LightHawk® 560DI
Compliance Opacity Monitor
Operations Manual

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1.0 SYSTEM OVERVIEW

This manual describes the installation, operation, calibration and routine maintenance of the Teledyne Monitor Labs *LightHawk*® 560DI Opacity/Dust Monitor.

This instrument is based on the principle of transmissometry. A light beam with specific spectral characteristics is projected through the effluent stream of a stack or duct exhausting combustion or process gases. The amount of light reflected back to the instrument from a reflector after passage through the stream is compared with the maximum possible return when no effluent is present. The return signal is an indication of the transmittance of the effluent. Particulate matter in the effluent stream attenuates the projected light beam. The opacity of the gas stream is determined by measuring the attenuated signal from the instrument. The opacity is usually expressed as a percentage.

The *LightHawk*® 560DI is designed to exceed all requirements of the ASTM D6216 "Standard Practice for Continuous Opacity Monitor Manufacturers to Certify Design Conformance and Monitor Calibration". The *LightHawk*® 560DI can be used in US compliance opacity applications regulated by 40CFR60 Performance Specification 1.

The *LightHawk*® 560DI system consists of the following standard equipment:

- ❑ Optical Head Assembly
- ❑ Retroreflector Assembly
- ❑ Protective Purge Air System (Single)
- ❑ Calibration Kit Assembly

<u>Optional items include:</u>

- ❑ Protective Purge Air System (Dual)
- ❑ Weather Cover Retro
- ❑ Purge Shutter Assemblies (Optical Head and Retroreflector)
- ❑ Instrument Air Purge System
- ❑ High Efficiency Purge Air Filtration System
- ❑ Hinged Fiberglass Weather Covers

- ❑ Purge Air Heater
- ❑ Optical Head Dust Cover
- ❑ High Temperature Operation (500° F to 1500° F)
- ❑ Heat Shield
- ❑ Pressure and Temperature Input Interface (Analog Input Module)
- ❑ Optical Head Transport Cover
- ❑ Alignment Scope, Mounting Flange
- ❑ Ethernet Module

A description of each optional item can be found in Section 2.0. To verify what options this monitor is equipped with see the "Site Specification Data Sheets" in the back of this manual.

1.1 SYSTEM DESCRIPTION, STANDARD EQUIPMENT

1.1.1 Optical Head Assembly

The Optical Head Assembly contains all the active electronics necessary to project a light beam across the sample medium to the Retroreflector Assembly. The Retroreflector Assembly reflects the light back to the Optical Head where a determination of the light attenuation is made. This optical configuration is called a *double pass* system because the beam travels through the medium twice before it is measured by the Optical Head circuitry.

A numeric display and keypad are available for operator interface. Circuitry is provided to output analog signals to customer-supplied display or data collection devices. Circuitry also permits remote operator control of instrument sample modes as well as discrete relay closures indicating alarm indications or operation mode changes. Automated simulated zero and upscale calibration devices are incorporated into the Optical Head Assembly.

1.1.2 Retroreflector Assembly

The Retroreflector Assembly is mounted on the opposite side of the stack from the Optical Head Assembly and contains a precision reflector to direct the light beam back to the Optical Head Assembly. It is mounted in a cast aluminum housing which is "O" ring sealed and connected to the Protective Purge Air System to prevent contamination of the optical surface.

1.1.3 Protective Purge Air System (Single)

The Purge Air System provides filtered air to the Optical Head and Retroreflector Assemblies. The Purge Air System consists of the blower motor, hose, air filter, blower mounting plate, and protective cover. The Purge System provides filtered air in a manner that keeps the effluent from contaminating the instrument optical surfaces.

There is a Purge Status Assembly on both the Optical Head and Retroreflector Assemblies. They are pressure switches to determine if the purge air system is delivering sufficient airflow to protect the instrument.

1.1.4 Calibration Kit

The Calibration Kit is a fixture designed to mount in front of the exit window of the Optical Head when performing maintenance or audits. It is adjusted to simulate a Clear Path Zero Condition. It also holds certified attenuators used to check upscale system response. Each Calibration Kit is unique to the monitor for which it was adjusted. It is labeled with a serial number that matches the monitor for which it was adjusted.

1.1.5 Attenuators

Three certified attenuators and an opaque blocking plate are provided to insert into the Calibration Kit. Each attenuator gives a different upscale response. The opaque disk is used to simulate a 100% opacity reading. The opacity values of the three certified attenuators are marked on their edge. The attenuators are certified according to the procedures specified in 40CFR60, Appendix B, PS-1. The attenuators are stored in a protective container.

1.2 SPECIFICATIONS (DIRECT INTERFACE)

PHYSICAL DIMENSIONS

Optical Head (w/o Purge Shutter)	*17”(423mm)(L) X 9-1/4”(235mm)(W) X 15”(381mm)(H)*
Optical Head (with Purge Shutter)	*22”(559mm)(L) X 9-1/4”(235mm)(W) X 15”(381mm)(H)*
Retro Assembly (w/o Purge Shutter)	*10”(254mm)(L) X 7”(178mm)(Diameter)*
Retro Assembly (with Purge Shutter)	*15”(381mm)(L) X 7”(178mm)(Diameter)*
Single Purge Blower Assembly	*22-1/4”(565mm)(L) X 20”(508mm)(W) X 33”(838mm)(H)*
Dual Purge Blower Assembly	*2 assemblies with Single Purge Blower dimensions*

PHYSICAL WEIGHTS

Optical Head (w/o Purge Shutter)	*27 lbs. (12.3 kg)*
Optical Head (with Purge Shutter)	*31.25 lbs. (14.2 kg)*
Retro Assembly (w/o Purge Shutter)	*6 lbs. (2.7 kg)*
Retro Assembly (with Purge Shutter)	*10.25 lbs. (4.7 kg)*
Single Purge Blower Assembly	*65 lbs. (29.5 kg)*
Dual Purge Blower Assembly	*2 assemblies with Single Purge Blower weights*

OPTICAL CHARACTERISTICS

Optical Measurement Technique	Double Pass Extinction
Angle of View	*Less than 4 degrees*
Angle of Projection	*Less than 4 degrees*
Spectral Response	*Peak: 500 to 600 nm* *Mean: 500 to 600 nm* *94% of Energy: 500 to 600 nm*

SYSTEM MEASUREMENT CHARACTERISTICS **

Response Time (To 95% of change)	Less than 10 seconds
Calibration Zero Operation	*On command*
Upscale Calibration Operation	*On command*
Calibration Error (Mean Error + Confidence Coefficient)	*2.0% Opacity Maximum*
Long Term (60 Day) Drift	*Zero: 0.5% Opacity Maximum* *Span: 0.5% Opacity Maximum*
Stability Over Operating Temperature Range	*±2.0% Opacity Maximum per 40°F (22.2°C) change in temperature (as per ASTMD6216)*
Stability Over Operating Mains Voltage Range	*±1.0% Opacity Maximum (as per ASTMD6216)*
Flange-to-Flange Range	*2 ft. (0.61 M) to 60 ft. (18.3 M)*

POWER REQUIREMENTS

Optical Head	85-245 VAC, 47-63Hz, Single Phase, 30 VA Maximum Fuses Power Supply Board: 1.25 Amp Time Delay, 250V, TR5 Power Input Module: 5 Amp Fast Acting, 250V, 5x20mm
Single Purge Blower System***	*115VAC/230VAC, 60/50 Hz, Single Phase, 414 VA Maximum*
Dual Purge Blower System***	*Two circuits, each with same requirements as Single Purge Blower*

AMBIENT OPERATING CONDITIONS

Optical Head	*Temperature Range:-4 to +140°F (-20 to +60°C)(startup)* *-25 to +140°F (-32 to +60°C)(operating)* Relative Humidity Range: 0 to 100% condensing

MEASUREMENT MEDIUM CONDITIONS

Static Pressure Range***	Single Purge Blower:-15.0 to +5.0 inches H2O (-3736 to +1246 Pa) Gauge Dual Purge Blowers:-15.0 to +15.0 inches H2O (-3736 to +3736 Pa) Gauge *>+15inches H2O consult factory*
Gas Composition	*not critical*
Humidity	*must be noncondensing for valid measurement*
Maximum Temperature***	*+500°F (260°C) (without High Temperature Option)* *+1500°F (816°C) (with High Temperature Option)* *Consult factory for higher temperature operation*

OPTICAL HEAD HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	Six 7 Segment LED's
Indicating LED's	*Fault, Set, In Cal, Power*
User Input Controls	*10-key keypad*

SIX POINT I/O BOARD ANALOG OUTPUTS

Number	*2*
Isolation Type	*Optical & capacitive barriers; channel to channel, channel to circuit common & earth*
Minimum Isolation Voltage	*500Vpeak*, 500VDC**
Output Type	*4-20mA with live 4mA zero, OR 0-20mA w/o live zero*
Maximum Load Resistance	*900 ohms*
Maximum Offset	*±0.05% of full scale*
Total Output Error	*±0.30% of full scale*

SIX POINT I/O BOARD DIGITAL INPUTS

Number	2
Modes	*Isolated and Non-isolated*
Isolated Mode Minimum Isolation Voltage	*500Vrms**
Isolated Mode Minimum Actuation Voltage	*5VDC (user supplied)*
Isolated Mode Maximum Actuation Voltage	*24VDC (user supplied)*
Isolated Mode Maximum Input Current	*50mA @ 24VDC*
Non-Isolated Mode Actuation Condition	*Dry contact closure*
Non-Isolated Mode Internal Operating Voltage	*5VDC*

SIX POINT I/O BOARD RELAY OUTPUTS

Number	2 SPST, N.O. (Single Pole Single Throw, Normally Open or Normally Closed [jumper selectable])
Minimum Isolation	*500Vrms**
Maximum Contact Voltage	*250VAC*
Maximum Contact Current	*1Amp AC, 1Amp DC*

* I/O wires with respect to earth (common mode).
** Measurement based on single pass response with a PLCF of 1.00.
*** Does not apply to Instrument Air Purge version. Consult factory.

1.3 MEASUREMENT UNITS

The amount of light received after passage through the gas stream is compared with the light returned when no effluent is present. This is an indication of the transmittance of the effluent. The amount of attenuation is defined as opacity and is usually expressed as a percentage. Opacity and transmittance account for 100% of the light. The percentage opacity is equal to 100% minus the percentage transmittance. No instrument outputs are displayed in terms of transmittance, however, other measurement units are often expressed in terms of their relationship to transmittance.

The relationship between transmittance and opacity is as follows:

$$\text{OPACITY} = 1 - \text{TRANSMITTANCE}$$

Where opacity and transmittance are expressed as a decimal

For a *CLEAR PATH* condition:

TRANSMITTANCE = 100% OPACITY = 0%

For a *BLOCKED STACK* condition:

TRANSMITTANCE = 0% OPACITY = 100%

Outputs in terms of Optical Density are also available from the system. The mathematical relationship between opacity, transmittance, and optical density is:

$$\text{O.D.} = \log \frac{1}{\text{transmittance}} \qquad \text{O.D.} = \log \frac{1}{1 - \text{opacity}}$$

Where: O.D. = Optical Density

transmittance and opacity are expressed as a decimal

Display outputs from the Optical Head may also be configured to correlate to particulate mass. These outputs can be configured only after comprehensive source testing is performed at the user's site. Simultaneous collection of the *LightHawk*® 560DI attenuation data and gravimetric analysis of the particulate mass of the stack effluent must be performed over a wide range of particulate mass conditions in order to generate a correlation curve. The measurement unit available is milligrams per cubic meter (mg/m^3).

1.3.1 Correction for Exit Path Length

In many applications the path length where the effluent exits to the atmosphere is different from the path length at the monitor location. Most opacity emission regulations are specified to be in terms of the opacity at the stack exit. In order to make this correction properly, the distance the light is traveling through the medium (inside dimension of the stack or duct) at the measurement path must be known (*monitoring pathlength).* The inside dimension at the stack exit (*emission outlet pathlength)* must also be known. This relationship is called the Path Length Correction Factor (PLCF)

PLCF = Path Length Correction Factor $= \frac{\textit{emission outlet pathlength}}{\textit{monitoring pathlength}}$

The correct Path Length Correction Factor (PLCF) must be entered at the Optical Head Assembly keypad.

1.4 SAFETY

This equipment is intended only for the purposes specified in this manual. Safety protections inherent in this equipment may be impaired if the LightHawk® 560 is used in a manner different than specified herein.

The following are internationally recognized symbols used on the LightHawk® 560 along with specific cautions applicable to the equipment.

Label Standard Number:
ISO 3864 B.3.1

Generic meaning:
CAUTION: RISK OF DANGER. CONSULT MANUFACTURER'S DOCUMENTATION.

Cautions Invoked By This Label for the LightHawk® 560:

1. Optical Head and Junction Box Cover Screws must be tightened beyond finger-tight.
2. Optical Head and Junction Box Covers are to be removed only by trained service personnel.
3. This equipment must be installed by a qualified electrician.

Label Standard Number:
ISO 3864 B.3.6

Meaning:
CAUTION: RISK OF ELECTRIC SHOCK.
Hazardous AC supply inside. Remove power before servicing.

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2.0 OPTIONAL EQUIPMENT

The components listed below are optional on the *LightHawk*® 560 Opacity/Dust system. They are not included on a standard system. Please consult the Site Specification Data Sheets in the back of this manual for the details of your particular system.

2.1 PROTECTIVE PURGE AIR SYSTEM (DUAL)

The Dual Protective Purge Air System consists of a separate blower and weather cover for the Optical Head and the Retroreflector. This option can be added to any *LightHawk*® 560 but is mandatory in cases of high positive stack pressures.

2.2 WEATHER COVER, RETRO

Provides the Retro Assembly with an additional level of protection from ambient weather conditions.

2.3 PURGE SHUTTER ASSEMBLIES

The Purge Shutter option uses a pair of air valves, one for the Optical Head and one for the Retroreflector. They mount in place of the standard purge nozzles and are designed to close on loss of purge air. This prevents stack gas from reaching the optical surfaces during a *temporary* loss of purge air. Extended purge failures may still cause damage to the instrument.

2.4 INSTRUMENT AIR PURGE

When this option is chosen, the customer must supply and install ½ inch pipe to carry the plant supplied Instrument Air. The air must be delivered at a dynamic pressure of 30 PSIG (7473 PaG) minimum at the regulator, at a flow rate of 25 CFM (707 LPM) minimum. Connection to the Retroreflector and Optical Head Assemblies is 3/8 inch tube. This option can be used with Purge Shutter Assemblies.

2.5 HIGH EFFICIENCY PURGE AIR FILTRATION SYSTEM

Our optional High Efficiency Filtration System may be employed where users have very dusty ambient conditions at the Optical Head or Retroreflector locations. This system uses three successive levels of particulate filtering to remove both coarse and fine dust before the purge air enters the blower. By removing the majority of course particles in the first stage, it prevents the subsequent filters from being overwhelmed and extends the periods between required maintenance.

2.6 HINGED FIBERGLASS WEATHER COVERS

The optional fiberglass weather cover(s) (1860-3113-01) are sealed and constructed of corrosion-resistant materials for very challenging outdoor applications. They provide additional protection to the purge air system from wind-blown rain, dust and snow; yet their top-hinged design still allows easy access to the instrument during maintenance and audit activities. Consult Teledyne Monitor Labs for additional pricing, clearance and application information.

2.7 PURGE AIR HEATER

The *LightHawk*® 560 Purge Air Heater option is offered only to those customers whose measured gas stream contains high moisture content with a dew point below the typical purge air temperature. In some rare cases, the inclusion of the relatively cool purge air may cause the stack water vapor to condense at the interface between the purge air and the stack effluent. Under these conditions the indicated opacity or particulate readings would be biased high because of the attenuation created by the condensed moisture.

The Purge Air Heater employs a 650 watt, 115VAC heater with over-temperature protection housed in a stainless steel pipe. Teledyne Monitor Labs Technical Support should be consulted prior to the decision to install this option, since there are additional site specific issues that must be considered in order to insure that the option is safe and effective.

2.8 OPTICAL HEAD DUST COVER

Provided in lieu of the Optical Head Weather Cover. This is only recommended for installations where the Optical Head is not subjected to outdoor weather conditions, for instance when the instrument is mounted indoors or in an annular space between the liner and exterior shell of a smokestack.

2.9 HIGH TEMPERATURE OPERATION

High Temperature Hardware Kits with fiberglass seals and Stainless Steel Nozzles ***MUST*** be supplied for applications where the stack gas temperature exceeds 500° F (260° C).

2.10 HEAT SHIELD

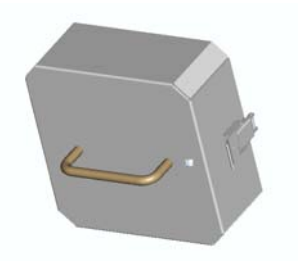
A Heat Shield is available for installations where radiant heat is a problem. This is typically necessary for stack temperatures of 1000° F (538° C) or more but in some instances may not be required when the stack is very well insulated. (Consult factory.)

2.11 PRESSURE AND TEMPERATURE INPUT INTERFACE

The Analog Input Interface Module is used when the stack temperature and pressure data must be input to the *LightHawk*® 560 to correct Particulate Mass to standard conditions. The user must supply the 4-20mA signals to the module corresponding to the absolute stack pressure and temperature. The pressure and temperature ranges must be provided before factory setup, so that a calibration curve can be programmed into the module. Temperature is scaled in degrees C, and pressure in Pascals absolute.

2.12 OPTICAL HEAD TRANSPORT COVER

The Rear Optical Section Transport Cover is a very useful optional device. It may be used whenever the Rear Optical Section of the transceiver is removed from the stack for maintenance, calibration or repair. The cast aluminum Transport Cover will protect the exposed Cal Mechanism and optical surfaces while providing a convenient and secure carrying handle to facilitate safe handling.



2.13 ALIGNMENT SCOPE, MOUNTING FLANGE

An aid in determining the optical center line between the two ports during installation. See section on Installation in this manual.

2.14 ETHERNET MODULE

The Ethernet Module option will provide web browser-based remote access, configuration and control of the *LightHawk*®. At the same time the Ethernet Module can provide HTML web pages for user interface and fast Modbus TCP access to instrument data and parameters. The module comes in standalone hardware configuration.

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3.0 OPTICAL HEAD ASSEMBLY

3.1 OVERVIEW

Section 3.0 describes the Optical Head mechanical, optical, electrical and user interface configurations. It also defines the Optical Head status and mode codes and status LEDs. A numeric display and keypad are mounted directly on the *LightHawk*® 560 Optical Head.

3.2 MECHANICAL DESCRIPTION

The Optical Head Assembly is constructed primarily of cast aluminum. It is comprised of a Rear Optical Section, an Integral Junction Box, and the automated Calibration Mechanism. The Rear Optical Section houses the electronic circuit boards and the primary projection and receive optics. The Integral Junction Box acts as a weather tight junction box to permit user power and signal wiring to connect with the instrument. The Calibration Mechanism acts as an automated simulated zero/upscale device. It receives its drive and control from a motor inside the Rear Optical Section. The optical portion of the Calibration Mechanism is housed in a plenum area that is protected by the Purge Air System. This mechanism is located outside of the Rear Optical Section and may be manually or automatically commanded to rotate two separate reflective devices into the optical field of view.

Access to the Calibration Mechanism and Exit Window may be gained by releasing the catches on both sides of the Optical Head Assembly. The Rear Optical Section may be swung to the right to fully access this area.

3.3 OPTICAL DESCRIPTION

The *LightHawk*® 560 uses a solid state light source (LED). The projected light intensity is monitored by a reference detector and maintained constant by control circuitry. A series of lenses and beamsplitters are used to collimate the light, project it to the Retroreflector and then focus the return energy onto a signal detector. An eyepiece is provided to allow the user to visually observe the alignment of the Optical Head. The eyepiece and instrument alignment may be viewed through a window in the Rear Optical Section cover.

The optical configuration is called double pass because the projected light travels through the medium once, on the way to the Reflector and a second time on the way back to the Optical Head. Figure 3-1 is a schematic diagram of the *LightHawk*® 560 Optical System.

The Calibration Mechanism intercepts the projected light from the LED when the mechanism is activated. Two separate optical references simulate both zero and upscale signals returned to the detection system. The effluent reading from the Retroreflector is interrupted while the device is activated.

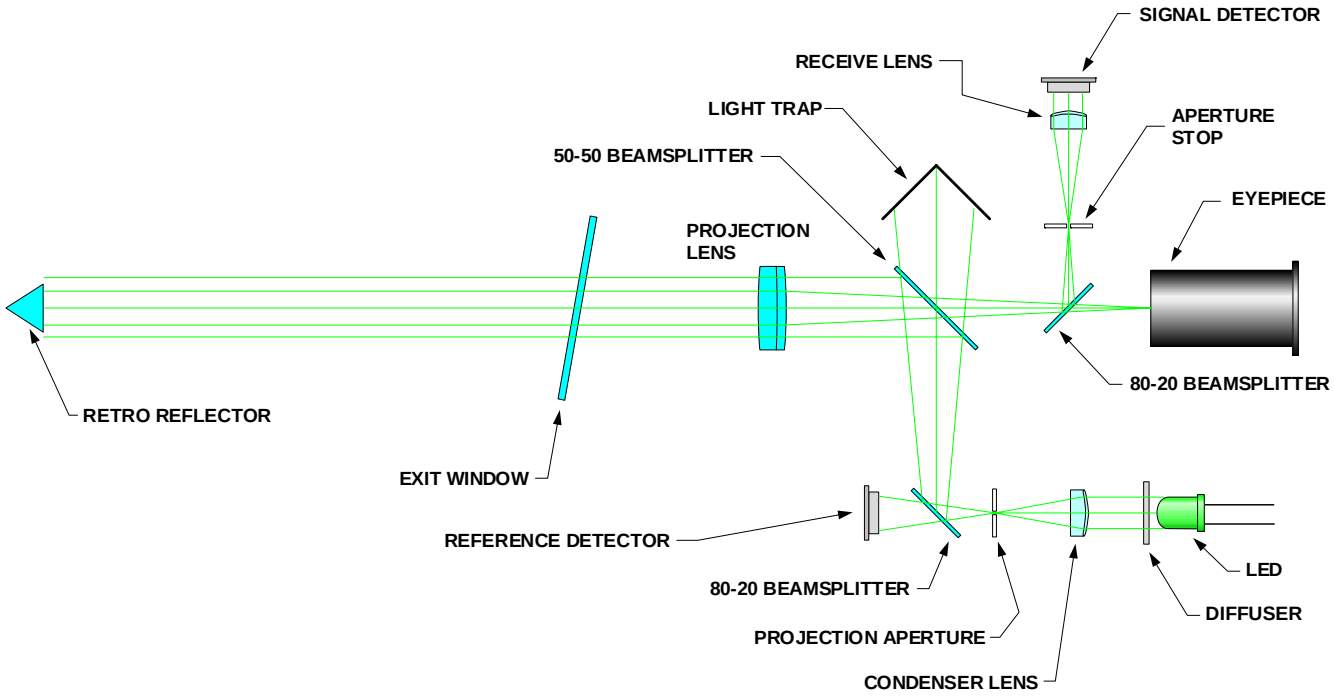


Figure 3-1

3.4 ELECTRICAL DESCRIPTION

The electrical configuration of the Optical Head includes connections for AC power wiring from user supplied circuits, internal signal processing electronics and Calibration Mechanism drive and position decode circuitry.

3.4.1 AC Power Connections

The Optical Head has been designed to operate over a wide range of international power supply ranges and frequencies without the need for modifications or adjustments. *(See Section 1.0 of this manual for input power specifications.)* All AC power connections from user supplied circuits are made to the Integral Junction Box located on the bottom of the Optical Head Assembly. Terminals for the network communication wiring between the Optical Head Assembly and peripheral devices are also located in this Integral Junction Box.

3.4.2 Signal Processing Electronics

A family of small electronic circuit boards is located inside the Rear Optical Section. These boards are responsible for the LED drive/modulation, signal detection, computer processing, display driver, keypad control and supporting power supply functions. These circuit boards are nested around the optical components and connected to the keypad on the electronics cover by a ribbon cable. *(See the block diagram of the Optical Head Circuitry, Figure 3-2.)*

3.4.3 Simulated Zero/Upscale Device Drive Components

A DC motor and associated position encoder are also located inside the Rear Optical Section cover. They drive and control the simulated zero/upscale device position. The position signals are transmitted through the Optical Amplifier Board and allow the signal processing electronics to determine whether the detector signals are being generated from the cross stack Retroreflector or the zero/upscale device.

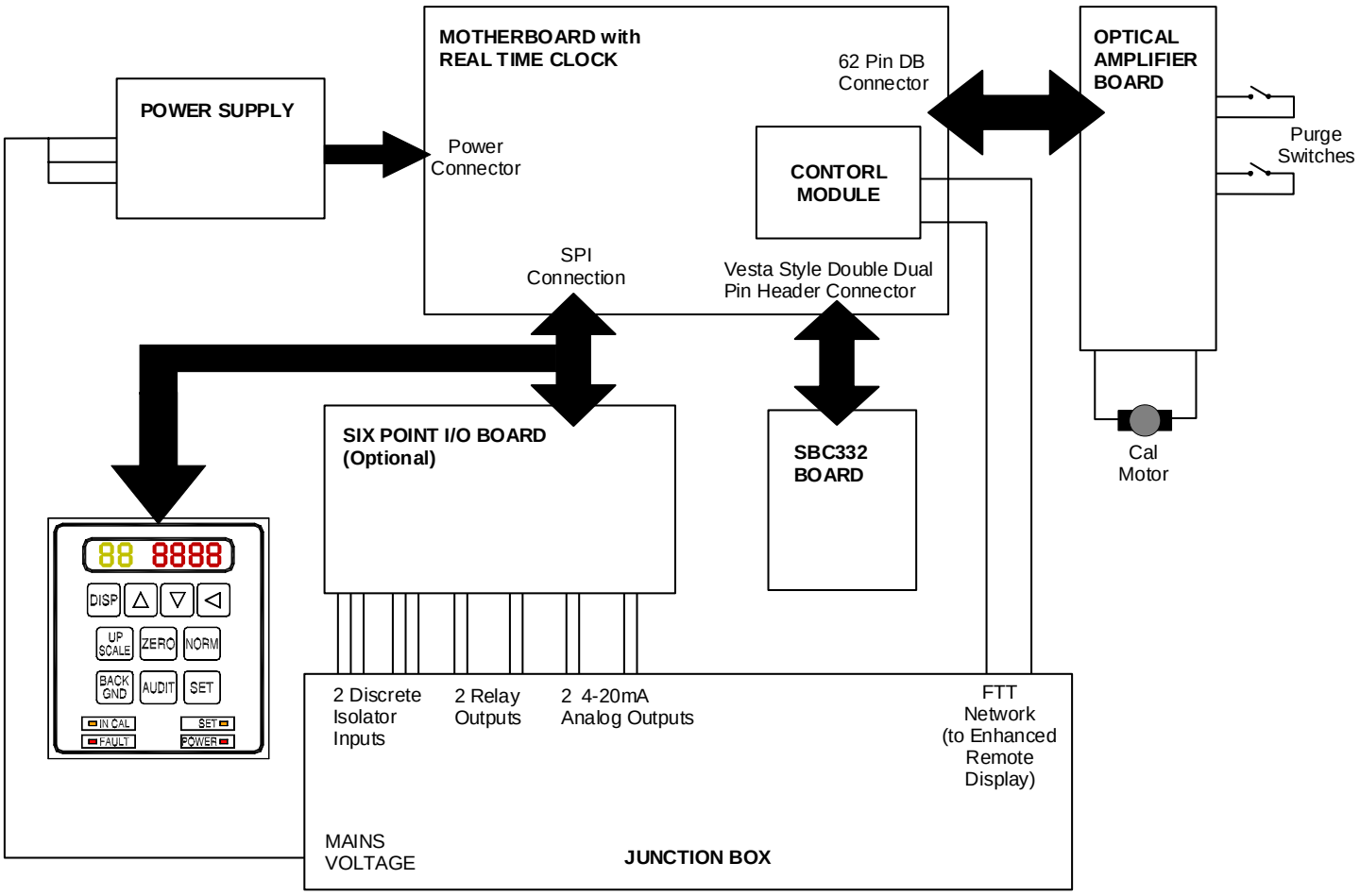


Figure 3-2

3.5 USER INTERFACE DESCRIPTION

The Optical Head Assembly user interface consists of a six character LED display and a keypad for data entry and display control.

3.5.1 Six Character LED Display

The Optical Head Assembly contains a 6 character, 7 segment display and a keypad. The two leftmost characters are GREEN while the 4 remaining characters to the right are RED. The display is organized so that the 2 GREEN characters describe the memory location of data, operational variables, markers or configuration modifiers. The 4 RED characters to the right hold the value of the data, status or marker in that memory location.

The locations are organized into different categories or BANKs of data and parameters. The leftmost GREEN letter character describes the BANK or category of display information, while the second GREEN numeric character identifies the individual memory location within the BANK.

The data BANKs are organized:

"U" - User data

"S" - Service data

"F" - Fundamental parameters

"C" - Calibration parameters

"A" - Auxiliary parameters

3.5.2 Key Pad

The Optical Head keypad contains 10 individual function keys that act both independently and in conjunction with one another to initiate actions, configure operations and control the six character display. The keypad also contains 4 LED status lights that provide operational information to the user.

3.5.2.1 Individual Keys

"SET": Used by itself to enter the value currently displayed into a parameter location. When pressed by itself while a data field is currently displayed, there is no effect. When pressed and held simultaneously with "CAL", ‘NORMAL”, "ZERO" or "BACKGND" keys, a “SET” function is initiated for each respective mode key.

"DISP": Increments the variable number and bank displayed, when used in conjunction with the ↑ ↓ or ← keys.

▲ "↑": Increases the value of the parameter displayed. For example if the value of location F3 is 1.32, pressing "↑" increases the F3 value to 1.33. Repeat functions are supported for this key. No effect if data is displayed.

▼ "↓": Decreases the value of the parameter displayed. For example if F3 is 1.32, pressing "↓" decreases the F3 value to 1.31. Repeat functions are supported for this key. No effect if data is displayed.

◄ "←": Used by itself only to select the character column for data input. Shifts the display to the next bank when pressed in conjunction with the "DISP" key.

"UPSCALE": Initiates an UPSCALE calibration.

"ZERO": Initiates a calibration ZERO.

"NORM": Places instrument in NORMAL mode.

"BACKGND": Has no function when used alone. Used in conjunction with the "SET" key to perform a BACKGROUND SET function during maintenance or calibration.

"AUDIT": Used in conjunction with the Audit Marker parameter (F4) and the "ZERO", "UPSCALE", "NORM" and "BACKGND" keys to mark the current selectable average Opacity, Optical Density and Particulate Mass data as audit data. See "Combination of Keys" section for more details. When actuated alone, the "AUDIT" button will toggle the LED display between U2 (Selectable Average) and F4 (Audit Marker).

3.5.2.2 Combinations of Keys

SET*ZERO: Initiates a ZERO SET function.

SET*BACKGND: Initiates a BACKGROUND SET function.

SET*NORMAL: Initiates a Clear Stack SET.

UPSCALE*ZERO: Initiates a complete Calibration Cycle.

DISPLAY*LEFT: Toggles the display from User data (U) to Service data (S) and parameter (F, C, A) banks when pressed and held for about a second. After 10 minutes with no keypad activity, the display defaults back to the User data bank (U).

DISPLAY*INC: Increments the variable number displayed, i.e., U0 becomes U1, F0 becomes F1, etc.

DISPLAY*DEC: Decrements the variable number displayed, i.e., U5 becomes U4, F5 becomes F4, etc.

AUDIT*ZERO: Used in conjunction with the Audit Marker parameter (F4). Marks the current selectable average values for Opacity, Optical Density and Particulate Mass as either Initial Zero (F4=10XX) or Final Zero (F4=50XX). The user must press “SET” after this key combination to propagate the data value over the network.

AUDIT*NORM: Used in conjunction with the Audit Marker parameter (F4). Marks the current selectable average values for Opacity, Optical Density and Particulate Mass as the Low Filter. The Run Number is defined by the value in the F4 at the time of button actuation. If F4=11XX, it is Filter Run #1 Low Filter; if F4=21XX, it is Filter Run #2 Low Filter; and so on. The user must press “SET” after this key combination to propagate the data value over the network.

AUDIT*UPSCALE: Used in conjunction with the Audit Marker parameter (F4). Marks the current selectable average values for Opacity, Optical Density and Particulate Mass as the Mid Filter. The Run Number is defined by the value in the F4 at the time of button actuation. If F4=12XX, it is Filter Run #1 Mid Filter; if F4=22XX, it is Filter Run #2 Mid Filter; and so on. The user must press “SET” after this key combination to propagate the data value over the network.

AUDIT*BACKGND: Used in conjunction with the Audit Marker parameter (F4). Marks the current selectable average values for Opacity, Optical Density and Particulate Mass as the High Filter. The Run Number is defined by the value in the F4 at the time of button actuation. If F4=13XX, it is Filter Run #1 High Filter; if F4=23XX, it is Filter Run #2 High Filter; and so on. The user must press “SET” after

this key combination to propagate the data value over the network.

3.5.3 Status LEDs

The status LEDs in the Optical Head overlay are defined as follows:

IN CAL: Lights when the calibration mechanism is in UPSCALE or ZERO position. Blinks when the calibration mechanism is in NORMAL position but the analog outputs contain DUST COMP or PLCF information.

FAULT: Lights when an instrument malfunction occurs.

SET: Lights when ZERO, NORMAL, or BACKGROUND sets are in progress or when parameter changes have been accepted. Blinks when ZERO, NORMAL or BACKGROUND sets are about to begin.

POWER: Lights when power is being delivered to the Optical Head.

3.5.4 Data and Parameter Location Definitions

The memory locations are organized into different categories or BANKs of data and parameters. The leftmost GREEN letter character describes the BANK or category of display information, while the second GREEN numeric character identifies the individual memory location within the BANK.

The "DISP" and "←" keys on the keypad are used to cycle the display through the different BANKs. Once inside the desired BANK, the "DISP" and "↑" and "↓" keys are used to cycle through the individual locations.

Example:

*To display the data in location **U2***

Press and hold the display ("DISP") key

Then press the "←" key until the left letter character displays the letter "U"

Press and hold the display ("DISP") key

Then press the "↑" key until the second character increments to the number "2"

The value of the data in location U2 will be displayed on the RED 4 digit display to the right of the location identifier.

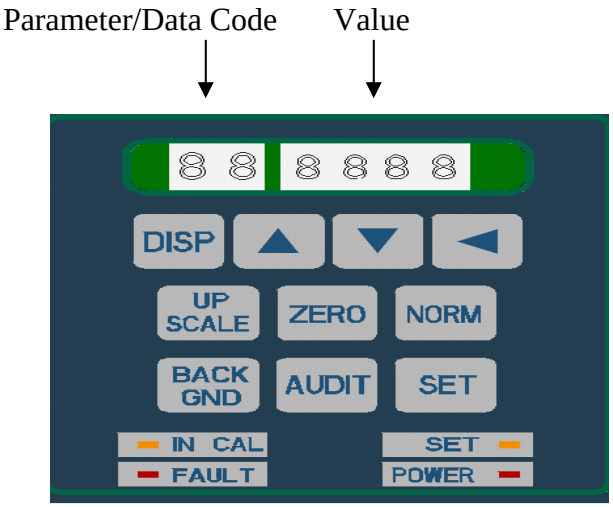
A laminated card describing the memory location definitions and display information is secured at the Optical Head for quick reference.

3.5.4.1 Data Codes

Data are not user configurable. They are primarily measurements that the instrument produces. There are two data banks:

1. User Data Bank

2. Service Data Bank



3.5.4.1.1 U Bank (User Data Bank)

The U Bank variables are outputs that users need to see regularly. The U Bank is referred to as the User Data Bank.

The following are the definitions of the data contained in the U BANK locations:

U0: Instantaneous Opacity {Optical Density}[Particulate Mass]

U1: 1 Minute Average Opacity {Optical Density}[Particulate Mass]

U2: Selectable Average Opacity {Optical Density}[Particulate Mass]

U3: Primary Status Code

Primary Status Code Definition

The following is the definition of the 4 digit Status Code displayed at location U3.

4 *X X X* = CLEAR STACK SET voltage out of range

2 *X X X* = BACKGROUND SET in progress

1 *X X X* = ZERO SET in progress

X 4 *X X* = CLEAR STACK SET in progress

X 2 *X X* = UPSCALE position not achieved

X 1 *X X* = ZERO position not achieved

X X 4 *X* = NORMAL position not achieved

X X 2 *X* = Reference Fault

X X 1 *X* = ADC Fault

X X X 4 = Out of Service

X X X 2 = Purge Failure Retro Side

X X X 1 = Purge Failure Analyzer Side

U4: Extended Status Code

Extended Status Code Definition

The following is the definition of the 4 digit Status Code displayed at location U4.

X X 1 *X*= Excessive DUST Compensation

X X X 4 = UPSCALE Calibration bad

*X X X*2 = ZERO Calibration bad

X X X 1 = ZERO SET voltage out of range

U5: Mode Code

Mode Code Definition

The following is the definition of the 4 digit Mode Code displayed at location U5.

