red flags. A yellow flag implies that the sensor may have a condition requiring future repair. A red flag implies that data may be compromised or lost. The monitor supplies red and yellow flag information to the user, along with instructions regarding the repair of the condition.

For the TWP fielding, the system is currently being updated to allow application of data processing programs during the wait interval. These programs will initially compute the opaque cloud cover, and later will be upgraded to include the thin cloud cover. These results will then be transferred to the TWP site's control computer.

### **3. System Diagram and Descriptions**

The basic Whole Sky Imager (WSI) system is contained in two mechanical assemblies, as illustrated in Fig. 3-1. The external and internal assemblies are normally interconnected by a set of 100 foot control cables which provide system power, synchronization and data logging capability. The external assembly (white box) houses and protects the sensor, as illustrated in Fig. 3-2. The internal assembly (blue box) controls the sensor.

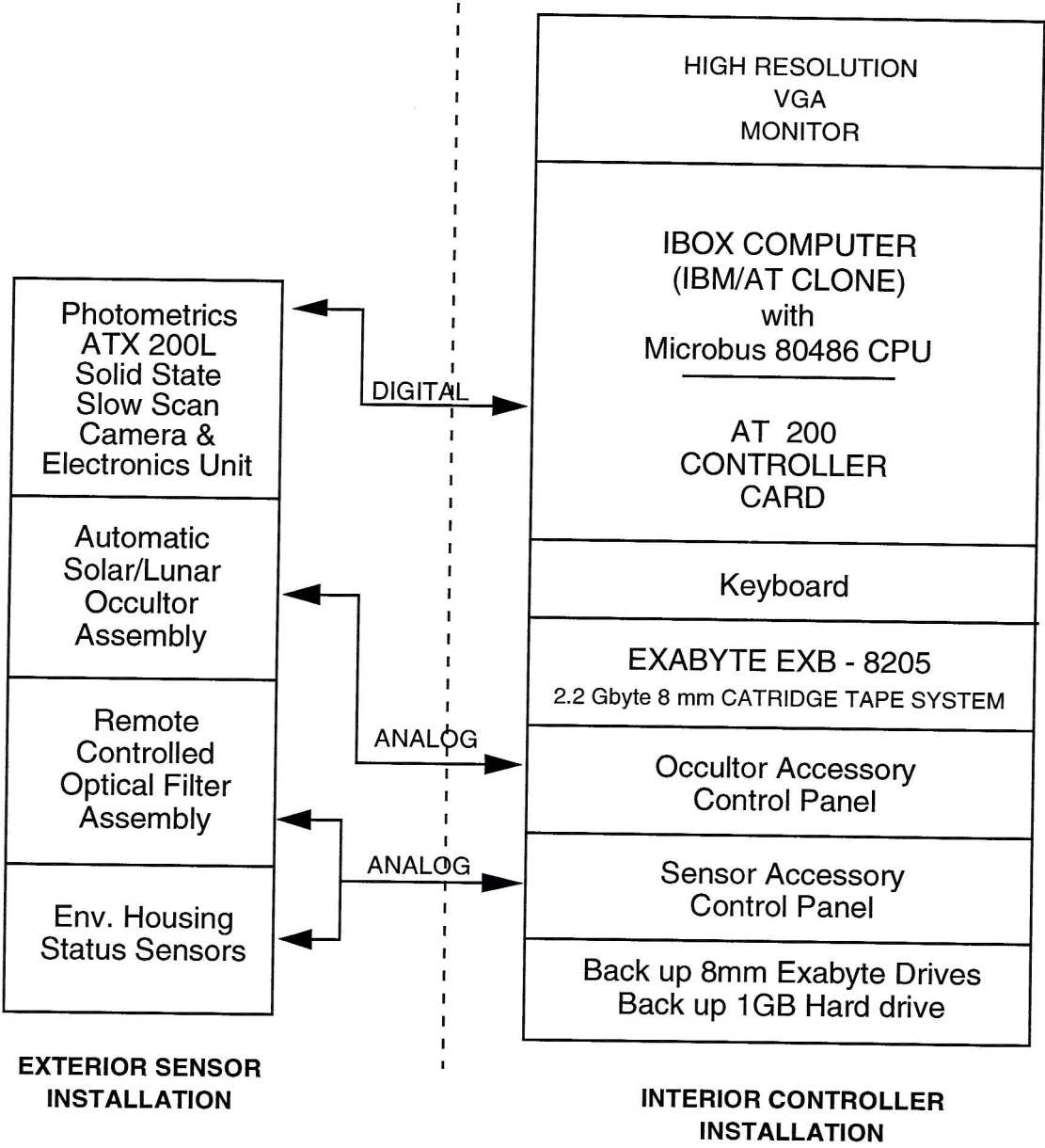
### **4. Subsystem Diagrams and Description**

The sensor system is illustrated in Fig. 4-1. This sensor is packaged in a purged camera housing, and mounted in the environmental housing illustrated earlier. It contains the primary optical elements, i.e. lens, filters, and camera. The control system is illustrated in Fig. 4-2. This system consists of a field hardened computer with specialized boards, accessory control panels for controlling the sensor, and other peripherals.

