OPERATIONS MANUAL

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

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(JUL 96)

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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 version applies to EO6 Field Units 3, 4, and 5.

System maintenance and trouble shooting instructions are included in Technical Note 241.

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1. Introduction

The Whole Sky Imager (WSI) is an automated imager used for assessment and documentation of the sky, cloud fields, and cloud field dynamics. The WSI is a ground-based electronic imaging system, which monitors the upper hemisphere. It is a passive, i.e. non-emissive, system which acquires multi-spectral images of the sky dome.

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 sensor system in its environmental housing is shown in Fig. 1-1. 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. The controller is shown in Fig. 1-2.

The WSI measures the sky radiance in approximately 1/3° increments over the entire sky dome. The measurements are made in two narrow spectral regions centered at 650 nm and 450 nm. The sky radiances are acquired as two 16-bit images and are used to determine the presence of opaque clouds and thin clouds in the line of sight on a pixel-by-pixel basis. These cloud cover and cloud distribution data will be used for studies of cloud radiative forcing and feedback mechanisms and in understanding relationships between the cloud field and incoming solar radiation at the surface. The current WSI model (EO System 6) is capable of image acquisition under daylight, moonlight and starlight conditions.

The purpose of this manual is to provide information needed for routine operation of the WSI in the field. Its emphasis is on the normal mechanical operation of the WSI in full automated mode. Technical Note 241, "Maintenance and Trouble Shooting Manual", provides details on long-term maintenance, trouble shooting, and repair. Technical Note 243, "Theory of Operations and Interactive Optimization" will give more details on the theory of operations and on optimizing the use of the WSI in interactive mode. The operating manuals which come with purchased items such as pumps and chillers are delivered with each system, and should be referred to for more detail regarding such components.

This version of the documentation describes Field Units 3 - 5, delivered in 1995.
Figure 1-1 WSI Sensor System in its Environmental Housing

Figure 1-2 WSI Controller System
2. System Diagram and Description

The basic Whole Sky Imager (WSI) system is contained in two mechanical assemblies, as illustrated in Fig. 2-1. The external and internal assemblies are 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. 2-2. The internal assembly (blue box) controls the sensor.

The camera system sensor system is illustrated in Fig. 2-3. 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. 2-4. This system consists of a field hardened computer with specialized boards, accessory control panels for controlling the sensor, and other peripherals.

The radiances images are acquired through a Nikkor 8mm f/2.8 fisheye lens. The lens has a full 180° field of view for viewing the complete sky dome simultaneously. The lens has equi-distant projection, i.e. the zenith angle in object space is nearly linear with respect to the position of the corresponding pixel in image space.

In order for the WSI to acquire images under all possible lighting conditions (sunlight, moonlight, and starlight), it must be able to handle an approximately 9 decade range of lighting. To help accomplish this, a neutral density (ND) filter wheel containing 2 and 3 log ND filters is positioned between the lens and CCD imaging chip. The spectral filter wheel containing the red (650 nm) and blue (450 nm) filters is also positioned between the lens and CCD chip.

The imaging camera is a Photometrics Slow Scan CCD. This camera has very low noise, outstanding sensitivity characteristics, and produces a high quality image. Its 16-bit digitization (approximately 4 log range) allows for fine radiometric resolution.

To prevent direct sunlight or moonlight from hitting the protective dome covering the lens and producing artifacts in the image from scattering, a solar/lunar occultor is actively positioned between the sun/moon and dome. The occultor has drive controls for two degrees of freedom and is automatically positioned in the correct place by the controlling computer. The central portion of the occultor contains a 4 log ND filter which allows detection of the sun and moon.
DAY/NIGHT WSI

HARDWARE BLOCK DIAGRAM

Photometrics
ATX 200L
Solid State
Slow Scan
Camera &
Electronics Unit

Automatic
Solar/Lunar
Occultor
Assembly

Remote
Controlled
Optical Filter
Assembly

Env. Housing
Status Sensors

EXTERIOR SENSOR
INSTALLATION

HIGH RESOLUTION
VGA
MONITOR

IBOX COMPUTER
(IBM/AT CLONE)
with
Microbus 80486 CPU

AT 200
CONTROLLER
CARD

Keyboard

EXABYTE EXB - 8205
2.2 Gbyte 8 mm CARTRIDGE TAPE SYSTEM

Occultor Accessory
Control Panel

Sensor Accessory
Control Panel

Back up 8mm Exabyte Drives
Back up 1GB Hard drive

INTERIOR CONTROLLER
INSTALLATION

DIGITAL

ANALOG

ANALOG

Figure 2-1
DAY/NIGHT WHOLE SKY IMAGER ASSEMBLY
E/O CAMERA SYSTEM 6A
(Approximate Scale)
(To be updated)

Figure 2-2
DAY/NIGHT WSI SENSOR SUBASSEMBLY

EO CAMERA SYSTEM 6A

(NOT TO SCALE)

PROTECTIVE ACRYLIC DOME

FISHEYE LENS, 4.8" DIA.
NIKKOR, 8mm, f 2.8
(A to B: EBFL = 47.7mm)

A = LENS MOUNTING PLATE
B = IMAGE PLANE

SEALED CAMERA CHAMBER

MPL CUSTOM DUAL INTERFACE w/ AUX. FILTERS

ELECTRO-MECH. SHUTTER ASSY.

MODIFIED 25mm FIBER OPTIC TAPER ASSY.

MODIFIED CH250 LIQUID COOLED CAMERA HEAD & HOUSING

Figure 2-3
Microbus 80486 CPU card (16-bit slot)  

AT 200 camera controller (16-bit slot) -> Camera Electronics Unit  

TSENG 4000 VGA adapter (16-bit slot) -> Sony VGA Monitor  

IDE hard disk controller (16-bit slot) -> Conner 1GB hard disk drive  

SMC Elite16C Ethernet card -> TWP Data Collector  

ASC-86 SCSI host adapter (16-bit slot) -> Exabyte tape drive: Raw Data, Exabyte tape drive: Processed, Exabyte tape drive: Standby  

Serial board (COM 1 & 2) with printer port (16-bit slot) -> WWV radio clock  

DIO120 digital I/O (16-bit slot) -> Sensor Accessory Control Panel: Filter, Temperature Control, Occultor Accessory Control Panel  

WSI Control Console Subassembly  

Figure 2-4  

*Physically mounted on CPU card

cr.113.hdware diag
3. Concept of Operations

In the field, the WSI units are operated in fully automated mode, acquiring data continuously 24 hours per day. Raw data are archived continuously. Data processing and data transfer to other computers vary with the system and sponsor. Data acquisition rates may be varied. Typically, data are acquired every 10 minutes when the system is used for building climatological records over many years, and data are acquired up to once a minute for test support.

The system is controlled through an automated data acquisition program. This program is illustrated in Fig. 3-1 and discussed in more detail in Technical Note 243. This program is designed to acquire data at 10-minute (or user-defined) 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 occultor, 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 may be placed in a location for transfer to a second computer managed by site personnel.

Data are labeled with headers including location, 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. In addition, diagnostic files are made available for transfer.

Data processing may occur, at the user’s option, during the wait interval. Data processing will initially compute the opaque cloud cover, and later will be upgraded to include the thin cloud cover. These results may then be transferred to the site’s computer.
Read inputs and initialize program and hardware

Initialize occultor and filter positions and exposure

Acquire images

Perform diagnostic checks

Compute ratio and cloud decision if required

Archive data to tape

Perform networking functions

Compute new occultor position and move occultor

Compute flux control and select filters and exposure

Fig. 3-1 Run WSI Overview Flowchart
4. Sub-system Descriptions

This section provides more information on the hardware, its characteristics, and how it is designed to work. Sections 4.1 through and 4.4 discuss the primary characteristics of the external sensor assembly shown in Fig 2-2. Sections 4.5 through 4.8 discuss the primary characteristics of the internal controller assembly shown in Fig 2-4.

4.1 Camera Housing Subsystem

As illustrated in Fig. 2-3, the camera housing contains the fisheye lens, the filter changer, a shutter, and the camera with fiber optic taper. The camera housing is an o-ring-sealed chamber which is purged with dry nitrogen to protect the components from water vapor. The camera housing is shown in Fig. 4-1. In this image, the black cylinder is the camera housing. The back of the camera and its electrical and coolant connections may be seen on the right. A pressure indicator and filter changer cable also enter at the bottom of the camera housing (on the right in this test) and are seen in more detail in Fig. 4-2. The top end is shown on the left in Fig. 4-1, with the fisheye lens and protective dome. Figure 4-3 shows the top end as it looks when the camera housing is fielded.

Physical Characteristics of Camera Housing

Camera Housing: MPL fabrication
Size: 10” diameter x 12.5” high (including dome and camera)
Dome: 7” acrylic

4.1.1 Fisheye Lens

The fisheye lens is an 8 mm f/2.8 lens with full 180 degree field of view. Its geometric mapping is equidistant, i.e. the relative distance from the center of the image is linearly related to the zenith angle. When the image is transferred to the chip (Secn. 4.1.5) via the optical fiber taper (Secn. 4.1.4), the full optical image is contained on the chip, so that the horizon may be imaged in all directions (i.e. the image underfills, rather than overfills, the chip). The lens aperture is variable under manual control prior to assembly, and is normally set to f/2.8. The lens also includes a filter wheel, which is left set on a LiBC (nearly clear) filter.

Physical Characteristics of Fisheye Lens

Lens: Fisheye-Nikkor 8 mm f/2.8
Field of View: 180-182°

4.1.2 Filter Changer

The filter changer holds 2 filter wheels, and each wheel has 4 positions. The filter changer also includes a filter changer shroud, for stray light control, and a lens mount. The filter changer, mounted on the upper camera housing bulkhead plate, is shown in the left half of Fig. 4-4.
Figure 4-1  WSI Camera Housing, Side View

Figure 4-2  WSI Camera Housing, Bottom View
Figure 4-3  WSI Camera Housing as fielded in Environmental Housing

Figure 4-4  Filter Changer on Upper Camera Housing Bulkhead Plate (left) and Shutter on Lower Camera Housing Bulkhead Plate (right)
The filter wheels contain spectral filters in one wheel, and neutral density filters in the other. The spectral filters enable the system to acquire data appropriate for use in a cloud decision algorithm, and acquire radiometrically accurate data. The neutral density filters assist in adjusting the incoming flux levels in order to keep the signal onscale under varying lighting conditions. The filter positions also include trim filters to match the optical thicknesses of the filters on each wheel, in order to preserve image focus and size from one filter to the next. The filters used in the current version of the WSI are listed below.

An additional IR cutoff filter is also placed between the filter changer and the shutter, to block light from the LEDs used in controlling the filter wheels. The automated selection of the filters will be discussed in Technical Note 243.

Physical Characteristics of Filters and Filter Changer

Filter Changer: Fabricated by MPL
Spectral Wheel:
1 Blocked
2 Open
3 Red (650 nm peak, 70 nm passband) Oriel 57610
4 Blue (450 nm peak, 70 nm passband) Oriel 57530

Neutral Density Wheel:
1 Open
2 2-log neutral density Oriel 50840 (.01 transmittance)
3 3-log neutral density Oriel 50850 (.001 transmittance)
4 Open

IR Cutoff Filter: Oriel 95060

4.1.3 Shutter

The shutter is an electronic shutter, which is controlled by the program via the Photometrics Camera Electronics Unit. The shutter, mounted on the lower camera housing bulkhead plate, is shown in the right half of Fig. 4-4. The program corrects for the shutter open/shut times, which are typically 16 ±1 msec. A minimum time of 100 msec is used for exposures normally, in order to minimize any uncertainty due to variations in shutter opening time. While the shutter opening time is longer in the center of the shutter than near the edge, this difference does not affect the image, because the shutter is not at an image plane in the optical train. The automated selection of the exposure time will be discussed in Technical Note 243.

4.1.4 Fiber Optic Taper

The fiber optic taper is designed to minimize the size of the image, and transfer it down to the camera CCD chip. The requirement for size reduction results from the need to show the full image within the chip, rather than overfilling the chip as is often done with fisheye systems. The lens produces an image of 23 mm diameter, and the chip is 10.2 mm square. The requirement for image transfer results from the short back focal length of the lens. In order to acquire spectrally selective data and also be able to adjust flux levels for both day and night, the WSI design required two filter wheels. This takes up much of the back focal length. The taper transfers the image plane down into the camera and onto the chip.
The taper consists of a bundle of fiber bundles which has been heated and stretched to form the taper. The taper is ground and polished to duplicate the shape of the CCD chip (as determined via interferometry) and bonded directly onto the chip by Photometrics. The light is imaged on the large end of the bundle. It transfers down the bundle, where it is deposited onto the pixels and sensed by the CCD.

The fiber bundle was used instead of relay optics in order to maximize light throughput. The quality of the fiber optic bundle is critical, and is well met by the current source.

Physical Characteristics of the Fiber Optic Taber

- Taper: Schott Glass
- Fibers per Pixel: 5
- Size: Approx. 25 mm to 11 mm reducer

4.1.5 Camera

The camera is a CCD digital camera produced by Photometrics. It includes the fiber optic bonding discussed in Section 4.1.4. With 16 bits resolution, the camera has a large dynamic range. As a result of this large dynamic range, the full sky image is normally onscale, even though the sky brightness varies significantly over the sky. The 16-bit resolution also provides high radiometric resolution in the signal. The camera has very low noise. With a readout noise of only 1.6 counts (out of 65,536) and a dark current variance of only 18 at 1 minute integration, the camera performs near the theoretical limit (Shot noise); it is shot noise-limited over most of the data acquisition conditions encountered by the WSI.