Calibration Mechanism Condition

XXX0 = Unknown Mode

XXX1 = NORMAL (Stack) Mode

XXX2 = ZERO Calibration Mode

XXX3 = UPSCALE Calibration Mode

Audit Mode Filter Value

X0XX = ZERO VALUE or Not in Audit Mode

X1XX = LOW FILTER

X2XX = MID FILTER

X3XX = HIGH FILTER

Audit Mode Condition

0XXX = Not in Audit Mode

1XXX = Run #1 and Initial Zero

2XXX = Run #2

3XXX = Run #3

4XXX = Run #4

5XXX = Run #5 and Final Zero

U6: Last ZERO Calibration {ZERO Optical Density}[ZERO Particulate Mass]

U7: Last UPSCALE Calibration {UPSCALE Optical Density}[UPSCALE Particulate Mass]

U8: Dust Compensation {Dust Comp. Optical Density}[Dust Comp. Particulate Mass]

U9: ML Correction Factor {Particulate Mass Load Correction Factor} [multiplicative correction of Particulate Mass data to standard temperature and pressure conditions]

UA: 332 Version. Software version of 68332 microprocessor code.

UB: Neuron Version. Software version of Neuron microprocessor code.

3.5.4.1.2 S Bank (Service Data Bank)

The S Bank data locations contain maintenance-oriented data from the analyzer. The S Bank is referred to as the Service Data Bank.

S0: Signal Voltage

S1: Reference Voltage

S2: LED Current

S3: Clear Stack SET Voltage

S4: Calibration ZERO SET Voltage

S5: BACKGROUND SET Voltage

S6: Optical Head Temperature, °C

S7: Calibration Mechanism Position

S8: +15V Power Supply Voltage (+/-5%)

S9: -15V Power Supply Voltage (+/-5%)

SA: +5VA (analog) Power Supply Voltage (+/-5%)

SB: -5VA (analog) Power Supply Voltage (+/-5%)

SC: +5VD (digital) Power Supply Voltage (+/-5%)

SD: Stack Temperature, °C

SE: Stack Pressure, kPa

3.5.4.2 Parameter Codes

Parameters are configuration-oriented variables. All are user configurable only after password entry, except F7 (PLCF), which must be factory configured. They are divided into F, C and A Banks, where F represents Fundamental, C represents Calibration and A signifies Auxiliary.

3.5.4.2.1 F Bank (Fundamental Parameter Bank)

F0: Measurement Unit (Opacity = 1, Optical Density = 2, Particulate Mass = 3)

F1: Time of Day, Hours Minutes

F2: Date, Month Day

F3: Year, YYYY

F4: Audit Marker

Audit Mode Condition
(This column may be edited by user to change audit run number.)
0XXX = Not in Audit Mode
1XXX = Run #1 and Initial Zero
2XXX = Run #2
3XXX = Run #3
4XXX = Run #4
5XXX = Run #5 and Final Zero

Audit Mode Filter Value
(This column modified by AUDIT * NORM, AUDIT * UPSCALE, etc., key combinations.)
X0XX = ZERO VALUE or Not in Audit Mode
X1XX = LOW FILTER
X2XX = MID FILTER
X3XX = HIGH FILTER

F5: Six Point I/O Control (Normal 6PIO AO data = 0, 6PIO AO's to TEST ZERO SCALE = 1, 6PIO AO's to TEST MID SCALE = 2 , 6PIO AO's to TEST FULL SCALE = 3)

F6: Service Marker (Normal Data = 0, Out of Service = 1)

F7: *PLCF* ***(Factory setting, not user adjustable)***

F8: Signal Gain

F9: Reference Gain

FA: Common Gain

FB: Averaging Interval, minutes

FC: Reference Temperature, °C

FD: Reference Pressure, kPa

FE: Six Point I/O Full Scale (may be % opacity, optical density, or mg/^3 depending on Measurement Unit [F0])

FF: Six Point I/O Zero/Dust Comp Scaling Flag (0 = NORMAL mode scaling; 1= EXPANDED scaling)

3.5.4.2.2 C Bank (Calibration Parameter Bank)

C0: Calibration ZERO Set Point, % Opacity

C1: Calibration UPSCALE Set Point, % Opacity

C2: Dust Compensation Tolerance, % Opacity

C3: Calibration Tolerance (Delta), % Opacity

C4: Hour of Calibration

C5: Minute of Calibration

C6: Interval Between Calibration, Hours

C7: Seconds of ZERO (In Calibration Automatic Daily Cycle)

C8: Seconds of UPSCALE (In Calibration Automatic Daily Cycle)

C9: Seconds of PLCF (In Calibration Automatic Daily Cycle)

CA: Seconds of DUST COMP (In Calibration Automatic Daily Cycle)

CB: Six Pt. I/O Analog Output Cal Flag (0=none, 1=DAC1, 2= DAC2, 3=DAC1 & DAC2)

3.5.4.2.3 A Bank (Auxiliary Parameter Bank)

A0: Instantaneous Alarm 1 Level

A1: Selectable Average Alarm 1 Level

A2: Password: (Password = 9860, expires after 2 hour boundaries are crossed, cleared at RESET)

A3 through A8 contain the three point Optical Density to Particulate Mass correlation curve

A3: X1, Input Point #1, Optical Density

A4: Y1, Output Point #1, Particulate Mass, mg/m^3

A5: X2, Input Point #2, Optical Density

A6: Y2, Output Point #2, Particulate Mass, mg/m^3

A7: X3, Input Point #3, Optical Density

A8: Y3, Output Point #3, Particulate Mass, mg/m^3

4.0 SIX POINT I/O BOARD FOR 560DI SYSTEM

4.1 OVERVIEW

This chapter describes the Six Point I/O Board (6PIO) in the *LightHawk*® 560 system. The Six Point I/O Board (P/N 1860-0700) is used in Direct Interface versions of the *LightHawk*® 560 where analog output and control signals are required directly from the Optical Head Assembly. The 6PIO is packaged under the Optical Head rear cover and is mounted vertically on the left side. External connections are in the Integral Junction Box. See Wiring Diagram for connections.

Many of the configuration details of the 6PIO Board are user selectable. Some parameters may be selected using the keypad and digital display of the Optical Head Assembly. Other details are configured by placement of small jumpers located on the circuit board.

4.2 ANALOG OUTPUT DESCRIPTION

There are two independently isolated analog outputs.

DAC 1 (Channel 1 or Out 1) is always dedicated to the Instantaneous value and carries NO calibration values. During the NORMAL mode, the analog output will track Instantaneous values. During any CALIBRATION mode, the analog output will hold the last NORMAL mode value.

DAC 2 (Channel 2 or Out 2) is always Selectable Average WITH calibration values. During the NORMAL mode, the analog output will track Selectable Average values. During any CALIBRATION mode, the analog output will track the calibration values chosen for output.

4.2.1 Analog Output Measurement Units Selection

The DAC 1 and 2 output units may be Opacity, Optical Density or Dust Mass depending on user selection. The output units are software selectable using the keypad and digital display. The Measurement Unit parameter value will dictate both the LED display and the analog output units. For example, if Measurement Unit (F0 location) = 1, the LED display and analog outputs will be in terms of Opacity. If the Measurement Unit = 2, both will display in units of Optical Density, etc.

4.2.2 Analog Output Current Range Selection

Two output current options are available from the 6PIO Board (either 4 – 20mA or 0 – 20mA). This range will apply to any measurement unit configuration selected above.

Both analog channels are configured identically and the current range selected by the placement of jumper JU9 on the 6PIO Board. Placing the removable jumper between the two *leftmost* pins of JU9 (or the "4" position) will select the 4 – 20mA range. Placement of the jumper between the two rightmost pins of JU9 (or the "0" position) will select the 0 – 20mA range.

4.2.3 Automatic Calibration Analog Output Sequence

The order of the Automatic Calibration Analog Output Sequence is shown below. The duration of each is programmable in seconds.

Order	Description	Duration/ Parameter #	Opacity Scaling	O.D. Scaling	Dust Scaling
1st	ZERO Calibration	Selectable/ C7	0-100	0-2	0-9999
2nd	UPSCALE Calibration	Selectable/ C8	0-100	0-2	0-9999
3rd	PLCF	Selectable/ C9	0-5	0-5	0-5
4th	DUST Compensation	Selectable/ CA	-5 to +5	-0.022 to +0.022	

Table 4-1
Automatic Calibration Sequence

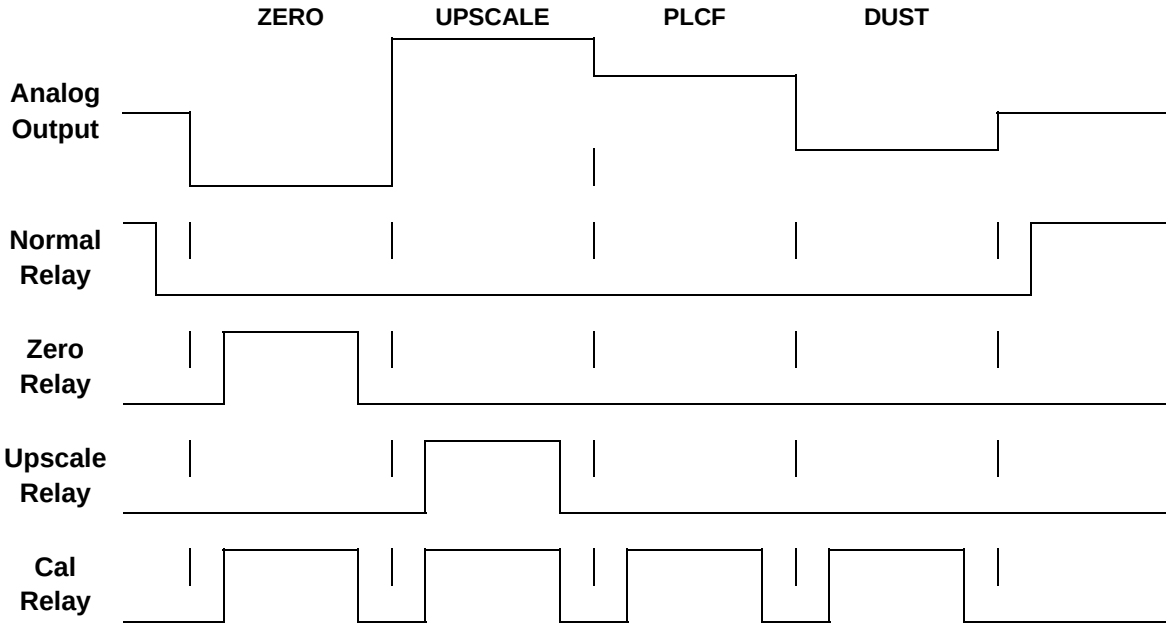


Figure 4-1
560 Analog Output Cal Cycle Sequence

PLCF scaling for the Analog Output Cal Cycle (AOCC) is fixed and not user adjustable due to security considerations. The scaling for PLCF is always 0 – 5.

4.3 DISCRETE ISOLATOR INPUTS AND JUMPER SETTINGS EFFECT ON ANALOG OUTPUTS

There are two discrete isolator inputs on the 6PIO Board. Both can be independently configured for operation from +5Vdc or Dry contacts: Jumper JU5 for isolator #1 and JU6 for isolator #2. They are also jumper configurable to perform the following functions:

- **FORCE UPSCALE:** (JU7 in position "A" and Isolator 1 engaged): The instrument goes into calibration UPSCALE mode. The calibration mechanism moves to the UPSCALE position. Normal sampling of stack data ceases. Analog output #2 follows the UPSCALE value. Analog output #1 holds the last stack value.

- **FORCE ZERO:** (JU8 in position "A" and Isolator 2 engaged): The instrument goes into calibration ZERO mode. The calibration mechanism moves to the ZERO position. Normal sampling of stack data ceases. Analog output #2 follows the ZERO value. Analog output #1 holds the last stack value read.

- **FORCE UPSCALE and FORCE ZERO:** (JU7 in position "A", JU8 in position "A", Isolators 1 and 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

- **DUMP PLCF**: (JU7 in position "B" and Isolator 1 engaged or JU8 in position "B" and Isolator 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the PLCF value with a dedicated scaling: ZERO SCALE = 0 PLCF; FULL SCALE = 5 PLCF.

- **DUMP DUST:** (JU8 in position "C" and Isolator 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

- **FORCE CALIBRATION:** (JU7 in position "C" and Isolator 1 engaged):

  1. The instrument first goes into calibration ZERO mode. The calibration mechanism moves to ZERO position. Analog output #1 holds the last stack value read. Analog output #2 follows the ZERO value.

  2. After a configurable amount of time, the instrument goes into UPSCALE mode. The calibration mechanism moves to UPSCALE position. Analog output #1 holds the last stack value read. Analog output #2 follows the UPSCALE value.

  3. After a configurable amount of time, the instrument goes into PLCF mode. The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the PLCF value with a dedicated scaling: ZERO SCALE = 0 PLCF; FULL SCALE = 5 PLCF.

  4. After a configurable amount of time, the instrument goes into DUST COMPENSATION mode. The calibration mechanism remains in NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

  5. After a configurable amount of time, the instrument goes into NORMAL mode. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the selectable average stack value.

Jumper Position	Function	Available Isolator
JU7 “A”	FORCE UPSCALE	ISO1
JU8 “A”	FORCE ZERO	ISO2
JU7 “B” or JU8 “B”	DUMP PLCF	ISO1 or ISO2
JU8 “C”	DUMP DUST	ISO2
JU7 “C”	FORCE CALIBRATION CYCLE	ISO1

Table 4-2
Isolator Configuration Jumpers

4.3.1 Other Jumpers That Effect Analog Outputs

- **TEST ZERO SCALE (JU10):** This jumper is used to set both analog outputs to ZERO SCALE when placed in position “Z” (rightmost).

- **TEST FULL SCALE (JU11):** This jumper is used to set both analog outputs to FULL SCALE (20mA) when placed in the “FS” position (rightmost).

- **TEST ZERO SCALE AND TEST FULL SCALE:** When both of these jumpers (JU10 and JU11) are actuated simultaneously, both the analog outputs go to MID SCALE (12mA if the JU9 jumper is set to position “4”, 10mA if the JU9 jumper is set to position “0”).

- **JU1, JU2, JU3 and JU4:** These jumpers are used to set up internal measurement parameters for the 6PIO Board. These must remain in the positions detailed below for all 6PIO configurations.

Jumper Position	Function
JU9 “0”	Analog Outputs 0-20 mA
JU9 “4”	Analog Outputs 4-20 mA
JU10 “Z”	Test Zero Scale
JU11 “FS”	Test Full Scale
JU10 “Z” and JU11 “FS”	Test Mid Scale
JU1 & JU3 = 0	Internal Ranging (do not move)
JU2 & JU4 = 1	Internal Ranging (do not move)

Table 4-3
Output Jumper Configuration

4.4 RELAY OUTPUTS

Two relays are available. Contacts are SPDT Form C. The configuration of the relays is jumper selectable per the following table.

K1 (JU12 position)	**K2** (JU13 position)	**Function**
A	A	Calibration Data on Analog Outputs
B	B	Instrument Malfunction (**Not Fail-safe**)
C	C	Instantaneous Alarm 1 Actuated
D	D	Selectable Average Alarm 1 Actuated
E	E	UPSCALE Data on Analog Outputs
F	F	ZERO Data on Analog Outputs
G	G	Purge Failure
H	H	Excessive Dust Compensation

Table 4-4
Relay Function Configuration Jumpers

The contacts of each relay are jumper configurable for either N.O. or N.C. operation as per the following table.

RELAY	**N.O.**	**N.C.**
K1	JU14 “A”	JU14 “B”
K2	JU15 “A”	JU15 “B”

Table 4-5
Relay Contact Configuration Jumpers

4.5 ANALOG OUTPUT ADJUSTMENT

The output current from each channel of the 6PIO may be measured at test points located on the board. The 0 – 20 or 4 – 20mA currents may be measured using a digital voltmeter to read the voltage across a 100Ω resistor at test points TP3 and TP4 for analog channel #1 (DAC1). 2.00 VDC between TP3 and TP4 indicates a 20mA output current. 0.40 VDC corresponds to a 4mA output.

The analog channel #2 (DAC2) output is measured between test points TP10 and TP11. Voltage readings on channel #2 are the same as channel #1.

2.00 VDC = 20mA
0.40 VDC = 4mA

Potentiometers are available for adjustment of the analog output current from each channel. Zero and full scale adjustments are made using the potentiometers while monitoring the above mentioned test points or the final external display device.

	TEST POINTS	ZERO ADJUST	FULL SCALE ADJUST
Channel #1 (DAC1)	TP3 – TP4	R11	R10
Channel #2 (DAC2)	TP10 – TP11	R23	R22

Table 4-6
Analog Output Channel Adjustment Details

4.6 DATA CABLES

Two data cables are needed to interconnect the 6PIO to external devices. One is a 4 conductor #20 AWG (0.5 mm^2) cable for connecting the contacts from the two relays. The other one Teledyne Monitor Labs recommends is a 6-pair #24 AWG (0.25 mm^2) shielded cable for connection to the two analog outputs and two isolators. This would leave two pairs as spares or for future use. See Wiring Diagram for details on external connections to the 6PIO PC Board.

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5.0 PURGE SYSTEM OVERVIEW

The Protective Purge Air System provides clean air to both the Optical Head and Retroreflector Assemblies. The filtered air is directed in a way that prevents the sample medium from touching the optical surfaces. The purge air is injected into the stack through the nozzles of the Optical Head and Retroreflector Assemblies. The Purge System has an air intake filter that prevents ambient dust from contaminating the purge air. Filter replacement is very important to prevent contamination of the optical system. The weather cover protects the filter so that rain does not wash through the filter and allow contaminants to enter the purge blower. The outlet of the blower motor is split off and purge air is routed to each assembly through flexible hoses.

Refer to the Site Specification Data Sheets in Appendix A to determine your particular system configuration.

5.1 MECHANICAL DESCRIPTION

The Purge Air System consists of the following major components.

- Mounting Plate and Weather Cover
- Purge Blower Motor
- Blower Intake Air Filter and Associated Pipes and Hardware

These components are shown on the Opacity Single Blower System Installation drawing provided.

5.2 ELECTRICAL DESCRIPTION

The purge blower motor is connected to user supplied AC voltage source capable of supplying continuous (uninterrupted) power. The input voltage, current and phase will differ for some users. A breaker of sufficient rating to allow for motor start up current must be used.

Please consult the Site Specification Data Sheets for the specific Purge Blower motor supplied with your system.

NOTE: *One of the primary causes of blower motor failure is the location of the inlet to the Purge System. These systems must draw air that is free from corrosive gaseous pollutants so that the lubricant in the bearings of the motors is not contaminated.*

5.3 OPERATION

The air intake filter and purge system must be maintained in good working condition in order to adequately protect the Optical Head and Retroreflector Assemblies.

NOTE: *Interruption of the Protective Purge Air System requires immediate corrective action by the user. In no case should the Optical Head or Retroreflector Assembly be placed in service or mounted on the stack without the Protective Purge Air System in operation.*

5.4 PURGE STATUS

If the purge blower is providing proper airflow, two pressure sensitive switches will be closed in the Retroreflector and Optical Head. If either switch senses that the airflow is not sufficient it will open. Switch status is determined on the Optical Amplifier Board and triggers a fault when purge air is malfunctioning. The termination for the Retroreflector purge cable is made at both the Retro Purge Switch Junction Box and the Optical Head Integral Junction Box. The status of the Optical Head purge switch is internal to the Optical Head Assembly.

5.5 DUAL PROTECTIVE PURGE AIR SYSTEM (DUAL) BLOWER OPTION

Please consult the Site Specification Data Sheets for the specific configuration of your system.

The system may be configured for a Dual Purge Blower option. A separate circuit powers each assembly as shown on the wiring diagrams. Each motor is mounted on the Optical Head and Retroreflector sides. The output of each blower goes to its respective assembly via a short flexible hose located under the protective hood.

5.6 PURGE SHUTTER ASSEMBLY OPTION

Please consult the Site Specification Data Sheets for the specific configuration of your system.

These shutters are located between the main casting and purge nozzles on the Optical Head and Retroreflector Assemblies. Their purpose is to prevent hot stack gases from entering the Optical Head and Retroreflector Assemblies if the purge blower or other air handling components should fail. The Purge Shutters are gravity operated and have no electrical connections. The shutters remain open as sufficient purge air volume is being supplied. If purge air is halted or reduced for any reason, the purge shutter will begin to close and drop down into the optical path of the monitor.

NOTE: *The Purge Air Shutters are designed to provide short-term protection for the optical components in the case of a purge air failure. "Purge Fail" faults must be evaluated and corrected immediately in order to prevent significant damage to the stack mounted equipment.*

5.7 INSTRUMENT AIR PURGE OPTION

Please consult the Site Specification Data Sheets for the specific configuration of your system.

This option requires that the customer must supply and install ½ inch pipe to carry the Instrument Air. The air must be delivered at a dynamic pressure of 30 PSIG (7473 PaG) minimum, at a flow rate of 25 CFM (707 LPM) minimum. Connection to the Retroreflector and Optical Head Assemblies is via 3/8 inch tube. Reference *LightHawk*® 560 Opacity w/Inst Air System Installation drawing provided. Customer must supply hardware to connect Instrument Air to both Optical Head and Retroreflector Assemblies.

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6.0 CALIBRATION KIT OVERVIEW

The Calibration Kit consists of a black external zero device fixture and a filter case. The fixture is made to mount on the Optical Head to simulate a clear path zero condition and hold the calibrated attenuators used to check system response. The case contains three attenuators and an opaque blocking plate. Each attenuator is calibrated to give a different upscale response. The external zero device has an adjustable iris.

NOTE: *The Cal Kit iris is adjusted only at the time of a clear path calibration to produce the same zero opacity response as the COMS reflector.*

6.1 OPERATION

The Calibration Kit Fixture is factory adjusted to simulate the exact amount of energy returned from the Retroreflector at the calibration distance. The Calibration Kit Fixture then becomes a standard or reference to be used to audit or completely adjust the Optical Head Assembly electronics at the stack location while the stack is in operation. Each Calibration Kit Fixture has a unique serial number that matches the serial number of the Optical Head and Retro Assemblies.

NOTE: *Only the Calibration Kit Fixture that has the same serial number as the Optical Head may be used to calibrate an individual monitor.*

CAUTION: ***The Calibration Kit iris must never be readjusted unless the "clear path" or zero opacity setting has been confirmed by completion of a clear path calibration.***

The Calibration Kit without attenuators should be used for all subsequent on-stack electronics adjustment of zero opacity.

Before installing the Calibration Kit, be sure that the window that protects the iris and reflective material of the Cal Kit is clean and free of lint so that the signal returned from the fixture will not be reduced.

Install the Cal Kit Fixture on the face of the Optical Head Subassembly. There are three small holes approximately one inch apart just above the instrument exit window. The two outermost of these will accept the two 1/4-inch diameter locator pins protruding from the rear of the Cal Kit Fixture. The center hole is tapped to receive the thumbscrew that holds the fixture in place while the kit is in use. It is very important that the Cal Kit Fixture sits flat and flush against the face of the Optical Head Subassembly so that the iris and reflector fall on the optical centerline of the exit window. Since the clearances are small on the precision locator pins, it may be necessary to wiggle the test fixture a bit so that the locator pins go into the subassembly face to their full extent before beginning to tighten

the thumbscrew by hand. A small common screwdriver may be used to tighten the captive thumbscrew to hold the fixture firmly in place.

CAUTION: ***Take care not to over torque the thumbscrew as this may damage the threads in the instrument mounting plate.***

With the Cal Kit Fixture in place and no attenuators or blocking plate installed, the Cal Kit will generate a signal equivalent to the clear path 0% opacity signal. The opaque disk is used to simulate a 100% opacity reading when inserted into the fixture. The opacity values of the three calibrated attenuators are marked on the edge of their tabs. The attenuators are used to check the linearity and system response to different values of opacity.

6.2 STORAGE

The Calibration Kit Fixture and attenuators should be stored in the protective case provided when not in use. Store the case in a location that will prevent dirt contamination of the optical surfaces and is not subject to extremes in temperature.

7.0 MAINTENANCE & ON-STACK CALIBRATION

This section contains the information needed to provide proper maintenance and on-stack recalibration.

Routine Maintenance normally consists of: •Verifying the LED operating current, •checking the condition of Purge Air System, •cleaning and aligning of the Optical Head, Retroreflector, and Cal Mechanism, •performing a manual Calibration Cycle check, •checking the Dust Compensation.

An On-Stack Calibration is a more comprehensive checkout and adjustment of the entire monitoring system. Teledyne Monitor Labs recommends an On-Stack Calibration be performed quarterly, while the Routine Maintenance be performed on an "as needed" basis.

It should be noted that in performing either Routine Maintenance or an On-Stack Calibration, the monitor will be experiencing malfunctions and will not be collecting valid data. Operators and other affected personnel should be notified that the monitor will be out of service until the maintenance or calibration is complete.

7.1 ROUTINE MAINTENANCE

The conditions under which the monitoring system operates vary widely from installation to installation. Teledyne Monitor Labs recommends a Routine Maintenance check be performed approximately 30 days after initial installation and again at 30 day intervals for the first 3 months of operation. This actual site experience should indicate the frequency of future Routine Maintenance.

1. LED Drive Current

   Manipulate the keypad until location S2 is displayed. The LED light source current will be displayed in milliamps on the RED 4 digit display. Typical factory settings are between 5.0 and 6.0 mA, though higher values may be used under some conditions. (Consult the Site Specification Data Sheets for the "as shipped" value.)

   NOTE: *Ambient temperature and instrument conditions will strongly influence LED current levels. Although typical factory LED currents are between 5.0 and 6.0 mA, currents of up to 10.0 mA are perfectly normal for your monitor and do not require readjustment.* ***LED currents beyond 10 mA should be investigated and Teledyne Monitor Labs recommends an Off-Stack Calibration described in Section 8.0 of this manual.***

2. Purge Air System

The Purge Air System has an air filter (P/N 528873) that prevents dust particles from entering the Optical Head area. This filter should be changed periodically so that the proper amount of purge air is provided to the system. In typical locations, replacing the filter quarterly should be adequate. The filters must be protected by the purge housing cover so that water does not wash through the filter and enter the purge blower.

Purge Shutters are optional equipment and may not be present on every *LightHawk*® 560. The Purge Air Shutters are not included on an upgrade from a Dynatron, MC2000, or LS541. If so equipped, check the condition of Purge Shutters by looking through alignment eyepiece window on the Optical Head. The mechanical shutter plates of the Purge Shutters should **not** be visible falling into the light beam on either the retroreflector or transceiver side. ***Note****: The image observed through the eyepiece is reversed. If the plates dip into the optical path they will appear on the bottom of the observed image.*

There is a desiccator in the Optical Head Assembly. It can be viewed by swinging open the Rear Optical section and looking to the upper right hand corner of the assembly. ***Note****: The transceiver must be in the NORMAL mode before opening the Rear Optical section.* When the desiccator is not completely spent, it will indicate a blue to blue/white color. When it indicates a pink color, it is completely spent. The desiccator will prevent moisture from condensing on the optical surfaces inside the Rear Optical section. Teledyne Monitor Labs recommends the desiccator be changed if it is **not blue**, or whenever the rear cover is removed.

3. Cleaning

During Routine Maintenance, only the exit window of the Optical Head Assembly, the surface of the Retroreflector Assembly, and the Cal Mechanism windows need to be cleaned.

NOTE: *Typical cleaning of the Cal Mechanism zero and upscale windows may be performed carefully without removal of the mechanism from the motor shaft.*

The window of the Cal Kit Fixture should also be cleaned prior to its use. The cleaning solution should be a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of a reagent grade isopropyl alcohol. A quality ammonia based window cleaner may be used as a second resort; however, do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning.

4. Alignment

Optical Head Assembly

The across stack alignment of the Optical Head and Retroreflector Assemblies is performed by observing the Retroreflector image through the eyepiece and adjusting the Optical Head mounting nuts on the four mounting bolts which support the Optical Head Assembly on the blower plate. You will notice that the eyepiece contains a cross hair and a series of concentric circles. Alignment is achieved by adjusting the head so that the cross hairs are centered on the bright green image of the Retroreflector and the eyepiece circles are concentric with the image.

NOTE: *A graphic depiction of the misalignment images for the user's individual monitor is permanently affixed to the Optical Head cover for easy reference.*

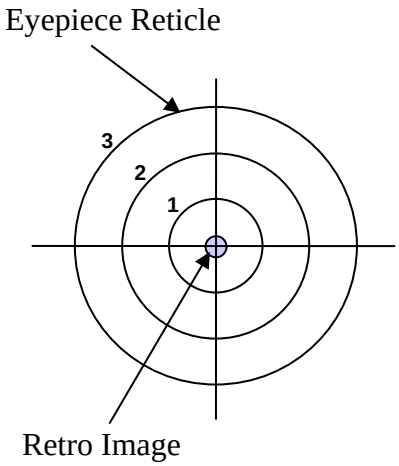

Figure 7-1

The Optical Head alignment may be observed by placing your eye about an inch (3cm) from the alignment window on the rear cover. In this view you are actually looking through the instrument's optical system with a real, but inverted, image of the Retroreflector.

Retroreflector Assembly

Retroreflector Assembly alignment is achieved by use of the Integral Retro Alignment Site. The Retro Alignment Site provides a visual indication during

misalignment. The alignment sight protrudes from the rear of the Retro Cap and has a frosted glass screen. The frosted glass screen has a circular target etched into it and a portion of the beam from the Optical Head is projected onto the target.

a. Preliminary adjustment of the Retro is accomplished by opening the Retro Cap and observing the green light projected from the Optical Head.

b. Adjust the 4 nuts on the mounting bolts until the bore of the Retro and purge nozzle is nominally centered on the projected beam.

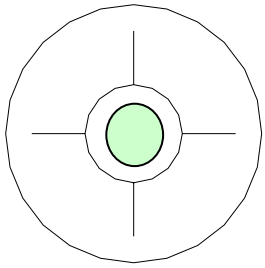

Figure 7-2

c. Close the Retro Cap and observe the GREEN light image on the frosted glass target. Then readjust the 4 nuts on the mounting bolts until the projected beam is completely contained within the circular target of the alignment device.

NOTE: *The Retro Alignment image is best viewed by keeping the eye 8 – 12 inches (20 – 30cm) back from the target and looking for the GREEN spot superimposed on the target. The spot may be difficult to see under bright ambient light conditions. It may be necessary to shield the ambient light from the target during adjustment under these conditions.*

The Retro Alignment Site is useful for providing on-line feedback during analyzer operation of small changes in Retroreflector position once initial alignment has been performed. It is well suited for alignment indication during normal operation.

5. Manual Calibration Cycle Check

   Perform a manual Calibration Cycle by simultaneously depressing the "ZERO" and "UPSCALE" keys on the keypad. When the Cal Cycle is complete, check the Dust Compensation value (location U8). If the Dust Compensation value is 0% ± 1%, the Routine Maintenance is complete. *If the Dust Compensation exceeds ±1%, Teledyne Monitor Labs recommends an On-Stack Calibration as described in Section 7.2 below.*

7.2 ON-STACK CALIBRATION

An On-Stack Calibration is a more comprehensive checkout and adjustment of the entire monitoring system. Teledyne Monitor Labs recommends an On-Stack Calibration be performed quarterly or when the Routine Maintenance delivers unacceptable results.

Appendix B of this manual contains an On-Stack Calibration Checklist to aid the user in performing the calibration. Teledyne Monitor Labs recommends this data be retained to provide a historical record of the opacity monitoring system.

7.2.1 Procedure for On-Stack Calibration Checklist

TOOLS:

- ❑ Standard Common Screwdriver
- ❑ 3/4 Open End Wrench or Adjustable Wrench

TEST EQUIPMENT:

- ❑ Instrument Calibration Kit Fixture
- ❑ Calibrated Neutral Density Attenuators

MISCELLANEOUS:

- ❑ 50% solution of distilled water and isopropyl alcohol or a quality commercially available glass cleaner
- ❑ Lint free, untreated lens cleaning cloth (Kimwipe® or equivalent)
- ❑ Teledyne Monitor Labs On-Stack Calibration Checklist for *Lighthawk*® 560DI Opacity System (Appendix B)

The checklist begins at the DAS/recording device for a few readings before going to the stack mounted equipment. After the stack equipment checks are complete, the checklist moves back to the DAS/recorder for "AFTER MAINTENANCE" readings. Begin the checklist by filling in the information regarding serial number, location, date, and service person.

(1) Reason for Calibration

Place a check or an "X" in the appropriate circle to indicate the reason maintenance is being performed. Explain any important information on the lines provided

(2) Permanent Display/DAS Checks

A. Fault Indicators

Record the status of any faults or alarms and explain the nature of the indications.

B. Current Readings

Record the "As Found" opacity readings from the display device. Also indicate the averaging time, if any, being used.

C. Current Calibration Values

Record the current calibration values in the BEFORE column of the data sheet. Obtain these values from the permanent data-recording device.

(3) On-Stack Checks

A. Calibration Set Points

On the Optical Head record the values displayed in locations C0, C1, C3 and F7.

B. Led Current

On the Optical Head manipulate the keypad until location S2 is displayed. The LED light source current will be displayed in milliamps on the RED 4 digit display. Typical factory settings are between 5.0 and 6.0 mA, though higher values may be used under some conditions. *Consult the Site Specification Data Sheets for the "as shipped" value.*

NOTE: *Ambient temperature and instrument conditions will strongly influence LED current levels. Although typical factory LED currents are between 5.0 and 6.0 mA, currents of up to 10.0 mA are perfectly normal*

for your monitor and do not require readjustment. ***LED currents beyond 10 mA should be investigated and Teledyne Monitor Labs recommends an Off-Stack Calibration described in Section 8.0 of this manual.***

C. Inspect

- Purge Filters - Check conditions of purge air filters and replace if necessary. Record condition.

- Flex Hoses - Check the condition of the flex hoses and replace if necessary. Record results.

NOTE: ***If single blower system is in use*** *and the Optical Head or Retroreflector is opened, the purge air valve on the* ***OPEN side*** *must be* ***CLOSED.***

- Mounting Tubes - Open the latch on the Optical Head and swing it open. Close the PURGE AIR valve. Check the mounting tube for obstructions. Open the cap on the Retroreflector. Close the PURGE AIR valve. Check its mounting tube for obstructions. Record condition of the mounting tubes.

- Purge Shutters - Purge Shutters are optional equipment and may not be present on every *LightHawk*® 560. The Purge Air Shutters are not included on an upgrade from a Dynatron, MC2000, or LS541. If so equipped, check condition of Purge Shutters by looking through alignment eyepiece window on the Optical Head. The mechanical shutter plates of the Purge Shutters should **not** be visible falling into the light beam. Record condition of Purge Shutters.

- Desiccator - To access the Optical Head's desiccator, open the latch and swing the Optical Head Assembly open. Its dessicator is mounted on the top right of the front plate. If the dessicator is still useable, it will indicate a blue to blue/white color. When the dessicator indicates a pink color, it is completely spent. The dessicator may be reactivated by baking at 150 degrees Fahrenheit for several hours. Report condition of desiccate. Teledyne Monitor Labs recommends the desiccator be changed if it is **not blue**, or anytime the rear cover is removed.

D. Alignment

Observe the projected beam image from the alignment eyepiece window at the rear of the Optical Head Assembly. The cross hairs of the reticule should be centered on the beam image and the outside edge of the GREEN Retro image must be inside of the # 1 ring of the eyepiece. Record the

alignment condition on the data sheet. The image of the beam should also be centered on the cross hairs of the Retroreflector. Refer to Section 7.1, Step 4, for a detailed alignment procedure.

E. Cleaning

Clean Retro surface, Exit Window, and Cal Mechanism Windows. A 50/50 mix of alcohol and distilled water and a lint free cloth is recommended. Mark the data sheet to indicate that each optical surface was cleaned.

NOTE: ***Clean the Cal Mechanism zero and upscale windows carefully without removal of the mechanism from the motor shaft.***

F. Install the Cal Kit Fixture

Be sure that the window of the Cal Kit is clean and free of lint so that the signal returned from the fixture will not be reduced. Install the Cal Kit Fixture on the face of the Optical Head Subassembly. It is very important that the Cal Kit Fixture sit flat and flush against the face of the Optical Head so that the iris and reflector fall on the optical centerline of the exit window. A small common screwdriver may be used to tighten the captive thumbscrew to hold the fixture firmly in place. Do not over tighten the thumbscrew as damage to the aluminum threads in the Optical Head may result.

G. Perform BACKGROUND SET

Create a 100% opacity condition by inserting the opaque blocking plate in the filter holder section of the Cal Kit. Perform a BACKGROUND SET by simultaneously pressing the “BACKGND” and “SET” keys on the keypad. The “SET” and “BACKGND” keys must be pressed continuously for about 10 seconds. The YELLOW “SET” LED will flash at a two second rate during this acknowledgement period. The SET LED will then come on continuously and stay lit for about 6 minutes. Once the SET LED goes out, remove the opaque blocking plate creating a 0 % opacity condition.