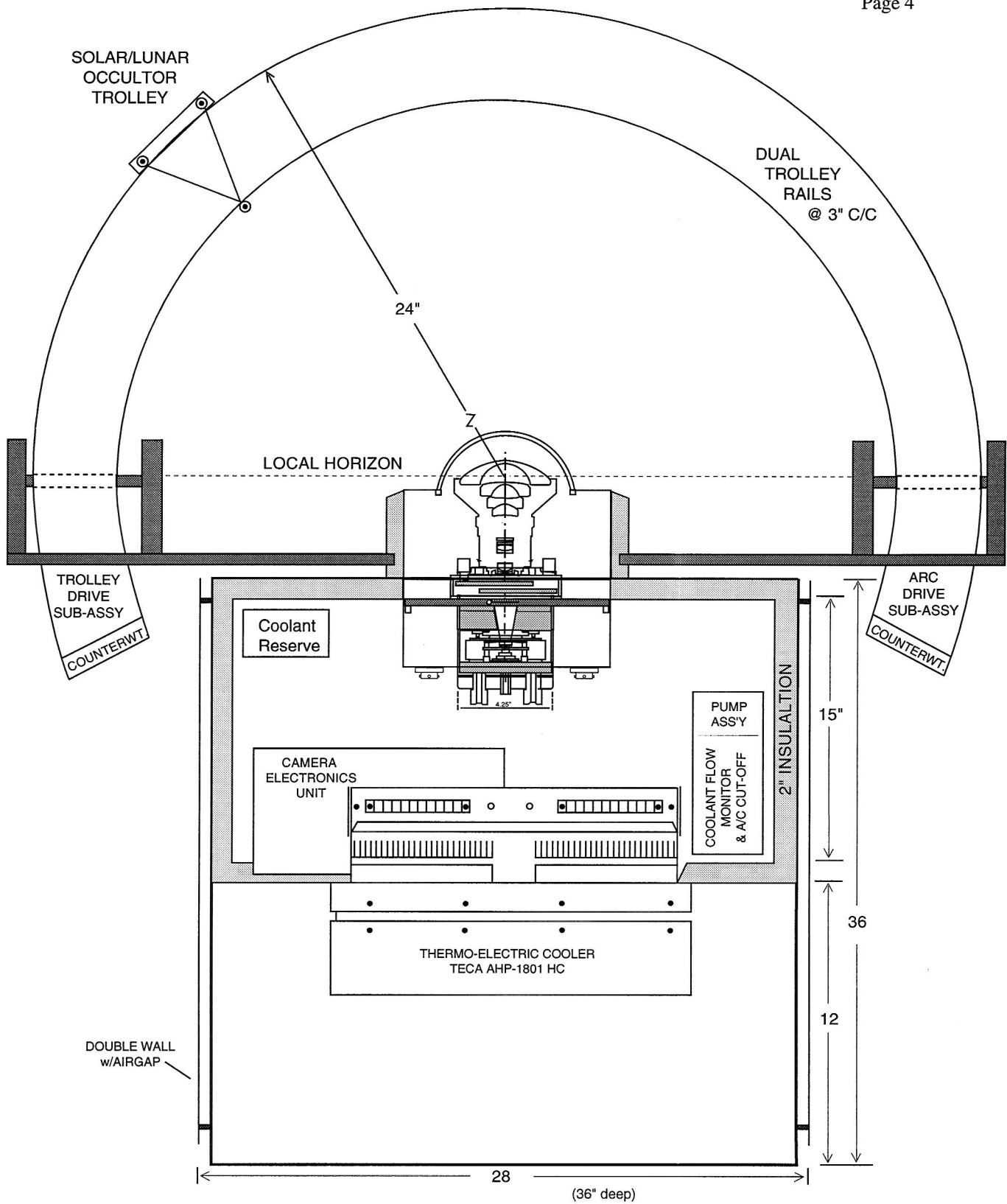
### **5. Instrument Power-up and Safety Considerations**

The internal and external assembly interconnection is illustrated in Fig. 5-1. Each unit must be connected to the specified power source and properly grounded. All interconnections should be verified before power is turned on for the first time. The power on sequence is not critical. Damage to the equipment will not occur as a result of how the unit is turned on.

**DAY/NIGHT WSI  
HARDWARE BLOCK DIAGRAM**



**Figure 3-1**



DAY/NIGHT WHOLE SKY IMAGER ASSEMBLY  
 E/O CAMERA SYSTEM 6A  
 (Approximate Scale)  
 (To be updated)

Figure 3-2



# DAY/NIGHT WSI SENSOR SUBASSEMBLY

## EO CAMERA SYSTEM 6A

(NOT TO SCALE)