Physical Characteristics of the Camera

- Camera: Photometrics ATC200L-16/40
- CCD: Thomson TH7895B, Grade 1
- Size: 512 x 512 pixels
- Digitization: Digital, 16 bits
- Readout: 40,000 pixels/second
- Thermoelectrically cooled camera head
- Camera Electronics Unit
- 25 mm to 11 mm fiber optic reducer
- Temperature readout with buffer

4.1.6 Overall Calibration Performance

The sensor is very linear with low noise, high precision, and very large dynamic range. The image uniformity is quite good, although limited somewhat by the use of the optical fiber taper. The figures below are based on the first calibration set, and may vary slightly with other calibration sets. The first 7 terms below relate to the radiometric performance. The last 3 terms in this list relate to the geometric or size calibrations. The average deviation from equi-distant is the average difference between the zenith angle represented by a pixel and the zenith angle of an equi-distant lens. That is, it is the average difference between the actual zenith angle and the zenith angle which would occur if the zenith angle and pixel position along the radius of the image were linearly related.
Performance Characteristics

Dynamic Range (overall): 10.6 log or 4000000000:1
Dynamic Range (single image): 45800:1
Readout Noise: 1.6 counts out of 65,536 grey levels
Dark Current Variation at 1 min integration: 18 counts
Uniformity (Spatial Variation): 1.6%
Precision (Temporal Variation): 0.2%
Linearity: 1% up to signal 10,000; 3% up to signal 50,000
Field of View: 181°
Pixel Resolution: .36
Avg. Deviation from Equi-Distant: 1.2°

4.2 Cooling Subsystem

The cooling subsystem, housed in the environmental housing, is designed to bleed off the heat from the camera chip’s thermo-electric cooler and to keep the camera electronics cool. Figs. 4-5 and 4-6 show conceptual views of the cooling system. Fig. 4-5 shows a front view of the components, and Fig. 4-6 shows the layout of the upper chamber shelf. The TECA cooler recirculates the air in the upper chamber of the environmental housing, sucking it in the top of the cooler and blowing it out the sides. On one side, it cools the camera electronics unit (CEU) directly; on the other side it cools a radiator as well as the general chamber.

The cooling system may be seen in Fig. 4-7 and 4-8. In Fig. 4-8, taken during installation, the camera is not yet linked into the cooling, but one can see the reservoir (upper left), pump (lower left), flow switch, flow meter, and temperature controller (center, lower right, middle right). The TECA is the large component with the perforated top, and the radiator is mostly hidden by the flow meter panel.

The radiator cools the liquid coolant. The liquid coolant flows from the reservoir to the pump, through a flow switch, followed by the radiator, and then up to the camera and back to the reservoir. In the camera, the coolant removes excess heat from the triple-level thermo-electric cooler which keeps the camera CCD chip cool (-40° C). The flow switch measures the flow rate. The signal is sent to a flow meter. The flow meter controls a relay which turns off power to the camera if the flow rate is too low, and it also sends the flow rate to the controller system which monitors the system. The cooler is controlled by a TECA controller, which is designed to keep the chamber near 60° F. This should enhance the lifetime of the camera and its electronics, as well as promote radiometric stability of the sensor calibration.

If the TECA fails, the system can safely run for at least an hour or two. If the camera becomes too hot, the computer will automatically turn it off.

Physical Characteristics of the Coolant System:

Cooler: TECA #AHP1801HC
Controller: Omega #CN76133-PV
Pump: Cole-Palmer #G-07105-00
Flow Switch: Proteus #100C110M
Flow Meter: Proteus #OG3001C110A
Radiator: Oil cooler #1009
Normal CCD Chip Temperature: -40° C or -35° C
  Yellow Flag Level: -30° C
  Red Flag Level: 0° C
Normal Env. Hsg. Temperature: 16° C
  Yellow Flag Level: 32° C
  Red Flag Level: 49° C

4.3 Environmental Housing

The Environmental Housing is an enclosure fabricated from marine grade aluminum. It is designed to protect the camera and related components from the environment. The exterior sides are white powder coat, to minimize heat absorption. The top is black anodize to minimize light reflection, with a black anodize sun shade and layers of close-cell foam insulation. The environmental housing is shown in Fig. 1-2.

Inside, the environmental housing includes an upper and lower compartment, as seen in Fig. 4-7. The upper compartment is insulated, and is designed to maintain a temperature of 60 degrees F under normal conditions (outside temperatures of 90 or less). The purpose of the temperature stabilization is to enhance the lifetime of the enclosed components, and to enhance the stability of the radiometric calibration of the cameras.

The lower compartment of the environmental housing contains the hot side of the thermo-electric cooler which cools the upper compartment. The hot air is ducted out through the sides of the environmental housing. The primary purpose of the lower chamber is to isolate the hot side of the cooler from the cooled chamber. The lower chamber also includes the bulkhead for connection of the cables.

Several transducers in the environmental housing are designed to enable automated checks of system health. Their signals are returned to the controller, which can turn off the camera if conditions become unfavorable. These signals are the following:

- Camera chip temperature (returned by the Camera Electronics Unit): -35°C or -40°C
- Environmental housing temperature: 16°C
- Camera housing temperature: nominally 16°C, normally higher
- Coolant flow rate: .25 gpm
- Nitrogen pressure in camera housing: 5 psi
- Relative Humidity inside the environmental housing: nominally 20-50%

Relays in the environmental housing will turn off the camera if either of two conditions occur: the coolant flow rate drops, or the controller triggers the relay to turn off because the chip temperature or environmental housing temperature are too high.

Physical Characteristics of the Environmental Housing

Housing: Hennessey, modified by MPL
Dimensions: 28° W x 36° D x 36° H
Weight: 350 lb
Power Requirements:
- Camera: .93 A, 79 watts (through controller)
- Meters: .04 A, 3 watts (AC)
- Teca: 6.0 A, 516 watts (AC)
Pump: .18 A, 15 watts (AC)
Total: 535 watts (wall) + 79 watts (UPS)

AC Voltage: 110 - 120 VAC, 2 cables
DC Voltage: None supplied externally
Insulation: RMAX 2” Thermosheath
Cable Bundle: 100’x3” diameter
Largest Connectors: 3” (camera cable) and 4.5” (power cable)
WSI Coolant Connections
11 Aug 95

Fig. 4-5

Ref: Setup Instructions
Figure 4-6

Environmental Housing Shelf
Figure 4-7 Inside the Environmental Housing

Figure 4-8 Detail view of cooling system inside the Environmental Housing
4.4 Occultor Description

The occultor is designed to shade the lens and the dome from direct solar or lunar rays. Shading the dome minimizes the stray light entering the system; without the occultor it would not be possible for the WSI to measure the radiance of the sky or to obtain the measurements required to generate a cloud cover determination. The occultor is shown in Fig. 4-9, with the trolley near the top of the arch.

Two of the more important design constraints are that the occultor must cover the moon as well as the sun, and it must be large enough to shade the whole dome. Regarding the moon, the moon is just as bright relative to the night sky as the sun is relative to the day sky, and therefore it must be shaded. Regarding the occultor size, it is not sufficient to cover the 1/2 degree solar disk. It is necessary to shade the full physical extent of the lens and the dome. Since the solar rays are parallel, the shade must be at least as large as the dome, which has a 7" diameter. In order to avoid obscuring too large a solid angle, the shade is placed 24" from the dome. The actual solid angle obscured by the shade is less than 1% of the sky dome. At remote sites, a larger shade is used, as discussed below.

The occultor includes two arcs with a 24" radius. A trolley rides on these arcs, and holds a 7.5" shade which shades the dome. An arc drive drives the arcs from east to west, rotating with respect to an axis which goes through the lens. A trolley drive drives the trolley from north to south along the arcs.

The arc drive includes a motor and gearhead, a right angle planetary gear head to transfer the motor to the arc axis, and a potentiometer to enable arc position readout. The trolley drive includes a motor and gearhead, drive gears which drive a trolley chain attached to the trolley, and a potentiometer to enable trolley position readout. These signals go to the accessory control panel, which allows either manual or computer control of the occultor. The computer program is supplied with the site latitude and longitude, the date and the time. It determines the sun or moon position, and the corresponding arc and trolley angles, and then positions the occultor automatically.

At remote sites, the trolley is replaced by a fixed shade, as shown in Fig. 1-1. In this configuration, the arc drive moves east to west, and the fixed shade is large enough to avoid the need for a moving trolley.

Physical Characteristics of the Occultor:

Occultor: Fabricated by MPL
Subassemblies: Arc, Trolley, Arc Drive, Trolley Drive
Arc Drive Range: 0 (east) - 180 (west), limited to about 2.5 - 176.5 by ACP
Trolley Drive Range: 0 (north) - 180 (south), limited to about 14° - 165° by ACP
Figure 4-9 WSI Environmental Housing showing Occultor Arc and Trolley above the Housing
4.5 Computer and Monitor

The computer, shown in Fig. 1-2, is a rack-mounted field-hardened PC computer (486). It includes the following boards and components:

1 GByte hard drive
Exabyte 8205 XL 2GB tape drive
Data tapes: Sony 112m 8mm computer grade
1.44 MB floppy drive
DIO (Digital input/output) board
SCSI ASC 86 board
CPU with 8 - 16 MB RAM and video driver
Photometrics camera controller card
Ethernet card or Scramnet card
Keyboard
Mouse and board
Rack-mounted monitor

The Exabyte tape drive archives the raw data. The hard drive contains the programs and inputs, and is used for temporary storage of images. The floppy drive is used to update hard drive contents. The DIO is the communication link between the computer and the accessory control panels discussed below. It has 120 channels. The SCSI card controls the drives. The camera controller card sends the instructions to the camera electronics unit. Either an Ethernet card or a Scramnet card is supplied, depending on the communication needs of the sponsor. The other components are used in the standard ways.

Operation of the WSI run program is discussed in Section 6, and the general software is discussed further in Technical Note 243.

4.6 Accessory Control Panels

The accessory control panels are built by MPL, and are used to control the sensor either under computer control or under manual control. The Sensor ACP controls the filter changer, and reads the 6 sensor outputs listed in Section 4.4. The Occultor ACP controls the arc drive and the trolley drive.

The ACP front panels are shown in Fig 1-2. In this figure, the Occultor ACP is the upper panel, and the Sensor ACP is the lower panel. The front panels of the ACPs are shown in Fig. 4-10. The switches and readout ranges are as follows:

Occultor ACP
Power On/Off: Controls power to ACP
Local Enable/Disable: Enables or disables local/computer switches; when set in enable, mode is determined by switches; when set in disable, control is from computer.
Local/Computer: Sets component in local (manual) or computer control; can operate in local only when local enable/disable key is enabled.
Forward/Reverse Limit Lights: Indicate drive is at ACP-controlled limit position when turned on.
Motor Control Switches: Under manual control, these drive the occultor. They drive the motors continuously in the "Drive" position, pulse the motors in the "Pulse" position, and are off in the neutral position.

Arc Position Readout: Arc drive position as sensed by potentiometer, range 0 (east) to 180 (west), normally limited to about 2.5° - 176.5° by ACP limits.

Trolley Position Readout: Trolley drive position as sensed by potentiometer, range 0 (north) to 180 (south), normally limited to about 14° - 165° by ACP limits.

Sensor ACP
    Power On/Off: Controls power to ACP
    Local Enable/Disable: Enables or disables local/computer switches; when set in enable, mode is determined by switches; when set in disable, control is from computer.
    Local/Computer: Sets component in local (manual) or computer control; can operate in local only when local enable/disable key is enabled.
    Up/Down: Indicates direction of filter changer wheel motion under local control.
    Left/Right: Indicates which wheel will be moved under local control.
    Pulse: Moves filter changer wheel one position.
    LED Lights: Indicate which filter is in position on each filter changer wheel.

Camera chip temperature (returned by the Camera Electronics Unit): range -99°C to 99°C, normal -35°C

Environmental housing temperature: range 0 - 99°C, normal about 16°C
Camera housing temperature: range 0 - 99°C, normal 0 - 31°C
Coolant flow rate: 0 - .99 gpm, normal .126 -.4 gpm
Nitrogen pressure in camera housing: 0 - 99 psi, normal 3 - 5 psi
Relative Humidity inside the environmental housing: 0 - 99 % RH, normal 20 - 50%
Figure 4-10 Front Panels of Accessory Control Panels
4.7 Exabyte Drives

In addition to the exabyte drive in the computer, most systems contain external housings holding one or more additional drives. In the simplest configuration, an extra drive is used to store the cloud processing results. In a more complex setup used for remote sites, the external housing holds one drive for processing results, a second drive which automatically goes on-line if either the raw or processed tape fills, and a third drive which is saved as a spare. The input files control which tape drive is used for which output. For example, in a system with one internal drive and one external drive, either drive may be used to store the raw data.

Exabyte tapes should be changed once a week when operated continuously at 10-minute intervals. When operated at shorter or longer intervals they may be changed at corresponding intervals. For example, when operated once every 2 minutes, the raw data tapes should last approximately 36 hours.

4.8 Controller Housing

The controller housing is an enclosure with racks for rack-mounting the computer, monitor, and ACP's, as shown in Fig. 1-2. The exabyte housing holding more than one exabyte is also rack-mounted. The controller is sealed, with filters at the air inlets and fans on the air outlets. This rack was chosen in order to minimize the dust into the system. When kept in an air-conditioned trailer, the cooling appears to be adequate, but it may be desirable to add a chiller, which can be purchased from the rack manufacturer.

A WWV clock radio is also mounted in or on top of the housing. This radio is designed to update the time on the computer. The computer can optionally accept time from the network input.

The controller is normally plugged into an Uninterruptible Power Supply (UPS), which may be supplied by the sponsor or by MPL.

Physical Characteristics:
Size: 26" W x 26" D x 52" H
Weight: 450 lb
Power:
- Computer and monitor: 1.1 A, 94 watt
- Occultor ACP: .20 A, 17 watt
- Sensor ACP: .26 A, 22 watt
- Fan: .20 A, 17 watt
Total: 150 watt (on UPS)
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 normally not critical. The first time the unit is powered, the instructions in Section P of the Setup should be followed. These are also listed in Section 4-8 of Technical Note 241, the Trouble Shooting manual. For normal use, it is adequate to cycle power and let the WSI do its self start.
6. Instrument Operation

The WSI includes programs resident on the controller for acquiring and handling data. The main data acquisition program is Program RUNWSI (formerly Runwsi24). The concept of operations for this program are discussed in Section 3. This section, Section 6, provides an overview of the screen displays and related files. Further discussion related to optimizing the use of the program for special purposes are included in Tech Note 243.

6.1 Program Start-up and Operation

The WSI is designed to start the RUNWSI program automatically, so that it may run autonomously and recover from power breaks. The program also allows user interface for a variety of purposes. The sequence of screens seen on power-up are documented in Appendix A, and summarized here. When power to the Whole Sky Imager is turned on, systems operating under DOS will boot directly to DOS and start the RUNWSI program. Systems operating under OS/2 (at the sponsor's request) will show a boot manager screen, which gives the user the option of booting to DOS or to OS/2. If no choice is made within 30 seconds, the OS/2 systems will boot automatically to OS/2.