NOTE: *The YELLOW “SET” LED will light continuously during the actual 6 minute BACKGROUND SET process.*

H. Perform NORMAL Set

With no filters in the Cal Kit, simultaneously press the "NORM" and "SET" keys on the keypad until the SET LED quits blinking. The "SET" and "NORM" keys must be pressed continuously for about 10 seconds. The YELLOW "SET" LED will flash at a two second rate during this acknowledgement period. Once again the SET LED will light continuously for about 6 minutes. Leave the unit undisturbed until the set light goes out. During this period, the clear path reference is established.

NOTE: *The YELLOW "SET" LED will light continuously during the actual 6 minute NORMAL SET process.*

I. Perform ZERO SET

Confirm that the unit is in the NORMAL mode/position. Simultaneously press the "ZERO" and "SET" keys on the keypad until the SET LED quits blinking. The "SET" and "ZERO" keys must be pressed continuously for about 10 seconds. The YELLOW "SET" LED will flash at a two second rate during this acknowledgement period. Once again the SET LED will light continuously for about 6 minutes. Leave the unit undisturbed until the set light goes out. During this period, the ZERO calibration value is established.

NOTE: *The YELLOW "SET" LED will light continuously during the actual 6 minute ZERO SET process.*

J. Check the Cal ZERO value

Check the EXTENDED STATUS CODE by reading the contents of location U4 on the Optical Head display. If the last digit of the U4 EXTENDED STATUS indicates a XXX1 malfunction (ZERO SET voltage out of range), the energy ratio returned by the Cal Zero section of the Cal Mechanism and the Cal Kit are outside the allowable range. Teledyne Monitor Labs strongly suggests an Off-Stack Calibration as outlined in Section 8.0 of this manual to determine the source of the malfunction and correct this problem.

K. Command Cal Cycle

Run through a complete Cal Cycle by simultaneously depressing the "ZERO" and "UPSCALE" keys on the keypad. When the Cal Cycle is complete, check that the last Zero Calibration (location U6) is the same value as Dust Compensation (location U8). If they are not, recheck all the SET functions you just did. Check that the last Upscale Calibration (location U7) is within $\pm$1% of the target value (location C1). The

Upscale Calibration value is generated using its own reflective optical reference on the Cal Mechanism. This means that the optical signal returned from the Upscale section may vary independently from the Cal Zero reading by as much as ±0.5% opacity. In the short term (from week to week or month to month), the COMS response should be very repeatable and the calibration set point should be maintained at the value established during the last full calibration.

However, whenever the COMS is recalibrated (clear path) for errors in path length or after replacement of optical components, the relationship between the Upscale Cal Value and the Clear Path Zero will likely change. Since the "NORMAL SET" function will command the new across stack energy to indicate ZERO opacity, the independent optical response from the Upscale Cal Value will change with respect to the new zero. The change in the Upscale Cal response may be dealt with in two ways:

- Readjust the Upscale Calibration set point to match the new response.

- Readjust the Upscale Calibration Iris on the Cal Mechanism to, as closely as possible, produce the same response as was historically used.

L. Analog Output Check

Indicate how the analog output was checked. Refer to Section 4 of this manual to determine the test points and procedure for test and adjustment of the analog outputs from the 6PIO Board. Indicate on the checklist the selection, range and condition of the outputs.

M. Cal Kit Readings, Attenuator Checks

Calculate and record the PLCF corrected value of each of the three attenuators. Use the formula below (PLCF was recorded previously). Place the attenuators in the Cal Kit one at a time. Allow sufficient time for your systems average opacity reading to reach the attenuator's value (at least two averaging periods) before removing it. Record the reading from location U2 (Selectable Average Opacity). The recorder/DAS readings will be compared with the corrected attenuator readings in a later step.

$$\textbf{Corrected filter value} = 1 - (1 - \textbf{actual value})^{\textbf{PLCF}}$$

Where the actual value = Labeled %opacity / 100

N. Remove the Cal Kit Fixture. Close the Optical Head Assembly.

Install the weather cover. At this time all stack checks are completed.

(4) Data Collection

A. Re-Check Output Device

- Examine the recorder or data collection device for the attenuator values that were collected during the Cal Kit checks. Record them under “Output Value” in the table of Step 3, Item N. Compare these values with the corrected attenuator values for the absolute difference. Enter this difference in the table. It should be ≤ 2% opacity.

B. Fill in Step 2, Item B, "AS LEFT"

- Record the instantaneous and average opacity values **“AS LEFT”** in Step 2, Item B**.**

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8.0 OFF-STACK CALIBRATION

If the analyzer is undergoing an annual recalibration, then the actual optical zero opacity energy must be verified empirically by performing a complete clear path zero calibration. Complete recalibration is also necessary under the following conditions:

Replacement or damage to:

- LED Source Assembly
- Retro Cap Assembly
- Signal Detector Assembly
- Calibration Kit Fixture

Optical alignment of:

- LED Source Assembly
- Signal Detector Assembly
- Any Internal Optics

8.1 FACTORY SELECTION OF OPTICAL ELEMENTS

Factory calibration of the Opacity Monitoring System involves the selection of optical components that are site specific. The electronic adjustments and across stack visual alignment portions of the calibration procedure may be performed by user maintenance personnel in the normal course of maintenance and audit testing.

NOTE: *The user should not attempt the internal alignment of individual optical elements.*

Small changes (± 10%) in the flange to flange calibration distance discovered by the user may be compensated for by performing a new clear path zero calibration. The Teledyne Monitor Labs factory should approve changes beyond the ± 10% limit. This will insure that the appropriate optical elements are installed before the recalibration begins.

8.2 GENERATING AN OPTICAL CLEAR PATH OPACITY SIGNAL

To properly calibrate the opacity monitor it is necessary to generate conditions equivalent to zero percent opacity (clear) and 100 percent opacity (completely opaque). These optical signals may be produced in the following ways:

- Simulating the installation path length on test stands
- At the actual installation site under *clear stack* conditions

8.2.1 Simulating Installation Path Length on Test Stands

This method may be used to calibrate the monitor under the conditions described in Section 8.0. This method is also used to perform the factory calibration. Information must be obtained on the precise distance between the opposing faces of the mounting flanges that the user has installed for the monitor. The Optical Head and Retroreflector Assemblies are mounted on special test stands. These stands are then separated by the exact same distance as that provided by the user. This distance is referred to as the "flange to flange" calibration distance. This distance is depicted on the installation drawing and has been documented by Teledyne Monitor Labs in the Site Specification Data Sheets of this manual.

If test stands are not available, a table whose length is greater than the "flange to flange" calibration distance may be used for calibration. To use this approach, take off the Retroreflector Assembly cover and re-install it with the ends of its curved surfaces pointing upward. If the Retroreflector and Optical Head Assemblies are now both placed on the table in an upside down orientation, the optical axes of both will be close to coaxial alignment. See Figure 8-1.

NOTE: *If the Optical Head and or Retroreflector is equipped with purge shutters or flange adapters, extra care must be taken when simulating the installation path length. If the purge shutters or flange adapters are not attached to the monitor during the Off-Stack Calibration, their distance must be accounted for. The Optical Path Length (the distance between the Optical Head Exit Window and the Retroreflector Surface Window) must be replicated. This Optical Path Length is sometimes referred to as the "hinge to hinge" distance.*

So long as the distance measurement supplied by the user is accurate and no obstruction of the beam occurs in the room in which the calibration occurs, these methods of calibration produce excellent results. ***Note:*** *Document both the "flange to flange" and "hinge to hinge" values in Table 8-1 at the end of this section.*

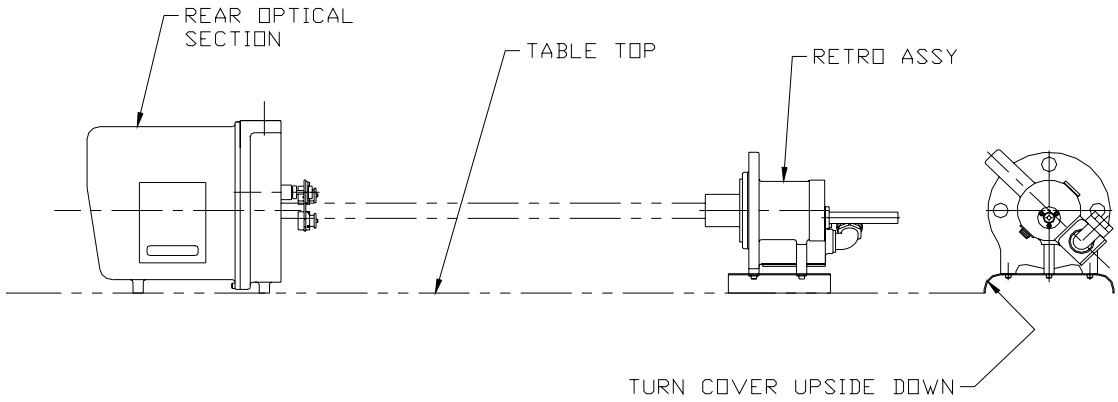

Figure 8-1

Tabletop Calibration

8.2.2 Actual Clear Path Conditions

This is done by performing the across stack calibration while the stack or duct is not in operation.

This type of calibration does not suffer from potential distance measurement errors; however, it is not uncommon for a stack that is out of service to have some circulating opacity in it. This may be a result of natural convection or maintenance work being performed somewhere in the effluent carrying duct work. *If such a condition exists while the 0% and 100% opacity adjustments are being made, it is certain that the calibration will be biased.*

8.3 ACROSS STACK ALIGNMENT

8.3.1 Optical Head Assembly

The across stack alignment of the Optical Head and Retroreflector Assemblies is performed by observing the Retroreflector image through the eyepiece and adjusting the Optical Head mounting nuts on the four mounting bolts which support the Optical Head Assembly on the blower plate. You will notice that the eyepiece contains a cross hair and a series of concentric circles. Alignment is achieved by adjusting the head so that the cross hairs are centered on the bright green image of the Retroreflector and the eyepiece circles are concentric with the image.

NOTE: *A graphic depiction of the misalignment images for the user's individual monitor is permanently affixed to the Optical Head Cover for easy reference.*

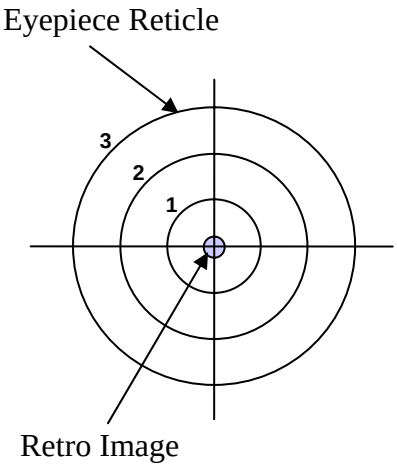

Figure 8-2

The Optical Head alignment may be observed by placing your eye about an inch (3cm) from the alignment window on the rear cover. In this view you are actually looking through the instrument's optical system with a real, but inverted, image of the Retroreflector.

8.3.2 Retroreflector Assembly

Retroreflector Assembly alignment is achieved by use of the Integral Retro Alignment Site. The Retro Alignment Site provides a visual indication during misalignment. The alignment sight protrudes from the rear of the Retro cap and has a frosted glass screen. The frosted glass screen has a circular target etched into it and a portion of the beam from the Optical Head is projected onto the target.

1. Preliminary adjustment of the Retro is accomplished by opening the Retro Cap and observing the green light projected from the Optical Head.

2. Adjust the 4 nuts on the mounting bolts until the bore of the Retro and purge nozzle is nominally centered on the projected beam.

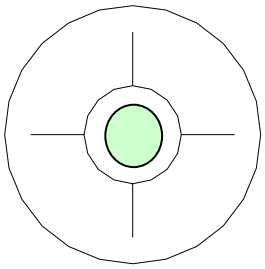

Figure 8-3

3. Close the Retro cap and observe the GREEN light image on the frosted glass target. Then readjust the 4 nuts on the mounting bolts until the projected beam is completely contained within the circular target of the alignment device.

NOTE: *The Retro Alignment image is best viewed by keeping the eye 8 – 12 inches (20 – 30cm) back from the target and looking for the GREEN spot superimposed on the target. The spot may be difficult to see under bright ambient light conditions. It may be necessary to shield the ambient light from the target during adjustment under these conditions.*

The Retro Alignment Site is useful for providing on-line feedback during analyzer operation of small changes in Retroreflector position once initial alignment has been performed. It is well suited for alignment indication during normal operation.

8.4 CLEANING THE OPTICAL SURFACES

Dirt that accumulates on the instrument optical surfaces will attenuate the optical energy and be detected as either increased dust compensation signal or increased opacity by the instrument. Under normal conditions, only the Exit Window of the Optical Head Assembly, the Retroreflector Surface, and the simulated zero/upscale Mechanism Windows need to be cleaned.

8.4.1 Cleaning Materials

The external optical windows and surfaces should be cleaned using a clean soft lint free cloth (Kimwipe® or equivalent) and quality commercial glass cleaning solution. Both are available from Teledyne Monitor Labs. An ammonia based window cleaner may be used so long as it does *not* contain any anti-fog additive. The anti-fog agents leave a residue on the glass surface that may react with stack gases and produce a perceptible haze on the windows. A second choice would be

a mixture of 50% alcohol and 50% distilled water. Care should be taken not to use alcohol containing oily contaminates as this will leave a residue on the optical surfaces. Teledyne Monitor Labs recommends the use of a reagent grade isopropyl alcohol. Many optical surfaces are treated with an anti-reflective coating. **Strong solvents such as acetone should never be used for cleaning.**

8.4.2 Cleaning Procedure

Three surfaces must be cleaned before calibration. All of these areas must be cleaned so that the opacity monitor may properly display and compensate for any future accumulations of dust on the surfaces.

- The Optical Head Exit Window
- The Retro External Surface
- The Cal Mechanism Windows

8.4.2.1 Optical Head Exit Window

The Exit Window is accessible by releasing the latches on both sides of the Optical Head Assembly and opening the hinged section. ***Carefully*** clean the optical elements using the standard cloth and solution. Cotton cleaning swabs may be employed to clean hard to reach areas.

8.4.2.2 Cal Mechanism Sections

While the Optical Head hinged section is open, the simulated zero and upscale windows of the Calibration Assembly may be cleaned. The Cal Mechanism Arm Assembly can be removed by loosening the gear clamp and pulling it off the shaft. See Figure 8-4. **Care should be taken not to damage the guide pin.** Using the standard cloth and solution, clean both windows. Cotton cleaning swabs may be employed to clean hard to reach areas, as long as the lint-free cloth is used to remove any cotton fibers left by the swab. Return the Cal Mechanism Arm to the shaft making sure that the guide pin slides fully into the slot on the arm. Put the gear clamp back on and tighten.

8.4.2.3 Retro Assembly Surface

Access the Retro surface by releasing the latch and opening the hinged section of the Retroreflector Assembly. Clean this surface as mentioned previously, then close the hinged section and proceed to adjustment of the electronics for zero and 100% opacity as outlined in this manual.

8.5 OPTICAL HEAD ZERO AND ONE HUNDRED PERCENT OPACITY

NOTE: *Refer to the Site Specification Data Sheets before attempting any of the adjustments in this section. Information regarding the initial factory calibration of the monitor is contained therein and is especially useful as a baseline reference.*

The electronic adjustment must not be undertaken until the Optical Head and Retro Assemblies have been properly aligned and cleaned, as per Sections 8.3 and 8.4 of this manual. These adjustments are made using the Optical Head keypad. To familiarize yourself with the keypad operation read the User Interface portion of Section 3.0 of this manual.

8.5.1 Setting the LED Current Level

NOTE: *The LED current level should ONLY be adjusted while the ambient temperature of the Optical Head is between 65 and 80°F (18 - 26°C). Ambient temperature and instrument conditions will strongly influence LED current levels. Although typical factory LED currents are between 5.0 and 6.0 mA, currents of up to 10.0 mA are perfectly normal for your monitor and do not require readjustment.* ***LED currents beyond 10 mA should be investigated and clear path calibration during this process is highly recommended.***

1. **Enter the password** in the A2 location

    1. While depressing the "DISP" key, increment the "←" key until an A appears in the left most green display character.

    2. While depressing the "DISP" key, increment either the "↑" or "↓" key until a 2 appears in the next green display character.

A	2

n	E	E	d

The word nEEd will appear in the 4 digit red display.

    3. Depress the "←" key. The 4 digit display will now contain all 0's, with the LSD (Least Significant Digit) blinking.

    4. Depress the "←" key again. The 4 digit display will still display all 0's, but the 2nd LSD will now be blinking.

    5. Depress the "↑" key until the 2nd LSD is a 6.

6. Repeat selecting and incrementing each character until the password (9860) is displayed.

A	2		9	8	6	0

7. Now depress the “SET” key. The 4 digit display will read 7200 and begin counting down. This indicates the number of seconds remaining to make adjustments before you must enter the password again.

A	2		7	2	0	0

2. **Read the LED Current**

1. Manipulate the keypad as above until location S2 is displayed. The LED light source current will be displayed in milliamps on the RED 4 digit display. Typical factory settings are between 5.0 and 6.0 mA, though higher values may be used under some conditions. (Consult the "Setting the Signal Gain" part of this section and the Site Specification Data Sheets.)

NOTE: *The LED current level should ONLY be adjusted while the ambient temperature of the Optical Head is between 65 and 80°F (18 - 26°C). Ambient temperature and instrument conditions will strongly influence LED current levels. Although typical factory LED currents are between 5.0 and 6.0 mA, currents of up to 10.0 mA are perfectly normal for your monitor and do not require readjustment.* ***LED currents beyond 10 mA should be investigated and clear path calibration during this process is highly recommended.***

3. **Set the LED Current (Optional)**

NOTE*: If it is necessary to adjust the LED current and all of the conditions mentioned in the information above have been met, continue below. However, if the LED current is already within acceptable limits, proceed directly to Section 8.5.2 Setting the Signal Gain.*

To adjust the LED current the Reference Gain must be changed. To increase the current, decrease the Reference Gain. To decrease the current, increase the Reference Gain

1. Manipulate the keypad until the Reference Gain (location F9) is displayed.

F	9		0	0	1	5

2. Using the "←", "↑", and "↓" keys increase or decrease the Reference Gain setting.

3. Depress the "SET" key to enter the change. The display stops blinking when the change has been entered.

4. Once again display the LED current (location S2). Repeat Reference Gain changes until LED current is between 5.0 and 6.0 mA.

5. If the required Reference Gain is greater than 125, this may be an indication of potential LED problems. Contact Teledyne Monitor Labs Tech Support at (800) 846-6062 before proceeding.

NOTE: *Successful completion of this section indicates that the reference loop and the LED source are functioning properly. Proper reference loop control allows compensation for variations in the LED output.*

8.5.2 Setting the Signal Gain

NOTE: *The Signal Gain must be set to a nominal value before further calibration. Setting of this nominal gain is necessary only during the initial clear path calibration.*

1. To set Signal Gain, manipulate the keypad as above until location F8 is displayed

2. Using the "←", "↑", and "↓" keys set the Signal Gain to 25.

3. Depress the "SET" key to enter.

F	8

0	0	2	5

4. Manipulate the keypad to display the Signal Voltage at location S0. The Signal Voltage must be between 6.0 and 7.0 VDC.

NOTE*: If the voltage is not between 6.0 and 7.0 VDC, the Signal Gain will need adjustment. To adjust the Signal Voltage the Signal Gain must be changed. An increase in Signal Gain will increase the Signal Voltage, and a decrease in Signal Gain will decrease the Signal Voltage. The Signal Gain is at location F8. The following formula can be used to calculate the desired Signal Gain value.*

New Gain = (Present Gain) (6.5 / Present Signal Voltage)

5. Modify the value of location F8 until the Signal Voltage (location S0) is greater than 6.0 and less than 7.0.

If the Signal Gain is less than 125, proceed to Section 8.5.3 Final Calibration SET Function Routines.

NOTE: *If the Signal Gain must be set above 125 to achieve the desired Signal Voltage, go to Step 6.*

6. Increase the LED current (location S2) by decreasing Reference Gain (location F9).

7. Then set Signal Gain (F8) again to establish the proper Signal Voltage (S0).

The maximum recommended LED current is 10 mA.

Once the proper LED Current, Signal Gain and Signal Voltage targets have been established, record the Reference and Signal Gains in Table 8-1 at the end of this section. Then continue with Section 8.5.3 Final Calibration SET Function Routines.

8.5.3 Final Calibration SET Function Routines

NOTE: *Performing the "SET" functions will configure the LightHawk® 560 firmware to accurately output the ZERO, 100% and linear intermediate opacity values. Although these routines are simple, they must be followed carefully and be performed in the following order.*

- *BACKGROUND SET (100% opacity)*
- *NORMAL SET (ZERO opacity)*
- *Set Out of Service Marker to 1.000*
- *Read raw CAL ZERO value (adjust as necessary)*
- *Set Out of Service Marker back to 0.000*
- *Perform CAL ZERO SET*
- *Adjust Upscale Calibration Iris as necessary*

Begin Procedure

1. Create a 100% opacity condition by blocking the optical path of the instrument.

2. Perform a BACKGROUND SET by simultaneously pressing the "BACKGND" and "SET" keys on the keypad. The "SET" and "BACKGND" keys must be pressed continuously for about 10 seconds. The YELLOW "SET" LED will flash at a two second rate during this acknowledgement period.

NOTE: *The YELLOW "SET" LED will light continuously during the actual 6 minute BACKGROUND SET process.*

3. Once the "SET" LED goes out, remove the blocking condition of the optical path creating a 0% opacity condition.

4. Perform a NORMAL SET by simultaneously pressing the "NORM" and "SET" keys on the keypad. The "SET" and "NORMAL" keys must be pressed continuously for about 10 seconds. The YELLOW "SET" LED will flash at a two second rate during this acknowledgement period. The "SET" LED will then light continuously indicating a SET function is in progress. Once again the SET function will take about 6 minutes.

NOTE: *When the NORMAL SET function is finished, it will be necessary to take the Optical Head Out of Service*.

5. Manipulate the keypad to display the Service Marker (location F6).

6. Change the Service Marker to 1.000 for "Out of Service".

NOTE: *When the "Out of Service" marker is on, the "Auto Zero Adjust" feature is disabled.*

7. Open the Optical Head by releasing the latches on both sides and swinging out.

8. Put the system into the Zero mode by depressing the "ZERO" key on the keypad. The Cal Mechanism will move to the Cal Zero position and the "IN CAL" LED will light. Allow the instrument to remain in the Zero mode for at least 2 minutes.

9. Manipulate the keypad to display the Instantaneous Opacity (location **U0**). The opacity must be 0% $\pm$ 2% opacity. If it is not within these limits, the Cal Zero Iris of the Cal Mechanism must be adjusted as described in steps (a) through (h) below.

NOTE: *If theU0 reading is **less** than $\pm$ 2 % go to step 10.*

a) Loosen the Allen head setscrew that locks the Zero Iris in place. See Figure 8-4.

b) Manipulate the keypad to display the Instantaneous Opacity (location **U0**).

NOTE: *The Iris MUST be adjusted while observing the Instantaneous Opacity (location U0).*

c) Slowly rotate the disc on the rear of the Cal Zero Iris to achieve as near as possible to 0% opacity (± 2% on U0). See Figure 8-4.

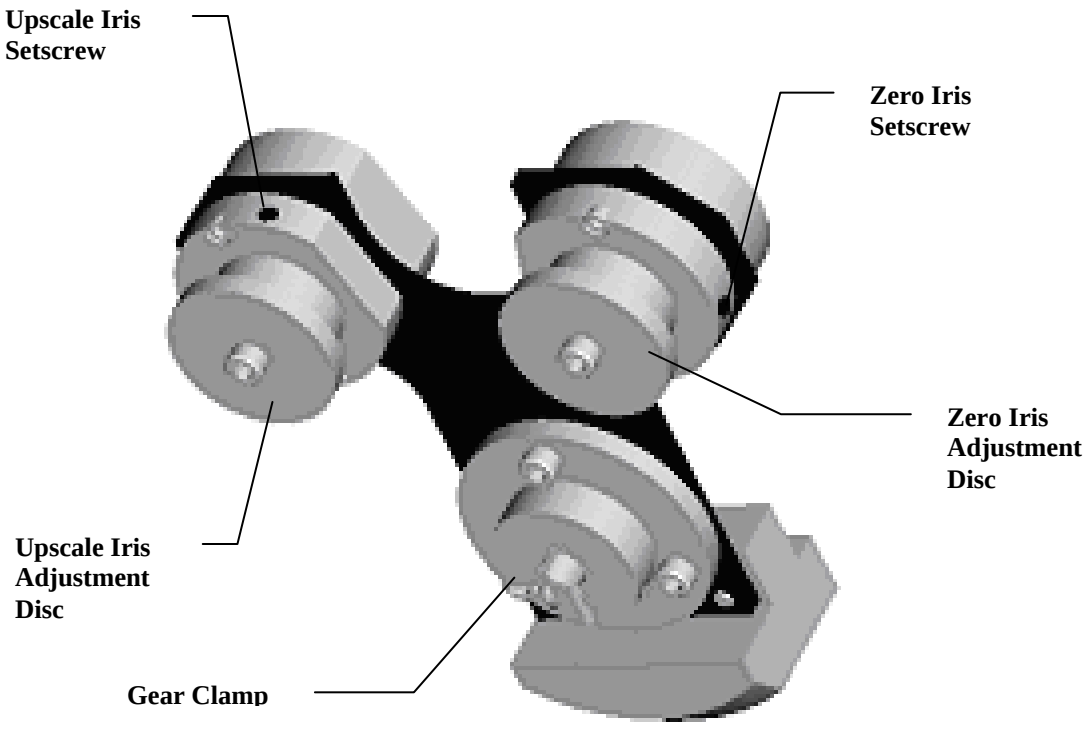

Figure 8-4

NOTE: *The Instantaneous Opacity display may have as much as ±0.5% variation over the period of a few seconds. Every attempt should be made to adjust the Iris carefully so that the normal variation is equally balanced around the 0% reading.*

d) Carefully lock down the Iris setscrew. See Figure 8-4.

e) Allow the monitor to operate in the Zero mode for an additional 2 minutes.

f) Then manipulate the keypad to again display the Instantaneous Opacity (location **U0**).

g) Confirm that the Instantaneous Opacity reading is less than ± 2% opacity before continuing on with the calibration.

h) Before proceeding, verify the Zero Iris opening is between 3/16 inch and 7/16 inch diameter. If the Zero Iris opening diameter is within limits, record the diameter in Table 8-1 at the end of this section. *Failure to obtain this specification will require the replacement of the Neutral Density window protecting the Zero Iris. Go to Section 8.8 for the Cal Mechanism Neutral Density Window Replacement procedure.*

NOTE: *If the 1-Minute Opacity reading of the Calibration Zero value is NOT within the ± 2 % opacity limit, return to step a) above and readjust the Calibration Zero Iris.*

10. Go to the Normal Mode by depressing the "NORM" key on the keypad.

11. Close the Optical Head, making sure the latches on both sides are closed.

12. Change the Service Marker (location F6) to a 0.000 ("In Service").

NOTE: *The ZERO SET must be initiated from the NORMAL mode.*

13. Perform a CAL ZERO SET by simultaneously pressing the "ZERO" and "SET" keys on the keypad. The "SET" and "ZERO" keys must be pressed continuously for about 10 seconds. The YELLOW "SET" LED will flash at a two second rate during this acknowledgement period. The "SET" LED will then light continuously indicating a "SET" function is in progress. Once again the "SET" LED will light continuously for 6 minutes while the CAL ZERO SET is completed.

NOTE: *Always return the Cal Mechanism to the NORMAL position before opening or closing the housing. If this is not done, the Cal Mechanism may strike the front housing and cause damage to the mechanism.*

14. Open the Optical Head by releasing the latches on both sides and swinging out the Cal Mechanism. Go to the UPSCALE mode by pressing the "UPSCALE" key on the keypad. Manipulate the keypad to display the Instantaneous Opacity (location **U0**). Allow the instrument to remain in the

Upscale mode for several minutes. The Instantaneous Opacity should read the target value for your installation. This value can be found in location C1.

15. If U0 does not read the target value, adjust the Upscale Iris on the Cal Mechanism as described in steps (i) through (v) below.

NOTE: *If theU0 reading is equal to the target value ±0.5% go to step 16 below.*

i) Loosen the Allen head setscrew that locks the Upscale Iris in place. See Figure 8-4.

ii) Manipulate the keypad to display the Instantaneous Opacity (location **U0**).

NOTE: *The Iris MUST be adjusted while observing the Instantaneous Opacity (location U0).*

iii) Slowly rotate the disc on the rear of the Cal Upscale Iris to achieve as near as possible to target value (location C1). See Figure 8-4.

iv) When the proper value is obtained, carefully lock down the Upscale Iris setscrew. See Figure 8-4.

v) Before proceeding, verify the Upscale Iris opening is between 3/16 inch and 7/16 inch diameter. If the Upscale Iris opening diameter is within limits, record the diameter in Table 8-1 at the end of this section. *Failure to obtain this specification will require the replacement of the Neutral Density Window protecting the Upscale Iris. Go to Section 8.8 for the Cal Mechanism Neutral Density Window Replacement procedure.*

16. Go to the NORMAL mode by depressing the "NORM" key on the keypad.

17. Close the Optical Head, making sure the latches on both sides are closed.

Run through a complete Cal Cycle by simultaneously depressing the “ZERO” and “UPSCALE” keys on the keypad. When the Cal Cycle is complete, check that the last Zero Calibration (location U6) is the same value as Dust Compensation (location U8). If they are not, recheck all the SET functions.

8.6 ADJUSTING CALIBRATION KIT

CAUTION: ***This adjustment must not be undertaken unless complete clear path recalibration is being performed.***

After all of the adjustments have been performed with the Retro Assembly, the Calibration Kit may be adjusted.

1. Open the Optical Head Assembly and attach the Calibration Kit Fixture to the front of the housing.

NOTE: *Before installing the Calibration Kit, be sure that the window that protects the Iris and reflective material of the Cal Kit is clean and free of lint so that the signal returned from the fixture will not be reduced.*

2. Confirm that the system is in the NORMAL mode by pressing the "NORM" key on the keypad.

3. Read the instantaneous opacity (location U0). It must read 0.0% opacity ±0.2% opacity. If not, the Calibration Kit Fixture Iris must be adjusted.

4. Loosen the cap screws and remove the cover that protects the Iris Adjustment Mechanism. There is a reduction gear drive mechanism under the cover used to provide precise adjustment of the Iris. See Figure 8-5.

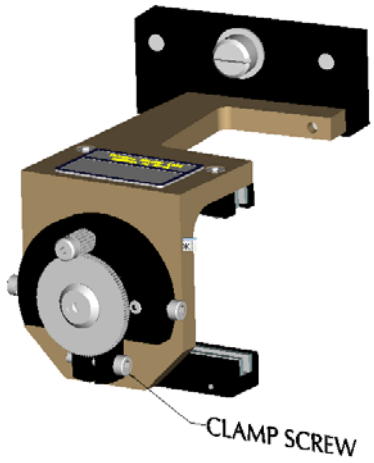

Figure 8-5

5. To unlock the Iris, loosen the small clamp screw located at the six o'clock position on the round backing plate just behind the larger gear. This will allow the gear to rotate and open and close the Iris.

6. In order to provide a fine adjustment device, temporarily place the gear clamp (an integral part of the cover previously removed) over the smaller gear and tighten the clamp. This will allow the cover to be rotated in order to move the Iris in small increments for the final adjustment. See Figure 8-6 showing the cover and gear clamp temporarily installed.

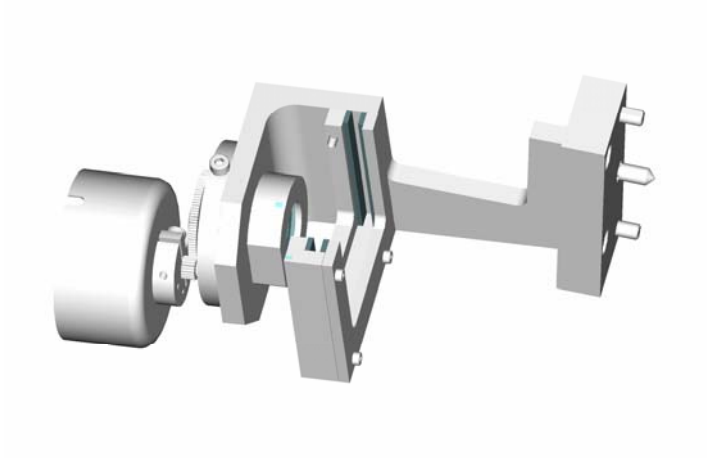

Figure 8-6

7. Rotate the cover until the analyzer U0 display value is 0.0% (±0.2%) opacity. If the cover is hard to turn, use a flat blade (common) screwdriver to spread the slot in the clamp.

NOTE: This adjustment must be made carefully in order for the Cal Kit to be used for subsequent testing. Be patient! There will be some natural variability in the instantaneous (U0) reading. *When the proper value is obtained, lock down the Iris with the clamp screw. While making the final adjustments it will be helpful to monitor location U1 (1-Minute Average Opacity) to be certain that the average reading stays within the ±0.2% tolerance.* Carefully tighten the clamp screw in the backing plate and recheck both the U0 and U1 display values to confirm the proper zero reading is maintained.

8. Before proceeding, verify the Cal Kit Iris opening is between 3/16 inch and 7/16 inch diameter. If the Cal Kit Iris opening diameter is within limits, record the diameter in Table 8-1 at the end of this section. *Failure to obtain this specification will require the replacement of the Neutral Density Window protecting the Cal Kit Iris. See Section 8.9 for the Cal Kit Neutral Density Window Replacement procedure.*

9. Carefully loosen the gear clamp and remove the cover. Reinstall the cover and tighten the cover retaining screws.

NOTE: *Some small changes in the Iris position may occur when the clamp screw is tightened or when the gear clamp is removed. Be certain that the zero opacity reading is proper after the Iris position is locked and the cover has been reinstalled.*

8.7 VERIFY THE RESPONSE OF THE OPTICAL HEAD

The neutral density attenuators in the Calibration Kit pouch have been marked to indicate their opacity at the measurement point. If a PLCF other than 1.000 has been entered in location F7, calculate the Exit value of the attenuators as follows.

Exit value = $1 - (1 - \text{Marked value})^{\text{PLCF}}$

EXAMPLE: Marked value 20% opacity

PLCF = 0.900

Exit value = $1 - (1 - 0.20)^{0.9}$

Exit value = $1 - (0.80)^{0.9}$

Exit value = 1 – 0.818

Exit value = 0.182

Exit value = 18.2 % opacity

Insert each attenuator into the Calibration Kit. The values read at U0 (Instantaneous), U1 (1 minute average), and U2 (selectable average) must be within ± 2% opacity of the attenuator's marked values.

8.7.1 Six Point I/O Response

As each of the attenuators is placed in the Calibration Kit, observe the output of each of the analog outputs.

Analog Output Channel Adjustment Details

	TEST POINTS	ZERO ADJUST	FULL SCALE ADJUST
Channel #1 (DAC1)	TP3 – TP4	R11	R10
Channel #2 (DAC2)	TP10 – TP11	R23	R22

8.7.2 Analog Output Adjustment

The output current from each channel of the 6PIO may be measured at test points located on the board. The 0 – 20 or 4 – 20mA currents may be measured using a digital voltmeter to read the voltage across a 100Ω resistor at test points TP3 and TP4 for analog channel #1 (DAC1). 2.00 VDC between TP3 and TP4 indicates a 20mA output current. 0.40 VDC corresponds to a 4mA output.

The analog channel #2 (DAC2) output is measured between test points TP10 and TP11. Voltage readings on channel #2 are the same as channel #1.

2.00 VDC = 20mA
0.40 VDC = 4mA

Potentiometers are available for adjustment of the analog output current from each channel. Zero and full scale adjustments are made using the potentiometers while monitoring the above mentioned test points or the final external display device.

Examples 1 and 2 below indicate how the Measurement Unit parameter, 6PIO Full Scale parameter and 6PIO jumper interactivity dictate the analog output response to the instrument measurement levels.

EXAMPLE 1:

If (Measurement Unit = 1) ***AND*** (6PIO Full Scale = 100) ***AND*** (0/4 6PIO Jumper = 4)):

4mA = 0% Opacity

20mA = 100% Opacity

EXAMPLE 2:

If (Measurement Unit = 2) ***AND*** (6PIO Full Scale = 2) ***AND*** (0/4 6PIO Jumper = 0):

0mA = Optical Density of 0

20mA = Optical Density of 2

8.8 CAL MECHANISM NEUTRAL DENSITY WINDOW REPLACEMENT

NOTE: *This procedure should only be undertaken if either the Cal Zero Iris or Cal Upscale Iris opening diameters fall outside of the specifications listed in Section 8.5.3 Step 9(h) or Section 8.5.3 Step 16(v) respectively.*

The Site Specification Data Sheets in Appendix A of this manual list the factory settings for the Iris diameters and Optical Density values for the ND windows "as shipped" in the Cal Mechanism. See Appendix C for ND window part numbers.

The Cal Mechanism Iris opening diameters must be between 3/16 inch and 7/16 inch. If during Iris adjustments these limits cannot be maintained, the ND window must be changed.

If the Iris opening is too small, the ND window must be replaced with one of a higher Optical Density value. If the Iris opening is too large, the ND window must be replaced with one of a lower optical density value.