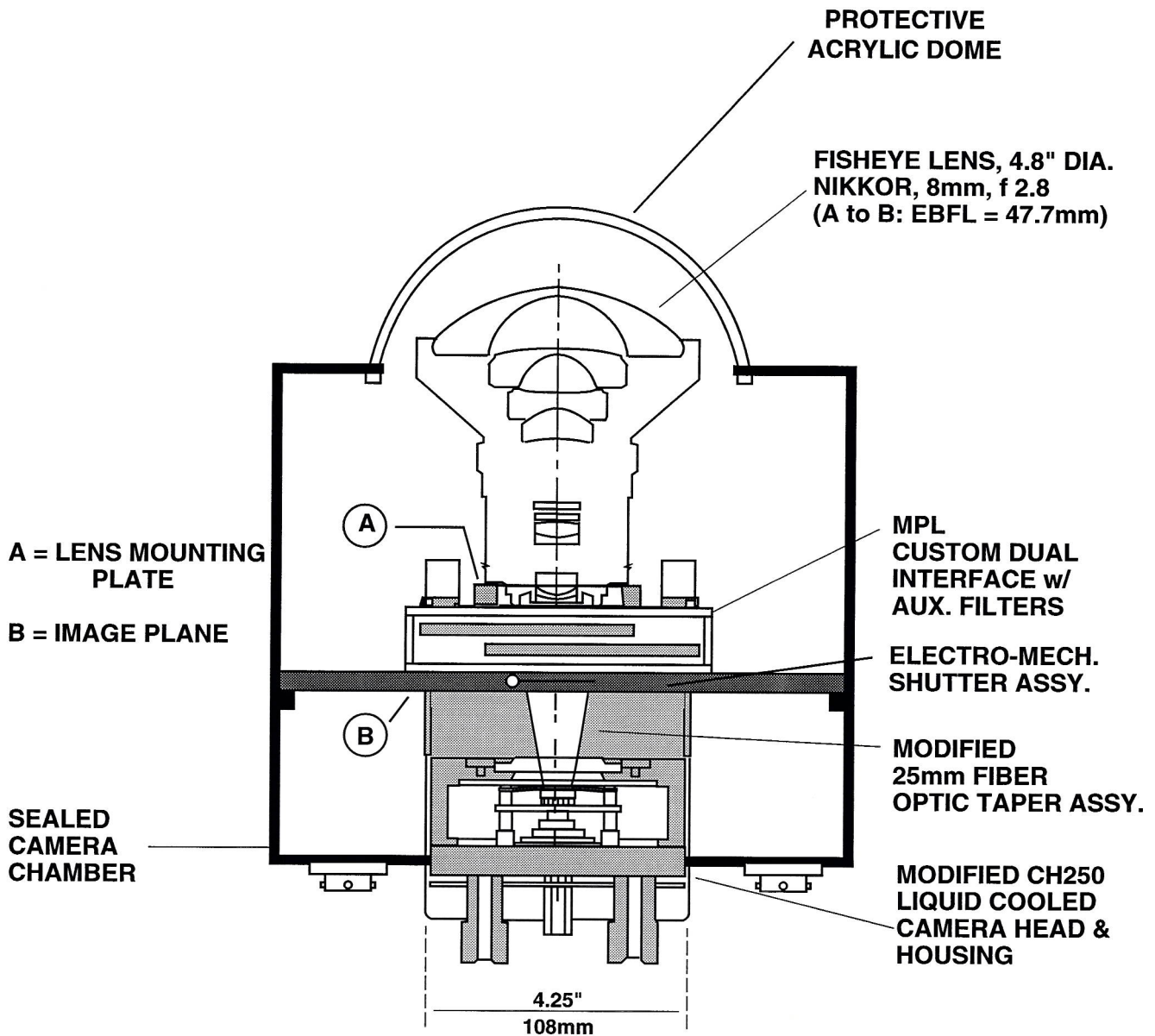
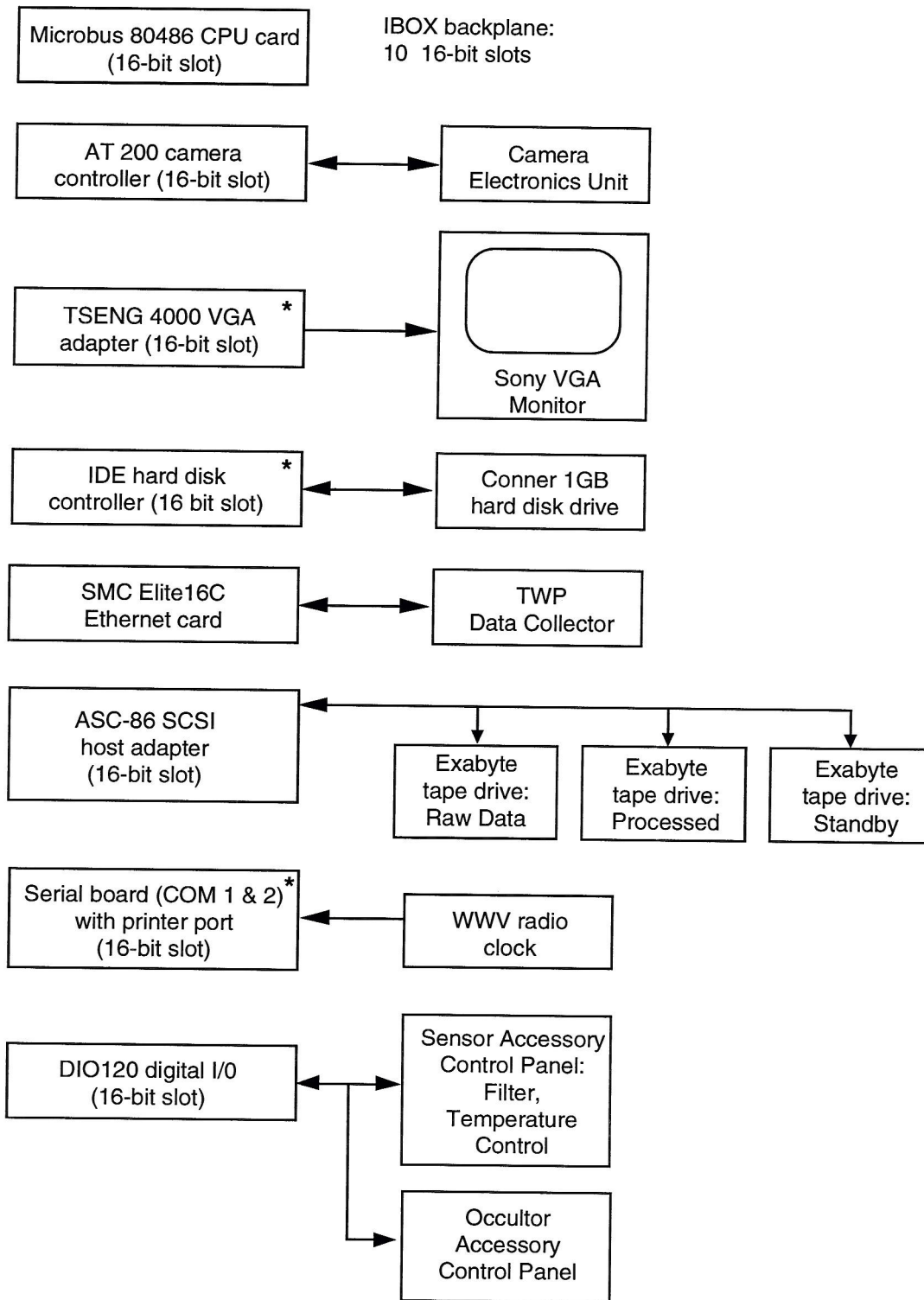