Next, the program will initialize itself, set up the tape archival system, initialize the camera, and move the occultor to its starting position. The monitor displays during this time are shown in Appendix A. On completion of these procedures, the program will wait for the start time, and then acquire images. A typical monitor display is shown in Fig. 6-1. In this image, the center of the image is directly overhead, and the edge of the round image is the horizon, with East to the right and South to the top (note that this format is different from typical map format, because the imager is looking up, rather than down). The thin white line along the top of the image is an ASCII encoded header. On the right are the following descriptors:

- Image type (normally red or clear)
- Date and time
- Exposure, neutral density filter, and spectral filter used
- Minimum and maximum values used in the displayed image
- Next grab time
- Instructions for exiting the program

The program will normally continue to run automatically, unless the operator exits it either to stop the program (X), change tapes (T), or use the menu display options documented in Appendix B. One of the important menu options is the diagnostic option, discussed both in Section 8 and in Appendix B. Appendix B provides more details on what the program is doing as it runs.

6.2 Program Input and Output

The primary program input file is shown in Fig. 6-2. These inputs will be discussed in more detail in Tech Note 243. In the input file, the first two entries under location (Latitude and Longitude) should be updated if the WSI is moved to a new site. The Acquisition Options may be changed by the user. These options are:

- Acquisition interval: changes the interval between image grabs
- Performatio Ratio: may be turned off if the user does not want processed cloud results
- Reb/blue grab: under starlight, the user may turn this on to force the system to acquire red and blue images rather than using the more time-efficient clear image grabs.
Exabyte Archive: may be turned off if there is no desire to save images, or exabytes are not functional
Allow hotkey access: allows access to hot keys
Starting Exabyte drive: defines drive number for raw data
Maximum Exabyte number: defines number of exabytes in use

In addition, the user might expect to change Dropshipper parameters in the input file. These define a directory for a site computer to network with, and also define whether the files should be sent to this directory. **This should be set to 0 unless the system is networked.** Finally, the TWP Specific Options may be changed by the user. These indicate the time source the user wishes the WSI to use (Bios, WWV, or sponsor-supplied GPS); whether the system should compute cloud decision images, which images should be displayed to the user; and which drive should be used to archive the processed data. The other input file parameters are generally not changed, as they relate to calibration constants (normally determined by MPL) or to diagnostic thresholds which are normally fixed.

The primary output of the program consists of data tapes. The data tapes are as follows:

**Raw data tape:** Contains images acquired (red, blue, dark, and clear), and a diagnostic file
**Processed data tape:** Contains ratio and cloud decision images

In addition, images, diagnostic information, and control information may be provided via network, but this output is quite different for different sponsors, and will be documented in separate documents provided to the sponsors.
Red Image

Mo/Da/Yr Time
3/30/95   1732Z

Exposure = 100ms
ND = 3   SP = 3

Min = 1000
Max = 3300

Waiting for grab at 1742Z

To exit press 'X'
RUNWSI.INP - Input file for RUNWSI.EXE

Location Information
Latitude ------------------------------- 32.70
Longitude ------------------------------- 117.24
Site Identifier -------------------------- MPL
Hardware vers. -------------------------- 3.2
Software vers. -------------------------- 4.0

Instrument Factors
Gear Cor (azi) -------------------------- 0
Gear Cor (zen) -------------------------- 0
Camera Azimuth Offset ------------------ 0
Field Azimuth Offset ------------------- 0
Image Azimuth Offset ------------------- 0

Acquisition Options
Acquisition interval in minutes ------- 10
Perform Ratio? ------------------------- 0
Red/Blue grab? ------------------------- 0
Exabyte Archive? ----------------------- 1
Allow hotkey access? ------------------- 1
Starting Exabyte drive (1-3) --------- 1
Maximum Exabyte number (1-3) --------- 3

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

Image Geometric Information
Center X ------------------------------- 252
Center Y ------------------------------- 256
90 Degree Radius ----------------------- 238

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
Fig. 6-2 (cont.)
RUNWSI.INP - Input file for RUNWSI.EXE cont.

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

Relative Humidity (%)

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

DropShipper parameters (Max. 15 chars. End with backslash)

Dropshipper send directory ---------- d:\send_dir\nSend files to Dropshipper? ---------- 0

Maximum Display Ratios

ND1 Maximum Display Ratio ----------- 65535
ND2 Maximum Display Ratio ----------- 30000
ND3 Maximum Display Ratio ----------- 30000

Opaque Thresholds

ND1 Opaque Threshold --------------- 120
ND2 Opaque Threshold --------------- 130
ND3 Opaque Threshold --------------- 130

Default Reference Value -------------- 80
RUNWSI.INP - Input file for RUNWSI.EXE cont.

Thin Cloud Acceptance Level (%) ----- 15
Indeterminate Window (%) -------------- 25

Time Offset -------------------------- 0

Create diagnostic log (runwsi.dgn)? - 0

TWP Specific Options

Time source 0=BIOS,1=WWV,2=GPS ------- 0
Perform Cloud Decision? ------------- 1
Display 0=Red,1=Rat+Cld,2=Rat,3=Cld - 1
EXB drive for processed data -------- 1
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 little interaction beyond standard inspections and maintenance. Long term (6 months or longer) maintenance is documented in Tech Note 241. The short term (daily through monthly) maintenance is outlined in this section and further detailed in Section 8.

1. Visually inspect system status DAILY. Report abnormalities. This includes:
   a. Provide daily visual inspection of camera assembly, environmental housing, and occultor. 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, being careful not to scratch the dome.
   b. Provide daily visual inspection of console assembly. Observe monitor to determine normal image quality and solar occultor 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. Press the “T” hotkey to access the tape change logic.
   b. Follow the instructions on the monitor for changing the tapes.

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

   a. Clean filter on the occultor with lint-free non-abrasive cloth and distilled water.
   b. Check drive chains for debris and remove any debris.
   c. Check the trolley for chain tension and for motional friction.

   This procedure is discussed in Section 8.3.

   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 7.

8.1 **Daily Visual Inspections**

1. **Camera Assembly**
   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 occultor drive chains of debris, if required.
   d. Inspect occultor chains and trolley for proper chain tension, and low friction on trolley wheels. See Section 8.3.

2. **Console Assembly**
   a. Check monitor for normal image quality, e.g., images are being acquired and sky is visible.
   b. Check monitor image for solar occultor position, i.e., sun's image within occultor boundary (unless blocked by clouds).
   c. If in doubt of occultor alignment, check solar occultor 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 Tech Note 241, Section 6.2.3.
   f. Verify filter changer indicator lights on Accessory Control Panel (ACP) are changing during grab sequence.
   g. Verify Occultor and system status readouts on ACP are changing normally and consistent with values in header.

3. **Diagnostic Check**
   a. Press "S" (for Status). 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 B). The program will then return to data acquisition. Follow the instructions provided on the screen, if any items are flagged.
### Sample Day/Night WSI Status File

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

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

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. The remaining image sets consist only of red and blue images.

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

<table>
<thead>
<tr>
<th>Site: HEL Lat=32.63 Long=106.33 File:03292239.red Day=29 Month=3 Year=93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time=2239Z Exposure=100 ms ND=2 SP=3 Occultor Destination: Arc=1.23.</td>
</tr>
<tr>
<td>Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stats: 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</td>
</tr>
<tr>
<td>000000000000 000000000000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site: HEL Lat=32.63 Long=106.33 File:03292239.blu Day=29 Month=3 Year=93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time=2239Z Exposure=100 ms ND=2 SP=4 Occultor Destination: Arc=1.23.</td>
</tr>
<tr>
<td>Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stats: 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</td>
</tr>
<tr>
<td>000000000000 000000000000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site: HEL Lat=32.63 Long=106.33 File:03292239.drk Day=29 Month=3 Year=93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time=2239Z Exposure=100 ms ND=2 SP=1 Occultor Destination: Arc=1.23.</td>
</tr>
<tr>
<td>Trolley= 98.2 Housing Temp=16 Hardware Ver:1.0 Software Ver:2.0 Time Stats: 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</td>
</tr>
<tr>
<td>000000000000 000000000000</td>
</tr>
</tbody>
</table>
8.2. Weekly Data Tape Replacements

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.

One drive holds raw data, and a second holds processed data. These will normally be changed every week.

In some systems, there is a third drive, 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. Press the T (for “Tape”) hotkey. You will see the output shown in Fig. 8-3. This will lead you through the remaining steps listed below.

   b. Remove data tapes from tape drives.

   c. Label tapes 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. Always use new data-quality tapes.
Change Exabyte tapes?: (1 = yes, 0 = no): 1

Wait... writing last EOF to drive 1
Wait... unloading tape in drive 1
Label tape in drive 1: Start date: 3/16/95, End date: 3/23/95

Check Exabyte status lights.
If the top and bottom LEDs are flashing on an Exabyte drive, please insert an Exabyte cleaning tape into that drive.
Also, if it has been two weeks since an Exabyte drive has been cleaned, please clean it. Each Exabyte drive should have its own cleaning tape. After cleaning a drive, label the cleaning tape with the current date.

Press the ENTER key when you have finished the cleaning process.

Insert new tapes into each empty tape drive.
Press the ENTER key after the tapes are loaded and the bottom green LED on each Exabyte drive has stopped flashing.
8.3  **Weekly Inspection of Solar Occultor**

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, do chains have normal tension, does trolley have low friction. See Tech Note 241, Section 4-6 for more details.

d. Verify that occultor flag is shadowing dome.

8.4  **Monthly Inspection of Sensor Housing**

a. Open box and verify chamber is dry. If it is not, or the relative humidity indicated for the chamber is high, replace the desiccant.

b. Verify coolant system is full, add distilled water as necessary, and verify flow. If coolant has become significantly clouded, check Tech Note 241, Section 4.2.

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, or see Tech Note 241, Section 4.5.

f. Inspect seals, grommets, and screws for leaks. See Tech Note 241, Section 4.10.

8.5  **Monthly Removal and Cleaning of Computer's External Air Filter**

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 241, “Maintenance and Trouble Shooting Manual”. Tech Note 241 also provides troubleshooting and repair procedures. Table 9.1, from Tech Note 241, provides an overview of long-term maintenance.

Table 9.1
Estimated Maintenance Schedule

<table>
<thead>
<tr>
<th>Operation</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>6-mo</th>
<th>2 Yr</th>
<th>Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection, white box</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.1</td>
</tr>
<tr>
<td>Clean optical dome</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.1</td>
</tr>
<tr>
<td>Inspect occultor</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.3</td>
</tr>
<tr>
<td>Visual inspection, blue box</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.1</td>
</tr>
<tr>
<td>Observe image</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.1</td>
</tr>
<tr>
<td>Check for diagnostic flags</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.1 T 7</td>
</tr>
<tr>
<td>Change tapes</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.2</td>
</tr>
<tr>
<td>Internal white box inspection</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>0 8.4</td>
</tr>
<tr>
<td>Clean computer air filter</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 8.5</td>
</tr>
<tr>
<td>Preventative Maint. Inspection</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>T 2</td>
<td></td>
</tr>
<tr>
<td>Fill coolant if needed</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 4.1</td>
</tr>
<tr>
<td>Drain coolant</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>T 4.2</td>
<td></td>
</tr>
<tr>
<td>Replace coolant tubing</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>T 4.3</td>
<td></td>
</tr>
<tr>
<td>Refill nitrogen if needed</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 4.4</td>
</tr>
<tr>
<td>Replace dome</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>T 4.5</td>
<td></td>
</tr>
<tr>
<td>Adjust occ chain &amp; trolley</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>T 4.6</td>
<td></td>
</tr>
<tr>
<td>Align trolley</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>T 4.7</td>
<td></td>
</tr>
<tr>
<td>Replace desiccant</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>T 4.9</td>
<td></td>
</tr>
<tr>
<td>Inspect seals, grommets, and screws</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>T 4.10</td>
<td></td>
</tr>
</tbody>
</table>

0 = Operations Manual
T = Trouble Shooting Manual, i.e. Op Man Secn 8.1
10. Packaging and Transport

The WSI is normally shipped in wooden crates with foam padding on the sides and a floating deck on vibration-isolators. This configuration is shown in Fig. 10-1. Detailed instructions for setup and packing are given in Appendices C and D. The resultant connections for a typical WSI are shown in Figures 10-2 through 10-6.
Figure 10-1  WSI Controller Shipping Crate with Floating Deck
Note: Internal wiring breakouts not shown

CEU View from side

Ref: Setup Instructions
WSI Camera Housing Connections
Bottom View
11 Aug 95

Pressure sensor → To env. hsg. internal wiring

Coolant → Cam Hsg Temp → To env. hsg. internal wiring

Filt Chg & shutter → To env. hsg. internal wiring

Camera → To CEU

Ref: Setup Instructions

Fig. 10-4
WSI Occultor External Connections
11 Aug 95

South Side

Arc Drive

Cover Plate

Limit On/Off

To env hsg interior wiring

Arc Drive

To env hsg interior wiring

North Side

Limit Swx

Cover Plate

Trolley Drive

To env hsg interior wiring

Limit Swx

To env hsg interior wiring

Fig. 10-5

Ref: Setup Instructions
Fig. 10-6

Ref: Setup Instructions
11. Spare Parts and Supplies

When a WSI is delivered to the sponsor, a Spares and General Supplies kit is normally included. Table 11.1 lists the spares which were delivered with one of the systems. This delivery list may vary slightly depending upon the needs of the sponsor.