1. Remove the Cal Mechanism Arm Assembly by loosening the gear clamp and pulling it off the shaft.

2. Remove the 2 Allen head screws holding the ND cover on the appropriate Iris. See Figure 8-7.

3. Remove the ND cover, front gasket, ND window and rear gasket. See Figure 8-7.

4. Re-assemble the rear gasket, new ND window, front gasket and ND cover as shown in Figure 8-7. ***Note: The ND window must be installed with the coating side IN toward the rear gasket.***

5. Return the Cal Mechanism Arm to the shaft making sure that the guide pin slides into the slot on the arm. Put the gear clamp back on and tighten.

6. Record the Optical Density value of the new ND window in the appropriate row of Table 8-1 at the end of this section.

7. The Iris can now be readjusted so the opening diameter is within specification. If the Zero Iris ND window was replaced, return to Section 8.5.3, Step 5. If the Upscale Iris ND window was replaced, return to Section 8.5.3, Step 16.

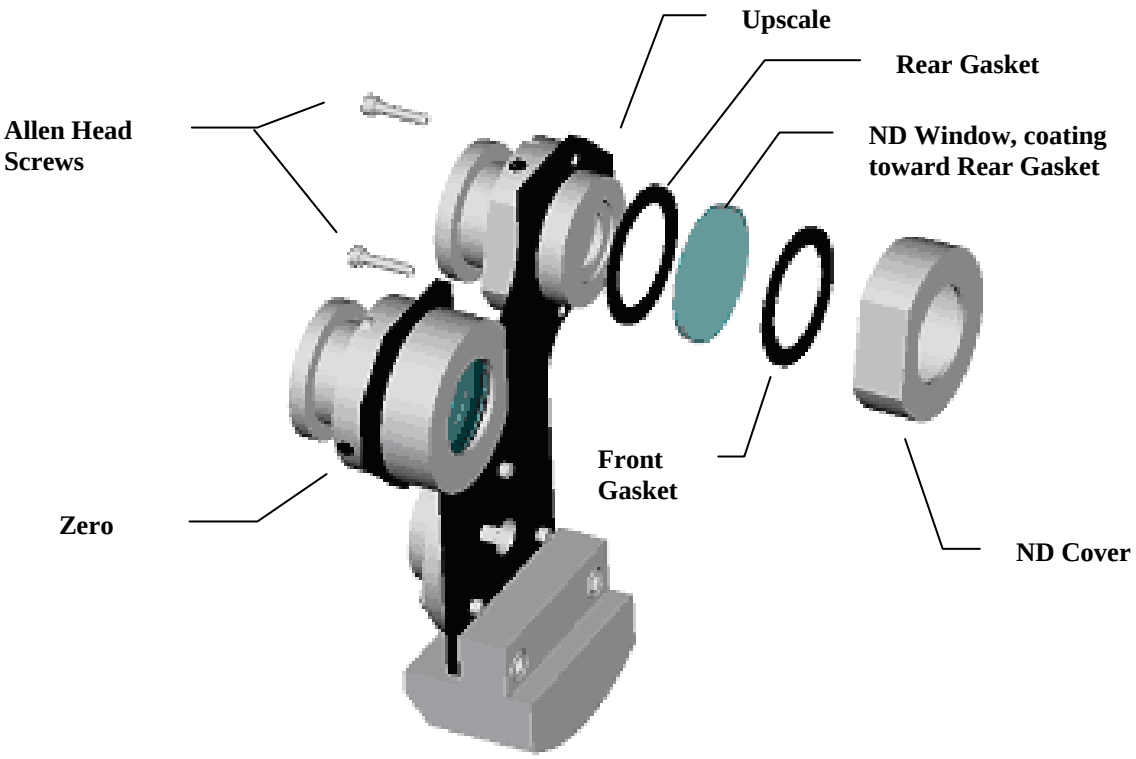

Figure 8-7

8.9 CAL KIT NEUTRAL DENSITY WINDOW REPLACEMENT

NOTE: *This procedure should only be undertaken if the Cal Kit Iris opening diameter falls outside of the specifications listed in Section 8.6, Step 8.*

The Site Specification Data Sheets in Appendix A of this manual list the factory settings for the Iris diameter and Optical Density value for the ND window "as shipped" in the Cal Kit. See Appendix C for ND window part numbers.

The Cal Kit Iris opening diameter must be between 3/16 inch and 7/16 inch. If during Iris adjustments these limits cannot be maintained, the ND window must be changed.

If the Cal Kit Iris opening is too small, the ND window must be replaced with one of a higher Optical Density value. If the Iris opening is too large, the ND Window must be replaced with one of a lower Optical Density value.

1. Loosen the cap screws and remove the cover that protects the Iris Adjustment Mechanism. See Figure 8-8.

2. Remove the gear screw, collar and gear. See Figure 8-8.

3. Remove the 2 Allen head screws holding the ND Cover. See Figure 8-8.

4. Remove the ND cover, front gasket, ND window and rear gasket. See Figure 8-8.

5. Re-assemble the rear gasket, new ND window, front gasket and ND cover as shown in Figure 8-8. ***Note: The ND window must be installed with the coating side <u>IN</u> toward the rear gasket.***

6. Re-install the gear, collar and gear screw. See Figure 8-8.

7. Record the Optical Density value of the new ND window in Table 8-1 at the end of this section.

8. The Cal Kit Iris can now be readjusted so the opening diameter is within specification. Return to Section 8.6.

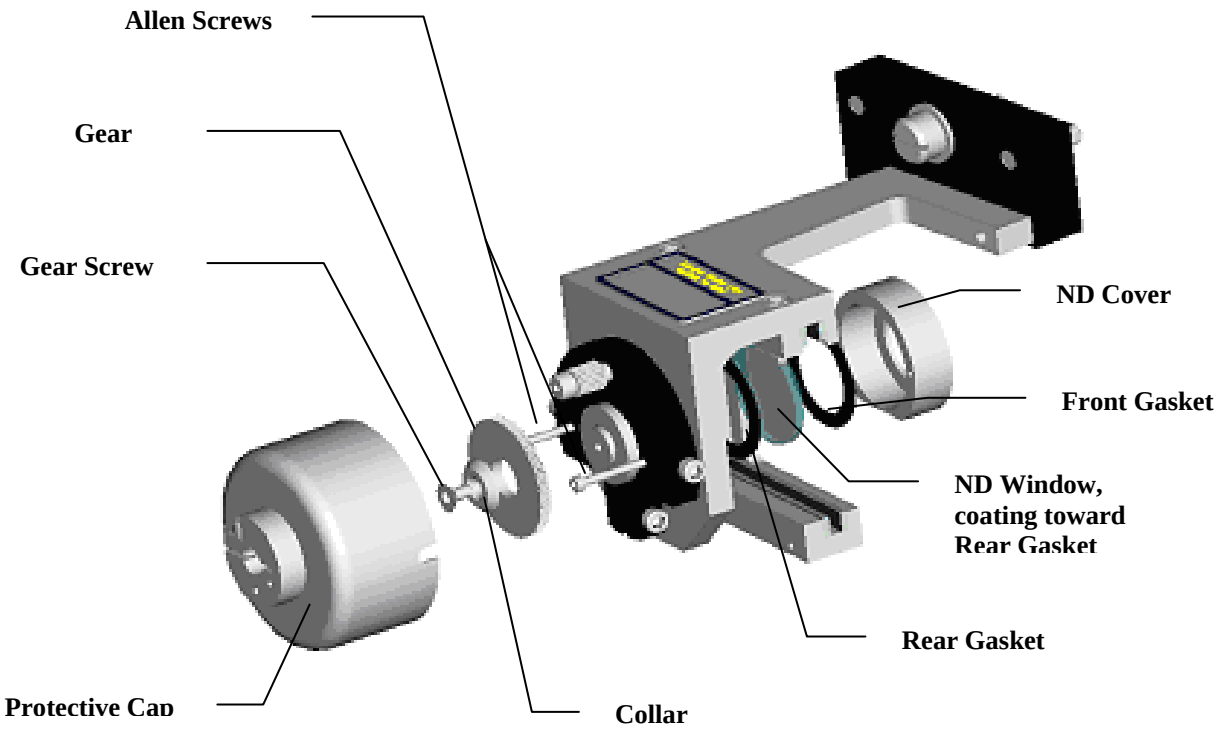

Figure 8-8

8.10 OFF-STACK CALIBRATION HISTORY

Use Table 8-1 below to record the adjustments made during the Off-Stack Calibration.

Date					
Flange to Flange[1]					
Hinge to Hinge[2]					
Reference Gain[3]					
Signal Gain[4]					
Zero Iris Diameter					
Zero ND Window					
Upscale Iris Diameter					
Upscale ND Window					
Upscale Target Value[5]					
Cal Kit Iris Diameter					
Cal Kit ND Window					

[1]The precise distance between the opposing faces of the mounting flanges for the monitor
[2]The precise distance between the Optical Exit Window and the Retroreflector Surface Window
[3]Parameter location F9
[4]Parameter location F8
[5]Parameter location C1

Table 8-1

9.0 INSTALLATION

The installation overview of the *LightHawk*® 560DI system is shown in the Installation Drawing. It is important that the optical center line of the Optical Head and Retro be maintained so that they are capable of being pointed directly at each other.

9.1 FLANGE MOUNTING

Before the flanges can be mounted, the stack or duct must be cut so that a clear path from one side to the other can be seen. These flanges must be put up so that the mounting holes fall on vertical and horizontal lines. A distance between the flange and the stack or duct must be provided so that the mounting hardware can be accessed. This dimension must be at least 4 5/8 inches (117.5mm). The flange must be welded to a 2-inch schedule 40 (American Standard) steel pipe. The pipe in turn must be attached to the stack or duct. **The pipe on one side must be in a straight line with the pipe on the other**. (THE LIGHT BEAM **MUST NOT TOUCH THE PIPE** BETWEEN THE OPTICAL HEAD ASSEMBLY AND GAS STREAM, NOR CAN ANY PART OF THE REFLECTIVE PORTION OF THE RETROREFLECTOR ASSEMBLY BE OBSCURED.)

9.1.1 Mounting Pipe Considerations

A typical installation on a stack simply requires a short pipe to be welded or cemented to the stack. The pipe should not protrude into the stack gas stream.

In cases where there is an outer shell and an inner stack liner which are too close together to make mounting between the two impossible, or desired, a long pipe will be required. The longer the pipe, the more it will have to be stepped up to ensure that no part of the light beam is obscured. Reference the *LightHawk*® 560 Opacity Monitor Flange Mtg. Methods drawing.

The accuracy of the mounting tube alignment becomes an issue when the user's installation requires the use of long mounting tubes. See Figure 9-1. The distance "L" is the length of the mounting tube required. "D" is the inside diameter of the mounting tube and "Phi" (ϕ) is the maximum allowable misalignment angle in degrees. Determination of the angle ϕ may be made by the following formula:

$$\phi = \text{ARC SIN } [\{(D/2) - .5)\} / (L+1")]$$

For a typical installation where Teledyne Monitor Labs recommends a 2" diameter tube 5.5" long, the maximum misalignment calculates to 4.41°.

Example:

ϕ = ARC SIN [{(2/2) - .5)} / (5.5+1")]

ϕ = ARC SIN .5/6.5

ϕ = 4.41°

For a mounting to be 2 feet or 24" long, the maximum angle would fall to 1.15°.

To avoid very small misalignment angles the mounting tube diameter should be increased when long mounting tube lengths (L) are required.

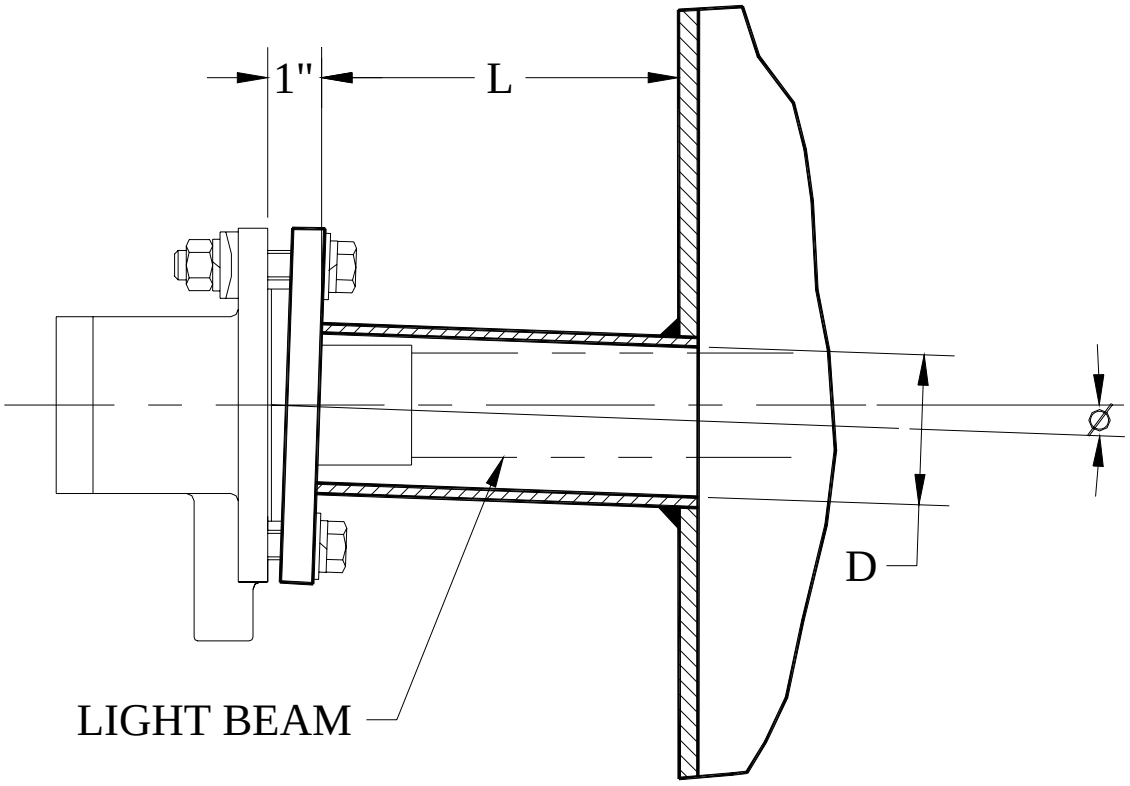

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Figure 9-1

560 Opacity Port Alignment

Teledyne Monitor Labs has a mounting plate alignment scope, which may be used to aid the user in determining the optical centerline between the two opposing ports.

CAUTION: ***The pipes must not be rigidly connected to the inner and outer shell stacks since they may move differently. Ensure that the pipes will not be bent or broken as the two stacks move. (Be sure to check size at maximum and minimum stack temperature.)***

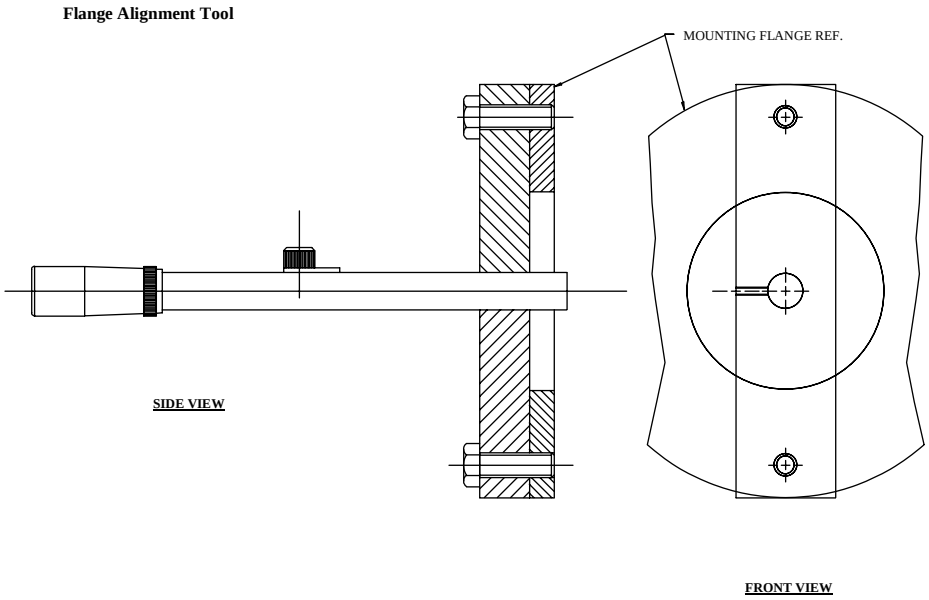

Figure 9-2

9.2 DISTANCE DETERMINATION

Once the flanges have been mounted properly, the distances required for calibration can be determined. There are three distances needed for calibration. Two of these are the inside dimension of the stack or duct in which the gas stream is flowing, both at the monitor location and at the exit. The other distance is known as the "flange to flange" distance. This distance is the distance from the

outside face of the mounting flange that is going to support the Optical Head to the outside face of the flange, which is going to support the Retroreflector. All of these distances are important in determining the calibration.

9.3 POWER REQUIREMENTS

Power requirements for the standard *Lighthawk*® 560DI system are determined primarily by the Purge System. The system power requirements are listed in Section 1.2 Specifications. Please consult the Site Specification Data Sheets for your system configuration and power mains voltage and install your system.

9.4 PURGE AIR SYSTEM

CAUTION: ***Care must be taken to be certain that the purge air to both the Optical Head Assembly and the Retroreflector Assembly is in operation and connected <u>BEFORE</u> any of the optical components are mounted on the flanges. Failure to provide purge air to the system components could result in damage to the system that will not be covered under the Teledyne Monitor Labs warranty.***

Power to the Purge System should be provided via a circuit that is always activated so long as the stack is in operation. This will prevent the inadvertent deactivation of the circuit causing potential damage to the optical components.

9.5 DATA CABLES

Two data cables are needed to interconnect the Six Point I/O Board (6PIO) to external devices. One is a 4 conductor #20 AWG (0.5 mm^2) cable for connecting the contacts from the two relays. The other one Teledyne Monitor Labs recommends is a 6-pair #24 AWG (0.25 mm^2) shielded cable for connection to the two analog outputs and two isolators. This would leave two pairs as spares or for future use. See Wiring Diagram for details on external connections to the 6PIO PC Board.

9.6 PURGE CABLE

The terminations for the purge cable are made at the time of installation. This cable must be terminated at both the Retro Purge Switch Junction Box and the Optical Head Integral Junction Box. Materials for the termination of these cables are contained in the Teledyne Monitor Labs hardware kit.

9.7 MOUNTING THE OPTICAL HEAD AND RETRO ASSEMBLIES

As mentioned previously, the purge air must be in operation and connected before mounting of the optical components. The mounting configuration of the Optical Head and Retro Assemblies is described in the Teledyne Monitor Labs drawings in Appendix D.

Optical alignment of the system is accomplished as described in Section 7.0 of this manual. Evaluation of the monitor output and calibration is covered in Section 8.0 of this manual.

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10.0 TROUBLESHOOTING

The Primary Status Code (U3) and the Extended Status Code (U4) will define almost any system problem.

Each of the digits in the status codes represents an octal number ranging from 0 to 7. A value of 0 indicates no problems for that particular digit. Three unique malfunctions are defined for each digit: 1, 2 or 4 as outlined below. Values of 3, 5, 6 and 7 represent a numerical summation for the defined malfunctions. For example: a value of 5 is defined as malfunction 1 and malfunction 4 simultaneously. If a fault is indicated or you suspect a problem, go to U3 and U4 and record the values displayed. Decode the malfunctions by using Section 10.1 and 10.2 below.

10.1 PRIMARY STATUS CODE U3

XXX1 Purge Fail Analyzer Side: Check the blower operation, blower plumbing and Optical Head side pressure switch.

XXX2 Purge Fail Retro Side: Check the blower operation, blower plumbing and Retro side pressure switch.

XXX4 Out of Service: The *LightHawk*® 560 has been logged out of service. Check the value of F6. For normal operation F6 must be set to 0.

XX1X ADC Fault: Beyond the scope of this manual. Call Teledyne Monitor Labs Tech Support at (800) 846-6062.

XX2X Reference Fault: Check the Reference voltage value at location S1. Reference Voltage must be between +5VDC to +8VDC.

XX4X NORMAL Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

X1XX ZERO Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

X2XX UPSCALE Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

X4XX CLEAR STACK SET in Progress: Normal indication when performing a CLEAR STACK SET.

1XXX ZERO SET in Progress: Normal indication when performing a ZERO SET.

2XXX BACKGROUND SET in Progress: Normal indication when performing a BACKGROUND SET.

4XXX CLEAR STACK SET Voltage Out of Range: Check the Clear Stack Set Voltage value at location S3. The Clear Stack Set Voltage must be between +5VDC to +8VDC.

10.2 EXTENDED STATUS CODE U4

XXX1 ZERO SET Voltage Out of Range: Check the value of the ZERO SET voltage (S4) and the CLEAR STACK SET voltage (S3). S4 must be equal to S3 ± 10%.

XXX2 ZERO Calibration Bad: Check the value of the Last ZERO Calibration (U6), Calibration ZERO Set Point (C0) and the Calibration Tolerance (C3). U6 must be ± C3 of C0.

XXX4 UPSCALE Calibration Bad: Check the value of the Last UPSCALE Calibration (U7), Calibration UPSCALE Set Point (C1) and the Calibration Tolerance (C3). U7 must be ± C3 of C1.

XX1X Excessive Dust Compensation: Check the value of the Dust Compensation (U8) and the Dust Compensation Tolerance (C2). The absolute value of U8 must be less than C2.

XX2X Not Used

XX4X Not Used

X1XX Not Used

X2XX Not Used

X4XX Not Used

1XXX Not Used

2XXX Not Used

4XXX Not Used

10.3 ASSISTANCE

If you are unable to determine the problem, call Teledyne Monitor Labs Tech Support at (800) 846-6062. An experienced factory trained technician will handle your call.

APPENDIX A

SITE SPECIFICATION DATA SHEETS

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SITE SPECIFICATION DATA
TML *LIGHTHAWK*® 560 OPACITY MONITORING SYSTEM

COMPANY: _____

TML SHOP ORDER NO: _____ CAL DATE: _____

UNIT SERIAL #: _____

CAL. TECHNICIAN: _____

I. OPTICAL HEAD _____

_____ FEET Hinge to Hinge

FLANGE TO FLANGE CALIBRATION DISTANCE: _____ FEET _____ meters

MONITOR PATH LENGTH: _____ FEET _____ meters

EXIT PATH LENGTH: _____ FEET _____ meters

PLCF: _____ *104 / F(7)*

A. SIX POINT I/O:

YES	
NO	

OUTPUT UNITS	F(0)	Opacity = 1, Optical Density = 2, Dust Mass = 3
OUTPUT FULL SCALE	F(E)	
CAL ZERO/DUST COMP SCALING	F(F)	0 = NORMAL mode scaling; 1= EXPANDED scaling

HARDWARE CURRENT RANGE

OUTPUT #1	*JU1*		0 or 1
	JU2		0 or 1
OUTPUT #2	*JU3*		0 or 1
	JU4		0 or 1

SOFTWARE RANGE FOR CURRENT OUTPUT

JU9		4 or 0	4 = 4-20ma, 0 = 0-20ma

RELAY JUMPERS

K1: JU12		A through H
K1: JU14		A = NO = Normally Open or B = NC = Normally Closed
K2: JU13		A through H
K2: JU15		A = NO = Normally Open or B = NC = Normally Closed

ISOLATOR INPUT JUMPERS

ISO1: JU7		A, B or C
ISO1: JU5		DRY or +5V
ISO2: JU8		A, B or C
ISO2: JU6		DRY or +5V

B. CAL MECHANISM

ZERO CAL VALUE _____ % Opacity *105 / C(0)*

_____ Optical Density

UPSCALE CAL VALUE _____ % Opacity *106 / C(1)*

_____ Optical Density

N.D. WINDOWS	Optical Density
ZERO	
UPSCALE	

IRIS OPENING DIAMETER

ZERO		decimal inches, approximate, enter 0.38" as 0.38
UPSCALE		

C. AUTO CAL CYCLE

CYCLE FREQUENCY

CAL TIME HOUR		HR	*76 / C(4)*
CAL TIME MIN.		MIN.	*77 / C(5)*
CAL INTERVAL HOUR		HR	*78 / C(6)*

CYCLE DURATIONS

UPSCALE		SEC	*79 / C(8)*
ZERO		SEC	*80 / C(7)*
PLCF		SEC	*81 / C(9)*
DUST COMP.		SEC	*82 / C(A)*

D. POWER SUPPLY

+15 VDC:		*28 / S(8)*
-15 VDC:		*29 / S(9)*
+5 VDC *analog*:		*30 / S(A)*
-5 VDC *analog*:		*31 / S(B)*
+5 VDC *digital*:		*32 / S(C)*

E. "AS SHIPPED" CONFIG.

ZERO CAL OPACITY		*17 / U(6)*	DUST COMP ALARM		*39 / C(2)*
UPSCALE CAL OPACITY		*18 / U(7)*	CAL DELTA		*107 / C(3)*
SIGNAL VOLTS		*20 / S(0)*	AVG. INTERVAL		*108 / F(B)*
REF. VOLTS		*21 / S(1)*	STACK 332 VERSION:		*116 / U(A)*
LED CURRENT		*22 / S(2)*	STACK NEURON VER:		*117 / U(B)*
XSTACK SET VOLTS		*23 / S(3)*	SIGNAL GAIN:		*121 / F(8)*
CAL ZERO SET VOLTS		*24 / S(4)*	REFERENCE GAIN:		*122 / F(9)*
BCK GRD SET VOLTS		*25 / S(5)*	COMMON GAIN:		*123 / F(A)*

II. PURGE SYSTEM

SINGLE BLOWER		CFM
DUAL BLOWER		
INSTRUMENT AIR		

AIR SHUTTERS:	YES	
	NO	

III. RETROREFLECTOR

	mm

IV. CALIBRATION KIT

A. N.D. WINDOW

Optical Density

B. IRIS OPENING DIAMETER

	decimal inches, approximate, enter 0.38" as 0.38

C. ATTENUATOR VALUES:

	O.D	OPACITY	CAL DATE	SERIAL NO.
1)				
2)				
3)				

D. NIST CALIBRATION:

YES	
NO	

V. ENHANCED REMOTE PANEL

E. R. P. PROVIDED:	YES	
	NO	

A. MULTI I/O PROVIDED:

YES	
NO	

B. ANALOG OUTPUT CHANNEL SELECTIONS

CHANNEL 1	DEFINITION		*52*
	WITH / W.O. CAL		*53*
	ZERO VALUE		*54*
	FULL SCALE		*55*
CHANNEL 2	DEFINITION		*56*
	WITH / W.O. CAL		*57*
	ZERO VALUE		*58*
	FULL SCALE		*59*
CHANNEL 3	DEFINITION		*60*
	WITH / W.O. CAL		*61*
	ZERO VALUE		*62*
	FULL SCALE		*63*
CHANNEL 4	DEFINITION		*64*
	WITH / W.O. CAL		*65*
	ZERO VALUE		*66*
	FULL SCALE		*67*

C. DIGITAL OUTPUT (Relay) SELECTIONS

DIGITAL OUTPUT 1		*68*
DIGITAL OUTPUT 2		*69*
DIGITAL OUTPUT 3		*70*
DIGITAL OUTPUT 4		*71*
DIGITAL OUTPUT 5		*72*
DIGITAL OUTPUT 6		*73*
DIGITAL OUTPUT 7		*74*
DIGITAL OUTPUT 8		*75*

D. "AS SHIPPED" CONFIG.

MIO VERSION		*118*
PANEL332 VERSION		*119*
PANEL NEURON VERSION		*120*
REF. TEMP		*124*
REF. PRESSURE		*125*

Static IP information

Static IP Address	
SubNet Mask	
Default Gateway	

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APPENDIX B

MAINTENANCE CHECK SHEETS

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Rev. 8/4/11

TELEDYNE MONITOR LABS

ON-STACK CALIBRATION CHECKLIST for *LightHawk*® 560DI OPACITY SYSTEM

PLANT NAME _____ LOCATION _____

SERVICE PERSON _____ SERIAL # _____

DATE _____ TIME _____

(1) A. REASON FOR CALIBRATION

QUARTERLY ○ EMERGENCY ○ INSTALL ○ OTHER ○

EXPLAIN: _____

(2) **Permanent Display/DAS Checks**

A. FAULT INDICATIONS

	FAULTS	ALARM
ON	○	○
OFF	○	○

EXPLAIN _____

B. CURRENT READINGS

	INST OPACITY	AVG OPACITY	AVERAGING INTERVAL
AS FOUND	_____ %	_____ %	_____ min
AS LEFT	_____ %	_____ %	_____ min

C. CURRENT CALIBRATION VALUES (From Data Recorder)

	BEFORE	AFTER	
1. CURRENT CAL ZERO	_____	_____	OPACITY
2. UPSCALE CAL	_____	_____	OPACITY
3. DUST COMP	_____	_____	OPACITY

(3) **On-Stack Checks**

A. CALIBRATION SET POINTS (C0, C1, C3, F7)

1. CAL ZERO SET POINT (C0)	_____	% OPACITY
2. UPSCALE SET POINT (C1)	_____	% OPACITY
3. CAL FAIL LEVEL (C3)	_____	% OPACITY
4 P. L. C. F. (F7)	_____	

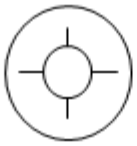
B. LED CURRENT _____(S2) **OK** ☐ ≤ 10mA

C. INSPECT

	PURGE AIR FILTERS	FLEX HOSES	MOUNTING TUBES	PURGE SHUTTERS	DESIC-CATOR
OK	○	○	○	○	○
CLEANED	○	○	○	○	
REPLACED	○	○		○	○

D. Optical Head Alignment as found

Retro Alignment as found



	OPTICAL ALIGNMENT	
	HEAD	RETRO
OK	○	○
ADJUSTED	○	○

COMMENTS: _____

_____

E. CLEAN: RETRO ☐ EXIT WINDOW ☐ CAL MECH ☐ CAL KIT ☐

F. ***INSTALL*** CAL KIT FIXTURE **OK** ☐

G. PERFORM BACKGROUND SET **OK** ☐

H. PERFORM NORMAL SET **OK** ☐

I. PERFORM ZERO SET **OK** ☐

J. CHECK CAL ZERO VALUE _____ U4 Extended Status Code

OK ☐

K. COMMAND CAL CYCLE **OK** ☐

CAL CYCLE RESULTS ZERO _____ UPSCALE _____

OK ☐

L. ANALOG OUTPUT CHECK

CHECKED WITH ○ MULTIMETER ○ OUTPUT DEVICE (DAS)

	SELECTION	RANGE	ADJUSTED? (Y/N)
CHANNEL 1			
CHANNEL 2			

M. CAL KIT READINGS PLCF = _____ (F7)

	ZERO	LOW	MID	HIGH	FS
ATTENUATOR VALUE					
CORRECTED VALUE					
LightHawk® READING					
OUTPUT VALUE (DAS)					
DIFFERENCE (+/- 2.0 %)					

N. ***REMOVE*** CAL KIT FIXTURE **OK** ☐

(4) DATA COLLECTION

A. RE-CHECK OUTPUT DEVICE **OK** ☐
VALUES ABOVE

B. FILL IN OPACITY READINGS SECTION 2 **"AS LEFT"** **OK** ☐

NOTES OR RECOMMENDATIONS :

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APPENDIX C

SPARE PARTS

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RECOMMENDED SPARE PARTS

Recommended spare parts for the *LightHawk*® 560 are organized into four categories. User can stock the appropriate parts for their level of maintenance. The four lists do not overlap. For the highest level of maintenance the first three lists should be stocked. The "Recalibration" list is for reference only in the event that major path length or optical changes are necessary. For normal maintenance the "Start Up/Operational" and "Normal Wear and Maintenance" lists should be stocked. The four levels are:

- ❑ Start Up/Operational
  - Parts and supplies that may be used during start up and daily operation.
- ❑ Normal Wear and Maintenance
  - Parts that may be required as a result of normal wear over time.
- ❑ Emergency/Quick Response
  - Parts that will facilitate the fastest possible repair time in failure situations such as power surges, lightning strikes, etc.
- ❑ Recalibration
  - Neutral Density Windows for the Calibration Mechanism and Calibration Kit

"Start Up/Operational" Spare Parts

The following table represents a selection of parts and supplies that may be required during start up and normal operation.

This is the least comprehensive list. These parts will support only a minimal maintenance level.

TELEDYNE MONITOR LABS (TML) *LIGHTHAWK*® 560 "START UP/OPERATIONAL" RECOMMENDED SPARE PARTS								
Part Name	**TML Part #**	**System Location**	**Stocking Quantity 1 on Site**	**Stocking Quantity 2 – 5 on Site**	**Stocking Quantity 5 – 10 on Site**	**Cal Kit Recal Required After Replacement**	**Off-Stack Recal Required After Replacement**	**Mean Time Between Replacement**
Fuse (1.25A)	527441	Optical Head Power Supply Board	5	5	5	No	No	N/A
Fuse (5.0 A)	527418	Optical Head	5	5	5	No	No	N/A
* Fuse, 2 amp	527438	Enhanced Remote and Multi I/O	6	6	12	No	No	N/A
** Purge Filters	528873	Purge System	12	24	48	No	No	N/A
Wipes	550026	General	1 Box	1 Box	2 Boxes	N/A	N/A	N/A
Lens Cleaning Fluid	530023	General	1 Bottle	1 Bottle	1 Bottle	N/A	N/A	N/A
Dessicator (Head)	997788	Optical Head Assembly	1	2	3	No	No	N/A
Alignment Scope Mounting Flange	1007-0000-01	General	1	1	1	No	No	N/A
Multi I/O Connector Kit	1803-0006-01	Enhanced Remote Panel	1	1	1	No	No	N/A

NOTES: * Not needed if Direct Interface option is chosen.

** Not needed if Instrument Air Purge option is chosen.

"Normal Wear and Maintenance" Spare Parts

These are parts that may be used as a result of normal wear over time.

TELEDYNE MONITOR LABS (TML) *LIGHTHAWK*® 560 "MAINTENANCE" RECOMMENDED SPARE PARTS								
Part Name	**TML Part #**	**System Location**	**Stocking Quantity 1 on Site**	**Stocking Quantity 2 - 5 on Site**	**Stocking Quantity 5 - 10 on Site**	**Cal Kit Recal Required After Replacement**	**Off-Stack Recal Required After Replacement**	**Estimated Mean Time Between Failures**
Purge Switch	528312SP	Optical Head & Retro	1	2	4	No	No	3-5 Yrs
** Purge Hose 1" Dia.	980536	Purge System	2 Ft.	6 Ft.	10 Ft.	No	No	2-5 Yrs
** Hose Clamp	980537	Purge System	2	4	6	No	No	N/A
Battery	550047	Optical Head Mother Board	1	2	3	No	No	3-5 Yrs
* Key Switch	525414	Remote Display with Multi I/O	1	1	2	No	No	N/A
Tubing Seal & Adhesive Epoxy	528553 & 530007	Optical Head & Retro	1	1	2	No	No	N/A

NOTES: * Not needed if Direct Interface option is chosen.

** Not needed if Instrument Air Purge option is chosen.

"Emergency/Quick Response" Spare Parts

The following is a list of spares that the user may wish to keep on hand in order to minimize system downtime in the event of an unforeseen failure such as power surges, lightning strikes, etc.

TELEDYNE MONITOR LABS (TML) *LIGHTHAWK*® 560
"EMERGENCY/QUICK RESPONSE" RECOMMENDED SPARE PARTS

Part Name	TML Part #	System Location	Stocking Quantity 1 on Site	Stocking Quantity 2 - 5 on Site	Stocking Quantity 5 - 10 on Site	Cal Kit Recal Required After Replacement	Off-Stack Recal Required After Replacement	Estimated Mean Time Between Replacement
Optical Amplifier PCB	1860-0400-01	Optical Head	1	1	1	Yes	No	N/A
## 560 Mother Board PCB	1860-0500-01SP	Optical Head	1	1	1	Yes	No	N/A
Display/Control PCB	1860-0600-01	Optical Head	1	1	1	Yes	No	N/A
** 6 Point I/O PCB	1860-0700-01	Optical Head	1	1	1	No	No	N/A
## Control Module PCB	515441	Optical Head	1	1	1	No	No	N/A
Power Supply PCB	1860-1100-02	Optical Head	1	1	1	No	No	N/A
Keypad	1860-0190-01	Optical Head	1	1	1	No	No	N/A
Keypad Panel Gasket	1860-0193-01	Optical Head	1	1	1	No	No	N/A
* Retro Cap	1802-0200-02 1802-0400-01 1802-0700-01 1802-0700-02	Retro Assembly	1	1	2	No	Yes	N/A
Cal Mechanism Drive Assembly	1860-0125-01	Optical Head	1	1	1	Yes	No	4-6 Yrs.
# Blower Motor	980142	Purge System	1	1	1	No	No	3-5 Yrs.
Exit Window	0601-0123-01	Optical Head	1	1	1	Yes	No	N/A
LED Source	1860-0250-01	Optical Head	1	2-5	5-10	No	Yes	N/A
Signal Detector Assy	1810-0230-01	Optical Head	1	2-5	5-10	No	Yes	N/A
Reference Detector Assembly	0601-1000-02	Optical Head	1	2-5	5-10	Yes	No	N/A
*** Enhanced Remote Mother Board PCB	1803-2200-02	Enhanced Remote Panel	1	1	2	No	No	N/A
*** Multi I/O PCB	1803-2500-03	Enhanced Remote Panel	1	1	2	No	No	N/A
*** Enhanced Remote LCD Display	1803-1400-02	Enhanced Remote Panel	1	1	2	No	No	N/A
*** Power Supply PCB	1803-0300-02SP	Enhanced Remote Panel	1	1	2	No	No	N/A
Viton O-ring	700233	Optical Head	1	1	2	No	No	N/A

NOTES: * Each monitor at a particular site may have a different Retro Cap. Review the site specification data for each monitor to insure that the proper Retro Cap is ordered.