Figure 4-1

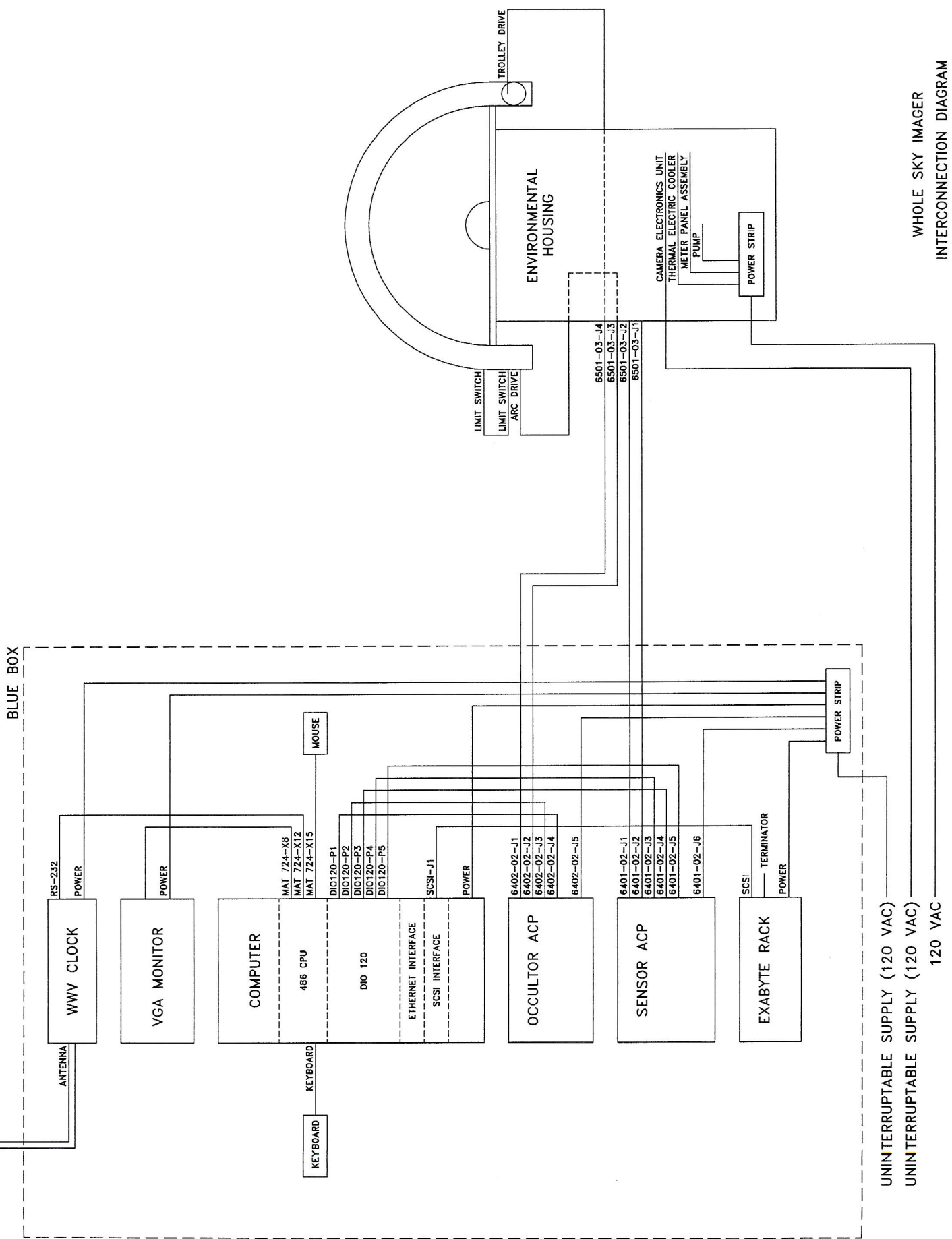


**WSI Control Console Subassembly**

**Figure 4-2**

\*Physically mounted on CPU card





WHOLE SKY IMAGER  
 INTERCONNECTION DIAGRAM

Figure 5-1

## 6. Instrument Operation

### 6.1 Program Start-up and Operation

When power to the Whole Sky Imager is turned on, the OS/2 boot manager screen comes up. You have the option of booting up the OS/2 operating system or the DOS operating system. If a choice isn't made within 30 seconds, the WSI will boot into OS/2. At this point, the WSI automated data acquisition program Runwsi24 is initiated. The screen shown in Fig. 6-1 will be seen briefly on the computer monitor. After the camera and processing functions have been primed automatically by the program, the WSI occulter begins to move to the computed position. You will then see the screen shown in Fig. 6-2. The left side of the screen will be blank because an image has not yet been acquired. The right side of the screen lets the user know the time at which the first image will be grabbed. After an image has been grabbed you will see the screen shown in Fig. 6-3. The thin white line you see at the top of the image is an ASCII encoded header. On the right are some image descriptions. The type of image is listed first. In Fig. 6-3 we see an image taken with the red spectral filter. The date and time the image was grabbed along with the exposure setting, neutral density and spectral filter settings are listed. The scale used to display the image is also shown. A new set of images will be grabbed every 10 minutes, and displayed in the Fig. 6-3 format. The program continues until stopped or interrupted by the user. The program interrupts are illustrated in Appendix A. The program is stopped by hitting "X".

### 6.2 Program Input and Output

The program input that the user has access to consists of the file illustrated in Fig. 6-4. This input file is not normally changed. The program output consists of data tapes. Details of this file and other input files, and the output tapes are described in Appendix B.

RunWSI24 - Automated Day/Night Data Acquisition  
and Ratio Processing Program  
with HotKey options

Version 3.2 01 Sep. 94



Atmospheric Optics Group  
Marine Physical Laboratory  
Scripps Institution of Oceanography  
University of California, San Diego