Table 11.2 lists sources for line replaceable units. For many of these components it may be helpful to work through MPL. These units and their replacements are documented in Technical Note 241.
Table 11.1

Whole Sky Imager Spares and General Supplies

I. Contents of Documentation and Spares Box

A. Documentation

- Operation Manual (includes daily, weekly, etc. check list)
- Trouble Shooting Manual (includes maintenance check list)
- Setup Instructions
- Packing Instructions
- Parts list (major components)
- RUNWSI (acquisitions program) Operation overview AV95-028t
- Table of RUNWSI error codes and hot keys
- Computer Display in Boot-up & RunWSI AV95-016t
- Desiccant renewal instructions
- Line Replaceable Units List
- Cable Connection Drawings
- WSI Overview - Tech Note 234
- Power Clean Flyer
- Precision alignment procedures

B. Spares and General Supplies

- Parts box of miscellaneous fasteners used in WSI
- Distilled water
- Isopropyl alcohol
- Funnel
- Keyboard and monitor cleaning supplies
- Lens cleaning supplies
- Lens cover for fisheye lens
- Spare camera shorting plug
- Spare camera housing o-ring
- Spare grommet material for sunshade and occultor sub-ass'y covers
- Spare boot disk
- Tie wrap
- Camera lid to sunshade fasteners
- Spare sunshade corner bolt
- Environmental housing corner eyebolts used for lifting
- Pen for marking baggies to hold parts

II. Larger Spares and General Supplies

- Desiccant
- Nitrogen bottle and gauges
- Rope (for use in lifting if required)
- Spare dome
- CO2 Powerclean
### Table 11.2

**Whole Sky Imager**  
**Line Replaceable Units**

Version: 1 Aug 95

### I. Sensor and Environmental Housing

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera Housing and CEU</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Acrylic Dome #G71.710</td>
<td>Edmund Sci</td>
<td>(609) 573-6250</td>
</tr>
<tr>
<td>Teca Cooler #AHP1801HC</td>
<td>Cathcart Rep</td>
<td>(714) 837-0797</td>
</tr>
<tr>
<td>TE Controller #CN76133-PV</td>
<td>Cathcart Rep</td>
<td>(714) 837-0797</td>
</tr>
<tr>
<td>Flow meter #OG3001C110A</td>
<td>Proteus Ind.</td>
<td>(415) 964-4163</td>
</tr>
<tr>
<td>Flow switch #100C110M</td>
<td>Proteus Ind.</td>
<td>(415) 964-4163</td>
</tr>
<tr>
<td>Pump # G-07105-00</td>
<td>Cole-Palmer</td>
<td>(800) 323-4340</td>
</tr>
<tr>
<td>Oil cooler #1009</td>
<td>Radiator Store</td>
<td>(619) 231-0123</td>
</tr>
<tr>
<td>Humidity sensor</td>
<td>Davis Instr.</td>
<td>(800) 368-2516</td>
</tr>
<tr>
<td>Occultor arc sub-ass'y</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Occultor arc drive</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Occultor trolley sub-ass'y</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Occultor trolley drive</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Signal cable set</td>
<td>MPL</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Power cables, 12 guage</td>
<td>Home Depot</td>
<td>(619) 277-8910</td>
</tr>
</tbody>
</table>

### II. Controller

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor ACP</td>
<td>MPL(619)</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>Occultor ACP</td>
<td>MPL(619)</td>
<td>(619) 534-1769</td>
</tr>
<tr>
<td>CPU Board w/VGA, 16 Ram</td>
<td>Microbus</td>
<td>(619) 457-9654</td>
</tr>
<tr>
<td>DIO Board #PCD1020-P</td>
<td>Indus Comp Src</td>
<td>(800) 523-2320</td>
</tr>
<tr>
<td>SCSI Board, ASC-86</td>
<td>Adv Stor Conc</td>
<td>(512) 335-1077</td>
</tr>
<tr>
<td>Ethernet Board SMC</td>
<td>Adv. Tech. Sys</td>
<td>(619) 279-6707</td>
</tr>
<tr>
<td>Floppy drive 3.5&quot; Hideus</td>
<td>Byte &amp; Floppy</td>
<td>(619) 523-2222</td>
</tr>
<tr>
<td>Exabyte tape drive 8205</td>
<td>Western Sci.</td>
<td>(619) 565-6699</td>
</tr>
<tr>
<td>Rackmount drive bay</td>
<td>Indus. Comp Src</td>
<td>(800) 523-2320</td>
</tr>
<tr>
<td>Hard drive 1GB Conner</td>
<td>Byte &amp; Floppy</td>
<td>(619) 523-2222</td>
</tr>
<tr>
<td>Keyboard #KD101</td>
<td>AmerInd Sys</td>
<td>(619) 457-9654</td>
</tr>
<tr>
<td>Mouse, Logitech</td>
<td>Byte &amp; Floppy</td>
<td>(619) 523-2222</td>
</tr>
<tr>
<td>Monitor, Sony 1430</td>
<td>Datel Systems</td>
<td>(619) 571-3100</td>
</tr>
<tr>
<td>Clock radio GCW-1001-B</td>
<td>Heathkit</td>
<td>(800) 253-0570</td>
</tr>
<tr>
<td>Radio antenna GCA-1001-3</td>
<td>Heathkit</td>
<td>(800) 253-0570</td>
</tr>
</tbody>
</table>
Table 11.2 (cont.)

Whole Sky Imager
Line Replaceable Units

III. Supplies

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exabyte cleaning tapes</td>
<td>Western Sci.</td>
<td>(619) 565-6600</td>
</tr>
<tr>
<td>Exabyte data tapes or Sony</td>
<td>Western Sci.</td>
<td>(619) 565-6600</td>
</tr>
<tr>
<td>Rubber grommet #8510K14</td>
<td>McMaster Carr</td>
<td>(310) 692-5911</td>
</tr>
<tr>
<td>Tygon tubing, #0001-071</td>
<td>Ryan Herco</td>
<td>(619) 693-1141</td>
</tr>
<tr>
<td>Tygon tubing, #0001-138</td>
<td>Ryan Herco</td>
<td>(619) 693-1141</td>
</tr>
<tr>
<td>Dessicant #2140K11</td>
<td>McMaster Carr</td>
<td>(310) 692-5911</td>
</tr>
<tr>
<td>Gas regulator # LBNA</td>
<td>Liquid Carbonic</td>
<td>(619) 232-7341</td>
</tr>
<tr>
<td>2 cu ft Nitrogen bottle</td>
<td>Liquid Carbonic</td>
<td>(619) 232-7341</td>
</tr>
</tbody>
</table>

Note:

Some items such as the Teca Cooler may require set-up. We have not attempted to presuppose the level of complexity which the field team will wish to approach. Items may be obtained through MPL if preferred, in order to have MPL do advance testing and/or setup; in fact we recommend that items be tested at MPL prior to shipping to remote sites.
12. Utility Programs

This section documents the utility programs used to download the hard disk contents to exabyte and recover files from exabyte. MPL also uses many other support programs, however, most of these are for special purposes and not used for general field work. Information on such programs may be requested as needed.

12.1 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 'e' 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.
Figure 12-1
EXBACK Menu

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)

12.2 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

**Figure 12-2**

**EXRCVR 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:
Appendix A

MARINE PHYSICAL LABORATORY, 0701
of the Scripps Institution of Oceanography
San Diego, California 92152-6400

April 20, 1995
AV95-016t

TECHNICAL MEMORANDUM

To: Atmospheric Optics Group

From: M. E. Karr

Subj: Normal WSI Computer Control Display During Boot-up and Program RunWSI

The WSI Day/Night acquisition program is called RunWSI. This memo documents what happens when the WSI computer system is powered up, assuming that there are no problems.

When the computer is turned on, it first goes through a series of power on self tests, which includes some memory tests. Then the SCSI card is reset. After the SCSI card is recognized, the OS/2 Boot Manager menu is displayed. See figure 1. Boot to OS/2 by using the up or down arrow keys to highlight the OS/2 line and then press the return key. If a user is not present to respond to the Boot Manager menu, the computer will automatically boot to OS/2 after a one minute delay.

Next the Ethernet card and TCP/IP drivers are recognized and loaded, the screen will then blank and you will see a small clock in the center of the screen. The OS/2 desktop appears briefly. The desktop display is then replaced with the RunWSI display. See Figure 2.

The next message to come up on the screen, let's the user know that the Exabyte will be skipping to the end of data on the tape (EOT). See Figure 3. This takes at least 30 seconds. Then an initial end of file mark (EOF) is written to tape. Following the Exabyte initialization procedures, the occultor is moved into position. See Figure 4.

After the occultor is set into position, we wait for the first image grab. See figure 5. The first image grab occurs approximately two minutes after the RunWSI initialization procedures have been completed. Each subsequent grab is at 10 minute intervals. The right hand column of the RunWSI screen shows the parameter of the current image on display and the status of RunWSI. In figure 6 we see a typical RunWSI screen after an image grab. Figure 6 shows a red image acquired on 30 Mar. 95 at 1732Z. The exposure is 100 milliseconds. The neutral density position is 3 and the spectral position is 3. The threshold used to display the image is 1000 - 3300. RunWSI is waiting for the next image grab at 1742Z. A reminder at the bottom of the screen lets the user know that by pressing the 'X' key, we can exit the RunWSI program.
After seven days it is time to change tapes. Use hotkey option T to change tapes. See figure 7. Answer 'y' or 'I' (yes) to the question -- "Do you want to change Exabyte tapes?". The tape in the first tape drive is rewound and ejected. The data period contained on each ejected tape is displayed. Label each ejected tape with the proper data period.

The cleaning process is next. Press the RETURN key when the cleaning process has been completed.

Place a new tape into each empty tape drive. Wait until the bottom green LED is a solid green before pressing the RETURN key. The RunWSI program will continue to run indefinitely until a user presses the 'x' key to exit the program.
<table>
<thead>
<tr>
<th>Boot Manager Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS/2</td>
</tr>
<tr>
<td>DOS</td>
</tr>
</tbody>
</table>

No Selection within 60 seconds, boots to OS/2
Press ESC to disable Timer
Use ↑ or ↓ to select. Press Enter to boot
RunWSI - Automated Day/Night Data Acquisition and Ratio Processing Program with HotKey options

Version 3.8   12 Mar. 95

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-----
Skipping to EOT...
Latitude 32.70
Longitude 117.42
Azimuth cor. 0.0

Now moving occulter into position ...

Anticipated positions:
Arc = 89.7
Trolley = 113.3
Waiting for first grab at

Mo/Da/Yr Time
3/29/95  2239Z

Expose = 100ms
ND = 3
Red Image
Mo/Da/Yr Time 3/30/95 1732Z
Exposure = 100ms
ND = 3  SP = 3
Min = 1000
Max = 3300
Waiting for grab at 1742Z
To exit press 'X'
TECHNICAL MEMORANDUM

To: Atmospheric Optics Group
From: M. E. Karr
Subj: RunWSI (WSI Data Acquisition Program) Operations Overview - Update

The attached list highlights the main operating procedures for the Whole Sky Imager data acquisition program RunWSI, version 4.0. For the user who wants to quickly boot up the WSI, a quick start guide is provided. A brief description of the RunWSI function and common OS/2 operating procedures is also included. For more detail on the RunWSI program and operating instructions, please refer to the RunWSI Program Description document and the WSI Operations Manual. This memo contains an updated hotkey description list and the new version of the RunWSI input file.
Day/Night WSI Computer Operations Checklist (Apr. 95)

Quick Start - How to run the Day/Night WSI acquisition program

1. Turn on power to the computer, Occultor ACP, Filter Changer ACP and external Exabyte chassis.

2. Wait for Boot Manager Menu screen. This takes about 20 seconds.

3. Boot to the OS/2 operating system. To boot OS/2, highlight the OS/2 line using the up or down arrow key. Press the ENTER key when finished.

4. Wait for the OS/2 operating system to finish initializing. This takes about 30 seconds.

5. When OS/2 has completed its bootup procedures, the TCP/IP communications protocol setup program, RunWSI, and DropShipper are all initiated.

The TCP/IP setup session will conclude when it has completed its setup procedures. This takes only a few seconds. The RunWSI start up screen is displayed. DropShipper will run in the background.

What is the RunWSI program doing?
Setup Procedures: When the RunWSI program is started up, it first resets the tape drives and sets up the camera and processing functions. If the camera's CCD chip temperature is above 0°C, then the WSI system will wait for up to 5 minutes for the temperature to decrease below zero. Under normal conditions, the camera setup procedure takes approximately 30 seconds. The next operation performed is with the Exabyte 8mm tape drive. The tape is forwarded to the End of Data (EOD) mark. All existing data will be preserved. The final Exabyte setup task is to write an initial End of File mark to tape. The occultor setup procedure is next. The solar/lunar occultor is positioned according to the time of day.

Data Acquisition: The first image grab occurs two minutes after the occultor position is set. Each subsequent grab occurs at the preset acquire interval of 10 minutes. After each grab the following takes place: 1) Data archival -- All images grabbed are saved to tape. The most four recent image sets are also saved on the hard disk. A sample image and current diagnostic status are sent to the DropShipper directory. 2) The occultor is positioned for the next image grab. 3) RunWSI waits until it is time for the next image grab. Data acquisition will continue until the user presses the 'X' key to exit RunWSI.

End of Data Archival Period: After seven days it is time to replace the tape in Drive 1 with a blank tape. Press the "T" key to perform the tape change procedure. Follow the procedures displayed on the screen. See figure 1. After the ejected tapes have been labeled, clean each Exabyte drive as necessary. Each drive should be cleaned every two weeks. After inserting blank Exabyte tapes into each empty tape drive, press the ENTER key to continue collecting data. Note that the user is not prompted to change tapes each week. Data acquisition will continue indefinitely, however data archival will be discontinued when all tape drives have been used and the hard disk becomes full. We strongly recommend changing tapes each week to avoid the possibility of partial tapes and loss of data.

Shutdown procedures
If it is necessary to shut down the WSI computer, do not just turn power off to the computer system. Data may be lost if the following procedures are not used. First exit
the RunWSI program. To exit RunWSI, press the 'x' key anytime after the first image has been acquired and archived. Next close all open sessions by pressing the CTRL and ESC keys simultaneously, to access the OS/2 Window List. A window showing all open sessions is displayed. Use the up or down arrow key to highlight the RunWSI title in the Window List. Click the third mouse button to close the window. Repeat this procedure for all titles in the Window List, except for the Desktop title. Answer yes to each confirmation prompt. After closing all windows and sessions follow the shut down procedure shown in figure 2.

Power outage:
If there is a power outage, the WSI computer will reboot itself when power becomes available. The OS/2 operating system will start up and then the RunWSI program will automatically begin acquiring data.

RunWSI Precautions:
The WSI acquisition program is designed to run unattended. The only user interaction required besides powering on the WSI components, is to exchange tapes each week. The OS/2 operating system requires that programs that display graphical information run in the foreground in order to remain active. It is therefore important that the user does not change sessions during active data acquisition. If RunWSI is placed in the background just before it is time to grab an image, RunWSI will not acquire the image until the program is brought back to the foreground. For more information on changing sessions during data acquisition, refer to the WSI Operations Manual.

How do I change the RunWSI input parameters?
There are two ways to change the operating parameters. Some RunWSI options can only be changed by exiting from the acquisition program and then editing the RunWSI input file, RunWSI.INP. A sample RunWSI.INP file is shown in table 3. Other options can be changed while the RunWSI program is running, via hotkeys. The hotkey options are described in table 1. Options for DropShipper can only be changed by editing the input file RunWSI.INP. To edit this file, first exit the RunWSI program by pressing the 'X' key. Use a text editor of choice to edit the RunWSI.INP file. The DropShipper parameters used by RunWSI are at the bottom of the file. You can change the pathname for DropShipper files and you can choose to send or not send DropShipper files. Enter a '1' to send files or a '0' to not send files. If the ARC's network is down, do not send files to the DropShipper directory. To restart data acquisition type "RUNWSI" at the keyboard.