****** Only needed when Direct Interface option is chosen.

*** Not needed if Direct Interface option is chosen.

Not required if Instrument Air Purge option is chosen.

Mother Board (1860-0500-01) includes one Control Module (515441).

"Recalibration" Parts

The following is a list of neutral density windows used in the Calibration Mechanism and Calibration Kit. These windows only need changed if directed by the Off-Stack Calibration procedure outlined in Section 8.0 of this manual.

TELEDYNE MONITOR LABS (TML) *LIGHTHAWK*® 560 "RECALIBRATION" PART NOS.						
Part Name	**TML Part #**	**System Location**	**Stocking Quantity 1 on Site**	**Cal Kit Recal Required After Replacement**	**Off-Stack Recal Required After Replacement**	**Estimated Mean Ttime Between Replacement**
Clear Window	528470	Cal Mechanism	* 2	No	No	N/A
0.2 Optical Density Window	528471	Cal Mechanism				
0.4 Optical Density Window	528474	Cal Mechanism				
0.5 Optical Density Window	528472	Cal Mechanism				
0.6 Optical Density Window	528475	Cal Mechanism				
0.7 Optical Density Window	528473	Cal mechanism				

NOTE: * The appropriate part no. can only be determined during the Off-Stack Calibration procedure outlined in Section. 8.0.

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APPENDIX D

DRAWINGS

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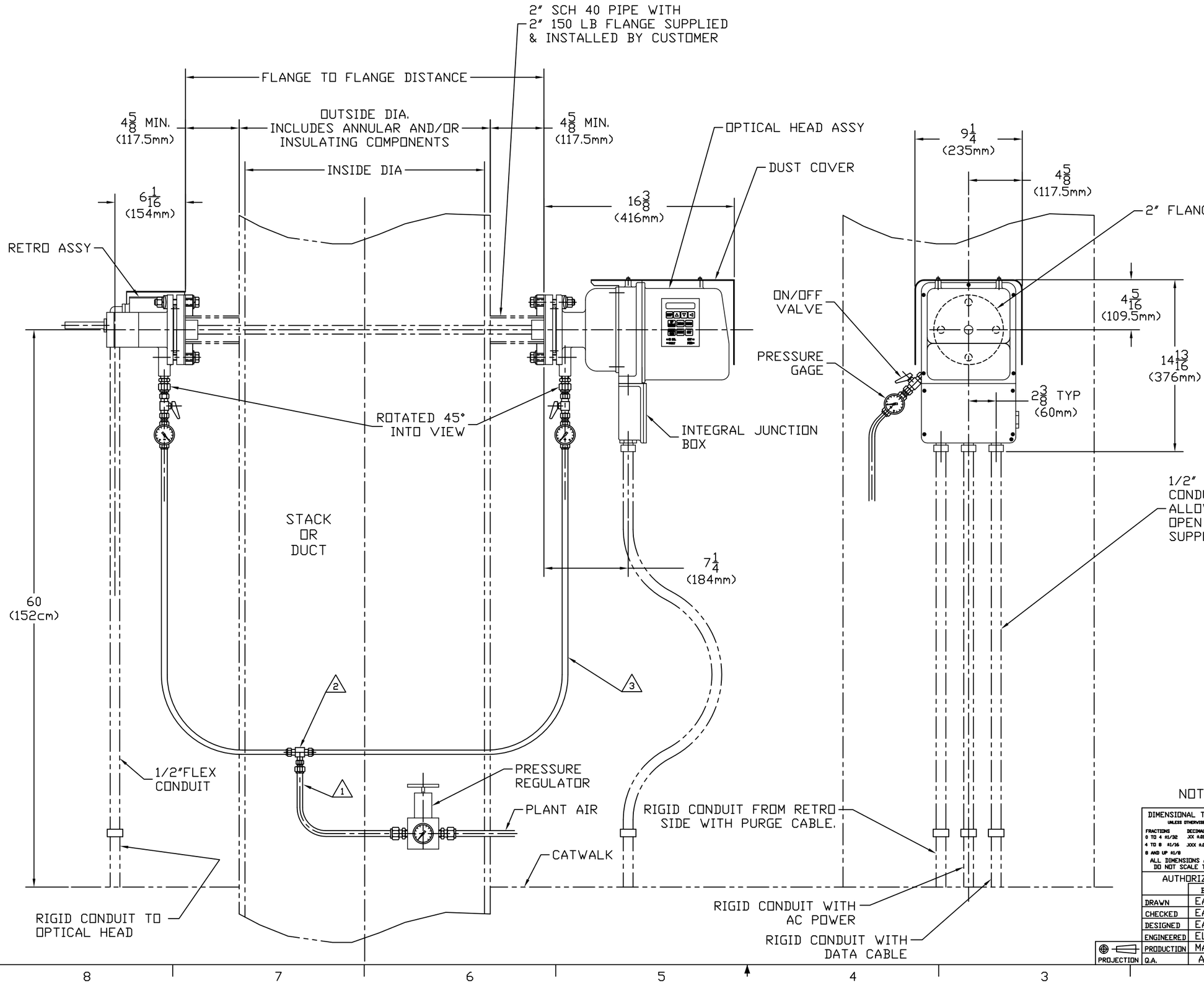
DWG. NO 1800-0007 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0007A	4-17-00	ELM
	B	NO CHANGE THIS SHEET	5-23-00	ELM
	C	NO CHANGE THIS SHEET	6-7-00	ELM
	D	NO CHANGE THIS SHEET	7-10-00	ELM
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



1/2" FLEX CONDUIT (TYPE EF), 3 PLACES. CONDUIT MUST HAVE ENOUGH SLACK TO ALLOW THE OPTICAL HEAD TO SWING OPEN TO THE RIGHT FOR SERVICING. SUPPLIED AND INSTALLED BY CUSTOMER

3. CUSTOMER TO SUPPLY AND INSTALL 3/8 OD x 5/16 ID TUBING TO CARRY INSTR. AIR

2. CUSTOMER TO SUPPLY AND INSTALL 3/8 UNION TEE W/1/2-3/8 REDUCER

1. CUSTOMER TO SUPPLY AND INSTALL 1/2"OD x 3/8"ID x 6 FT LONG TUBE TO CARRY INSTRUMENT AIR FROM THE REGULATOR TO THE TEE. PLANT AIR SYSTEM TO SUPPLY A TOTAL FLOW OF 25 CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER @ THE REGULATOR. PRESSURE AT THE ON/OFF VALVES SHOULD BE THE SAME AS THE REGULATOR PRESSURE WITH THE VALVES CLOSED. PLANT PRESSURE MAY NEED TO BE HIGHER IF THERE ARE RESTRICTIONS UPSTREAM IN THE PLANT AIR SYSTEM. THE REGULATOR SHOULD BE RATED FOR HIGH FLOW.

NOTES:

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	11-3-97
CHECKED	EAS	5-00
DESIGNED	EAS	NOV-97
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE: LightHawk 560 OPACITY W/INSTR. AIR SYSTEM INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE 1/4 | SHEET 1 OF 7

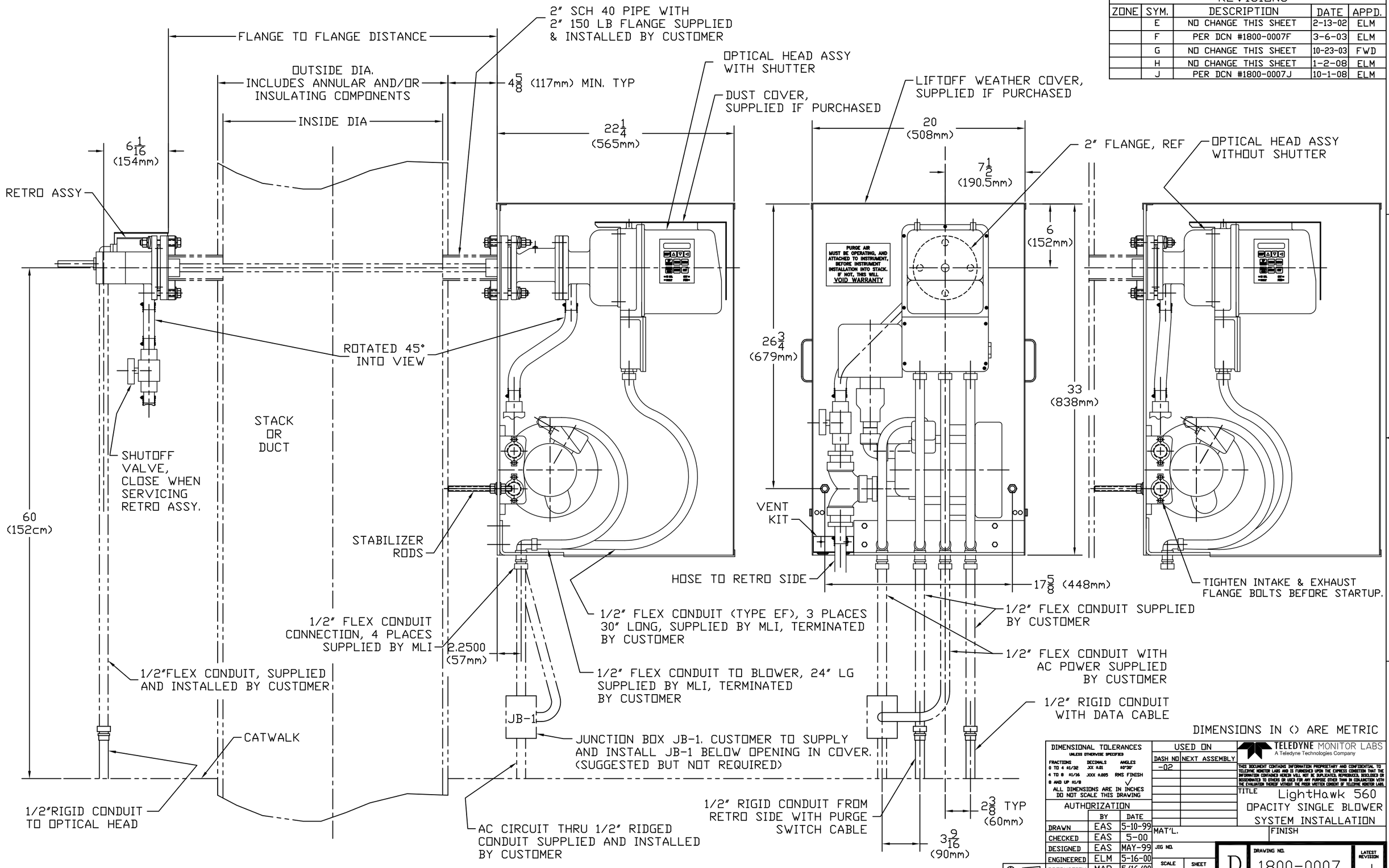
D | DRAWING NO. 1800-0007 | LATEST REVISION J

ACAD FILE 1800007-MS

10-1-08

DWG. NO 1800-0007 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APP'D.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS ±1/32 DECIMALS .XX ±.01 ANGLES ±0°30'
4 TO 8 ±1/16 .XXX ±.005 RMS FINISH
8 AND UP ±1/8
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	EAS	5-10-99
CHECKED	EAS	5-00
DESIGNED	EAS	MAY-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-02	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE LightHawk 560
OPACITY SINGLE BLOWER
SYSTEM INSTALLATION

MAT'L. FINISH

JIG NO.

SCALE 1/4 SHEET 2 OF 7

DRAWING NO. 1800-0007

LATEST REVISION J

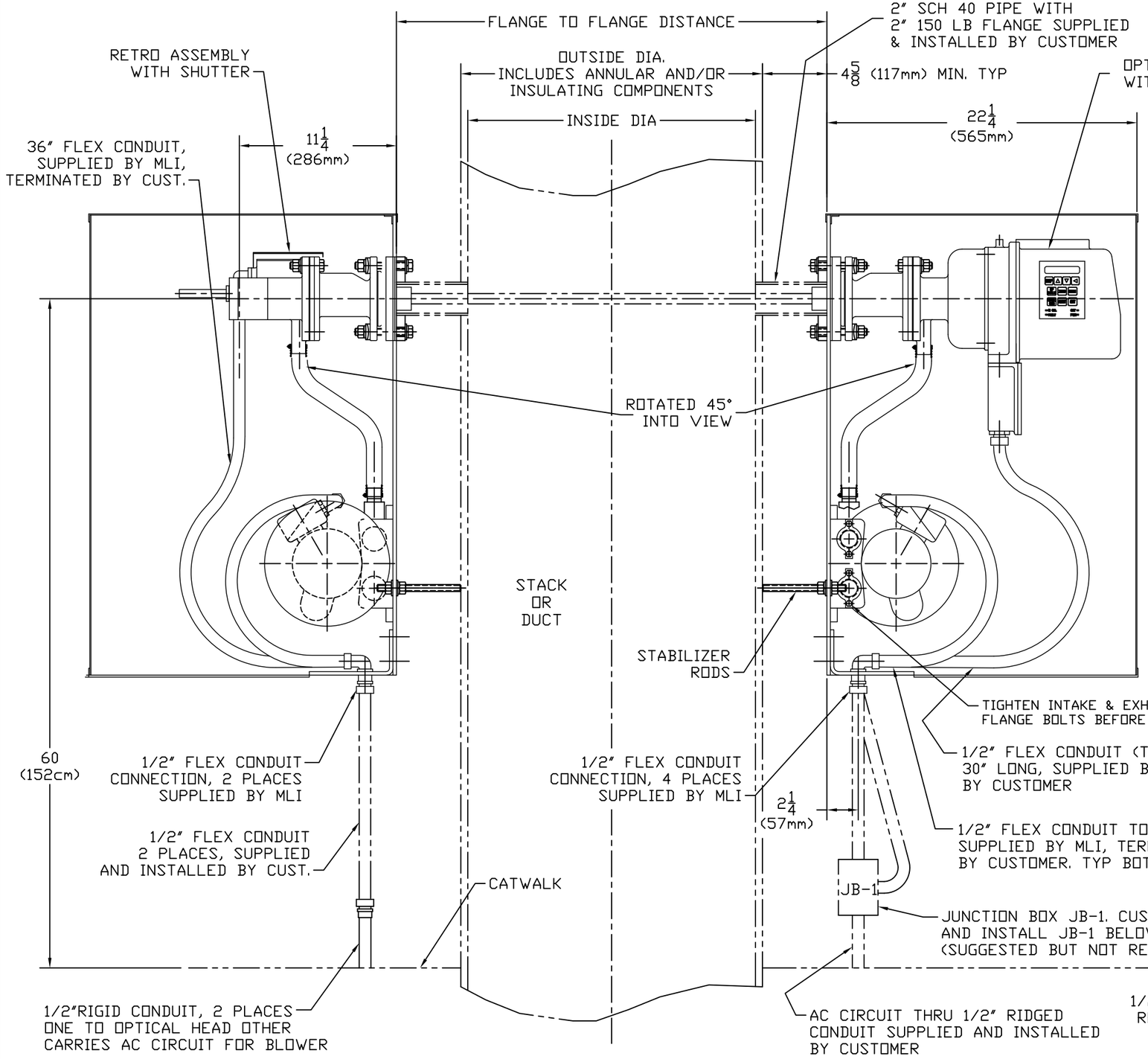
D

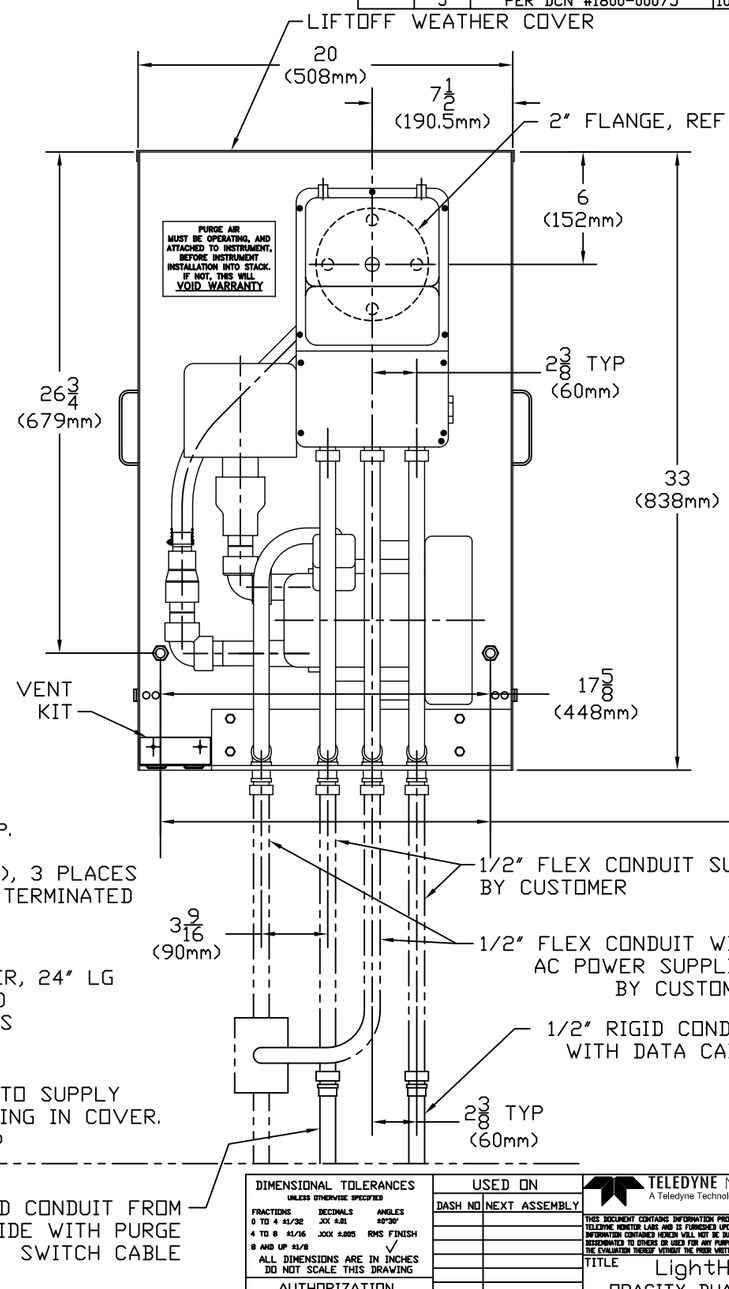
ACAD FILE 1800007-MS

10-1-08

DWG. NO 1800-0007 SH 3

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM





DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	.XX ±.01	±0°30'
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH
8 AND UP ±1/8		✓
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		

AUTHORIZATION	BY	DATE
DRAWN	EAS	8-19-99
CHECKED	EAS	5-00
DESIGNED	EAS	AUG-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

USED ON	
DASH NO	NEXT ASSEMBLY

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LightHawk 560
OPACITY DUAL BLOWER
SYSTEM INSTALLATION

MAT'L.
FINISH
JIG NO.
SCALE 1/4
SHEET 3 OF 7

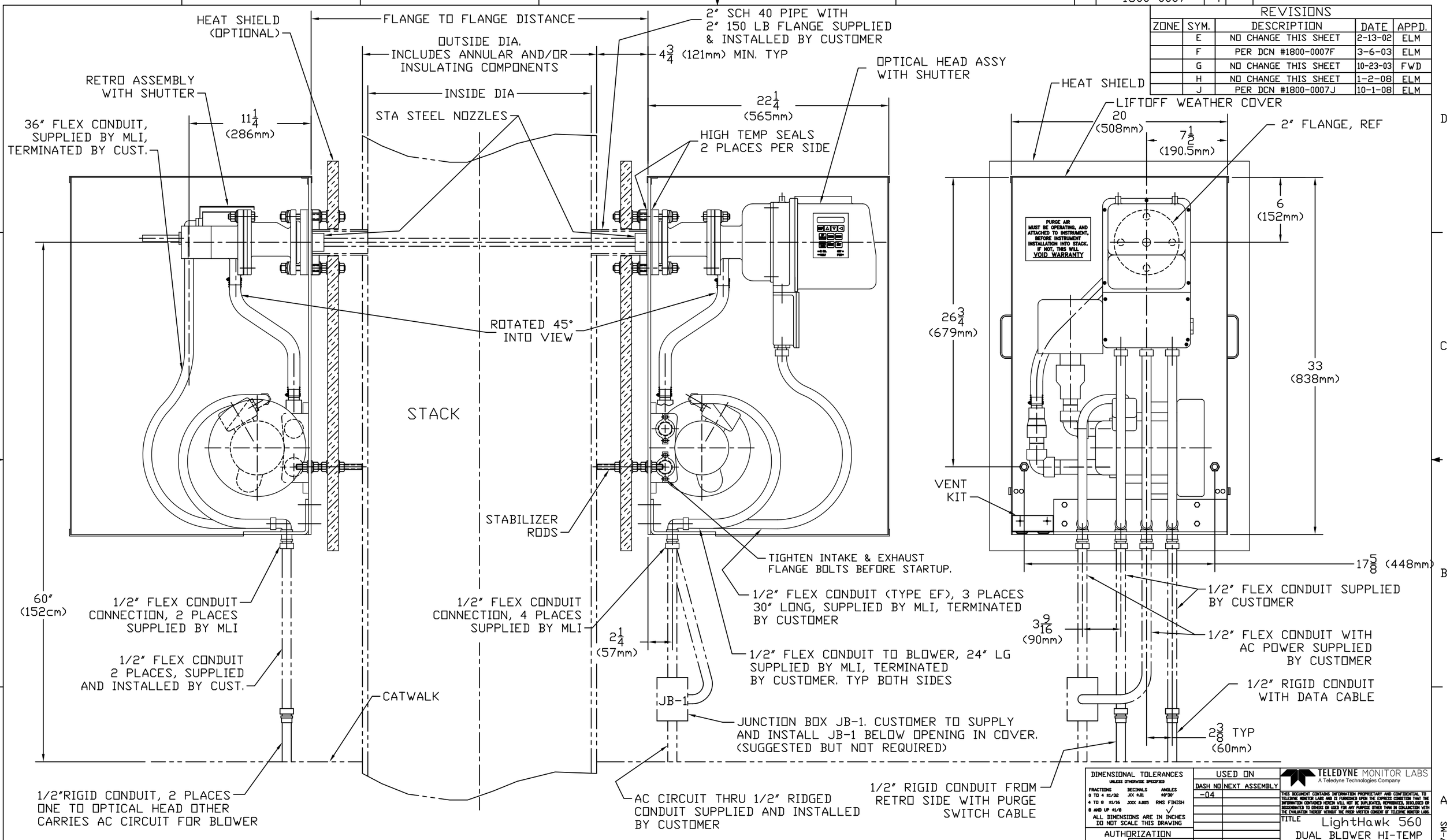
PROJECTION

D	DRAWING NO. 1800-0007	LATEST REVISION J

ACAD FILE 18000007-MS
10-1-08

DWG. NO 1800-0007 SH 4

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



DIMENSIONS IN () ARE METRIC

PROJECTION

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	.XX ±.01	±0°30'	
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH	
8 AND UP ±1/8		✓	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	8-24-99
CHECKED	EAS	5-00
DESIGNED	EAS	AUG-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

USED ON	
DASH NO	NEXT ASSEMBLY
-04	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LightHawk 560
DUAL BLOWER HI-TEMP
SYSTEM INSTALLATION

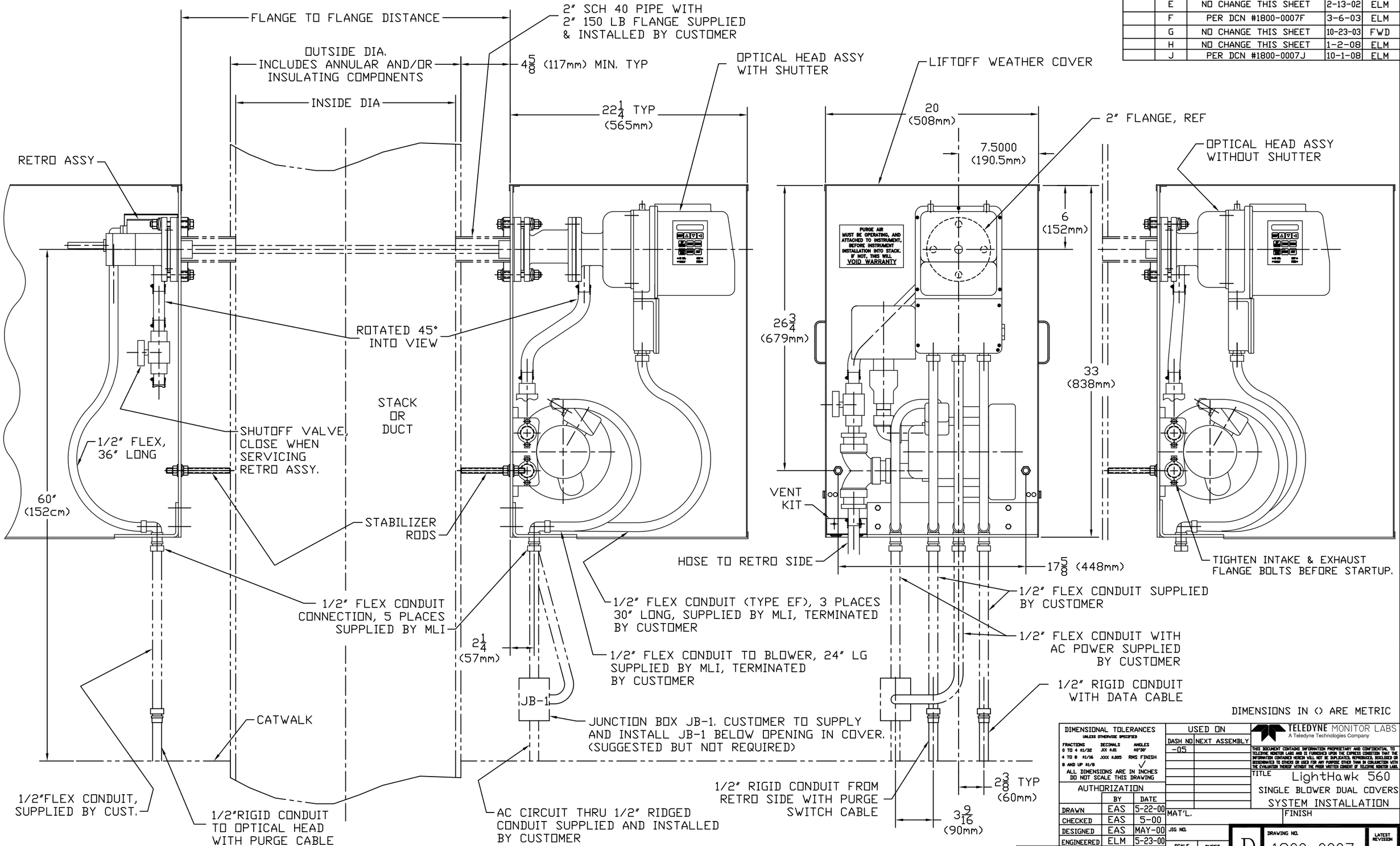
MAT'L.
FINISH
JIG NO.
SCALE 1/4
SHEET 4 OF 7

DRAWING NO.	LATEST REVISION
D 1800-0007	J

ACAD FILE 18000007-MS
10-1-08

DWG. NO 1800-0007 SH 5

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APP'D.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	EAS	5-22-00
CHECKED	EAS	5-00
DESIGNED	EAS	MAY-00
ENGINEERED	ELM	5-23-00
PRODUCTION	MAR	5/23/00
Q.A.	AS	5-23-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-05	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE LightHawk 560
SINGLE BLOWER DUAL COVERS
SYSTEM INSTALLATION

MAT'L. FINISH
JIG NO.
SCALE 1/4 SHEET 5 OF 7

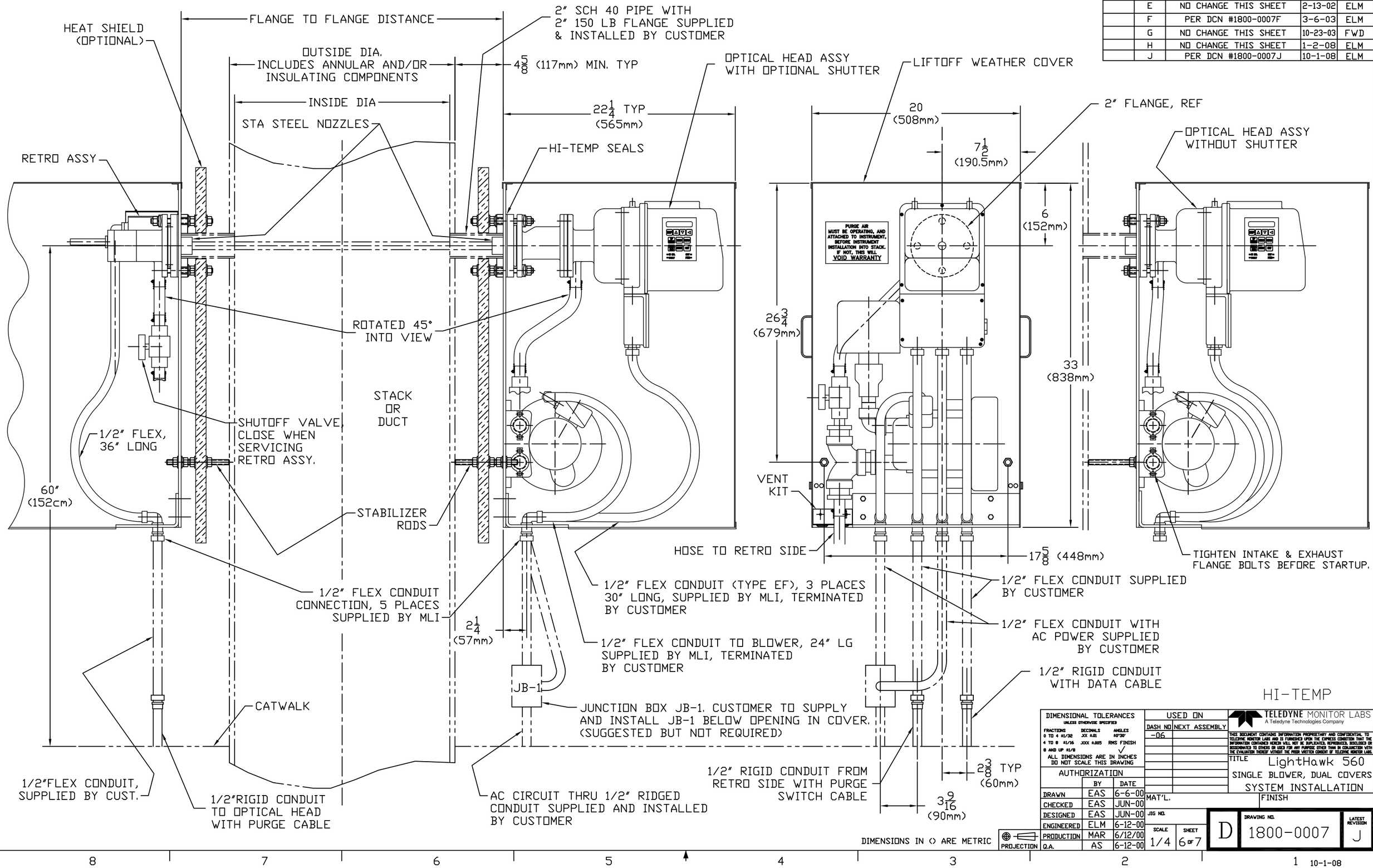
D | DRAWING NO. 1800-0007 | LATEST REVISION J

10-1-08

ACAD FILE 18000007-MS

DWG. NO 1800-0007 SH 6

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



DIMENSIONS IN () ARE METRIC

PROJECTION

HI-TEMP

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	XX ±.01	±0°30'
4 TO 8 ±1/16	XXX ±.005	RMS FINISH
8 AND UP ±1/8		✓

ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	6-6-00
CHECKED	EAS	JUN-00
DESIGNED	EAS	JUN-00
ENGINEERED	ELM	6-12-00
PRODUCTION	MAR	6/12/00
Q.A.	AS	6-12-00

USED ON	
DASH NO	NEXT ASSEMBLY
-06	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LightHawk 560
SINGLE BLOWER, DUAL COVERS
SYSTEM INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE 1/4 | SHEET 6 OF 7

DRAWING NO. 1800-0007

LATEST REVISION J

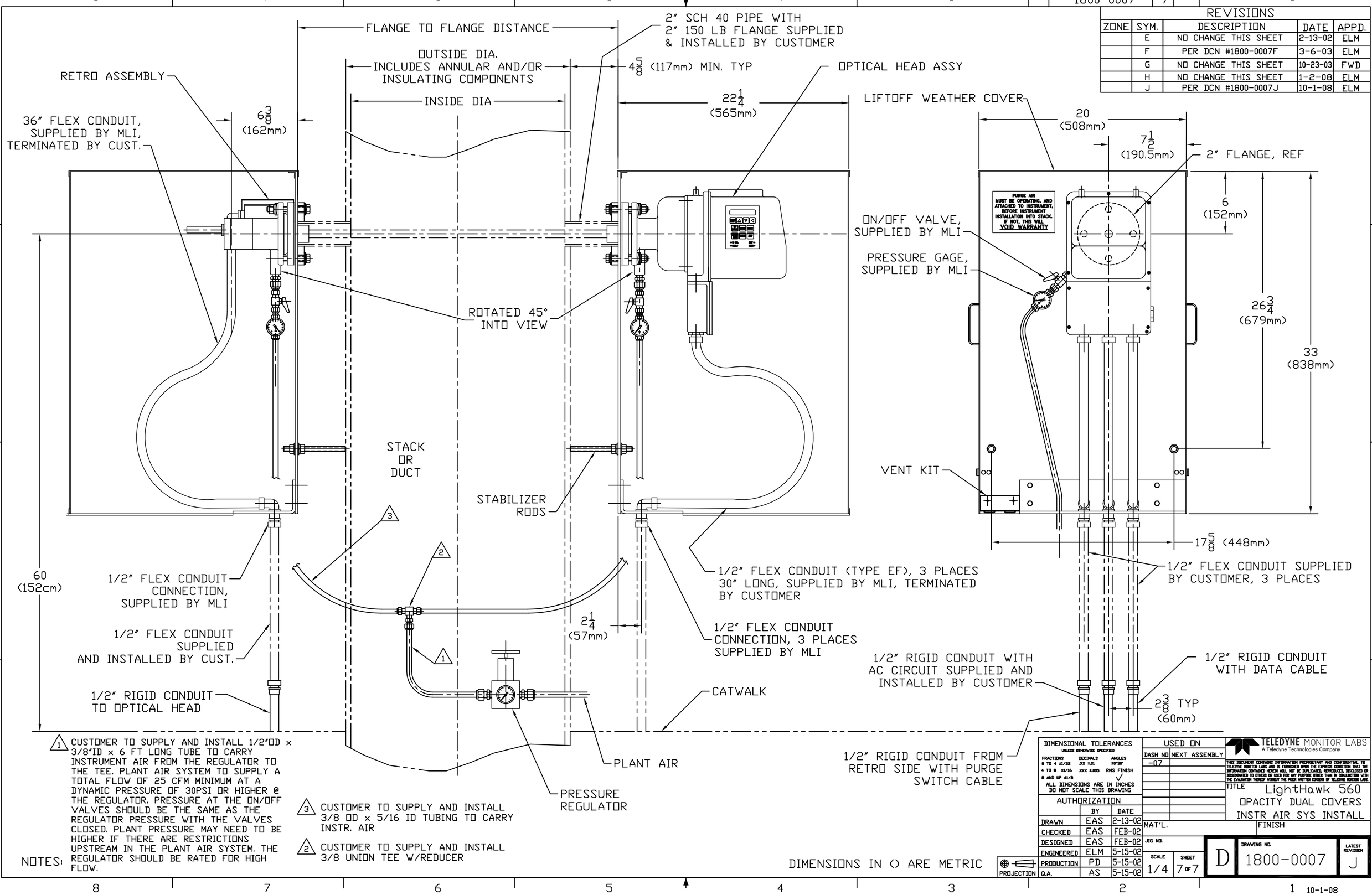
D

10-1-08

ACAD FILE 18000007-MS

DWG. NO 1800-0007 SH 7

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO CHANGE THIS SHEET	1-2-08	ELM
	J	PER DCN #1800-0007J	10-1-08	ELM



1. CUSTOMER TO SUPPLY AND INSTALL 1/2"OD x 3/8"ID x 6 FT LONG TUBE TO CARRY INSTRUMENT AIR FROM THE REGULATOR TO THE TEE. PLANT AIR SYSTEM TO SUPPLY A TOTAL FLOW OF 25 CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER @ THE REGULATOR. PRESSURE AT THE ON/OFF VALVES SHOULD BE THE SAME AS THE REGULATOR PRESSURE WITH THE VALVES CLOSED. PLANT PRESSURE MAY NEED TO BE HIGHER IF THERE ARE RESTRICTIONS UPSTREAM IN THE PLANT AIR SYSTEM. THE REGULATOR SHOULD BE RATED FOR HIGH FLOW.