Uses the Victor Image Processing Library

----- Initializing the camera system and processing functions-----

----- Camera and processing functions ready -----

**Figure 6-1**

Waiting for  
first grab at

Mo/Da/Yr Time  
3/29/93 2239Z

Expose = 100ms  
ND = 3

Figure 6-2



Red Image

Mo/Da/Yr Time  
3/29/93 2239Z

Expose = 100ms  
ND = 3 SP = 3

Min = 1000

Max = 8500

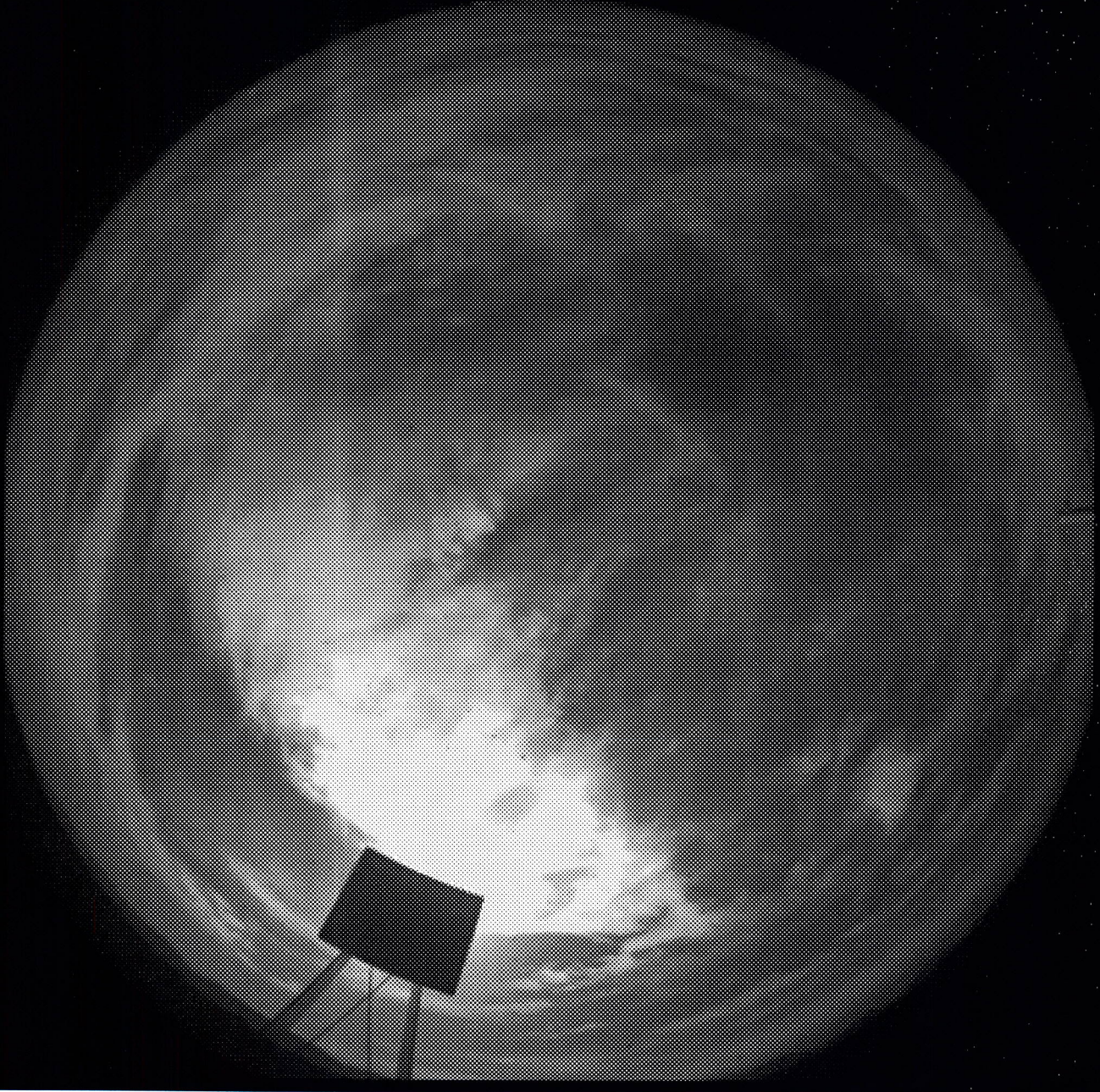


Figure 6-3



Figure 6-4

Input file for Day/Night WSI acquisition program

Location Information

Latitude ----- 32.63  
Longitude ----- 106.33  
Site Identifier ----- HEL  
Hardware vers. ----- 1.0  
Software vers. ----- 2.0

Instrument Factors

Gear Cor (azi) ----- -12.0  
Gear Cor (zen) ----- 1.0  
Camera Azimuth Offset ----- 10.0  
Field Azimuth Offset ----- -6.8  
Image Azimuth Offset ----- 3.2

Acquisition Options

Acquisition interval in minutes ----- 10  
Perform Ratio? ----- 1  
Red/Blue grab? ----- 1  
Exabyte Archive? ----- 1  
Allow hotkey access? ----- 0

Display Options

Autoscale displayed images? ----- 1  
Display target track? ----- 0  
Display geometric overlay? ----- 0

Image Geometric Information

Center X ----- 252  
Center Y ----- 257  
90 Degree Radius ----- 265

Red/Blue Calibration Factors

ND1 ----- 4837.  
ND2 ----- 5430.  
ND3 ----- 4468.

Camera Housing Temperature (°C)

Normal temperature ----- 16  
Yellow flag level ----- > 32  
Red flag level ----- > 49



CCD chip Temperature (°C)

Normal temperature ----- -35  
Yellow flag level ----- > -30  
Red flag level ----- > 0

Environmental Housing Temperature (°C)

Normal temperature ----- 16  
Yellow flag level ----- > 32  
Red flag level ----- > 49

Flow rate (gallons per minute, gpm)

Normal flow rate ----- .25  
Yellow flag level ----- < .125  
Red flag level ----- < .09

Nitrogen Pressure (pounds per square inch, psi)

Normal temperature ----- 5  
Yellow flag level ----- < 2  
Red flag level ----- = 999

Relative Humidity (%)

Normal temperature ----- 20  
Yellow flag level ----- > 50  
Red flag level ----- > 80

## 7. Host Personnel Responsibilities Overview

The WSI system is designed to operate in automatic data acquisition and archival modes with a minimum of operator interaction. Thus, once the system has been installed and initialized by UCSD/MPL technical staff or other trained staff, it requires only those services listed below.

1. Visually inspect system status DAILY. Report abnormalities. This includes:
  - a. Provide daily visual inspection of camera assembly. Wipe or brush optical dome lightly if required to remove snow, heavy dew, thick dust, etc. Clean if necessary with lint-free, non-abrasive cloth and distilled water.
  - b. Provide daily visual inspection of console assembly. Observe monitor to determine normal image quality and solar occulter position.