Hotkey Options:
As mentioned earlier, RunWSI is designed to run unattended. However, the user may change any of the parameters described in table 1. Because changing the input parameters and reviewing imagery can affect data acquisition, there are several methods to disable hotkey access. Method #1: Change the Allow Hotkey Access option in the RunWSI.INP file to 0. If hotkey access is disabled the only options available to the user are the health and status check (option 'S') and exit RunWSI (option 'X'). To enable all hotkey options, the user may enter a password after selecting an option. For example, if the user wants to change the acquire interval, press 'T' at the keyboard. The user is notified that hotkey access is disabled. The user then has the option to enter a password to enable the hotkeys. Method #2: Remove the keyboard from the front of the WSI computer system and store until needed.
How can I check the WSI performance history?
Anytime after the first image set is acquired, the user can check the status of the Whole Sky Imager. Press the 'S' key to view the status tables. Severe errors that affect the health of the Whole Sky Imager require immediate attention. These errors are called red flag errors. Red flag messages are listed first. A brief diagnostic message is displayed with each error. The WSI operations manual should be consulted for more detail. Errors that may affect WSI data and that require eventual user attention are called yellow flag errors. These errors are shown second. The next table displayed is an image grab history table. This table can be used to help pinpoint the time any errors may have occurred. For further diagnostic information the user can also display the header information saved for each image. The header is a line of data embedded into each WSI image. The header contains information such as time of grab, occultor and filter settings. For more information on RunWSI headers, refer to the RunWSI program description document.

How do I decode the error numbers shown in the WSI status table?
When the user requests status information, all errors encountered are displayed with a brief diagnostic description. The image grab history table lists only the most severe error. In order to maximize the amount of information displayed in the table, a code is used to indicate the type of error. Table 2 shows the WSI error decoder list.

The RunWSI program has started but there are no tapes in the Exabyte drives.
This can happen when the WSI is first installed or if a user simply forgets to replace tapes during a tape change operation. The RunWSI program is intended to run automatically with little user interaction, therefore there is no mechanism built into the program to wait until tapes are inserted into the 8mm tape drives. RunWSI will continue with data acquisition but write data to the hard disk instead of to tape. This can quickly fill up available hard disk space. To close the RunWSI session and then insert tapes into each empty tape drive: 1) Access the OS/2 Window List by pressing the CTRL and ESC keys simultaneously. A window showing all open sessions is displayed. 2) Point to the RunWSI title in the Window List using the mouse. 3) Double click the first mouse button. Click the YES box in the confirmation window to close the RunWSI session. 4) Insert new tapes into each Exabyte drive. Restart RunWSI by double clicking on the RunWSI icon on the OS/2 desktop.
Table 1
RunWSI HotKey Options

The HotKey feature allows the user to interact with the Whole Sky Imager computer system to 1) vary Whole Sky Imager operating parameters 2) check the performance history of the WSI, 3) review recently acquired imagery, and 4) perform maintenance procedures. The incorrect use of hotkeys can adversely affect data acquisition, please follow the guidelines listed below. Hotkey options can be accessed by pressing the appropriate key.

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5*</td>
<td>Track Overlay - If you have a pre-established track file, you can view the track overlay by using this option. This is a toggle switch so that you may turn on/off this option by pressing the key twice. <em>Use of this option can slow down the display of acquired images.</em></td>
</tr>
<tr>
<td>7*</td>
<td>Geometric Grid Overlay - Use this option to see the displayed image divided into sectors. A green overlay indicating N, S, E and W is displayed over the acquired image. <em>Use of this option can slow down the display of acquired images.</em></td>
</tr>
<tr>
<td>A*</td>
<td>Autoscale display option - WSI images are 16 bit images. The normal display range is 0 - 65535. With this range it may be difficult to see any details in the image. The Autoscale function automatically displays the image such that there is more contrast. <em>This option should be left on.</em></td>
</tr>
<tr>
<td>C*</td>
<td>Enable/Disable Cloud decision processing</td>
</tr>
<tr>
<td>E*</td>
<td>Enable/Disable Exabyte archival. This option is normally enabled.</td>
</tr>
<tr>
<td>H</td>
<td>Help Key - A list of hotkey options is displayed for approximately 3 seconds.</td>
</tr>
<tr>
<td>I</td>
<td>Change Acquisition Interval - The default acquisition interval is set in the RunWSI.INP file. The normal acquisition interval is 10 minutes. Valid acquisition interval range is 2 - 60 minutes. An acquisition interval of less than 10 minutes will require that the Exabyte tapes be exchanged more frequently. <em>A 2 minute acquisition interval requires that Exabyte tapes be replaced every 2 days. A 10 minute acquisition interval requires a tape change every 7 days.</em></td>
</tr>
<tr>
<td>M</td>
<td>Image Review menu - The last four image sets grabbed are available for the user to review. The images can be rescaled to view specific features. The images can then be saved to hard disk for future reference. <em>Data acquisition is delayed if the user spends too much time in the image manipulation menu.</em></td>
</tr>
<tr>
<td>R*</td>
<td>Compute Ratio - A ratio image can be computed within RunWSI. The four most current ratio images are stored on hard disk. These images can be reviewed by using the 'M' hotkey. The ratio images are also archived with the raw data, on 8mm tape.</td>
</tr>
<tr>
<td>T</td>
<td>Change Exabyte tapes - <em>Use this option on scheduled tape change days.</em> The data period contained on each tape used is displayed when the tapes are ejected. A reminder to clean the Exabyte tape drives is posted.</td>
</tr>
<tr>
<td>X</td>
<td>Exit RunWSI - <em>For all data and diagnostic files to be saved properly, use the 'X' key to terminate the RunWSI program.</em></td>
</tr>
</tbody>
</table>

* These keys act as toggle switches. Each key press either activates or deactivates the option. A message indicating the status of the option is displayed after each key press.
Table 2
RunWSI Status Table Error Codes

When a status check request is made, RunWSI first lists a brief diagnostic message for all errors that have occurred. At the end of the error listing the user can choose to look at the image grab history. Flashing red and yellow flag codes appear in the right hand column of the image grab history table. Only the most severe error is shown in this table. The following list gives a brief description of each error code. The codes are listed from the most to the least severe error. Refer to the WSI Operations Manual for more detail on WSI errors.

Red Flag Errors

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Camera CCD chip temperature above 0°C</td>
</tr>
<tr>
<td>2</td>
<td>Environmental housing temperature above 49°C</td>
</tr>
<tr>
<td>3</td>
<td>Coolant flow rate less than .09 gallons per minute</td>
</tr>
<tr>
<td>4</td>
<td>Camera housing temperature above 49°C</td>
</tr>
<tr>
<td>5</td>
<td>No response from camera. Images are not being snapped.</td>
</tr>
<tr>
<td>6</td>
<td>Arc occultor not responding to commands in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>7</td>
<td>Trolley occultor not responding to commands in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>8</td>
<td>Arc occultor is responding but is unable to get to programmed destination in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>9</td>
<td>Trolley occultor is responding but is unable to get to programmed destination in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>10</td>
<td>Neutral density filter operation error in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>11</td>
<td>Spectral filter operation error in &gt; 90% of images grabbed</td>
</tr>
<tr>
<td>12</td>
<td>Nitrogen pressure reading error</td>
</tr>
<tr>
<td>13</td>
<td>All available tape drives have failed or all available tapes are full</td>
</tr>
</tbody>
</table>

Yellow Flag Errors

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Camera CCD chip temperature above -30°C</td>
</tr>
<tr>
<td>2</td>
<td>Environmental housing temperature above 32°C</td>
</tr>
<tr>
<td>3</td>
<td>Coolant flow rate less than .125 gallons per minute</td>
</tr>
<tr>
<td>4</td>
<td>Camera housing temperature above 32°C</td>
</tr>
<tr>
<td>5</td>
<td>Arc occultor not responding to commands in &gt; 10% of images grabbed</td>
</tr>
<tr>
<td>6</td>
<td>Trolley occultor not responding to commands in &gt; 10% of images grabbed</td>
</tr>
<tr>
<td>7</td>
<td>Arc occultor is responding but is unable to get to programmed destination in &gt; 10% of images grabbed</td>
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<tr>
<td>8</td>
<td>Trolley occultor is responding but is unable to get to programmed destination in &gt; 10% of images grabbed</td>
</tr>
<tr>
<td>9</td>
<td>Neutral density filter operation error in &gt; 10% of images grabbed</td>
</tr>
<tr>
<td>10</td>
<td>Spectral filter operation error in &gt; 10% of images grabbed</td>
</tr>
<tr>
<td>11</td>
<td>Writing to last available Exabyte drive</td>
</tr>
<tr>
<td>12</td>
<td>Hard disk is full</td>
</tr>
<tr>
<td>13</td>
<td>Nitrogen pressure is less than 2 PSI</td>
</tr>
<tr>
<td>14</td>
<td>WWV clock not responding</td>
</tr>
</tbody>
</table>
Change Exabyte tapes?: (1 = yes, 0 = no):

Wait... writing last EOF to drive 1
Wait... unloading tape in drive 1
Label tape in drive 1: Start date: 3/16/95, End date: 3/23/95

Check Exabyte status lights.
If the top and bottom LEDs are flashing on an Exabyte drive, please insert an Exabyte cleaning tape into that drive. Also, if it has been two weeks since an Exabyte drive has been cleaned, please clean it. Each Exabyte should have its own cleaning tape. After cleaning a drive, label the cleaning tape with the current date.

Press the ENTER key when you have finished the cleaning process.

Insert new tapes into each empty tape drive. Press the ENTER key after the tapes are loaded and the bottom green LED on each Exabyte drive has stopped flashing.

Figure 1
Option T - Change Exabyte Tapes
Table 3
RUNWSI.INP - Input file for RUNWSI.EXE

Location Information

Latitude ---------------------- 32.70
Longitude --------------------- 117.24
Site Identifier ---------------- MPL
Hardware vers. ----------------- 3.2
Software vers. ----------------- 4.0

Instrument Factors

Gear Cor (azi) ------------------ 0
Gear Cor (zen) ------------------ 0
Camera Azimuth Offset ---------- 0
Field Azimuth Offset ----------- 0
Image Azimuth Offset ---------- 0

Acquisition Options

Acquisition interval in minutes ---- 10
Perform Ratio? ------------------ 0
Red/Blue grab? ------------------ 0
Exabyte Archive? ------------- 1
Allow hotkey access? ------- 1
Starting Exabyte drive (1-3)---- 1
Maximum Exabyte number (1-3)---- 3

Display Options

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

Image Geometric Information

Center X ---------------------- 252
Center Y ---------------------- 256
90 Degree Radius ------------- 238

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
RUNWSI.INP - Input file for RUNWSI.EXE  cont.

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

Relative Humidity (%)

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

DropShipper parameters (Max. 15 chars. End with backslash)

Dropshipper send directory --------- d:\send_dir\nSend files to Dropshipper? --------- 0

Maximum Display Ratios

ND1 Maximum Display Ratio --------- 65535
ND2 Maximum Display Ratio --------- 30000
ND3 Maximum Display Ratio --------- 30000

Opaque Thresholds

ND1 Opaque Threshold --------------- 120
ND2 Opaque Threshold --------------- 130
ND3 Opaque Threshold --------------- 130

Default Reference Value -------- 80
RUNWSI.INP - Input file for RUNWSI.EXE  cont.

Thin Cloud Acceptance Level (%) ----- 15
Indeterminate Window (%) ----------- 25

Time Offset ------------------------- 0

Create diagnostic log (runwsi.dgn)? - 0

TWP Specific Options

Time source 0=BIOS,1=WWV,2=GPS ------ 0
Perform Cloud Decision? -------------- 1
Display 0=Red,1=Rat+Cld,2=Rat,3=Cld - 1
EXB drive for processed data -------- 1
Shutting Down Your System

You can preserve your desktop and the integrity of the operating system by doing a shut down on your system before turning it off. The shut-down process stores information about which windows are open, their placement on the desktop, and with some programs even their current state, in addition to writing the information that is in the cache (storage buffer) to the hard disk.

Note: Be sure to check all programs for unsaved information (such as documents you are editing) before you start the shut-down procedure.

To shut down your system using a mouse:

1. Point to an empty area on the desktop.
2. Click mouse button 2.
3. Select Shut down.
4. Select Yes.
5. Wait for a message that states that the shut down is complete.
6. Turn off the computer.

To shut down your system using the keyboard:

1. Press Alt+Shift+Tab. (If you are in a full-screen session, press Alt+Esc before you press Alt+Shift+Tab.)
2. Press Ctrl+\ to deselect the icons on the desktop.
3. Press Shift+F10 to display the pop-up menu for the desktop.
4. Use an arrow key to highlight Shut down.
5. Press Enter.
6. Press Enter again to select Yes.
7. Wait for a message that states that the shut down is complete.
8. Turn off the computer.
WSI Set-up Instructions

Version Date: June 96, Generic

Comments:

The Whole Sky Imager (WSI), for transport, ships in 5 reusable wooden shipping crates. The crates were designed around a fork lifttable reusable pallet with hard and/or soft foam incorporated to absorb shock and high frequency vibrations. Floating decks with vibration isolators are used in the larger crates. The crates conveniently unpack with the removal of the hex head bolts that hold the top and sides of the crate together. It is recommended that one use a Makita cordless power drill (or other power driver) and a 7/16" drive socket to facilitate in the removal of the bolts. (The large crates use T-nuts and bolts on the tops and sides, and lag bolts at the base; the boxes use T-nuts and bolts for the lid.) Generally it is easiest to first remove the top of the crate then the sides. The crates contain the following items:

1. Blue Box computer rack (requires indoor environment location)
2. WSI White Box environmental housing (located outside)
3. WSI Camera Housing (goes in environmental housing)
4. Occultor (goes on environmental housing)
5. Cabling and miscellaneous

A) Placing the Crates at the site

_____ Before placing the crates containing the white and blue boxes, one should determine how the boxes will be lifted from the pallets. A fork lift may be used. A small crane can be used, using the eyebolts on the top of the blue and white boxes, and using two people to balance the boxes. The boxes can be roped to 2 x 4's and 4 people can lift the ends of the 2 x 4's. The blue box has wheels, and can be rolled on a strong nearly-level ramp. The choice of method affects the choice of placement of the crates, e.g. next to the platform or on the platform.

_____ The Blue Box crate (33"x 36"x 64"") contains the computer rack which will be located and operated in a temperature controlled indoor environment. It should be placed near or in the room or trailer.