3. CUSTOMER TO SUPPLY AND INSTALL 3/8 OD x 5/16 ID TUBING TO CARRY INSTR. AIR

2. CUSTOMER TO SUPPLY AND INSTALL 3/8 UNION TEE W/REDUCER

NOTES:

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	EAS	2-13-02
CHECKED	EAS	FEB-02
DESIGNED	EAS	FEB-02
ENGINEERED	ELM	5-15-02
PRODUCTION	PD	5-15-02
Q.A.	AS	5-15-02

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-07	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE LightHawk 560
OPACITY DUAL COVERS
INSTR AIR SYS INSTALL

MAT'L. FINISH

JIG NO.

SCALE 1/4 SHEET 7 OF 7

DRAWING NO. 1800-0007

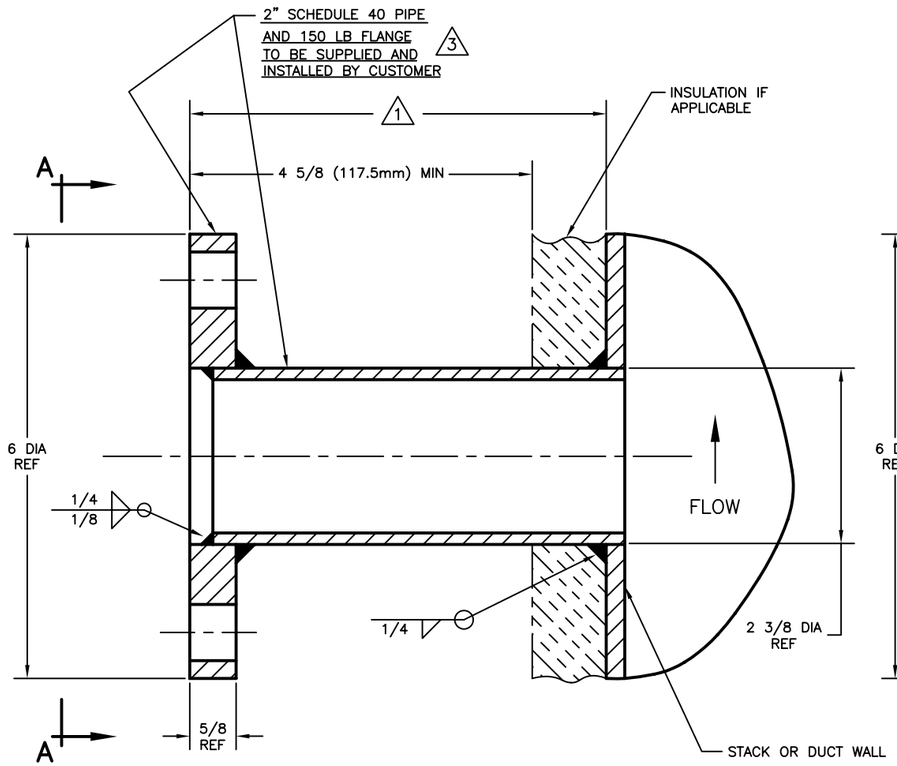
LATEST REVISION J

D

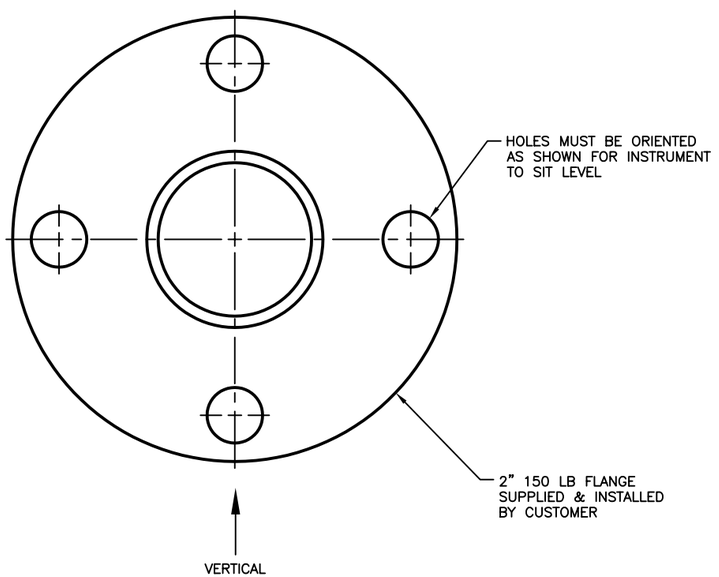
10-1-08

ACAD FILE 18000007-MS

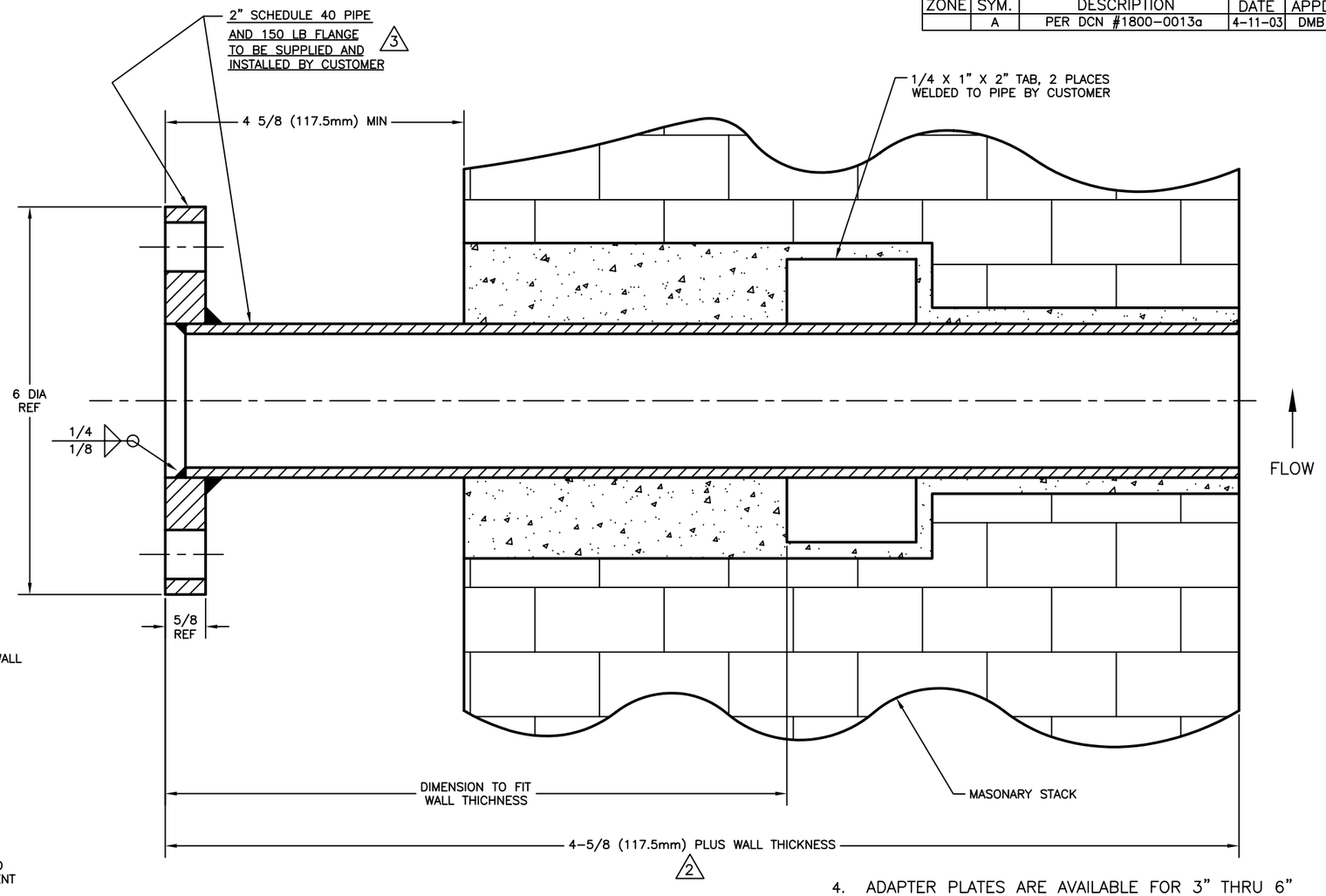
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800–0013a	4–11–03	DMB



MAX. ANGULAR MISALIGNMENT PORT TO PORT
FOR PORT LENGTH OF 4–5/8" IS 5°
FOR PORT LENGTH OF 12" IS 2.5°



VIEW "A–A"



MAX. ANGULAR MISALIGNMENT PORT TO PORT
FOR PORT LENGTH OF 18" IS 1.7°

4. ADAPTER PLATES ARE AVAILABLE FOR 3" THRU 6" PIPE WITH 150# FLANGES.

3. PIPE SIZES ARE AMERICAN STANDARD.

2. SEE SHEET 2 IF THIS DISTANCE EXCEEDS 18" (457mm).

1. SEE SHEET 2 IF THIS DISTANCE EXCEEDS 12" (305mm).

NOTES:

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	9–30–99
CHECKED	EAS	5–00
DESIGNED	EAS	Sept–99
ENGINEERED	ELM	5–16–00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5–16–00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
–01	1860–0000

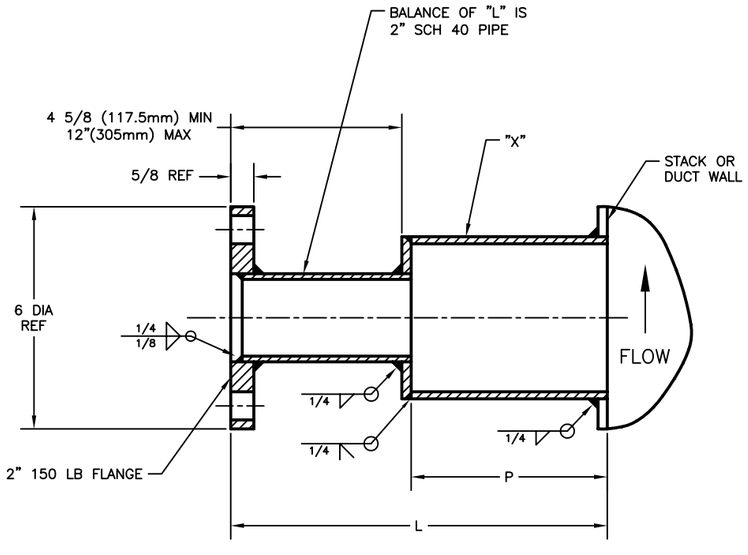
TITLE LightHawk 560
OPACITY MONITOR
FLANGE MTG. METHODS

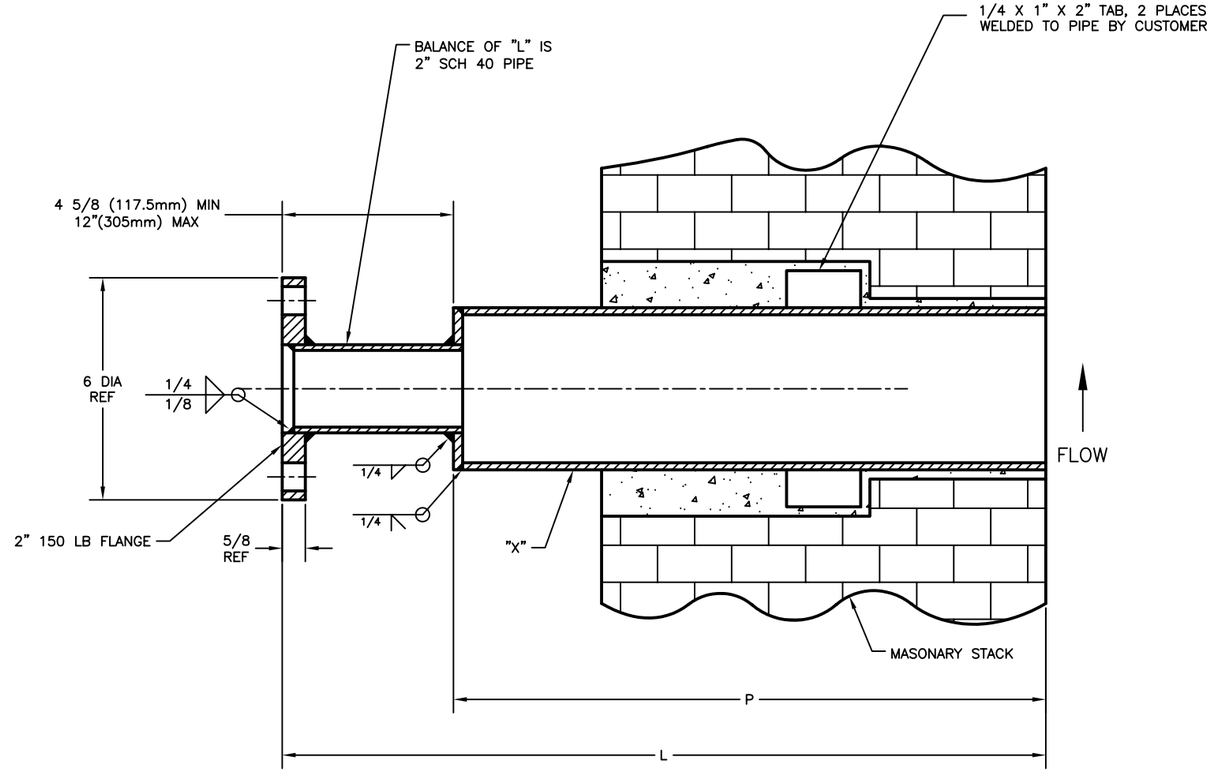
MAT'L.
FINISH
JIG NO.
SCALE 1:1
SHEET 1 OF 2
DRAWING NO. 1800–0013
LATEST REVISION A
D

4–11–03

ACAD2002 FILE: 18000013

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	NO CHANGE THIS SHEET	4-11-03	DMB





△3

L	P	L (METRIC)	P (METRIC)	SIZE OF "X"	MAX. ANGULAR MISALIGNMENT PORT TO PORT
13"–19"	7"	320.2mm–482.6mm	177.8mm	3"SCH. 40	2.50°
20"–26"	14"	508.0mm–660.4mm	335.6mm	3"SCH. 40	2.17°
27"–33"	21"	685.8mm–838.2mm	533.4mm	4"SCH 40	2.50°
34"–40"	28"	86.36cm–101.60cm	711.2mm	4"SCH. 40	2.12°
41"–47"	35"	104.14cm–119.38cm	889.0mm	5"SCH. 40	2.40°
48"–54"	42"	121.92cm–137.16cm	106.68cm	5"SCH 40	2.12°
55"–61"	49"	139.70cm–154.94cm	124.46cm	6"SCH. 40	2.34°
62"–68"	56"	157.48cm–172.72cm	142.24cm	6"SCH. 40	2.06°
69"–75"	63"	175.26cm–190.50cm	160.02cm	8"SCH 40	2.50°
76"–82"	70"	193.04cm–208.28cm	177.80cm	8"SCH 40	2.46°
83"–89"	77"	210.82cm–226.06cm	195.58cm	8"SCH 40	2.23°
90"–96"	84"	228.60cm–243.84cm	213.36cm	8"SCH 40	2.06°
97"–103"	91"	246.38cm–261.62cm	231.14cm	10"SCH 40	2.50°
104"–109"	97"	264.16cm–276.86cm	246.38cm	10"SCH 40	2.35°
110"–116"	104"	279.40cm–294.64cm	264.16cm	10"SCH 40	2.23°

THIS CHART IS SUGGESTED PIPE SIZES FOR PORTS OVER 12" IN LENGTH.
THIS WILL ALLOW A REASONABLE PORT TO PORT MISALIGNMENT.
IF TIGHTER TOLERANCES CAN BE MET, PIPE SIZES CAN BE DECREASED.
CONSULT FACTORY IF ASSISTANCE IS NEEDED

SEE SHEET 1 FOR NOTES

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	9-30-99
CHECKED	EAS	5-00
DESIGNED	EAS	Sept-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-01	1860-0000

TELEDYNE INSTRUMENTS
MONITOR LABS

TITLE LightHawk 560
OPACITY MONITOR
FLANGE MTG. METHODS

MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 2 OF 2

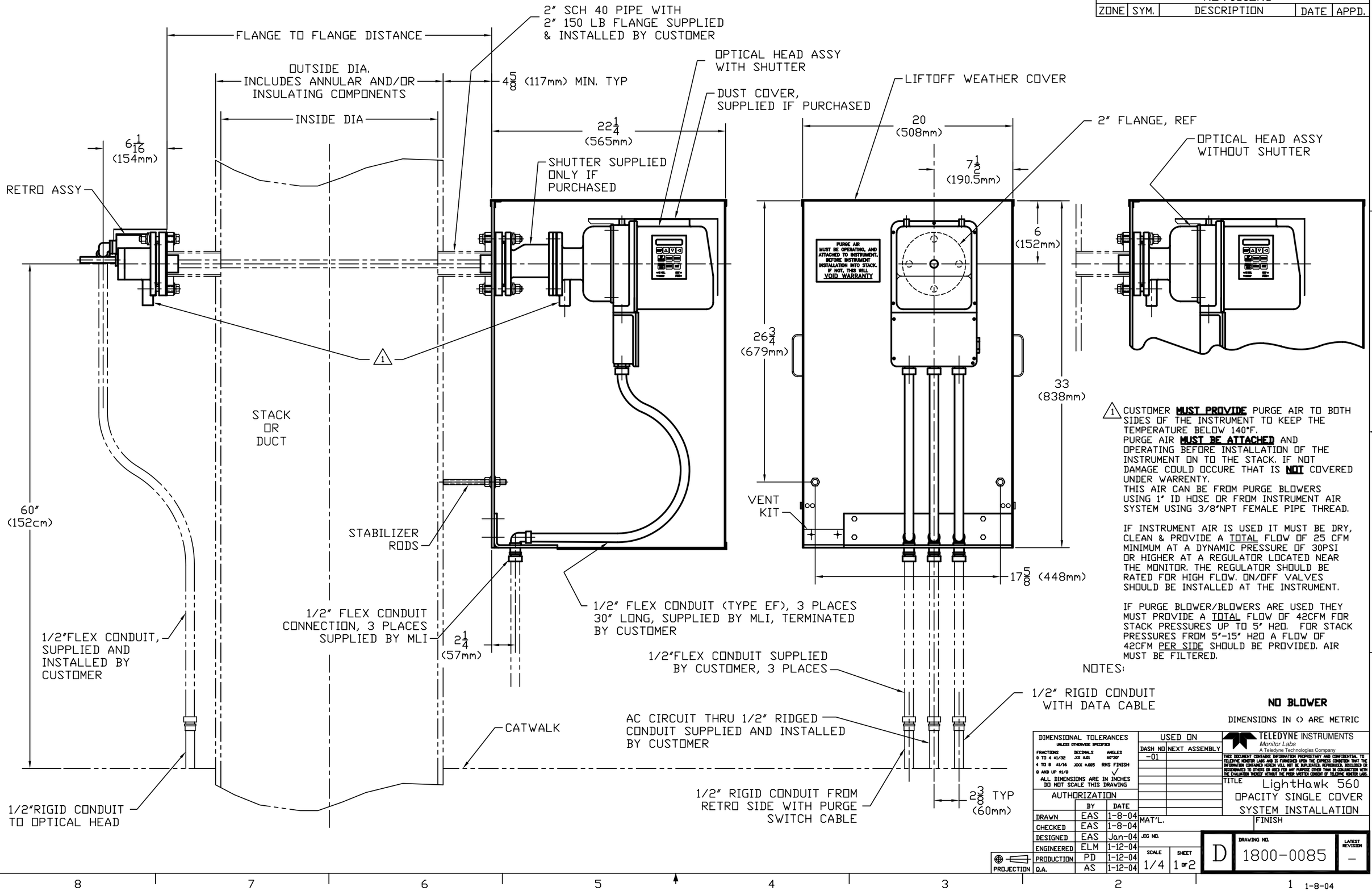
DRAWING NO. 1800-0013
LATEST REVISION A
D

4-11-03

ACAD2002 FILE 18000013-S2 A

DWG. NO 1800-0085 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.



1 CUSTOMER **MUST PROVIDE** PURGE AIR TO BOTH SIDES OF THE INSTRUMENT TO KEEP THE TEMPERATURE BELOW 140°F.
PURGE AIR **MUST BE ATTACHED** AND OPERATING BEFORE INSTALLATION OF THE INSTRUMENT ON TO THE STACK. IF NOT DAMAGE COULD OCCURE THAT IS **NOT** COVERED UNDER WARRENTY.
THIS AIR CAN BE FROM PURGE BLOWERS USING 1" ID HOSE OR FROM INSTRUMENT AIR SYSTEM USING 3/8"NPT FEMALE PIPE THREAD.

IF INSTRUMENT AIR IS USED IT MUST BE DRY, CLEAN & PROVIDE A TOTAL FLOW OF 25 CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER AT A REGULATOR LOCATED NEAR THE MONITOR. THE REGULATOR SHOULD BE RATED FOR HIGH FLOW. ON/OFF VALVES SHOULD BE INSTALLED AT THE INSTRUMENT.

IF PURGE BLOWER/BLOWERS ARE USED THEY MUST PROVIDE A TOTAL FLOW OF 42CFM FOR STACK PRESSURES UP TO 5" H20. FOR STACK PRESSURES FROM 5"-15" H20 A FLOW OF 42CFM PER SIDE SHOULD BE PROVIDED. AIR MUST BE FILTERED.

NOTES:

NO BLOWER

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	1-8-04
CHECKED	EAS	1-8-04
DESIGNED	EAS	Jan-04
ENGINEERED	ELM	1-12-04
PRODUCTION	PD	1-12-04
Q.A.	AS	1-12-04

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE
LightHawk 560
OPACITY SINGLE COVER
SYSTEM INSTALLATION

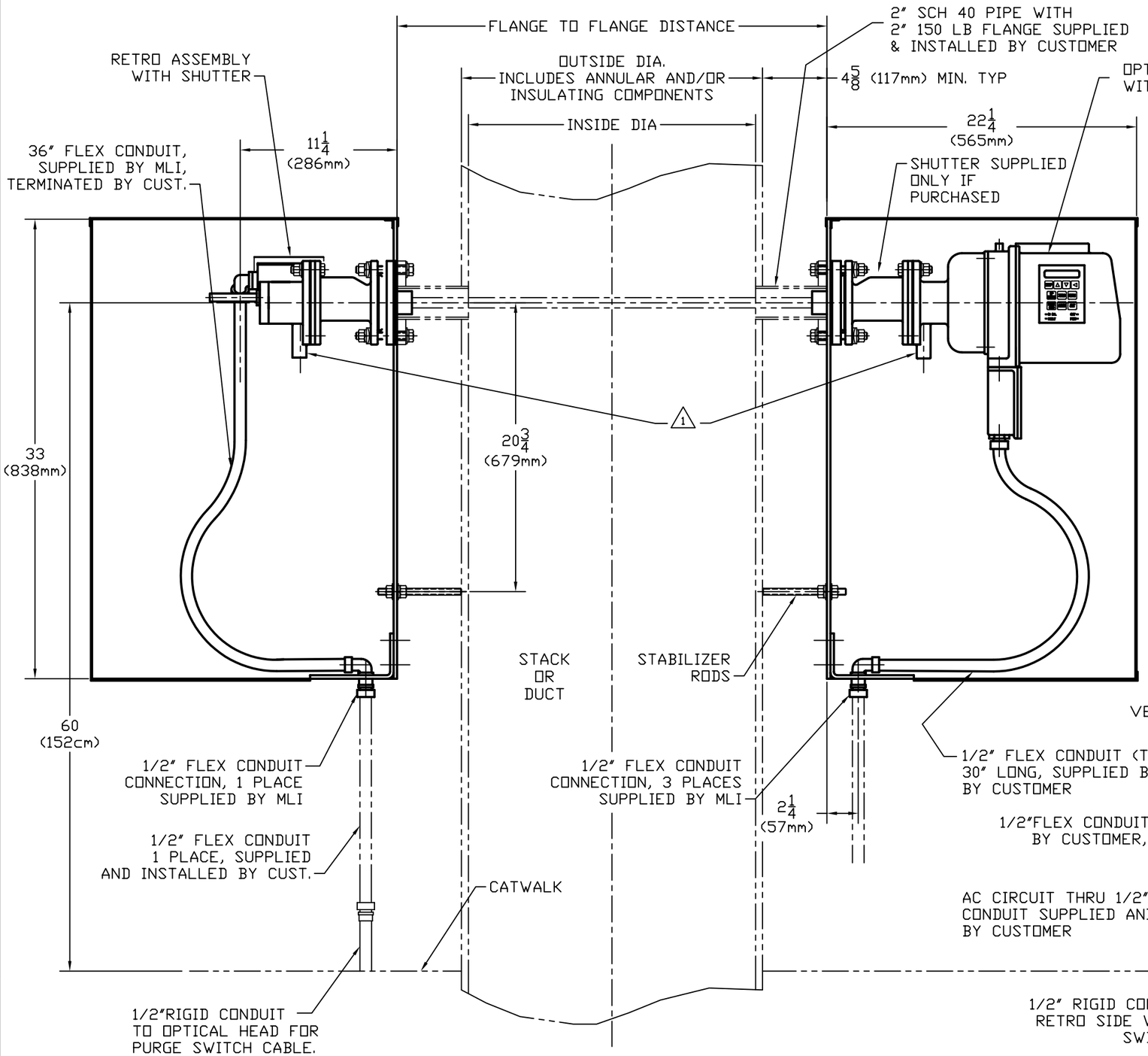
MAT'L.
FINISH
JIG NO.
SCALE 1/4
SHEET 1 of 2
D
DRAWING NO. 1800-0085
LATEST REVISION –

1-8-04

ACAD2002 FILE 18000085

DVG. NO 1800-0085 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.



1 CUSTOMER **MUST PROVIDE** PURGE AIR TO BOTH SIDES OF THE INSTRUMENT TO KEEP THE TEMPERATURE BELOW 140°F.
PURGE AIR **MUST BE ATTACHED** AND OPERATING BEFORE INSTALLATION OF THE INSTRUMENT ON TO THE STACK. IF NOT DAMAGE COULD OCCURE THAT IS **NOT** COVERED UNDER WARRENTY.
THIS AIR CAN BE FROM PURGE BLOWERS USING 1" ID HOSE OR FROM INSTRUMENT AIR SYSTEM USING 3/8"NPT FEMALE PIPE THREAD.

IF INSTRUMENT AIR IS USED IT MUST BE DRY, CLEAN & PROVIDE A TOTAL FLOW OF 25 CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER AT A REGULATOR LOCATED NEAR THE MONITOR. THE REGULATOR SHOULD BE RATED FOR HIGH FLOW. ON/OFF VALVES SHOULD BE INSTALLED AT THE INSTRUMENT.

IF PURGE BLOWER/BLOWERS ARE USED THEY MUST PROVIDE A TOTAL FLOW OF 42CFM FOR STACK PRESSURES UP TO 5" H20. FOR STACK PRESSURES FROM 5"-15" H20 A FLOW OF 42CFM PER SIDE SHOULD BE PROVIDED. AIR MUST BE FILTERED.

NOTES:

NO BLOWERS

DINENSIONS IN () ARE METRIC

PROJECTION

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	XX ±.02	±0°30'	
4 TO 8 ±1/16	XXX ±.005	RMS FINISH	✓
8 AND UP ±1/8			
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	1-8-04
CHECKED	EAS	1-8-04
DESIGNED	EAS	Jan-04
ENGINEERED	ELM	1-12-04
PRODUCTION	PD	1-12-04
Q.A.	AS	1-12-04

USED ON	
DASH NO	NEXT ASSEMBLY
-02	

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE
LightHawk 560
OPACITY DUAL COVERS
SYSTEM INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE	SHEET
1/4	2 OF 2

D

DRAWING NO. 1800-0085

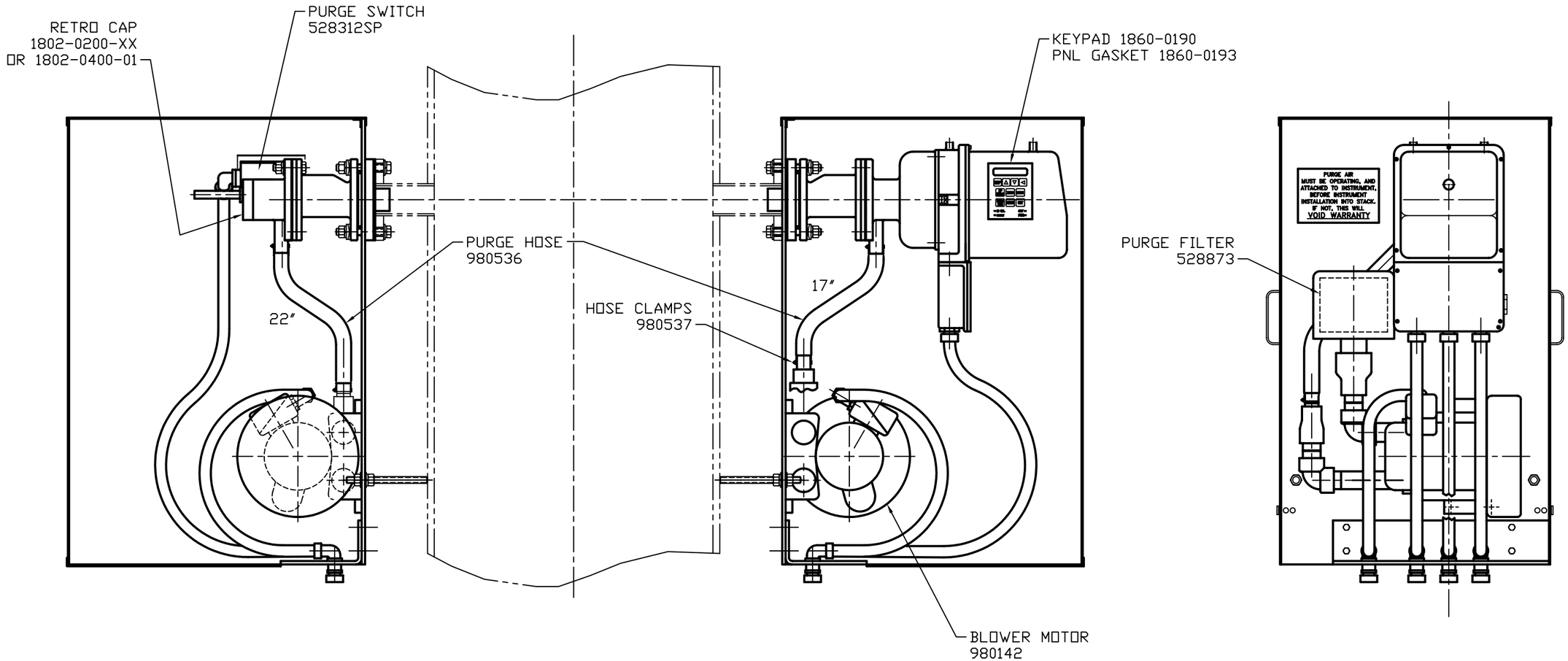
LATEST REVISION –

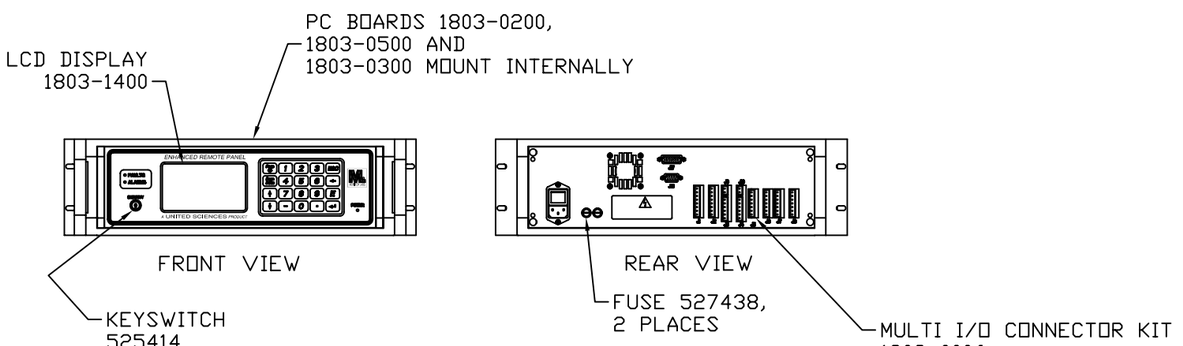
1-8-04

ACAD2002 FILE 18000085-S2

DVG. NO 1800-0090 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0090A	5-28-02	ELM





ENHANCED REMOTE PANEL

SEE SHEET 2 FOR INTERNAL OPTICAL HEAD SPARE PARTS

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30′
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	4-24-00
CHECKED	EAS	Jun-00
DESIGNED	EAS	Apr-00
ENGINEERED	ELM	7-11-00
PRODUCTION	MAR	7/11/00
Q.A.	AS	7-17-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE 560 LightHawk SPARE PARTS LOCATION DRAWING

MAT'L. | FINISH | JIG NO.

SCALE 1/4 | SHEET 1 of 2

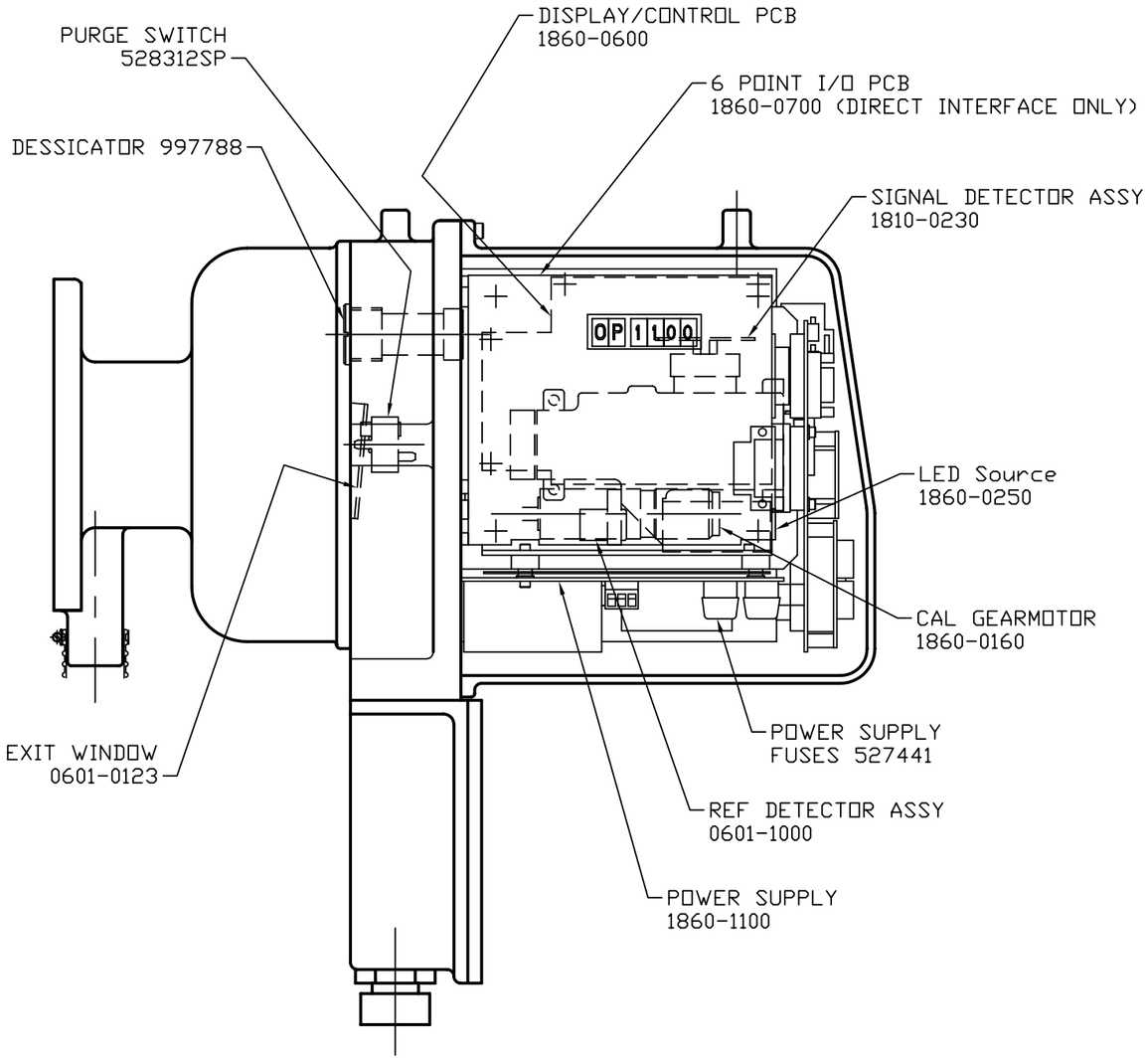
D | DRAWING NO. 1800-0090 | LATEST REVISION A

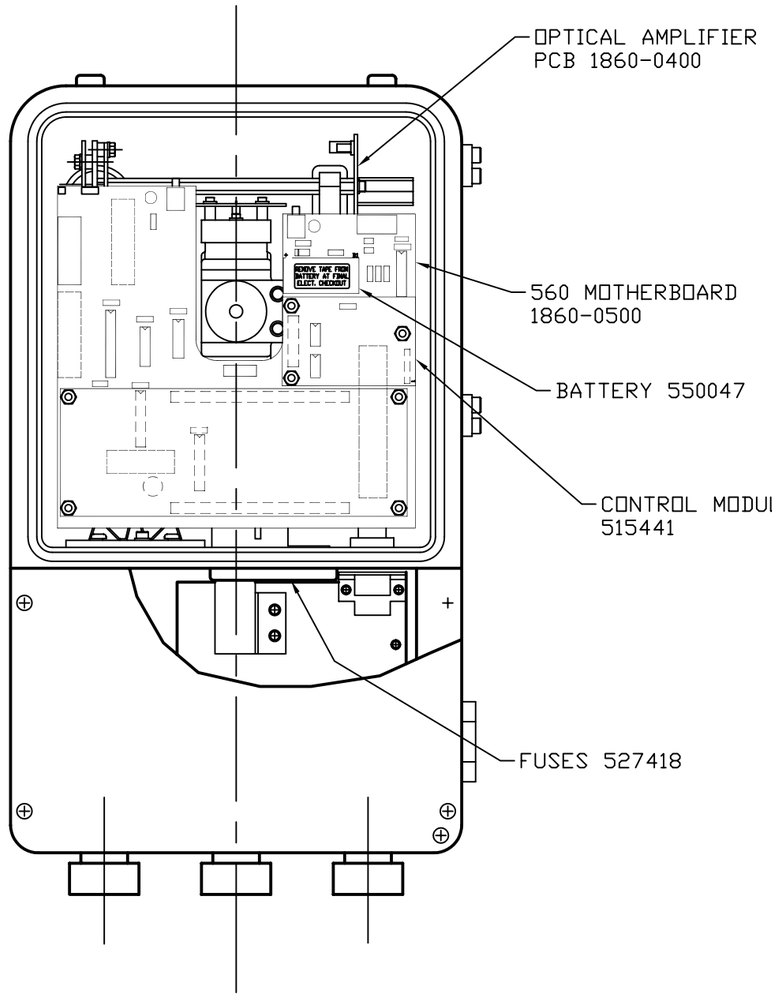
5-28-02

ACAD2002 FILE 18000090

DWG. NO 1800-0090 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0090A	5-28-02	ELM





DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS DECIMALS ANGLES
0 TO 4 ±1/32 XX ±.01 ±0°30'
4 TO 8 ±1/16 XXX ±.005 RMS FINISH
8 AND UP ±1/8 ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	4-24-00
CHECKED	EAS	Jun-00
DESIGNED	EAS	Apr-00
ENGINEERED	ELM	7-11-00
PRODUCTION	MAR	7/11/00
Q.A.	AS	7-17-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE 560 LightHawk OPTICAL HEAD SPARE PARTS LOCATION DRAWING

MAT'L. FINISH

JIG NO.