  - c. If any red or yellow flags are indicated on monitor, follow instructions on monitor.

A more detailed checklist for this inspection is provided in Section 8.1.

2. Remove data tapes & replace WEEKLY and mail to the experimental center.
  - a. Normally, remove and replace tapes in drives 1 and 2.
  - b. Remove and replace tape in drive 3 if it is in use.

A more detailed discussion of this procedure is provided in Section 8.2.

3. Weekly inspection of solar occulter.
  - a. Clean filter on the occulter with lint-free non-abrasive cloth and distilled water.
  - b. Check drive chains for debris and remove any debris.

This procedure is discussed in Section 8.3.

4. Monthly inspection of sensor housing. Report abnormalities.
  - a. Open box and verify desiccant is normal color, replace as required.
  - b. Verify coolant system is full, add distilled water as necessary, and verify flow.
  - c. General visual inspection of sensor and housing.

This procedure is discussed in Section 8.4.

5. Monthly removal and cleaning of computer's external air filter.

This procedure is discussed in Section 8.5.

6. Provide telephone contact with UCSD/MPL or designated personnel in the event of system malfunction, and assist in preliminary fault assessment. Permit intermittent access to site by UCSD/MPL or designated personnel to effect system repair/replacement as required.

Checklists to assist in conducting the tasks listed above are provided in Section 8.

## **8. WSI Operational Checklists**

This section provides detailed information pertaining to the WSI site support discussed in Section 2.

### 8.1 Daily Visual Inspections

1. Camera Assembly (at White Box)
  - a. Wipe or brush optical dome lightly, if required.
  - b. If further dome cleaning is necessary, use distilled water only (not alcohol) and try to avoid rubbing the dome too hard.
  - c. Clear occulter drive chains of debris, if required.
2. Console Assembly (Blue Box)
  - a. Check monitor for normal image quality, e.g. images are being acquired and sky is visible.
  - b. Check monitor image for solar occulter position, i.e., sun's image is either showing through the occulter filter, blocked by the opaque part of the occulter, or blocked by clouds.
  - c. If in doubt of occulter alignment, check solar occulter position at LAN, i.e., support structure vertical, solar image on vertical center line.
  - d. Check monitor for normal image cycle, i.e., one to three spectral frame sequence, followed by stable standby.
  - e. Check image for correct annotation, i.e., time/date and filter ident. If date is incorrect, correct as described in Appendix C.
  - f. Verify filter changer indicator lights on Accessory Control Panel (ACP) are changing during grab sequence.
  - g. Verify Occulter and system status readouts on ACP are changing normally.