_____ The White Box crate should be placed on or near the platform which will be used for the WSI. The platform should be close enough to the blue box location to allow connection of the white box to the blue box via a pre-assembled 100 foot cable bundle.

_____ The other crates should be placed near the white box crate.

B) Unpack the White box.

_____ Using a fork lift, small crane, or four people, place the White Box crate on a stable platform.
Remove the White Box crate top and sides. Store the bolts in a baggie labeled "Crate 2".

There should be 4 eyebolts in the upper corners; if not, find them inside the box and install them if needed in the next step for lifting.

Briefly lift the white box from its pallet and pull the pallet out from under the white box. Turn the white box so that the North side of the box (the side of the White Box enclosure to which the door latches attach) is pointed toward North, and the box approximately aligned along a North-South line.

Remove the black sunshade plate from the top of the housing. Secure the bolts in a ziplock baggie for use in Step C.

Set aside the small round piece of insulation for use in Step E (installing the camera in the white box).

C) Mount the Occultor Assembly on the Environmental Housing (White Box)

Verify that the insulating foam and 4 nylon stand off blocks are positioned such that the hold down bolts line up with the top plate of the White Box.

Remove the top of the occultor shipping box and remove extra packing material, carefully saving both the bolts and packing material.

Remove the bungie cord which holds down the occultor arc. Remove the lag bolts which hold the occultor on the box support. (Or, if occultor is secured in a different manner, remove fasteners holding occultor in box). Leave in the packing which holds the arcs in their set position.

Lift the occultor by the large circular support plate, while gently supporting the arc. DO NOT lift it by the arc or motor assemblies (use the cylindrical, parallel spacers at each end of occultor assembly).

Place the circular occultor base plate on top of the nylon blocks with the end extensions orientated north and south, and the end marked North to the north.

Temporarily place the bolts removed in Step B into the bolt holes to hold the occultor in place.

Verify that the 7.5" occultor disk is in place. If it was removed for shipment, position it on the ends of the stand-offs on the trolley (at the top of the arc), and screw on the disk using the screws from the Baggie marked "Occultor disk".

Replace the baggie and packing materials in the occultor box.
D1) Fasten the Occultor Arc Drive Motor

Procedure used only if occultor was shipped with arc drive in place, otherwise use D2.

1. Verify that the packing material is still in place, supporting the arcs near a 10 degree position.

2. Find the arc drive cover, which is the rectangular box on the south end of the occultor. Remove the 7 screws holding it in place, and carefully remove the cover, being careful not to strain the wires.

3. Inside you should see, from top down, the black box containing the planetary gearhead, some shafts, gears, and potentiometer, and on the bottom the motor. Locate the motor.

4. Move the arc up or down slightly, until the vertical pen mark on the motor is centered in front. At this point the 4 holes in the top motor flange should be in line with the 4 holes in the mounting plate directly above the motor.

5. Attach the motor to the mounting plate by screwing in the 4 screws, which should be in a baggie taped to the inside of the arc drive cover.

6. Replace the arc drive cover, being careful not to pinch any wires.

7. Remove any remaining packing material in the occultor. The motor should now support the arcs. Now go to step E.

D2) Install the Arc Drive on the Occultor

Procedure used only if Occultor was shipped with dummy plate

1. Verify that the packing material is still in place, supporting the arcs near a 10 degree position.

2. The dummy support plate is attached at the south end of the occultor to four one-inch diameter round stand-offs with four 8-32 stainless steel shoulder cap screws. Remove these screws, and carefully remove the dummy support plate.

3. Bring up the arc drive base plate. Note the drive shaft clamp, which will mate with the drive shaft. The drive shaft is keyed with the clamp to minimize backlash and slippage. The clamp and arc should both be aligned with the arcs near 10 degrees; if not, loosen and/or remove the packing and move the arcs until the key on the drive shaft is aligned with the clamp.

4. Gently slide the clamp over the drive shaft, moving the plate at the same time, until the base plate is fully up against the stand-offs and the drive shaft and clamp are fully engaged. If the clamp is too tight, one may remove the clamping screws, insert a thin shim into the clamping slot and use the clamping screws to slightly spread the clamp.

5. Secure the arc drive base plate to the stand-offs using the four 8-32 screws.
Tighten the clamp using the 3 8-32 cap screws.

Remove any remaining packing material in the occultor.

E) Install the Camera Housing in the Environmental Housing

Verify that the red rubber ring is seated on the top of the nylon support ring in the top plate of the environmental housing.

Remove the lid from the top of the camera housing crate. Lifting the camera housing by its large support ring (not by the lid), remove the camera housing, being sure to save all bolts and packing material.

Loosen the 4 screws which protrude slightly on the outer diameter of the camera housing lid and remove the lid.

Position the camera housing unit above the top plate of the environmental housing. Rotate the camera until the largest connector on the bottom is to the south. Lower camera unit until the camera housing is seated on the nylon support ring.

Partly insert the 8 screws in the baggie marked "camera housing".

Align the camera so that the screws are in the center of the slots.

Once the camera housing is properly aligned, screw the camera housing to the nylon support ring being careful not to over tighten the screws (the nylon threads are easily stripped).

Place the two rings of black insulation over the camera housing flange. (One of these was set aside in Step B, and the other is normally shipped in the camera housing box.)

Remove the 8 bolts which secure the occultor assembly, then replace the sunshade and replace the outer 4 bolts.

Find the baggie marked "Cmg Hsg lid" in the spares box, and attach the four pieces to the camera housing lid, and replace the 4 long screws on the outer diameter of the lid with the 4 short screws in the baggie. Put the 4 long screws in the baggie and return it to the spares box.

Place the camera housing lid over the camera, and hold it down with the remaining 4 bolts that hold the sunshade.

Replace the baggies and any packing materials in the box, and seal the box for storage, being sure to use all the bolts.
F) Connect Camera Electrical and Coolant Lines

_____ Open the east * door of the environmental housing.

_____ Remove the black foam holding in the lexan window, remove the window, and set it and the foam aside in a safe place.

_____ Connect the two tygon tube coolant fluid lines to the quick disconnect lines emanating from the base of the CCD camera. Either tube may be connected to either fitting.

_____ Find the grey camera cable which comes from the Camera Electronics Unit (CEU) and is labeled "Cable, Camera Head CH250"; this will be used in the next step. It is normally shipped in the cable box.

_____ Remove the Camera grounding plug (Blue 37-pin connector) on the back of the CCD camera, place on the inside shelf of the environmental housing, and IMMEDIATELY attach the free end of the camera cable, being careful not to reverse the cable. Store the grounding plug in the white box attached to the camera cable.

_____ Connect the cable for the filter changer and shutter; this connector, labeled "Filter changer", should be connected to the bottom of the camera housing.

_____ Connect the temperature cable connector. This is a smaller cable labeled "Camera Hsg" which connects to the bottom of the camera housing.

_____ Connect the two nitrogen sensor cable connectors (two ends of one cable); one leads from the sensor on the bottom of the camera housing, and the other is part of the cable bundle on the housing shelf, and is labeled "N₂ Pressure".

G) Unpack the Computer rack (Blue Box)

_____ Remove the top and sides from the Blue Box computer rack crate, and remove it from its pallet.

_____ Save all bolts in a baggie marked "Crate 1", and set any packing material aside temporarily.

_____ Move the computer rack to its designated position in a trailer or room. The indoor location must be environmentally controlled and be able to maintain a relatively constant temperature. A cool constant room temperature and low humidity is required (i.e. a standard office environment appropriate to a PC computer).

_____ Remove all packing foam from inside of the Blue Box enclosure and remove any extra packing from around the monitor. Set aside temporarily.

* may be west door on some units
Find the keys, taped inside the back of the blue box enclosure. They are keys for a) the front door of the blue box, b) the ACPs, c) power to the computer, and d) the SCSI rack if there is one (TWP and NSA units only). Set in a safe place.

H) Connect interior Blue Box cabling.

Open the cable box, saving the bolts in a baggie. Find the keyboard rest, and install it on the front of the Blue Box.

Find the keyboard in the cable box, plug it in to the front of the Blue Box, and place it on top of the computer for safety.

Find the WWV clock and the mouse in the cable box.

Unwrap the Heath WWV clock. Set the clock above the computer monitor and route the clock power adapter cord to the 115V plug-in terminal strip on the floor of the Blue Box.

To connect the clock, find the grey cable on the upper left in back, which is labeled "Clock", and connect it to the "RS232" port on the clock.

Unwrap the mouse, and connect the cable to the third port from the top on the left-most computer board (the CPU board).

Verify that the monitor power connection on the back of the monitor is solid.

Verify that the following connections on the computer back are good:

- Switch is on "1", i.e. "on"
- Top plug under switch (power in) is seated
- Second plug under switch (power out to monitor) is seated
- Monitor signal cable on top port, left-most board (CPU) is seated
- White plug for peripheral SCSI enclosure on second card from left (SCSI) is seated-only on units with peripheral exabyte rack.

Verify that the following connections on the Accessory Control Panel (ACP) backs are good:

- Occultor ACP trolley ribbon cable 6402-02-J3 is seated in ACP receptor 6402-02-P3
- Occultor ACP arc ribbon cable 6402-02-J4 is seated in ACP receptor 6402-02-P4
- Occultor ACP power cord 6402-02-J5 is seated in ACP power receptor 6402-02-P5
- Sensor ACP ribbon cable 6401-02-J3 is seated in ACP receptor 6401-02-P3
Sensor ACP ribbon cable 6401-02-J4 is seated in ACP receptor 6401-02-P4

Sensor ACP power cord 6401-02-J5 is seated in ACP power receptor 6401-02-P5

On units with a Peripheral SCSI Enclosure (Exabyte rack), verify that the following connections are good.

White SCSI input cord on upper left port is seated.
Termination plug in lower part is seated.
Power cable in lower plug is seated.
Install all keys set aside in Step G.

I) String 100 foot cable bundle

Carefully remove the 100 foot cable bundle from the cable box. There should be a large cable which says "Cable, Integ Cntrlr CE200a" at one end; this end will go to the environmental housing. At the other end, the cable is labeled "Connect to interface card"; this end will go to the computer rack.

Lay out the 100 foot cable bundle between the indoors computer rack and the outdoors environmental housing, with the ends laid out as noted above.

Comment:
The 100 foot cable bundle consists of 2 orange power cords, 2 small 1/4" diameter gray cables for the occulter arc and trolley, and 3 large 1/2" diameter gray cables for the filter changer, camera, and other sensors such as temperature. The orange power cord labeled "Camera AC" (or smaller diameter cord) supplies power to the camera electronics unit and MUST RECEIVE POWER THROUGH AN UPS (uninterrupted power supply). The other orange power cord supplies power to the thermal electric cooler, the coolant circulation pump and the system status meters.

J) Connect the Cable Bundle at the Blue Box

Route the cable bundle under the sandwich port provided below the rear door of the Blue Box.

Connect Occulter ACP 6402-02-J1 to port 6402-02-P1 on the Occ ACP.
Connect Occulter ACP 6402-02-J2 to port 6404-02-P2 on the Occ ACP.
Connect Sensor ACP 6401-02-J1 to port 6401-02-P1 on the Sensor ACP.
Connect Sensor ACP 6401-02-J2 to port 6401-02-P2 on the Sensor ACP.
Connect the camera cable, labeled "connect to interface card" to the upper port of the fourth card from the left in the back of the computer (computer control card).

Ignore the orange power cords; they will be connected at a later step.

K) Connect cable bundle to Environmental Housing

Open the West * door of White Box.

Remove the black foam holding in the lexan window, remove the window, and set it and the foam aside in a safe place.

Feed the cable bundle through the side-cut holes located at the base of the housing on the right hand side, and then up through the bottom plate.

Plug the black power cord labeled "camera AC" into one orange power cord.

Plug the following into the 3 plugs attached to the other orange power cord: The yellow-ended plug from the thermal electric cooler labeled "TECA AC" The black plug labeled "Meter AC" and the yellow-ended plug from the coolant circulation pump labeled "Pump AC".

The camera cable labeled "Cable, intg cntrl CE200a" snakes up to the upper housing chamber and connects to the bottom port of the camera electronics unit (grey box); the port is labeled "Controller".

Connect the large gray Sensor ACP cable 6501-03-J1 to port 6501-03-P1 on the environmental housing bulkhead (in the lower env hsg chamber).

Connect the large gray Filter cable 6501-03-J2 to port 6501-03-P2 on the environmental housing bulkhead.

Connect the small gray cable 6501-03-J3 to port 6501-03-P3 on the environmental housing bulkhead.

Connect the small gray cable 6501-03-J4 to port 6501-03-P4 on the environmental housing bulkhead.

Place the small "anti-bug" plate over the hole in the bottom through which the cables run, and snug it down with the provided screws.

L) Connect cables to occultor

On South side, connect cable labeled "Arc drive" to the left-hand (west end) connector plug on the bottom of the occultor arc drive housing.

On South side, connect cable labeled "Limit On/off" to the right-hand (east end) connector plug on the bottom of the occultor arc drive housing.

* East on some units
On North side, connect cable labeled "Trolley drive" to the connector plug on the round trolley drive housing.

On North side, connect cable labeled "Limit switch" to the connector plug on the limit switch housing which is labeled "North".

M) Setup the clock antenna

Find the clock antenna. Lay out the brass antenna wires along a line approximately orthogonal to the direction to Colorado (Hawaii if that is closer).

If Hawaii is the nearer WWV time source, follow the instructions in the clock manual for setting up the clock.

Run the cable in to the blue box, and hook it up to the connector plug marked "antenna" on the back of the clock.

Turn on the volume on the clock, so you can hear the incoming signal.

Move the antenna wires as necessary to optimize the incoming signal, taking into account the practicalities of being able to attach the wire to something where it won't be a danger.

If you are unable to receive a strong signal, it may take several hours for the clock to lock-on. If the clock does not eventually lock-on, follow the instructions in the clock manual for initializing the time manually.

Attach the brass antenna wires to available support structures, avoiding metal where possible.

Turn volume off.

N) Prepare Housing Coolant

Verify that the coolant path is complete, from reservoir out to reservoir in.

Unscrew the cap from the reservoir fill tube on top of the environmental housing.

Fill coolant reservoir with a 60/40 mixture of distilled water and isopropyl alcohol (mixing ratio is approximate; about 2 parts water to 1 part alcohol). This is easiest using the supplied funnel. Do not fill over the top of the reservoir.

Place the saddle to hold the desiccant on top of the camera electronics unit (shipped in the cable box).

Place the desiccant (shipped in the cable box) in the desiccant saddle.

Replace the lexan on both sides of the housing, replacing the black foam, and being sure that the foam is not in the "keep unobscured" region.