SCALE 3/4 SHEET 2 OF 2

DRAWING NO. 1800-0090

LATEST REVISION A

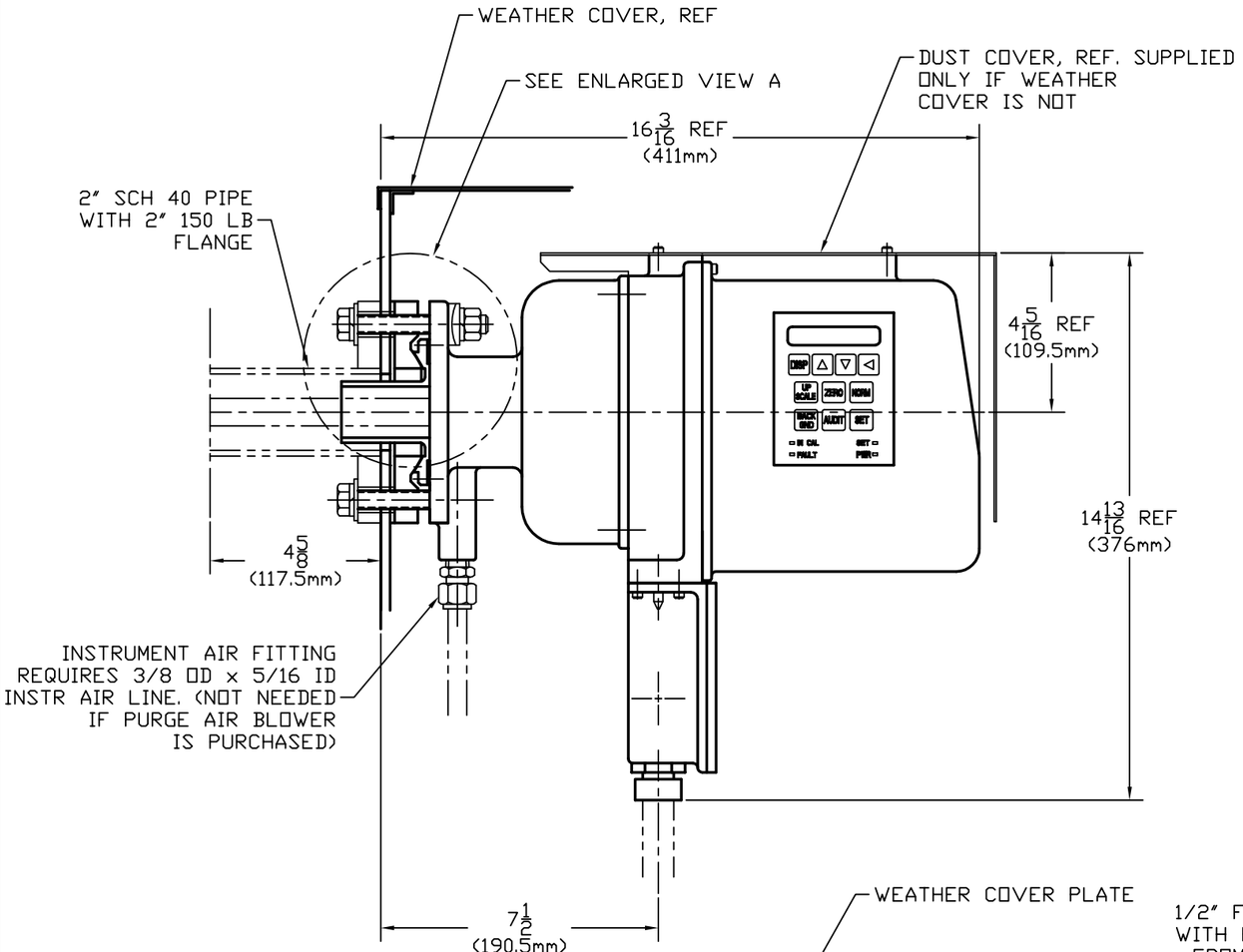
D

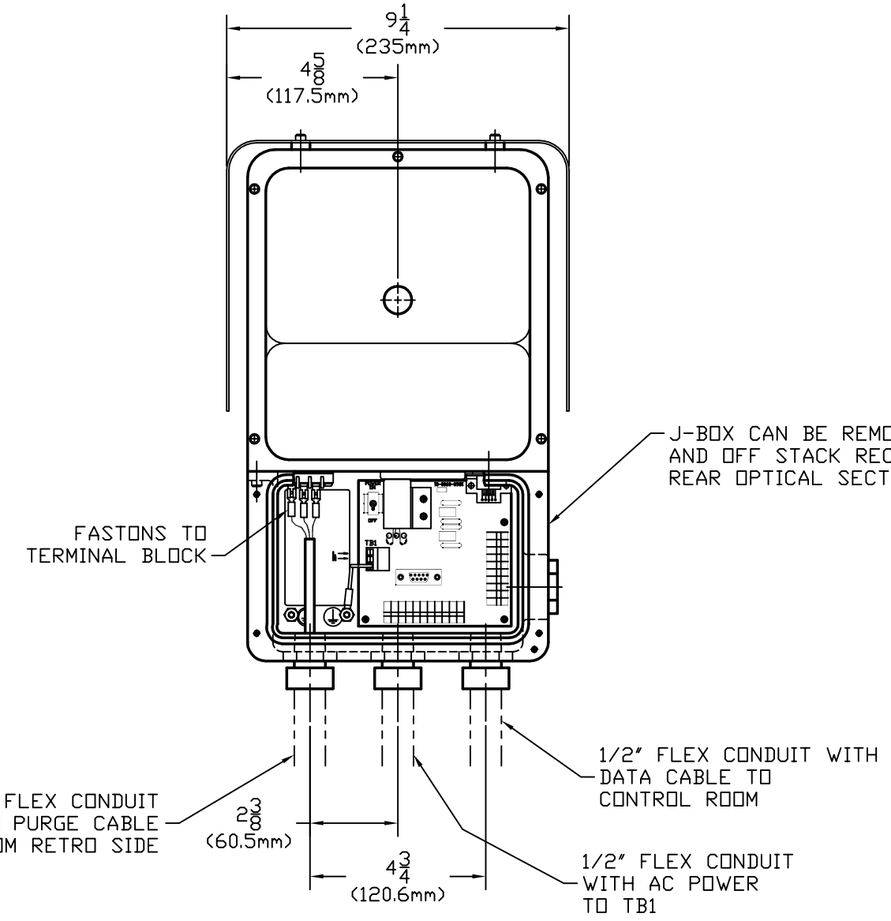
5-28-02

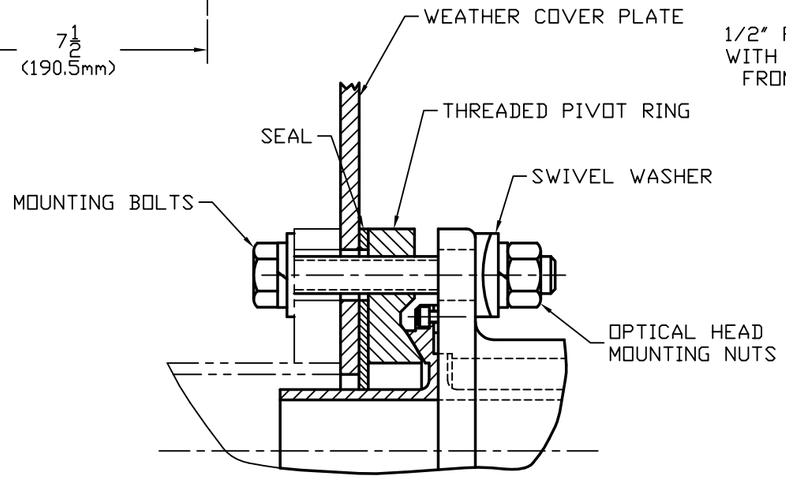
ACAD2002 FILE 18000090-S2

DWG. NO 1801-0015 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1801-0015A	1-2-08	ELM
	B	NO CHANGE THIS SHEET	4-29-11	FWD







VIEW A
FULL SCALE

NO SHUTTER

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	XX ±.01	±0°30'	
4 TO 8 ±1/16	XXX ±.005	RMS FINISH	
8 AND UP ±1/8		✓	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	11-4-97
CHECKED	EAS	5-00
DESIGNED	EAS	Nov-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

USED ON	
DASH NO	NEXT ASSEMBLY

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LightHawk 560
OPTICAL HEAD INSTALL

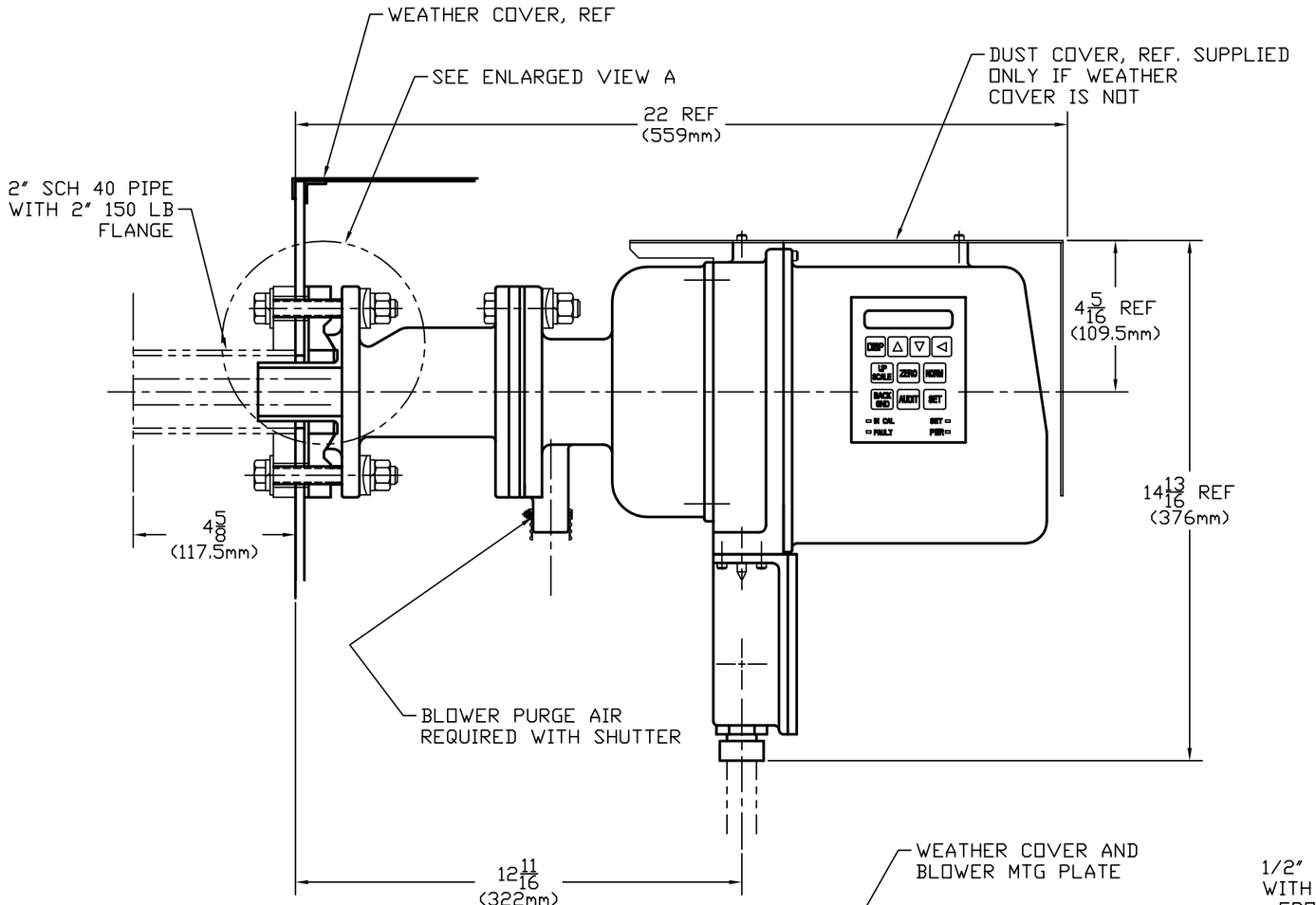
MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 1 OF 3
PROJECTION

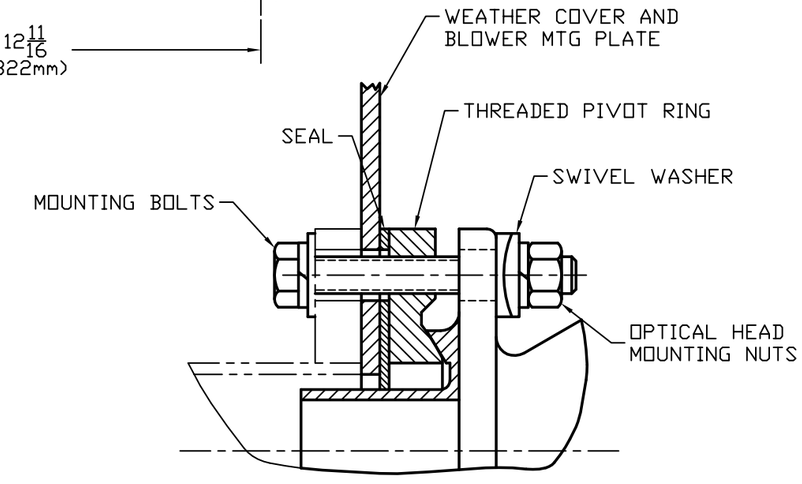
DRAWING NO.	LATEST REVISION
D 1801-0015	B

ACAD FILE 18010015

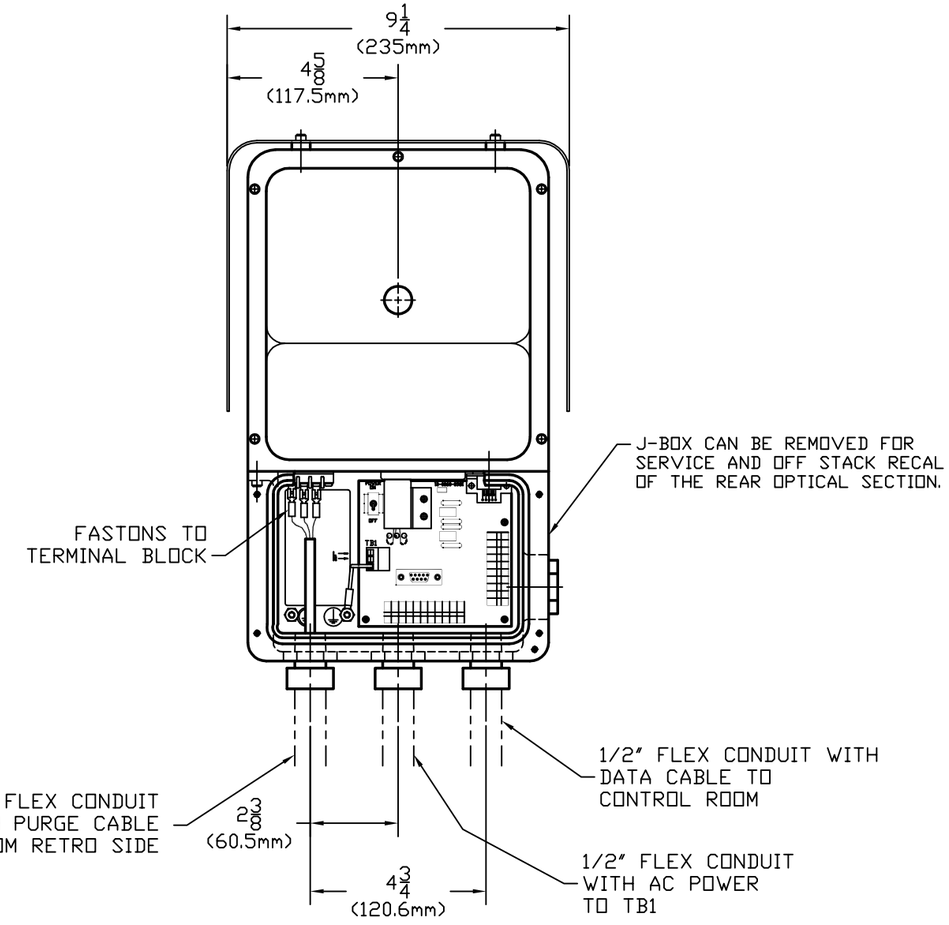
4-29-11

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1801-0015A	1-2-08	ELM
	B	PER DCN #1801-0015B	4-29-11	FWD





VIEW A
FULL SCALE



WITH SHUTTER

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS: 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS: .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	8-19-99
CHECKED	EAS	5-00
DESIGNED	EAS	Aug-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE
LightHawk 560
OPTICAL HEAD INSTALL

MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 2 OF 3

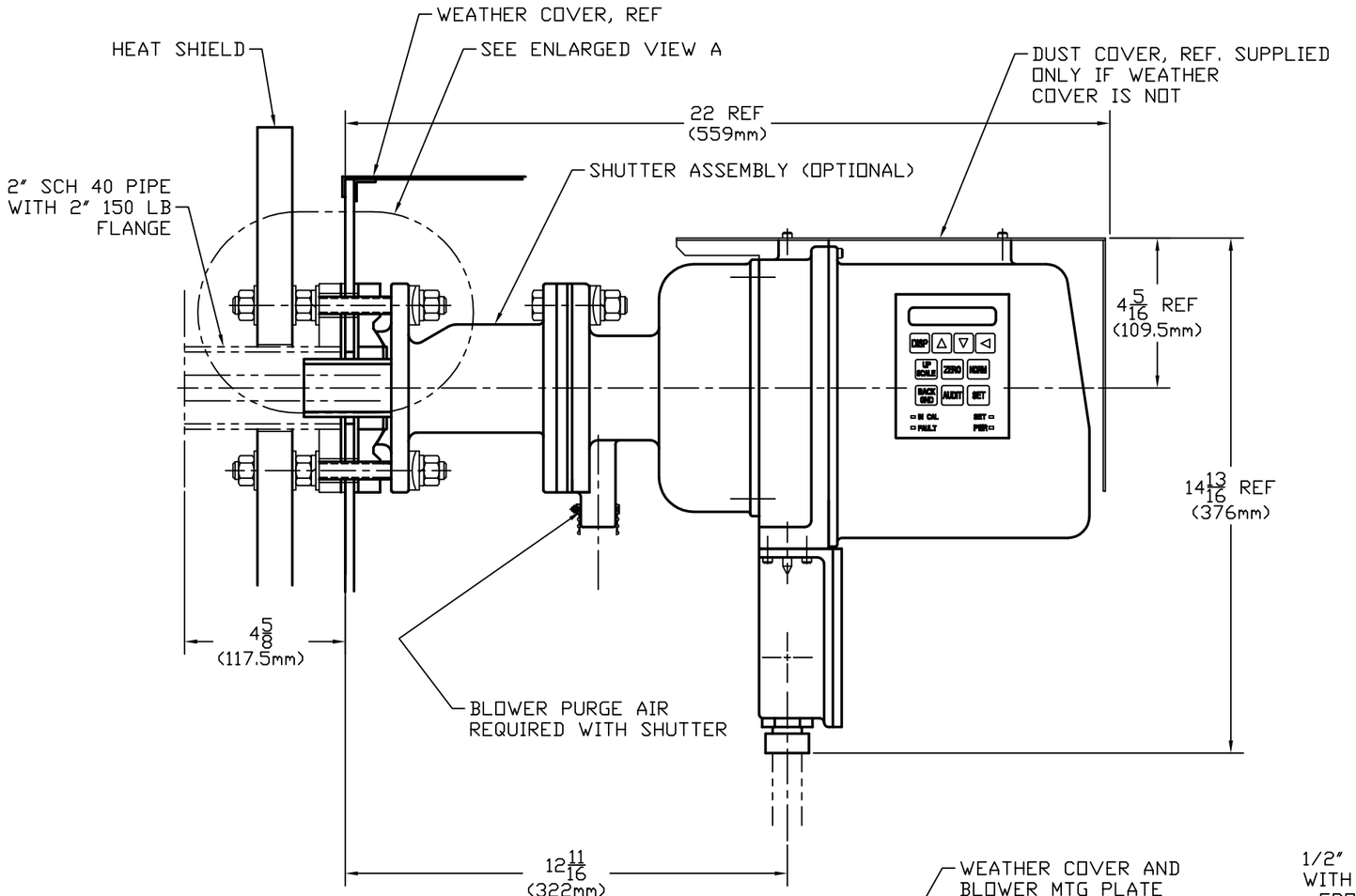
DRAWING NO.	LATEST REVISION
D 1801-0015	B

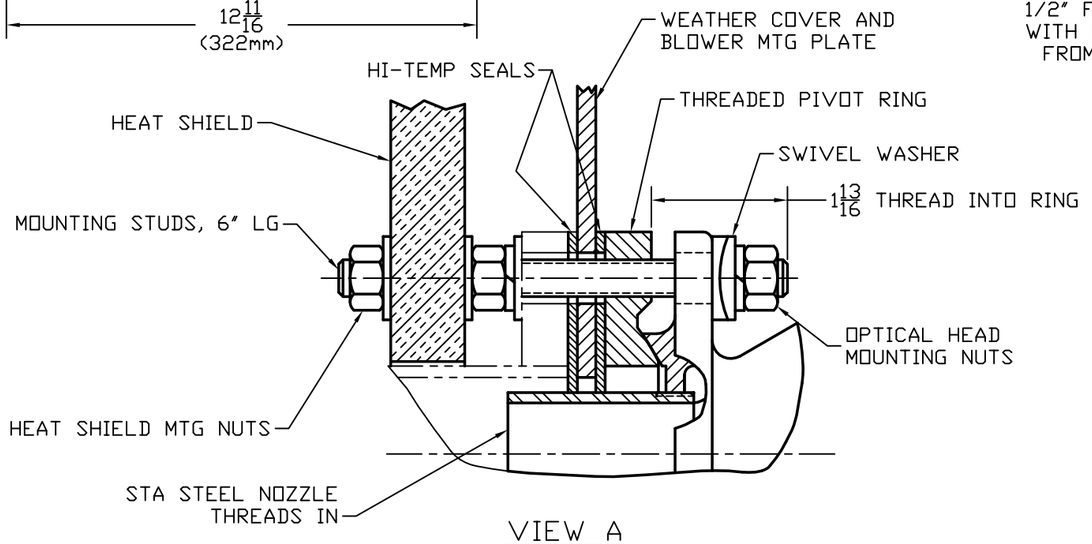
4-29-11

ACAD2002 FILE 18010015-S2

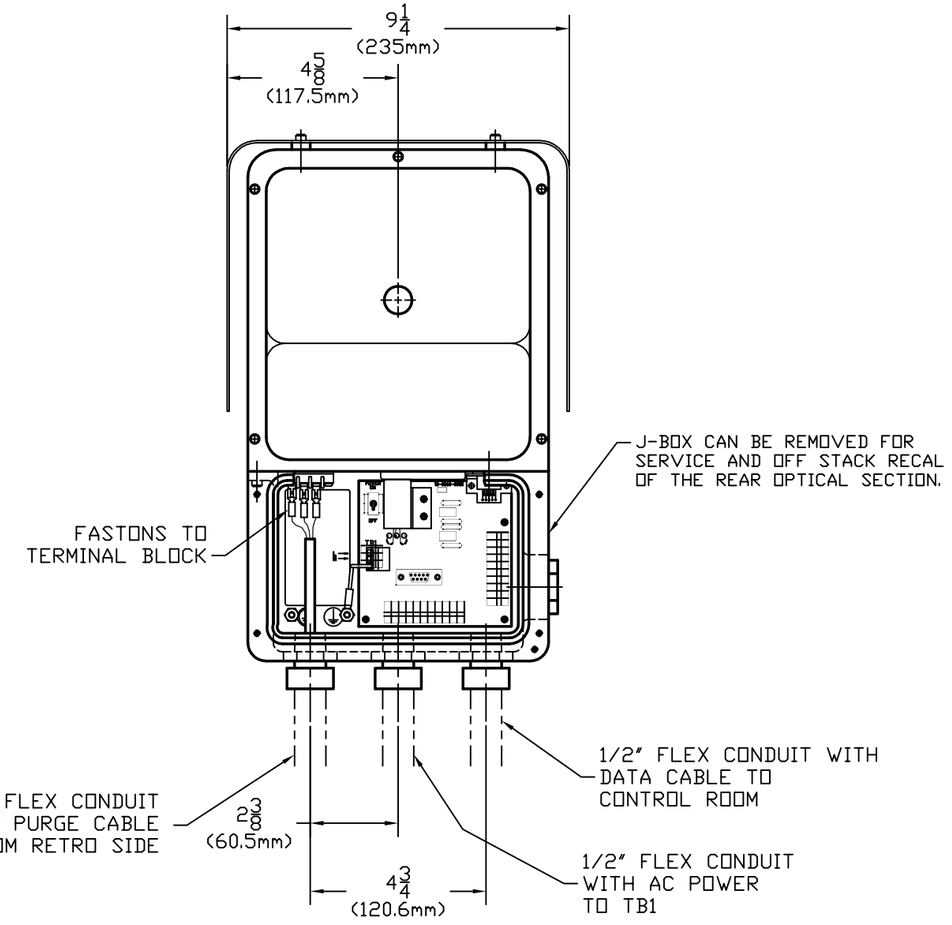
DWG. NO 1801-0015 SH 3

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1801-0015A	1-2-08	ELM
	B	PER DCN #1801-0015B	4-29-11	FWD





VIEW A
FULL SCALE



HI-TEMP

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	8-19-99
CHECKED	EAS	5-00
DESIGNED	EAS	Aug-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

USED ON

DASH NO	NEXT ASSEMBLY

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE
LightHawk 560
OPTICAL HEAD INSTALL

MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 3 OF 3
PROJECTION

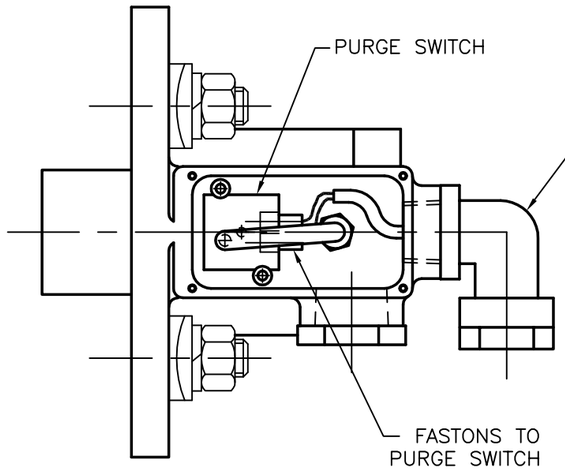
D | DRAWING NO. 1801-0015 | LATEST REVISION B

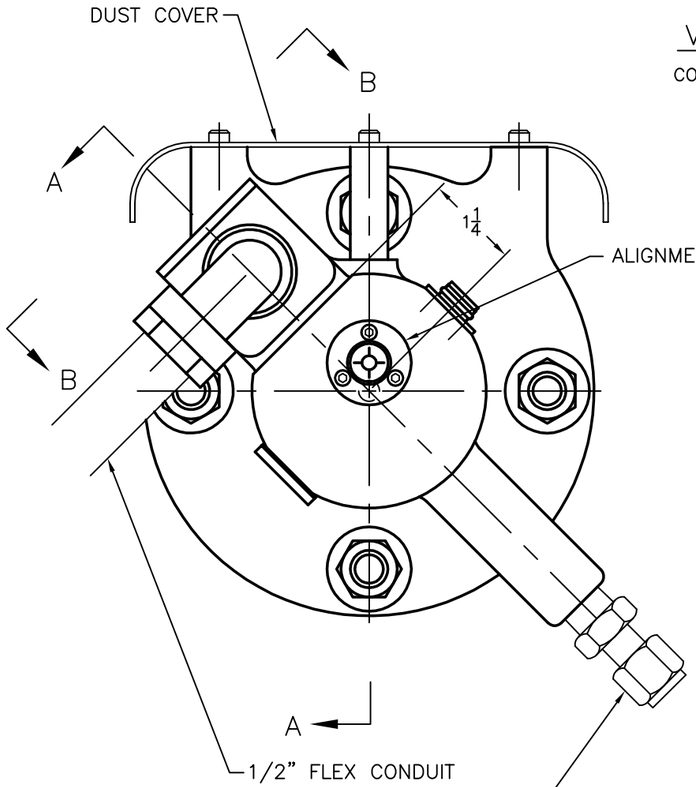
4-29-11

ACAD FILE 18010015-S3

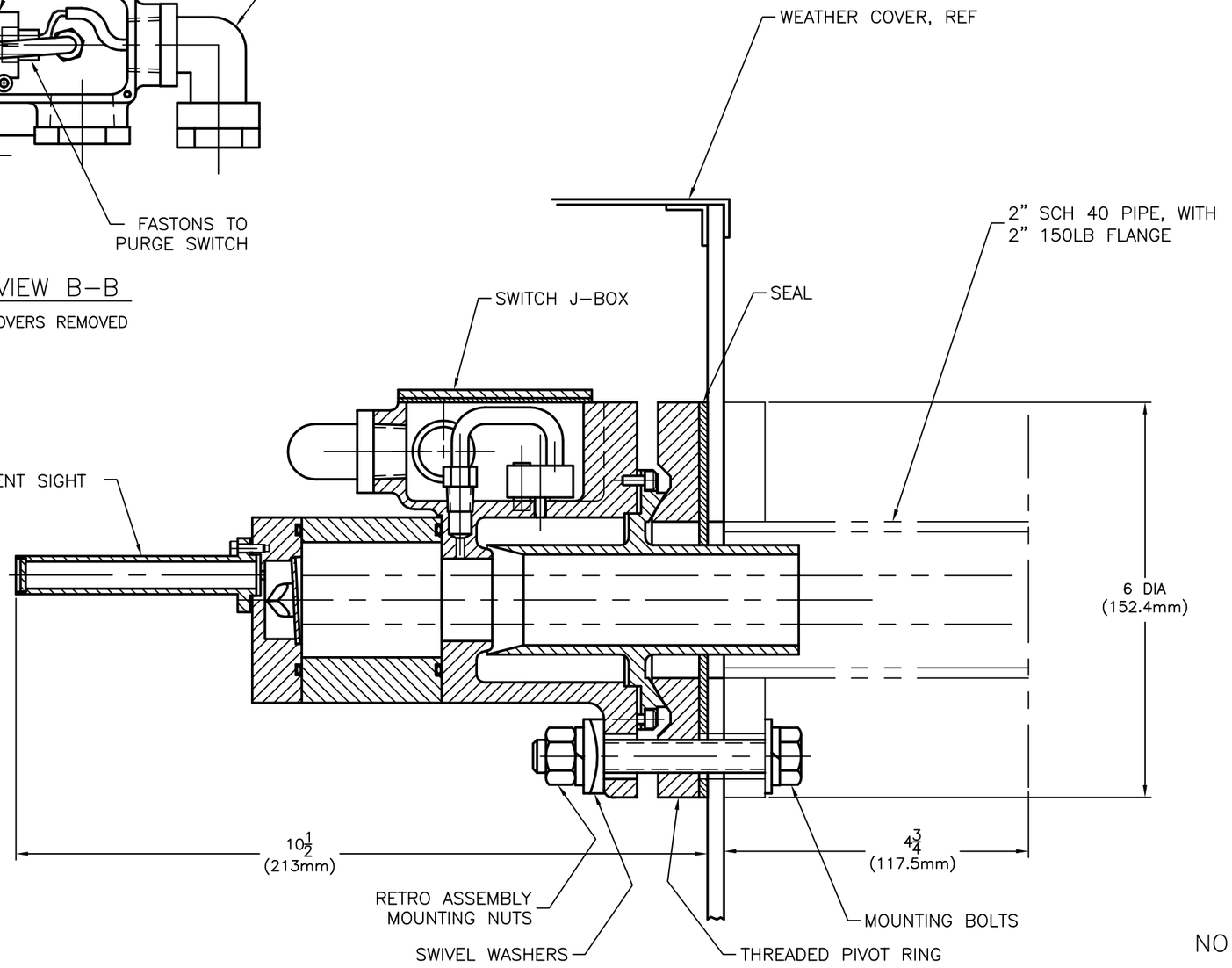
DWG. NO 1802-0015 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1802-0015A	4-14-00	ELM
	B	PER DCN #1802-0015B	1-2-08	ELM
	C	PER DCN #1802-0015C	10-01-08	ELM
	D	NO CHANGE THIS SHEET	4-28-11	FWD





VIEW B–B
COVERS REMOVED



SECTION A–A

NO SHUTTER

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	.XX ±.01	±0°30'	
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH	
8 AND UP ±1/8		√	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	11-4-97
CHECKED	EAS	5-00
DESIGNED	EAS	NOV-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LIGHTHAWK 560
RETRO INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE 1:1 | SHEET 1 OF 3

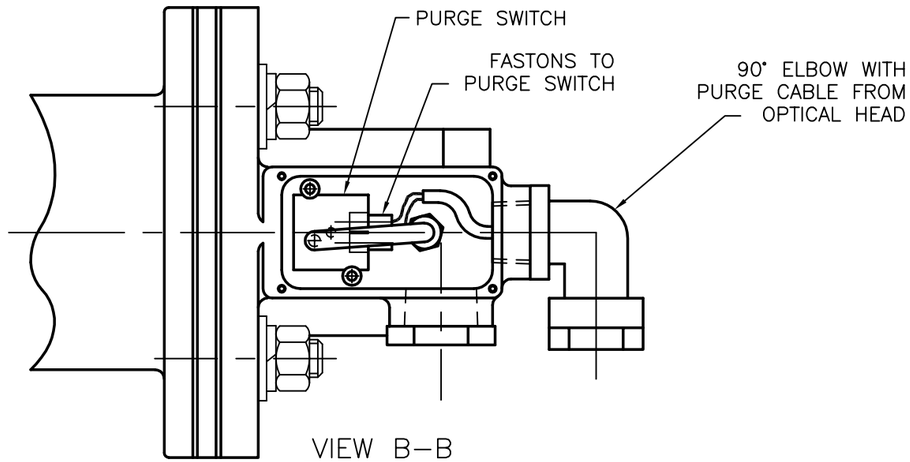
D | DRAWING NO. 1802-0015 | LATEST REVISION D