3. Diagnostic Check - To be performed on request only
  - a. Hit "S" (for Status) on computer in "Blue Box". If there are no current red or yellow flags, this will show a diagnostic file as illustrated in Fig. 8-1. If there are flags, the program will first show you the flags, with instructions, and then ask if you wish to see this table. After the diagnostic table is shown, the program will ask if you wish to see a header table (Fig. 8-2), which will give more information (ref. Appendix A). The program will then return to data acquisition. Follow the instructions provided on the screen, if any items are flagged.

## 8.2. Weekly Data Tape Replacements (Blue Box)

Each 8 mm tape cassette that is used in the EXB-8205 streaming tape drive is designed to hold approximately 2.2 Gigabytes of data. This is in excess of the amount normally expected from a continuous seven day data collection cycle. Thus the normal operating procedure is to change data tapes every seven days during the normal reset cycle. It is recommended that the tapes be changed on the same day each week, at roughly the same time.

The first drive holds raw data, and the second holds processed data. These will normally be changed every week.

The third drive is a standby drive. It is used in any of the following circumstances.

- a) In the event of an EXB-8205 write failure, the system will transfer to Drive 3.
- b) If a tape is not changed on time, and Drive 1 is full, the system will transfer to Drive 3.
- c) If Drive 3 is full, the system will pre-empt Drive 2.

Change tapes 1 and 2, and tape 3 if required, as follows:

Normal WEEKLY (7 day) reloading sequence.

- a. Push button on tape drive.
- b. Remove data tape from tape drive.
- c. Label tape with end date.
- d. If all lights are flashing, insert the cleaning tape and remove cleaning tape when it is ejected.
- e. Label a NEW data tape with tape drive # and start date.
- f. Insert new data tape into tape drive.

The system will now automatically resume data collection.



**Figure 8-1**  
**Sample Day/Night WSI status file**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date	Time	Img #	Acq Mode	SP Seq	ND	Exp	Cam	CCD	Env	Flow	N2	RH	R	Y
8/18/94	2012W	1	1	341	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2014W	2	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2016W	3	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2018W	4	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2020W	5	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2022W	6	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2024W	7	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2026W	8	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2028W	9	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2030W	10	1	34	1	120000	17	-35	33	0.23	4	20	0	2
8/18/94	2032W	11	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2034W	12	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2036W	13	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2038W	14	1	34	1	120000	17	-35	25	0.23	4	20	0	0
8/18/94	2040W	15	1	34	1	120000	17	-35	25	0.23	4	20	0	0

Column 1,2 Date and Time - Date and time image was grabbed. In this example the source of the time is the WWV clock.

Column 3 Img # - The number of image sets grabbed/image set sequence number

Column 4 Acq mode - Type of image set grabbed. Acq mode 1 - Red, Blue spectral filter grab sequence. Acq mode 2 - Clear filter grab image. The remaining image sets consist only of red and blue images.

Column 5 Sp Seq - Spectral filter sequence used for image set. In this example, image set 1 consists of a red image, blue image and dark image.

Column 6 ND - Neutral density filter used during image acquisition.

Column 7 Exp - Camera exposure in milliseconds

Column 8 Cam - Camera housing temperature (°C)

Column 9 CCD - CCD chip temperature (°C)

Column 10 Env - Environmental housing temperature (°C)

Column 11 Flow - Coolant flow in gallons per minute

Column 12 N2 - Camera housing pressure in pounds per square inch

Column 13 RH - Relative humidity

Column 14 R - Red flag indicator column

Column 15 Y - Yellow flag indicator column In this example, a yellow flag was set at time 2030 because the environmental housing temperature went above 32°C.

**Figure 8-2**  
**Sample Day/Night WSI Header Table**

Site:HEL Lat=32.63 Long=106.33 File:03292239.red Day=29 Month=3 Year=93  
Time=2239Z Exposure=100 ms ND=2 SP=3 Occultor Destination: Arc=123.  
7Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stat  
: N2 pressure=5 Flow rate=.25 Env. Housing Temp=16 CCD Chip Temp=-  
35 Occultor Position: Arc=111.8 Trolley= 99.7 Rel. Humidity= 20  
000000000000 000000000000

Site:HEL Lat=32.63 Long=106.33 File:03292239.blu Day=29 Month=3 Year=93  
Time=2239Z Exposure=100 ms ND=2 SP=4 Occultor Destination: Arc=123.  
7Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stat  
: N2 pressure=5 Flow rate=.25 Env. Housing Temp=16 CCD Chip Temp=-  
35 Occultor Position: Arc=111.8 Trolley= 99.7 Rel. Humidity= 20  
000000000000 000000000000

Site:HEL Lat=32.63 Long=106.33 File:03292239.drk Day=29 Month=3 Year=93  
Time=2239Z Exposure=100 ms ND=2 SP=1 Occultor Destination: Arc=123.  
7Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stat  
: N2 pressure=5 Flow rate=.25 Env. Housing Temp=16 CCD Chip Temp=-  
35 Occultor Position: Arc=111.8 Trolley= 99.7 Rel. Humidity= 20  
000000000000 000000000000



### 8.3. Weekly Inspection of Solar Occultor (at White Box)

- a. Clean filter on occultor with lint-free non-abrasive cloth and distilled water.
- b. Check drive chains for debris and remove any debris.
- c. Check occultor operation for any apparent abnormalities; do chains appear to be moving normally.
- d. Verify that occultor flag is shadowing dome.