Shut both doors to the housing
Note the time. In a very moist environment, it is best to leave the doors shut, with the desiccant in place, for 1-3 hours before turning on the coolant, to avoid condensation.

O) Align the Environmental Housing to True North

Note: This alignment gets the WSI sufficiently aligned to check the WSI operation. For final precision alignment, follow the precision alignment procedures documented separately.

_____ Remove the sun shade and camera housing cover.

_____ Place a level on the occultor plate, on whichever side, E or W, has two (not three) legs. * Determine whether that side of the housing is level along a N-S line.

_____ Adjust the N-S level as necessary by adjusting the leveling legs in the NE and SE corner. Leveling legs are adjusted by lowering the top nut, lowering or raising the leg, and retightening the top nut.

_____ Placing a level along a E-W line, determine whether the E-W line is level.

_____ Adjust the E-W level by moving the leveling leg in the CENTER of the W side of the housing.

_____ Using a magnetic compass with sites on it, determine magnetic north, being sure to be far enough away from motors and large metal masses to get an accurate position.

_____ The magnetic variation should be determined in advance (or MPL can supply this number). Correct the compass alignment for magnetic variation so that the sites on the compass are pointed to true north.

_____ Looking through the compass sites, determine a distant object at true north. If the compass is not close to the WSI, then the compass should be placed so that it is on a N line with the WSI. In this way the distant object will also be at true north with respect to the WSI.

_____ Siting along any N-S line on the environmental housing, make a final orientation adjustment to align the housing with the distant object.

_____ Once alignment is complete, readjust the 3 leveling legs as necessary.

_____ When the system is fully level, snug down the leveling legs in the NW and SW corners to support the system more with stability, being careful not to change the leveling.

_____ Snug the nuts on all 5 legs up against the white box to secure the leveling leg position.

* This section is written for the case in which the two legs are on the E side. If they are on the W side, adjust the instructions accordingly.
True north can be verified by running Program SRCINFO, which is on the hard disk, determining the time for local apparent noon (LAN), and casting a vertical shadow at local apparent noon. (Or MPL can supply this time.) The shadow, if truly vertical, should align with true north.

Replace the sun shade. This time, the camera lid may be left off, and the shorter bolts originally shipped with the system may be used.

Replace the four screw eyes in the corners, which were originally used to lift the White Box, with the bolts in the baggie marked "White Box corner hardware". Place the screw eyes in this baggie.

Install the four shorter screw eyes from the baggie into the corners of the white box, so that they protrude horizontally. Store the baggie with supplies.

Install 4 screw-eyes near the corner of the platform. These should be in the occultor shipping box along with plastic-coated tie down cable, 16 or 17 wire nuts, and 4 turnbuckles.

Using the plastic-coated tie-down cable, connect the housing to the platform as follows. A piece of cable is connected to the housing eye-bolts using one of 16 wire nuts. About halfway down, the end is cut and attached to a turnbuckle using another wire nut. Another piece is cable then attaches the turnbuckle to the platform screw-eye, using 2 more wire nuts, and adjusting the tension so it doesn’t sag with the turnbuckle fully extended. After doing this on each corner, tighten the turnbuckles evenly so they are taut but not tight.

P) Power-up Sequence

Note the time. If in a moist environment, be sure that 1-3 hours have elapsed since the environmental housing doors were sealed with the desiccant in place.

Do a final visual inspection of the white box for abnormalities.

Do a final visual inspection of the blue box for abnormalities.

Verify that front switches are in the "off" position on both ACP’s and the computer.

Connect the UPS (Uninterruptible Power Supply) to power, and turn it on.

Plug the orange power cord labeled "Camera AC" into the UPS.

Plug the orange power cord labeled "Meter Assemb" into a power strip or UPS.

Plug the Blue Box power cord into the UPS.

Verify that the computer is off, so you can check the ACP’s before the computer takes over.

Turn the Sensor ACP power on, and the local enable on.
Verify that the filter changer wheel on the Sensor ACP is operable.

Verify that the panel meters on the Sensor ACP come up.

Turn the Occultor ACP power on, and the local enable on.

Verify that both the arc drive and trolley drive on the ACP can be changed.

Compare the arc physical position with the ACP panel meter. In normal shipping configuration, the arc should be at 10 degrees above horizontal toward the East, and the panel meter should be near 10.

Compare the trolley physical position with the ACP panel meter. In normal shipping configuration, the trolley should be at 45 degrees from North, and the panel meter should be near 45.

If the arc or trolley positions are not consistent with the ACP positions, refer to the ACP alignment procedures (to be included in the Trouble Shooting Manual). It is important that the ACP readout matches the occultor position before the computer is turned on.

If the unit has a peripheral SCSI rack, turn on the upper switch on the rack.

If this unit runs under OS/2, note that if you are familiar with OS/2, you must not put the primary program in the background. OS/2's handling of graphics programs will cause the acquisition program to become inactive while in the background.

Turn on the computer. Verify that it and the monitor comes on.

On OS/2 units, when the computer arrives at the OS/2 or DOS choice, choose DOS.

On OS/2 units, change to the D drive by entering D:

Change to the WSITEST directory by entering WSITEST.

Run program RTGRAB by entering RTGRAB and following the instructions. This program will grab images every 8 seconds when set on exposure = 100 msec, and allow you to see the images.

In RTGRAB, verify that images are being acquired by the camera.

Change the filter positions, and verify that the image changes (remember that the response is not instantaneous).

Change the occultor position, and verify that the image changes.

Check the Sensor ACP panel readings for normal:

Camera housing less than 32, generally near 16 (degrees C)
Chip temperature near -35 (degrees C)

Environmental housing up to 32, generally near 16 (degrees C)

Flow rate above .125, generally near .2 (gallons/min)

N2 pressure above 2, generally near 4 (psi)

Relative Humidity below 99% (below 30% after it has been sealed for a day).

Return the ACP local enable to off.

Check the input file for the correct local lat, long, and site ID, as follows. Enter "MS RUNWSI.INP". Use the down arrow to find the appropriate input lines. If it is necessary to change them, use the right arrow to get to the right space, enter the corrected values by typing them in, and use the Del key to remove the old values. Once all 3 lines are done, check them to verify that you have preserved the format. To exit, press the "F10" key, followed by "F", "q", and "y" (or use the editor of your choice.)

Install a tape in the tape drive in the drive by pressing the button, and inserting the tape in the open door.

Return to root directory by typing "cd \". Edit AUTOEXEC.BAT, removing the "REM" from the line which has "REM RUNWSI". Exit the edit program, saving the change.

Reboot the system by entering Ctrl Alt Del.

Verify that the WSI goes through normal start-up procedure documented in Memo AV95-016t. (This memo includes OS/2 steps which will not be present on Unit 5.)

Q) Seal the Unit

After everything has been verified to be normal, seal the camera housing and the environmental housing for moisture, by running an RTV bead between the inner circumference of the white insulation ring and the outer ring of the camera housing, on top. (It is necessary to remove the sunshade and black foam insulating ring to get to this.)

Seal any screws which penetrate the top on either the ring or the metal top.

The outer circumference on the white insulation ring is normally either sealed underneath the ring at MPL, or sealed with an RTV bead on installation. Verify that it has been sealed, and if not, seal it.

Check all subassembly cases to verify that they appear to be sealed (See Tech Note 241, Section 4.10 for more details.) Seal with RTV if required, particularly at sites with frequent rain and/or infrequent technical support.
R) Clean-up

_____ Put the bolts and packing materials from the two large crates in the cable shipping box.

_____ Seal the cable shipping box, being sure to use all the bolts.

_____ Store the 3 boxes and the sides, top, and pallets from the two larger crates in a safe location for future shipment, if desired.

_____ Remove and store the keys from the ACP when the system is left in final field configuration, if desired.

S) Second Day Check

_____ On the second day, go through the Maintenance procedures documented in the Preventative Maintenance Checklist to verify performance.

Note: the hook-up for remote communications is the responsibility of the host computer team. The system will have an Ethernet or Scramnet card, depending on host requirements.

Typical Contents of Shipping Boxes:

Box 1: Computer rack (Blue Box) Crate
- computer monitor (well locked for shipment)
- 2 Accessory Control Panels
- SCSI rack (if provided)
- blue eye bolts in bottom
- Various cables pre-attached

Box 2: Environmental housing Crate
- Completed housing with a variety of parts pre-installed, including:
  - TECA cooler
  - pump and coolant system
  - reservoir
  - temperature and flow rate sensors
  - insulation and sun shield on top

Box 3: Camera housing Crate
- camera housing subassembly includes sensor, lens, filters, etc.
- camera housing lid

Box 4: Occultor Crate
- WSI Occultor

Box 5: Cable and Miscellaneous Crate
- cable bundle
- WWV clock
- keyboard rest
keyboard
distilled water
alcohol
desiccant
desiccant saddle
nitrogen
nitrogen gauges
tie-down cables with screw-eyes, turnbuckles, wire nuts
antenna cable
documentation and supplies kit
spare exabyte tapes
spare desiccant
spare dome

Box 6 (for some sponsors):
Universal transit
Alignment device

Additional equipment normally used by field team

Tool kit
Spare black tie downs
compass and levels
rope
square for providing shadow at LAN
WSI Packing Instructions

Version Date: 5 Dec 95, Unit 5

Comments:

This list describes the shipping method used by MPL, which we have found to be reasonably safe. The list is being provided for guidance to the sponsor. We understand that these procedures may not be followed exactly, but it is important for the sponsor to substitute equally safe measures if these steps are changed.

The Whole Sky Imager (WSI), for transport, ships in 5 reusable wooden shipping crates. The crates were designed around a fork liftable reusable pallet with hard and/or soft foam incorporated to absorb shock and high frequency vibrations. Floating decks with vibration isolators are used in the larger crates. The crates conveniently unpack with the removal of the hex head bolts that hold the top and sides of the crate together. It is recommended that one use a Makita cordless power drill (or other power driver) and a 7/16" drive socket to facilitate in the insertion of the bolts. (The large crates use T-nuts and bolts on the tops and sides, and lag bolts at the base; the boxes use T-nuts and bolts for the lid.) Generally it is easiest to first place the sides of the crate on, and then the lid. The crates contain the following items:

1. Blue Box computer rack (requires indoor environment location)
2. WSI White Box environmental housing (located outside)
3. WSI Camera Housing (goes in environmental housing)
4. Occultor (goes on environmental housing)
5. Cabling and miscellaneous

A) Start a List

_____ Make a copy of the packing list at the end of this note, so you can be prepared to check off each item as it goes in its box.

B) Power-down Sequence

_____ If the program is running, type the T (for Tape) key, and follow the instructions for removing, labeling, and storing the tapes.

_____ Terminate the RunWSI program by pressing the 'X' key.

_____ On OS/2 systems, in order to close all open sessions using the Window List, press the CTRL and ESC keys simultaneously. A window showing all open sessions is displayed. Use the up or down arrow key to highlight the RunWSI title in the Window List. Click the third mouse button to close the window. Repeat this procedure for all titles in the Window List, except for the Desktop title. Answer yes to each confirmation prompt. After closing all windows and sessions, follow the shut down procedure shown in figure 1.

_____ Turn off the upper switch on the SCSI rack, if there is one.
Turn off the computer. This should also shut down the monitor.

Turn the Sensor ACP power off.

Turn the Occultor ACP local enable key on, and put the local switches into local. Move the arc drive to 10 degrees, and the trolley drive to 45 degrees.

Turn the Occultor ACP power off.

Unplug the Blue Box power cord from the UPS.

Unplug the large diameter orange power cord from the power strip or UPS.

Unplug the small diameter orange power cord from the UPS.

C) Disconnect the Cable Bundle at the Blue Box

Disconnect Occultor ACP 6402-02-J1 from port 6402-02-P1 on the Occ ACP.

Disconnect Occultor ACP 6402-02-J2 from port 6404-02-P2 on the Occ ACP.

Disconnect Sensor ACP 6401-02-J1 from port 6401-02-P1 on the Sensor ACP.

Disconnect Sensor ACP 6401-02-J2 from port 6401-02-P2 on the Sensor ACP.

Disconnect the camera cable, labeled "connect to interface card" from the upper port of the fourth card from the left in the back of the computer (computer control card).

Remove the cable bundle from the blue box via the sandwich port provided below the rear door of the blue box.

D) Disconnect cable bundle from Environmental Housing

Open the West * door of White Box.

Remove the black foam holding in the lexan window, remove the window, and set it and the foam aside in a safe place.

Unplug the black power cord labeled "camera AC" or "Camera electronics unit" from the orange power cord.

Unplug the following from the 3 plugs on the other orange power cord: the yellow-ended plug from the thermal electric cooler labeled "TÉCA AC", the black plug labeled "Meter AC" and the yellow-ended plug from the coolant circulation pump labeled "Pump AC".

* May be East on some units
The camera cable labeled "Cable, intgr cntrlr CE200a" snakes up to the upper housing chamber and connects to the bottom port of the camera electronics unit (grey box); the port is labeled "Controller". Unplug this connector, and bring it down into the bottom of the environmental housing.

Disconnect the large gray Sensor ACP cable 6501-03-J1 from port 6501-03-P1 on the environmental housing bulkhead (in the lower env hsg chamber).

Disconnect the large gray Filter cable 6501-03-J2 from port 6501-03-P2 on the environmental housing bulkhead.

Disconnect the small gray cable 6501-03-J3 from port 6501-03-P3 on the environmental housing bulkhead.

Disconnect the small gray cable 6501-03-J4 from port 6501-03-P4 on the environmental housing bulkhead.

Remove the small "anti-bug" plate from the hole in the bottom through which the cables run, and place it in the housing for shipment.

Feed the cable bundle out through the bottom plate, and then out through the side-cut holes located at the base of the housing on the right hand side.

E) Pack the 100 foot cable bundle

Coil the cable bundle into a figure 8 formation. This avoids kinks in the bundle. It should be loose enough so that it is easy to work with, i.e. can be slung over the shoulder if desired for carrying up platforms at the site.

Open the Cable box, saving the bolts in a baggie, remove any loose packing material, and pack the cable bundle in the cable box.

F) Prepare Blue Box for Crating

Unplug the keyboard. Wrap it carefully in foam secured with fiber tape, and pack it in the cable box.

Remove the keyboard rest from the from door of the blue box, wrap in foam secured with fiber tape, and pack in the cable box.

Unplug the WWV clock from the 115V plug-in terminal strip on the floor of the blue box.

Disconnect the cable from the clock RS232 port, coil it and tuck it into the side of the blue box.