### 8.4 Monthly Inspection of Environmental Housing (White Box)

- a. Open box and verify desiccant is normal color, replace as required.
- b. Verify coolant system is full, add distilled water as necessary, and verify flow.
- c. Is cooler still working normally, i.e. no unusual sounds or indications.
- d. Verify that platform remains secure, and housing is firmly attached to platform.
- e. Check dome for crazing or degradation. Report significant abnormalities.

### 8.5 Monthly Removal and Cleaning of Computer's External Air Filter (in Blue Box)

- a. Check back of computer. If filter appears dirty, remove, wash, and replace it.

## 9. Maintenance and Troubleshooting Procedures

The maintenance procedures for a 6-month preventative maintenance inspection are documented in Technical Note 237, "Maintenance and Trouble Shooting Manual". Tech Note 237 also provides troubleshooting and repair procedures.

## 10. Packaging and Transport - TBD

## 11. Spare Parts and Supplies - TBD

## 12. Utility Programs

12.1 TESTWSI – for interactive WSI control - TBD

12.2 RTGRAB – for real time image grabs - TBD

12.3 IMGVIEW – for viewing and evaluation of saved images - TBD

12.4 EXBACK – for system backup to exabyte

The EXBACK program can be used to archive the contents of the WSI hard disk drive. Listed below are instructions for using EXBACK. Figure 12-1 shows the EXBACK menu.

### EXBACK Instructions

Type EXBACK then press return.

To see the EXBACK options press the ESC key.

Enter your options at the selection line.

To save the entire hard drive use the 'd' option

If you wish to archive data to a tape that already contains some files that you wish to keep, use the 'a' option.

If you do not want to keep the files that are on the tape use the 'r' option to rewind the tape first. The 'a' or append option is the default.

To enter the path name of the files to save, specify the 'e' option.

EXBACK can be issued commands through the command line.

The following are examples of command line executions of EXBACK:

- 1) EXBACK -r \*.\*           rewind the tape and archive all files in the current directory.  
No subdirectories will be saved.
- 2) EXBACK -a d:/util/\*.\*   search for end of data on tape , then archive all of d:/util  
directory.
- 3) EXBACK -rd \*.\*           archive all of current disk partition. For example if you are  
in the D drive, all of the D drive will be archived, including  
subdirectories. Similarly if you are in the C drive all the C  
drive will be archived, including subdirectories.

## 12.5 EXRCVR – for Exabyte tape recovery to system disk

Use the EXRCVR program to recover files archived to tape via the EXBACK program. Figure 12-2 shows the EXRCVR menu.

### EXRCVR Instructions

Type EXRCVR then press return

You should now see the menu of EXRCVR options.

To obtain a listing of an archive tapes contents, written to the hard disk as file 'DIR.LST', use the 'dw' option.

Use the 'p' option to write the files to the same directory they were archived from.

Use the 'h' option to recover only one file.

Use the 't' option when you have archived more than one version of the same file, but want the most recent version.

Like the EXBACK program, EXRCVR can be executed using the command line format. The following are examples of EXRCVR sessions:

- 1) EXRCVR -rwd \*.\*           rewind tape, then create a DIR.LST of the tape contents
- 2) EXRCVR -r c:/msdos/\*.\*   rewind tape, recover all files from the c:/msdos directory
- 3) EXRCVR -h \*.red           recover the first file with a '.red' filename extension

EXBACK. Version 5.4 -- 28 February 1990  
This program will copy information from disk to tape.

WARNING: EXBACK can overwrite existing data.  
If you want to continue press the <<ESC>> key.

```
| | Marine Physical Laboratory - Optical Systems Group
| | Scripps Institute of Oceanography
|--|---| University of California, San Diego
|
| 28 February 1990 - All Rights Reserved.
| Version 5.4.
```

Options:

- (a) Append to tape--has precedence over -r.
- (b) Mark file as backed up (archived).
- (c) Check archive. Back up if necessary.
- (d) Back up all of disk starting from root directory.
- (e) Enter file name/pattern.
- (q) Quit.
- (r) Rewind tape first.
- (u) Set options to default.

Press <<<ESC>>> to begin writing to tape.

Options set: -a  
Files & Patterns: (none)

**Figure 12-1**  
**EXBACK Menu**

EXRCVR.      Version 5.4 --    28 February 1990

```
| | | Marine Physical Laboratory - Optical Systems Group
| | | Scripps Institute of Oceanography
|--|---| University of California, San Diego
|
| 28 February 1990 - All Rights Reserved.
| Version 5.4.
```

Options:

- (d) Tape directory. No file recovery.
- (q) Quit.
- (e) Enter 1 file name/pattern.
- (r) Rewind tape first.
- (h) Halt after 1 file is recovered.
- (s) Recover to drive file was saved from.
- (n) No overwrite.
- (t) Recover if time most recent.
- (p) Recover with directory preserved.
- (u) Unset all set options.
- (w) Writes directory listing to: DIR.LST. Can only be used with 'd' option.

Press <<<ESC>>> to transfer files from tape to disk.

Options set: -

Files & Patterns:      (none)

Enter Selection:

**Figure 12-2**  
**EXRCVR Menu**