Disconnect the Scramnet cable or the Ethernet cable. If an Ethernet card is used, terminate the card.

Disconnect the clock antenna from the back of the clock.
Carefully wrap the clock in bubble wrap, tape it, and pack it in the cable box.

Disconnect the mouse cable from the computer, wrap the mouse in bubble wrap, tape it, and pack it in the cable box.

Verify that the monitor power connection on the back of the monitor is left connected.

Verify that the following connections on the computer back are left in the following configuration:

- Switch is on "1", i.e. "on"
- Top plug under switch (power in) is seated
- On units with a peripheral SCSI device, white plug for peripheral SCSI enclosure on second card from left (SCSI card) is seated
- Second plug under switch (power out to monitor) is seated
- Monitor signal cable on top port, left-most board (CPU) is seated

Verify that the following connections on the Accessory Control Panel (ACP) backs are left connected:

- Occultor ACP trolley ribbon cable 6402-02-J3 is seated in ACP receptor 6402-02-P3
- Occultor ACP arc ribbon cable 6402-02-J4 is seated in ACP receptor 6402-02-P4
- Occultor ACP power cord 6402-02-J5 is seated in ACP power receptor 6402-02-P5
- Sensor ACP ribbon cable 6401-02-J3 is seated in ACP receptor 6401-02-P3
- Sensor ACP ribbon cable 6401-02-J4 is seated in ACP receptor 6401-02-P4
- Sensor ACP poser cord 6401-02-J5 is seated in ACP power receptor 6401-02-P5

For units with a peripheral SCSI enclosure (Exabyte rack), verify that the following connections are left connected:

- White SCSI input cord on upper left port is seated
- Termination plug in lower port is seated
- Power cable in lower plug is seated

Place white etha (rigid) foam around the monitor, to hold it RIGIDLY so that it cannot slip sideways, vertically, or front to back. THIS STEP IS VITAL.
Tuck all cabling on back of the rack in neatly, taping if necessary for safe shipment.

Inspect the blue box to verify that it appears to be safe to ship.

Remove all keys, and put in a baggie.

Shut the front door and lock it.

Tape the baggie containing the keys to the inside of the blue box in back.

Secure the back door of the Blue Box (OK to leave unlocked).

G) Crate the Blue Box

If preparing for overseas shipment, wrap the blue box in commercial stretch wrap, including going under the box, so that it is sealed against moisture. (Or, if in San Diego, ask MPL to do this.)

Unlock the wheel locks, and place the blue box on its shipping pallet, i.e. the base of crate 1, with the front toward the side of the base labeled "front".

Adjust the position of the blue box on the base, so that the sides of Crate 1 can be set in place. Note labeling on the sides, base, and top to help you find which is front etc. The etha foam should fit snugly against the sides of the blue box to hold it tightly in place. If they don't, thin layers of soft foam can be added as necessary.

Hold the sides of the crate in place by inserting the bolts in the T-nuts loosely. (Make sure none of the T-nuts have fallen out, and replace with spares as necessary.)

Prepare packing slips as required, and insert in the top of the box.

Place the top of the box on in the correct orientation, and tighten down the rest of the bolts, including the lag bolts which secure the sides to the bottom.

Label the outside of the box with shipping addresses, packing slips, fragile stickers, and "UP" stickers.

H) Disconnect Camera Electrical and Coolant Lines

Open the east * door of the environmental housing.

Remove the black foam holding in the lexan window, remove the window, and set it and the foam aside in a safe place.

* May be west on some units
Remove the desiccant, seal it in plastic so that it's airtight, and wrap it and pack it in the cable box.

Remove the saddle to hold the desiccant from the top of the camera electronics unit, wrap in bubble wrap, and back in the cable box.

Disconnect the two nitrogen sensor cable connectors; one leads from the sensor on the bottom of the camera housing, and the other is part of the cable bundle on the housing shelf. Both are labeled "Pressure sensor".

Disconnect the temperature cable connector. This is a smaller cable labeled "Camera Hsg TEMP" which connects to the bottom of the camera housing.

Disconnect the cable for the filter changer and shutter; this connector, labeled "Filter changer", should be disconnected from the bottom of the camera housing.

Find the Camera grounding plug, a small blue plug which is stored in the environmental housing. This will be used in the next step.

Find the grey camera cable which comes from the Camera Electronics Unit (CEU) and is labeled "Cable, Camera Head CH250", and is connected into the back of the camera. Remove this cable, and IMMEDIATELY attach the camera grounding plug.

Find the two tygon tube coolant fluid lines, and note the disconnects near the camera. Only the female connectors have a liquid cutoff (in order to avoid too much pressure loss through cutoffs), so you will need to be prepared for some leaking. Have plenty of paper towels under the tubing, if there still is water in the tubes.

Disconnect the two tygon tube coolant fluid lines to the quick disconnect lines emanating from the base of the CCD camera. Connect the two tubes coming out of the back of the camera to each other.

Using the remaining male connector, drain the liquid from the reservoir, then connect to the remaining female connector. Clean up any spilled water.

I) Remove the Camera Housing from the Environmental Housing

Open the camera shipping box, and remove any spare packing material.

Remove the 8 bolts which secure the occultor, then remove the sunshade and set aside.

Remove the two rings of black insulation over the camera housing flange. (The smaller will be shipped in the camera housing box, and the larger will be shipped with the environmental housing.)

Unscrew the nylon screws which hold down the flange of the camera housing to the environmental housing. Save these in the baggie marked "camera housing".
With your arms inside the environmental housing, lift the camera housing up out of the lid, and have a partner lift it on out, being careful not to hit the connectors underneath or to mar the dome.

Disconnect the coolant disconnects, drain the camera, and reconnect the disconnects.

Remove the four flange pieces from the camera housing lid if they are on it, and place them in the baggie marked "Cmg Hsg lid", along with their screws. Attach the camera housing lid to the camera using the thumb screws which should be in the baggie.

Lower the camera into the camera shipping box, holding it by the flange, not the lid.

Pack in the baggie with the camera housing screws, and the baggie with the lid materials. Pack foam around and above the lid, to secure the camera.

Seal the camera shipping box, and add shipping documents and labels to the inside and outside as noted in Step G.

Verify that the red rubber ring is seated on the top of the nylon support ring in the top plate of the environmental housing.

J) Disconnect Occultor from Environmental Housing Electrically

On South side, disconnect cable labeled "Arc drive" from the left-hand connector plug on the bottom of the occultor arc drive housing.

On South side, disconnect cable labeled "Limit On/off" from the right-hand connector plug on the bottom of the occultor arc drive housing.

On North side, disconnect cable labeled "Trolley drive" from the connector plug on the round trolley drive housing.

On North side, disconnect cable labeled "Limit switch" from the connector plug on the limit switch housing which is labeled "North".

Bubble wrap these four short cables, and tuck them in on the sides, between the housing and the housing sun shield. Tape them in place for shipment.

K) Install the Arc Drive Dummy Plate on the Occultor Base Plate Frame

Call MPL for a dummy plate, or disengage the motor so that no dummy plate is required; see instruction sets D1 and D2 in the set-up instructions for documentation on these two approaches.

Place a wooden shim snugly between the arc counter weight and the uppermost one inch diameter stand-offs, to prevent the arc sub-assembly from dropping down when the arc drive base plate is removed.
Use 6" deep throat "C" clamps, or their equivalent, to clamp the arcs snugly, in their existing position, to the in-board support plate. This plate is at the in-board end of the stainless steel drive shaft and will remain in place during this procedure. Try to avoid putting cross torque on the drive shaft bearing while clamping the arcs in position.

The arc drive sub-assembly base plate is attached to four one-inch diameter round stand-offs with four 8-32 stainless steel shoulder cap screws. Loosen these four screws until they protrude from their countersinks about 1/16 inch. Do not remove these screws completely at this point since they will help maintain alignment while the drive shaft is disconnected.

Immediately adjacent to the inboard side of the arc drive baseplate is the retaining clamp on the stainless drive shaft. The clamp is held tight by three 8-32 cap screws.

Loosen the screws to release the drive shaft clamp. Note: the drive shaft is keyed inside the clamp to minimize backlash and slippage. If the clamp does not adequately release, one may remove the clamping screws, insert a thin shim into the clamping slot and use the clamping screws to slightly spread the clamp.

With the four stand-off screws and the three clamping screws loose, the arc drive sub-assembly is ready for removal. Using a hard wood block against the inside of the arc drive base plate immediately adjacent to the shaft clamp, tap the base plate directly outboard away from the clamp. Tap parallel with the drive shaft. Tap briskly until the base plate moves slightly outboard (not to exceed 1/16"").

Once the arc drive base plate separates slightly from the clamp, i.e. approximately 1/16", remove the four stand-off screws, grasp the arc drive sub-assembly and gently tap outward until the keyed shaft protruding from the arc drive base plate completely clears the end of the stainless steel clamp. At this point the disassembly procedure is complete.

Immediately upon completing disassembly, install the dummy support plate, using the four one inch long 8-32 machine screws provided. These attach the dummy plate to the four stand-offs previously used to support the arc drive base plate. Insert the plastic slug through the dummy plate into the stainless steel clamp. Tape slug in place.

Remove shims and clamps, and brace the arc in the 10 degree shipping position using etha foam inserts, with soft foam to fill in as necessary.

L) Remove the Occultor Assembly from the Environmental Housing (White Box)

Remove the top of the occultor shipping box and remove extra packing material, carefully saving both the bolts and packing material.

Lift the occultor by the large circular support plate, while gently supporting the arc. DO NOT lift it by the arc or motor assemblies.

Place the circular occultor base plate on top of the wooden support structure in the occultor box. Bolt down to the T-nuts on the underside of the support.
The arc should be laying on the etha foam support. Pad with soft foam as necessary, and then hold down the arcs with the bungie cords which hook into the bottom of the box.

Wrap the arc drive carefully in foam with fiber tape, and pack into the occultor box, packing it in foam so that it will not rattle around in the box.

M) Prepare the White Box for Shipment

Verify that the insulating foam and 4 nylon stand off blocks are positioned such that the hold down bolts line up with the top plate of the White Box.

Replace the small round piece of insulation removed in Step I.

Replace the black sunshade plate on the top of the housing, using the bolts saved in Step I.

Loosen the plastic-coated tie-down cables, by loosening the turnbuckles, then remove the cables (by loosening a wire nut at each end). Remove the screw eyes from the platform, and the screw eyes from the sides of the environmental housing. Store all these together in a sack, and pack in with the cable box.

Replace the four vertical screw eyes in the corners; these are used to lift the white box, and are stored in the baggie marked "white box corner hardware".

Inspect the interior of the environmental housing, to verify that it appears to be safe for shipping.

Replace the lexan on both sides of the housing, replacing the black foam, and being sure that the foam is not in the "keep unobscured" region.

Shut both doors to the housing.

Loosen the bolts on the top of each leveling feet where it is snug against the bottom of the environmental housing, and then screw each leg in to its shortest configuration. Retighten the bolts.

Inspect the exterior of the environmental housing, to verify that it appears to be safe for shipping.

N) Pack the White Box.

Find the pallet, sides, and top for Crate 2, which houses the White Box.

Place the pallet or base near the white box, with the side labeled "front" facing the same direction as the front door. [Verify, this may not be correct - check which way it will fit.]

Briefly lift the White Box up, and pull the pallet under the it.
Center the white box on the pallet. Place 2 x 4's under the sides of the white box so that the leveling legs are not supporting the weight. Seal the crate and label it using the same procedures noted in Section G.

O) Pack the clock antenna

Disconnect the clock antenna from the roof (or wherever it is).

Coil up the cable, and pack it in the cable box.

P) Clean-up

Check the packing list. Place in any spares listed on the list, and verify that everything is packed.

Be sure the occultor is well protected in its box, adding padding if necessary, and seal and label the occultor shipping box as noted in Step G.

Seal and label the cable shipping box as noted in Step G.

Using a fork lift, place the crates where they will be ready for shipment.

Typical Contents of Shipping Boxes:

Box 1: Computer rack (Blue Box) Crate
- monitor (well blocked for shipment)
- computer
- 2 Accessory Control Panels
- SCSI rack (if provided)
- blue eye bolts in bottom
- Various cables pre-attached

Box 2: Environmental housing Crate
- Completed housing with a variety of parts pre-installed, including
  - TECA cooler
  - pump and coolant system
  - reservoir
  - temperature and flow rate sensors
  - insulation and sun shield on top

Box 3: Camera housing Crate
- camera housing subassembly includes sensor, lens, filters, etc.
- camera housing lid
  (baggie with screws for adapting lid for field configuration)
  (baggie with screws for attaching camera housing)

Box 4: Occultor Crate
- WSI Occultor
  (Arc drive sub assembly plate)
Box 5: Cable and Miscellaneous Crate
- cable bundle
- WWV clock
- keyboard rest
- keyboard
- distilled water
- alcohol
- desiccant
- desiccant saddle
- nitrogen
- nitrogen gauges
- tie-down cables with screw-eyes, turnbuckles, wire nuts
- antenna cable
- Documentation and Supplies kit
- spare exabyte tapes
- spare desiccant
- spare dome

Box 6 (some sponsors):
- Universal transit
- Alignment device

Additional equipment used by field team
- Tool kit
- Spare black tie downs
- compass and levels
- rope
- square for providing shadow at LAN
WSI Packing List

Contents of Shipping Boxes:

Box 1: Computer rack (Blue Box) Crate
- monitor (well blocked for shipment)
- computer
- 2 Accessory Control Panels
- SCSI rack (if provided)
- blue eye bolts in bottom
- Various cables pre-attached

Box 2: Environmental housing Crate
- Completed housing with a variety of parts pre-installed, including
  - TECA cooler
  - pump and coolant system
  - reservoir
  - temperature and flow rate sensors
  - insulation and sun shield on top

Box 3: Camera housing Crate
- camera housing subassembly includes sensor, lens, filters, etc.
- baggie with screws for adapting lid for field configuration
- baggie with screws for attaching camera housing

Box 4: Occultor Crate
- WSI Occultor
- (Arc drive sub assembly plate)
Box 5: Cable and Miscellaneous Crate

cable bundle
WWV clock
keyboard rest
keyboard
distilled water
alcohol
desiccant
desiccant saddle
nitrogen
nitrogen gauges
tie-down cables with screw-eyes, turnbuckles, wire nuts
antenna cable
Documentation and Supplies kit
spare exabyte tapes
spare desiccant
spare dome

Additional equipment used by field team

Tool kit
Spare black tie downs
compass and levels
rope
square for providing shadow at LAN