ACAD 1802001S-MS

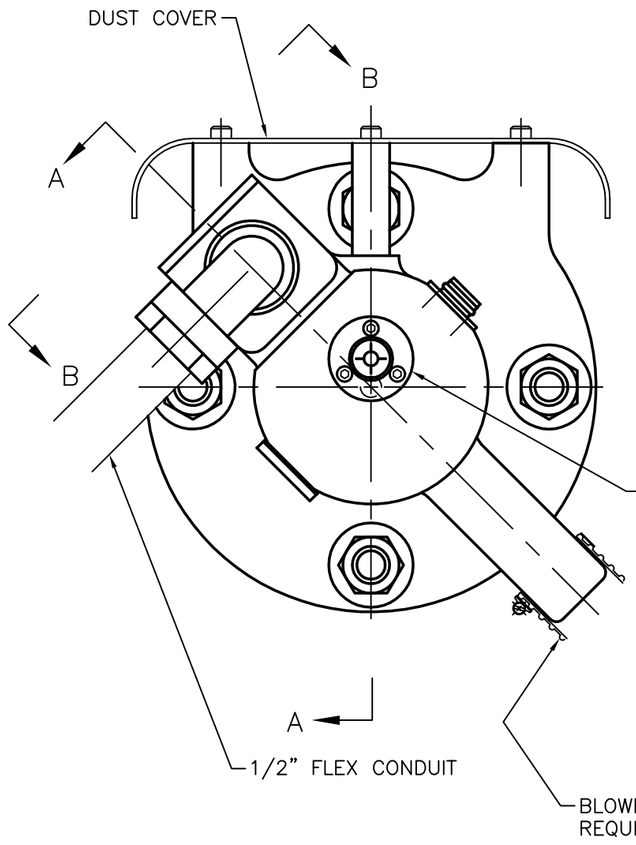
4-28-11

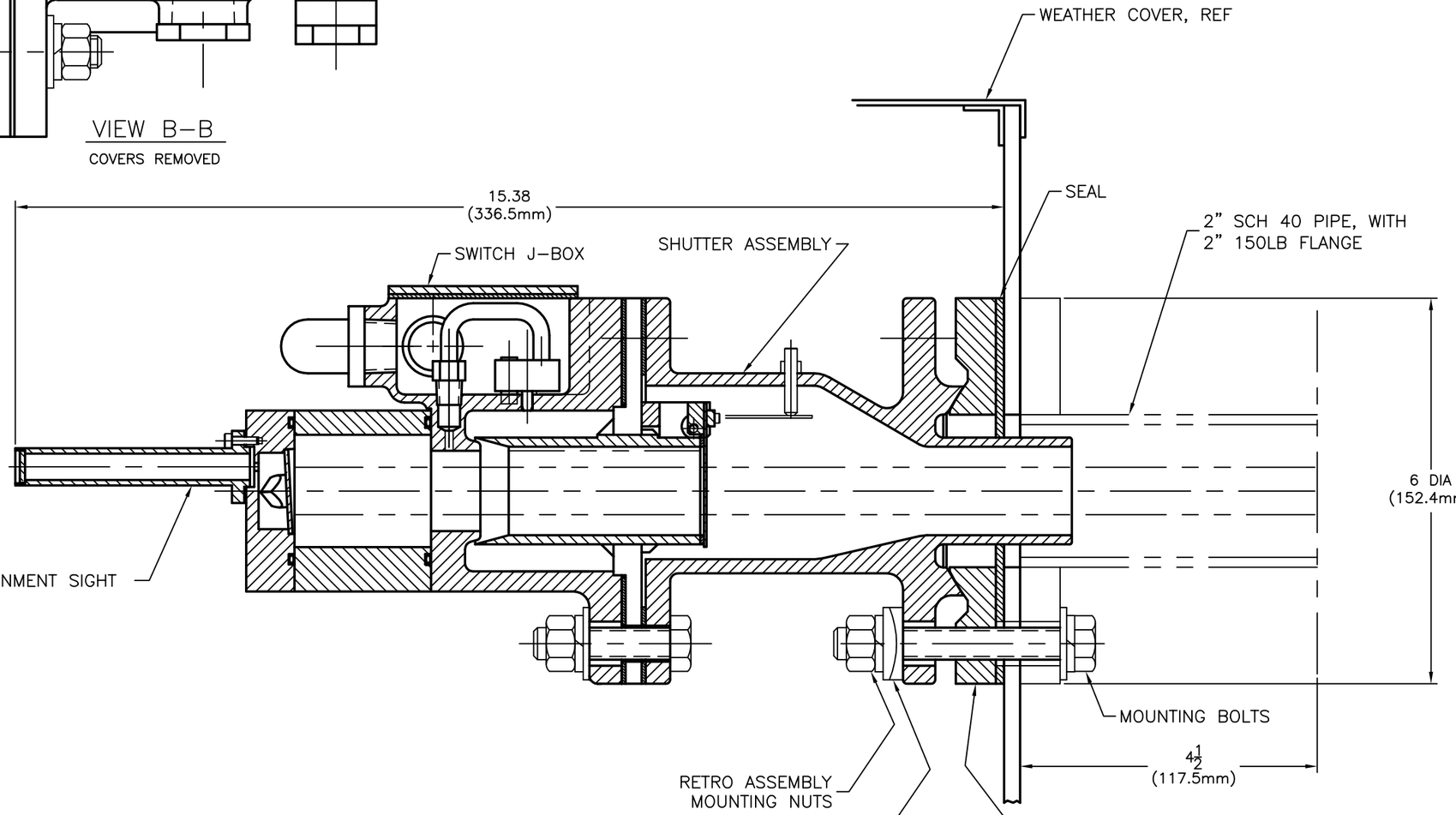
DWG. NO	SH
1802–0015	2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1802–0015A	4–14–00	ELM
	B	PER DCN #1802–0015B	1–2–08	ELM
	C	PER DCN #1802–0015C	10–01–08	ELM
	D	NO CHANGE THIS SHEET	4–28–11	FWD



VIEW B–B
COVERS REMOVED





SECTION A–A

WITH SHUTTER

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED

FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	.XX ±.01	±0°30'
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH
8 AND UP ±1/8		√

ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	11–4–97
CHECKED	EAS	5–00
DESIGNED	EAS	NOV–99
ENGINEERED	ELM	5–16–00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5–16–00

USED ON	
DASH NO	NEXT ASSEMBLY
–01	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LIGHTHAWK 560
RETRO INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE 1:1 | SHEET 2 OF 3

DRAWING NO. 1802–0015 | LATEST REVISION D

PROJECTION

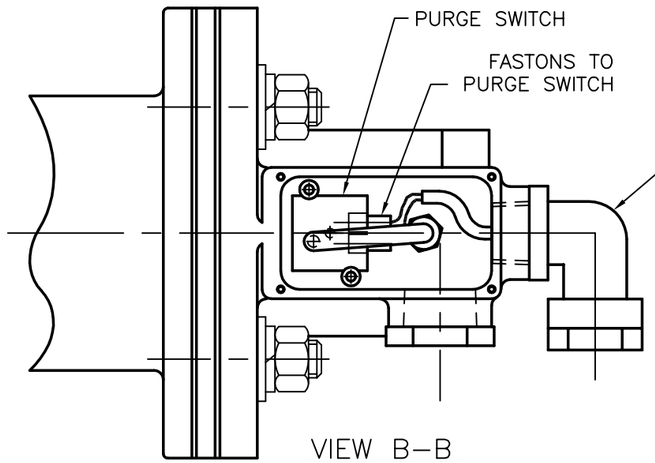
DIMENSIONS IN () ARE METRIC

ACAD 1802001S–MS

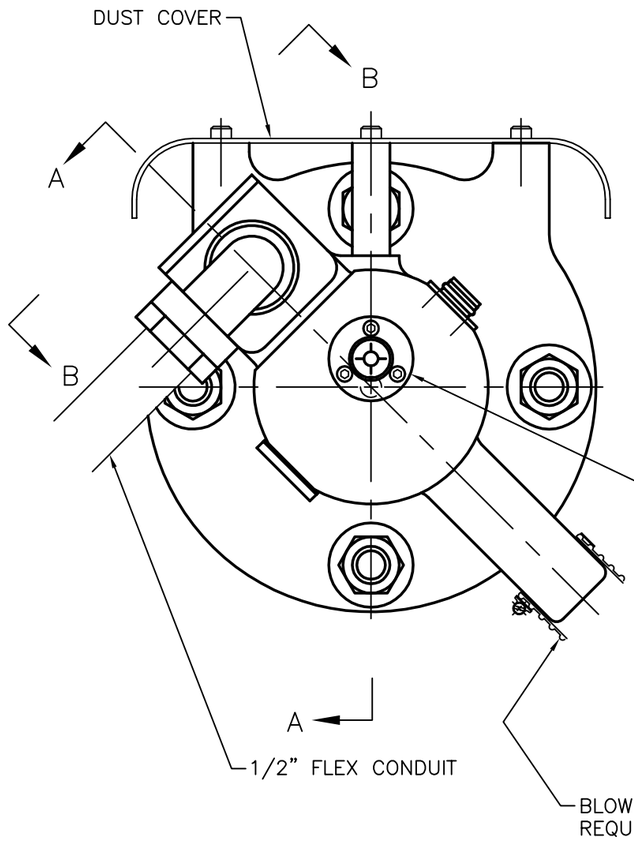
4–28–11

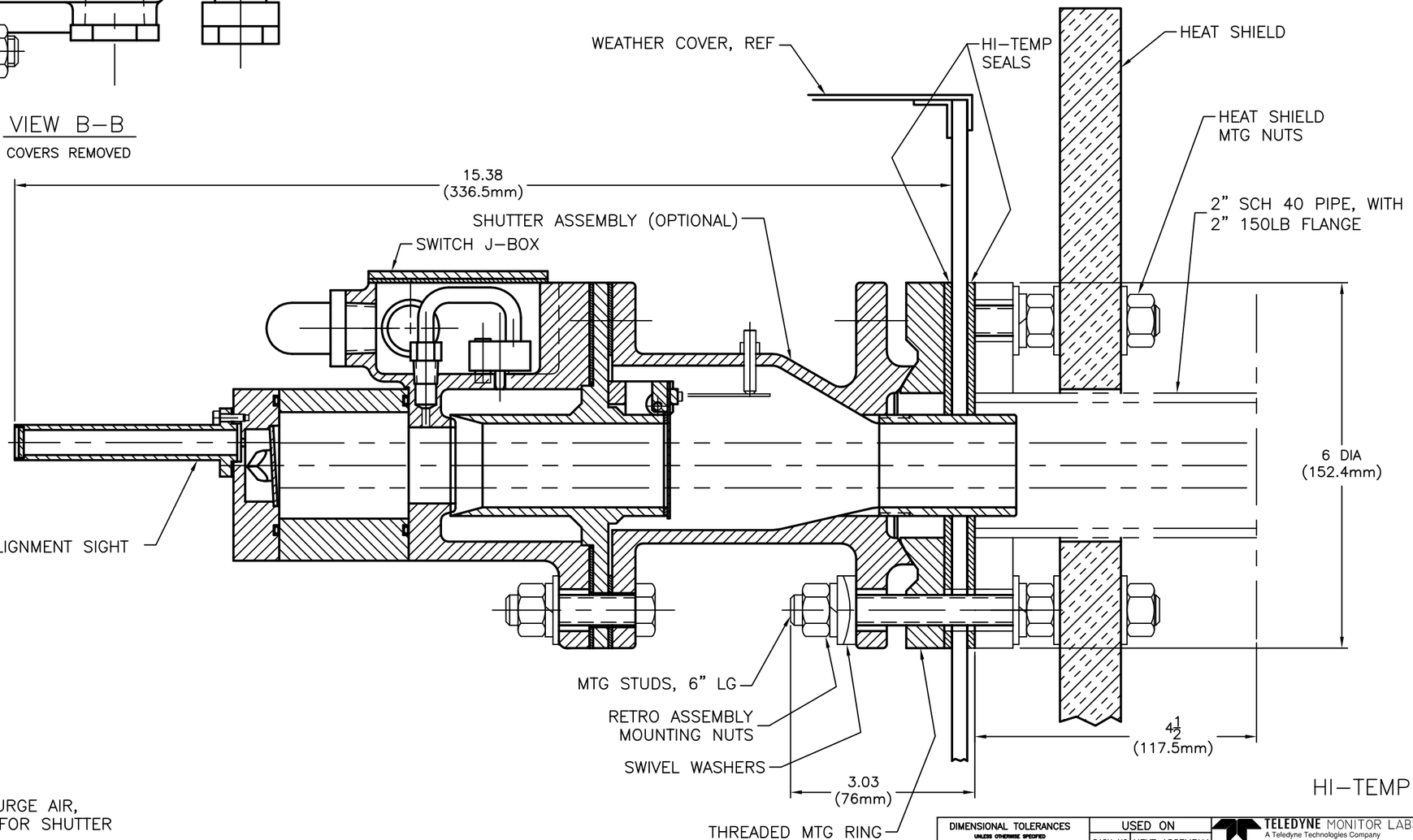
DWG. NO 1802–0015 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1802–0015A	4–14–00	ELM
	B	PER DCN #1802–0015B	1–2–08	ELM
	C	PER DCN #1802–0015C	10–01–08	ELM
	D	PER DCN #1802–0015D	4–28–11	FWD



VIEW B–B
COVERS REMOVED





HI–TEMP

SECTION A–A

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	EAS	11–4–97
CHECKED	EAS	5–00
DESIGNED	EAS	NOV–99
ENGINEERED	ELM	5–16–00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5–16–00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
–01	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
LIGHTHAWK 560
RETRO INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE 1:1 | SHEET 3 OF 3

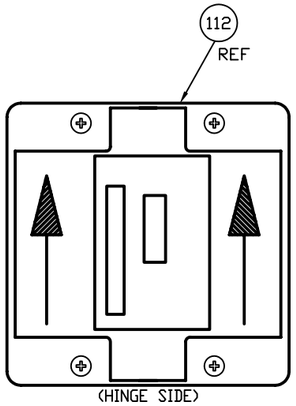
D | DRAWING NO. 1802–0015 | LATEST REVISION D

ACAD 1802001S–MS

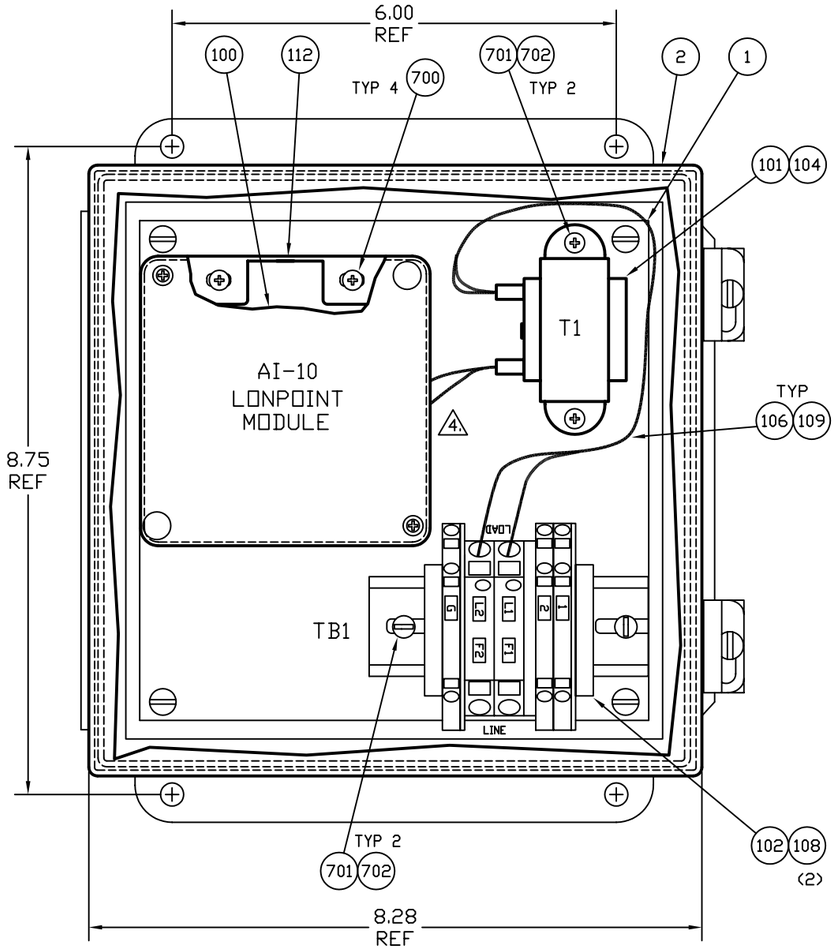
4–28–11

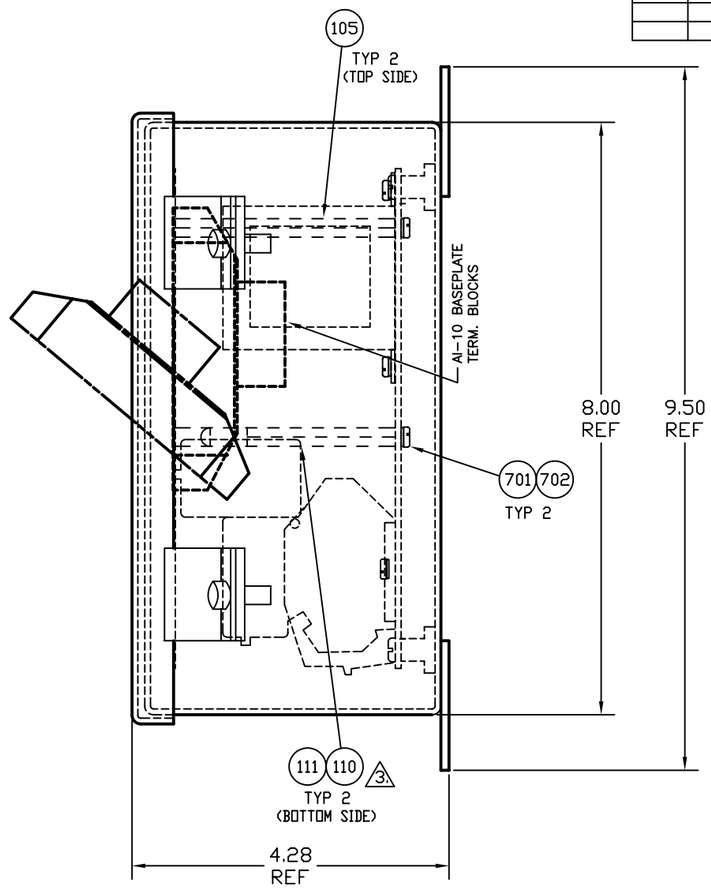
DWG. NO 1807-0000 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER ECN #1807-0000A	3-1-00	DMB
	B	PER ECN #1807-0000B	5-31-00	DMB
	C	PER ECN #1807-0000C	2-11-02	

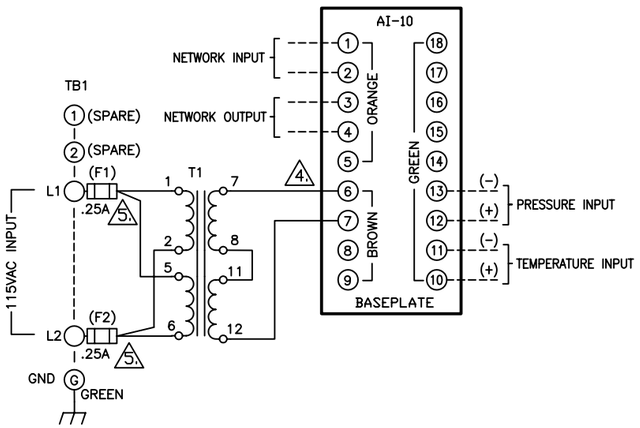


BASEPLATE
FOR AI-10 MODULE
WITH MODULE REMOVED

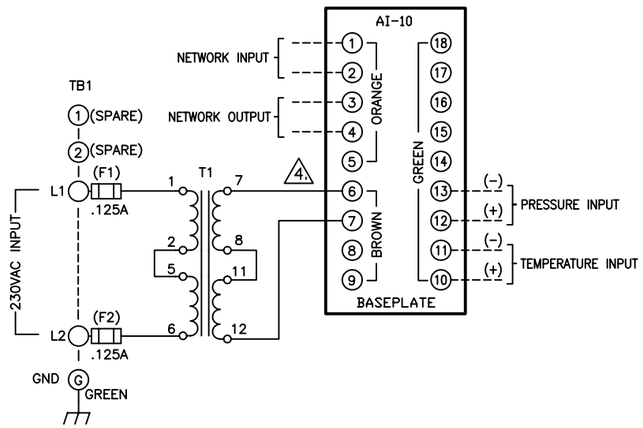




SHOWN W/COVER CUTAWAY



DASH-01 (115VAC) WIRING



DASH-02 (230VAC) WIRING

5. STRIP BOTH WIRES AND TWIST TOGETHER PRIOR TO INSERTING INTO CAGE CLAMP TERMINAL.

4. ALLOW ENOUGH SPARE CABLE FOR ADEQUATE SERVICE LOOP FOR MODULE TO SWING UP MINIMUM 90 DEGREES.

3. INTALL HINGED STANDOFF (IT. 111) TO ITEM 110. INSTALL ITEM 110 TO PANEL SUCH THAT HINGES SWING TOWARD BOTTOM OF PANEL (TOWARDS TB1) AND TIGHTEN DOWN SCREWS ON UNDERSIDE OF PANEL. HINGES MUST SWING PARALLEL TO EACH OTHER.

2. INSTALL COMPONENTS ON SUBPANEL AND WIRE OUTSIDE OF BOX.

NOTES: 1. ALL WIRE TO BE #18 AWG BLACK UNLESS NOTED OTHERWISE.

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	DCH	10-20-99
CHECKED	ELM	11-4-99
DESIGNED	DCH	10-20-99
ENGINEERED	ELM	11-4-99
PRODUCTION	MAR	11-10-99
Q.A.	A.S.	3-1-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	MODEL 550/560
-02	MODEL 550/560

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

TITLE: ANALOG INPUT MODULE ASSEMBLY/ SCHEMATIC

MAT'L.

FINISH

JIG NO.

SCALE 1:1

SHEET 1 OF 1

DRAWING NO. 1807-0000

LATEST REVISION C

2-11-02

ACAD2002 FILE 18070000

DWG. NO 1860-0001 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	F	PER DCN 1860-0001F	11-12-03	DMB
	G	PER DCN 1860-0001G	3-15-07	ELM
	H	PER DCN 1860-0001H	2-24-10	ELM

OPTICAL HEAD ASSEMBLY 1860-1000

COMPUTER MODULE
MOTHERBOARD
NETWORK MODULE
KEYPAD
DISPLAY/CONTROL BOARD
6 POINT I/O BOARD
POWER SUPPLY BOARD
OPTICAL AMPLIFIER BOARD
POSITION SENSOR
SIGNAL DETECTOR
MOTOR
ENCODER
PURGE SWITCH 1
REF. DETECTOR
LED

EXTERNAL INTERFACE BOARD

TB1: L N G
TB3: K1 (NO/NC) K1 COM K2 (NO/NC) K2 COM ISO1 (+) ISO1 (-) DGND ISO2 (+) ISO2 (-) DGND
TB2: NET A (TXD) NET B (RCD) NET A (TXD) NET B (RCD) DGND DAC1 (+) DAC1 (-) FGND DAC2 (-) DAC2 (+) FGND
TB4: 1 2 (BLK, RED)

INTEGRAL 1. 6. 7. JUNCTION BOX 1801-0300

PE
GRN/YEL (PE)
BD. MTG. SCREW
ESD PROTECTOR 1860-0006-01

528139

RETRO ASSY 1802-0000
PURGE SWITCH (BLK, RED)

AC SERVICE ENTRANCE CIRCUIT #2
(TO BE SUPPLIED BY CUSTOMER)
1 POLE, 5 AMP CIRCUIT BREAKER WITH HI INDUCTIVE INRUSH CURRENT DELAY
115VAC-LINE (L)
115VAC-NEU (N)
GND

AC SERVICE ENTRANCE CIRCUIT #2
(TO BE SUPPLIED BY CUSTOMER)
2 POLE, 3 AMP CIRCUIT BREAKER WITH HI INDUCTIVE INRUSH CURRENT DELAY
230VAC-LINE (L)
230VAC-NEU (N)
GND

RETRO BLOWER
(USED IN DUAL BLOWER 42 CFM CONFIGURATION ONLY)
(NOT USED IN SINGLE BLOWER SYSTEMS)

LINE-(L) NEU-(N) GND
SEE BLOWER MFR. WIRING DETAILS PACKAGED WITH BLOWER
BLOWER MOTOR (RETRO SIDE)

POWER CIRCUIT BOX INSTALLED BY CUST.

520083
520084

AC SERVICE ENTRANCE CIRCUIT #1
(TO BE SUPPLIED BY CUSTOMER)
1 POLE, 5 AMP CIRCUIT BREAKER WITH HI INDUCTIVE INRUSH CURRENT DELAY
(42 CFM BLOWER)
L 115VAC-LINE (L)
N 115VAC-NEU (N)
GND GND

AC SERVICE ENTRANCE CIRCUIT #1
(TO BE SUPPLIED BY CUSTOMER)
2 POLE, 3 AMP CIRCUIT BREAKER WITH HI INDUCTIVE INRUSH CURRENT DELAY
(42 CFM BLOWER)
L 230VAC-LINE (L)
N 230VAC-NEU (N)
GND GND

LINE-(L) NEU-(N) GND
SEE BLOWER MFR. WIRING DETAILS PACKAGED WITH BLOWER
BLOWER MOTOR (OPTICAL HEAD SIDE)

DAC1 (+) BLU
DAC1 (-) BLK
DAC2 (+) YEL
DAC2 (-) BLK
ISO1 (+) RED
ISO1 (-) BLK
DGND
ISO2 (+) WHT
ISO2 (-) BLK
DGND
K1 (NO/NC) RED
K1 COM BLK
K2 (NO/NC) WHT
K2 COM BLK

1. DIRECT INTERFACE TO CUSTOMER EQUIPMENT

8. TERMINATE SHIELDS TO FRAME GROUND AT CUSTOMER'S EQUIPMENT END OF CABLE.
7. ALL FIELD WIRING TERMINATING ON STACK MOUNTED EQUIPMENT MUST BE RATED MINIMUM 70 DEGREES C. NO GREEN FIELD WIRES MAY BE TERMINATED ON TML PROVIDED TERMINALS OTHER THAN 'PE' AS SHOWN.
6. MAINTENENCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONELL ONLY. CONSULT MANUAL.
5. CUSTOMER TO PROVIDE CIRCUIT BREAKERS OF OF APPROPRIATE RATING AT SAME ELEVATION AS TML EQUIPMENT BEING SUPPLIED. LABEL DISC. DEVICES WITH NAME/TAG NO. OF EACH DEVICE BEING SUPPLIED. CONTACT TML FOR RECOMMENDED BREAKERS.
4. CABLES SIZED AND CHOSEN TO FIT IN 1/2" CONDUIT TOGETHER WITH 40% MAXIMUM FILL. USING OTHER CABLES MAY REQUIRE LARGER CONDUITS/FITTINGS.
3. ISO1 AND ISO2 SHOWN IN DRY CONTACT CONFIGURATION. THEY ARE JUMPER SELECTABLE ON 6 PT. I/O PC BOARD. TERMINAL WIRING CONNECTIONS MAY BE AFFECTED. SEE USER'S MANUAL.

DRY	+5V
TB3-6 [ISO1 (-)]	TB3-5 [ISO1 (+)]
TB3-7 [DGND]	TB3-6 [ISO1 (-)]
TB3-9 [ISO2 (-)]	TB3-8 [ISO2 (+)]
TB3-10 [DGND]	TB3-9 [ISO2 (-)]

2. RELAY CONTACTS ARE JUMPER SELECTABLE ON 6 POINT I/O PC BOARD (N.O. OR N.C.). SEE USER'S MANUAL.

NOTES: 1. TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES 60'30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	DCH	10-15-99
CHECKED	DMB	4-00
DESIGNED	DMB	4-00
ENGINEERED	DMB	4-00
PRODUCTION	MAR	5-3-00
Q.A.	A.S.	5-3-00

USED ON

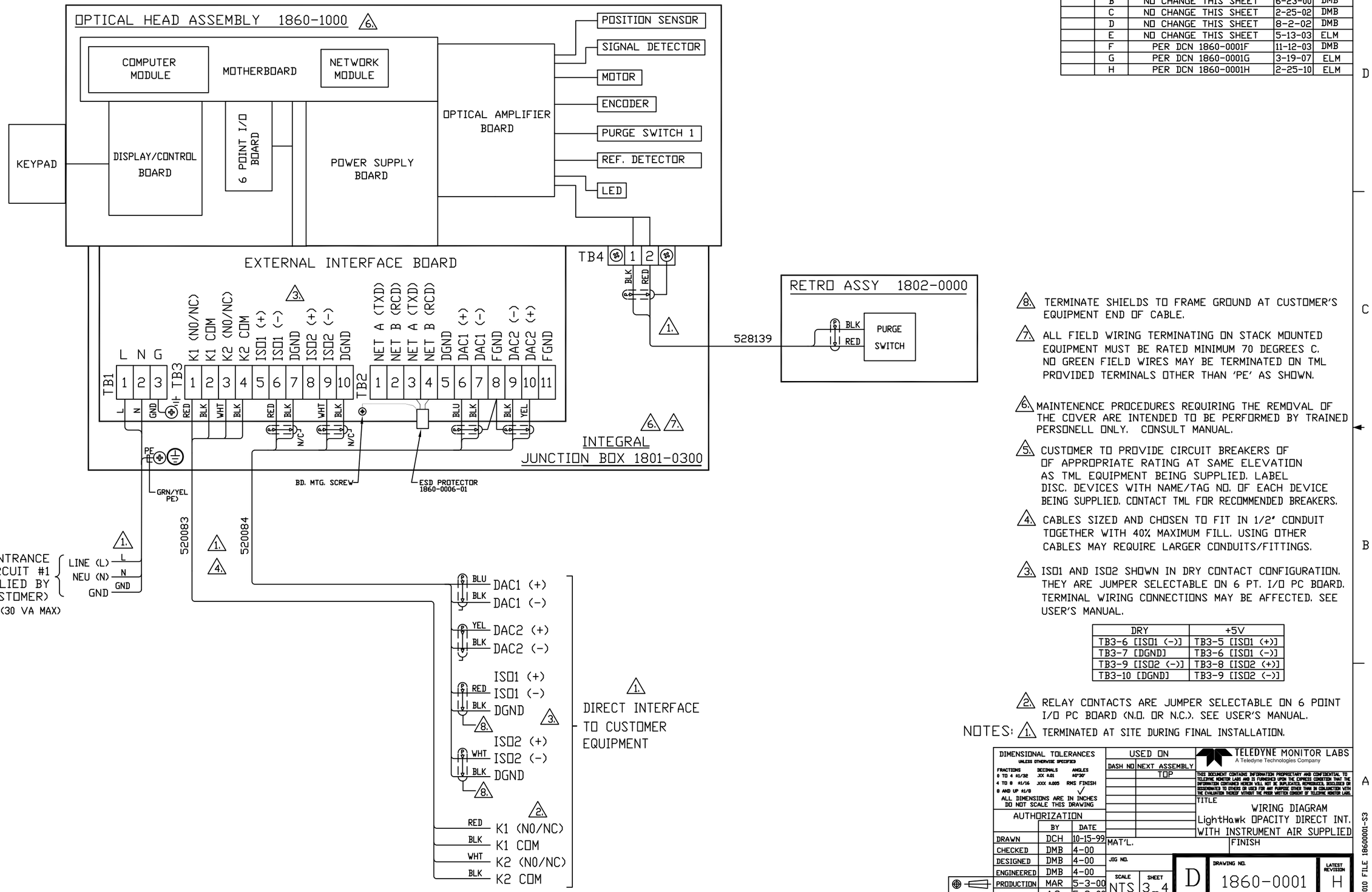
DASH NO	NEXT ASSEMBLY
	TOP

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
WIRING DIAGRAM
LightHawk OPACITY DIRECT INTERFACE WITH BLOWER(S)

MAT'L.
FINISH
JIG NO.
SCALE NTS
SHEET 1 OF 4
DRAWING NO. 1860-0001
LATEST REVISION H
PROJECTION
2-24-2010
ACAD2010 FILE 18600001

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	NO CHANGE THIS SHEET	05-16-00	ELM
	B	NO CHANGE THIS SHEET	6-23-00	DMB
	C	NO CHANGE THIS SHEET	2-25-02	DMB
	D	NO CHANGE THIS SHEET	8-2-02	DMB
	E	NO CHANGE THIS SHEET	5-13-03	ELM
	F	PER DCN 1860-0001F	11-12-03	DMB
	G	PER DCN 1860-0001G	3-19-07	ELM
	H	PER DCN 1860-0001H	2-25-10	ELM



8. TERMINATE SHIELDS TO FRAME GROUND AT CUSTOMER'S EQUIPMENT END OF CABLE.

7. ALL FIELD WIRING TERMINATING ON STACK MOUNTED EQUIPMENT MUST BE RATED MINIMUM 70 DEGREES C. NO GREEN FIELD WIRES MAY BE TERMINATED ON TML PROVIDED TERMINALS OTHER THAN 'PE' AS SHOWN.

6. MAINTENENCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONELL ONLY. CONSULT MANUAL.

5. CUSTOMER TO PROVIDE CIRCUIT BREAKERS OF OF APPROPRIATE RATING AT SAME ELEVATION AS TML EQUIPMENT BEING SUPPLIED. LABEL DISC. DEVICES WITH NAME/TAG NO. OF EACH DEVICE BEING SUPPLIED. CONTACT TML FOR RECOMMENDED BREAKERS.

4. CABLES SIZED AND CHOSEN TO FIT IN 1/2" CONDUIT TOGETHER WITH 40% MAXIMUM FILL. USING OTHER CABLES MAY REQUIRE LARGER CONDUITS/FITTINGS.

3. ISO1 AND ISO2 SHOWN IN DRY CONTACT CONFIGURATION. THEY ARE JUMPER SELECTABLE ON 6 PT. I/O PC BOARD. TERMINAL WIRING CONNECTIONS MAY BE AFFECTED. SEE USER'S MANUAL.

DRY	+5V
TB3-6 [ISO1 (-)]	TB3-5 [ISO1 (+)]
TB3-7 [DGND]	TB3-6 [ISO1 (-)]
TB3-9 [ISO2 (-)]	TB3-8 [ISO2 (+)]
TB3-10 [DGND]	TB3-9 [ISO2 (-)]

2. RELAY CONTACTS ARE JUMPER SELECTABLE ON 6 POINT I/O PC BOARD (N.O. OR N.C.). SEE USER'S MANUAL.

NOTES: 1. TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	DCH	10-15-99
CHECKED	DMB	4-00
DESIGNED	DMB	4-00
ENGINEERED	DMB	4-00
PRODUCTION	MAR	5-3-00
Q.A.	A.S.	5-3-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
	TOP

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
WIRING DIAGRAM
LightHawk OPACITY DIRECT INT. WITH INSTRUMENT AIR SUPPLIED

MAT'L.
FINISH
JIG NO.
SCALE NTS
SHEET 3 OF 4
DRAWING NO. D 1860-0001
LATEST REVISION H

2-25-2010
ACAD2010 FILE 18600001-S3

DWG. NO 1860-0100 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	L	PER ECN #1860-0100L	7-10-08	ELM
	M	PER ECN #1860-0100M	6-18-10	ELM
	N	PER DCN #1860-0100N	8-9-10	ELM
	P	NO CHANGE THIS SHEET	5-25-11	ELM
	E	NO CHANGE THIS SHEET	2-5-02	ELM
	F	NO CHANGE THIS SHEET	6-11-02	ELM
	G	NO CHANGE THIS SHEET	2-18-03	DMB
	H	NO CHANGE THIS SHEET	10-31-03	DMB
	J	NO CHANGE THIS SHEET	12-21-06	DMB
	K	PER DCN 1860-0100K	4-10-07	ELM

P1M/J1M
COMPUTER MODULE
P2M/J2M

1860-0500
MOTHERBOARD

P1L/J1L LONWORKS CONTROL MODULE P2L/J2L

P5-(62)-FEM. J5-(62)-MALE

J4-(15)-FEM. P4-(15)-MALE

J6-(9)-FEM. P6-(9)-MALE

J3-(3)-MALE P3-(3)-FEM.

J2-(9)-MALE P2-(9)-FEM.

1860-0600
DISPLAY/CONTROL

J1

1860-0700
6 POINT I/O
-02 ONLY

J2-(14)-MALE P2-(14)-FEM.

1860-1400

1860-1100
POWER SUPPLY

TB1 H N G (1 2 3)

P14-(25)-FEM. J14-(25)-MALE

1860-0400
OPTICAL
AMPLIFIER

POWER INPUT MODULE
1860-1050-01

GRN/YEL BLK WHT GRN/YEL

F1 F2

AC
LINE
FILTER

POWER
SWITCH

1.

P1-(15)-FEM. P3-(3)-MALE
J1-(15)-MALE J3-(3)-FEM.

1860-0900
EXTERNAL INTERFACE

K1 (NO/NC)	K1 COM	K2 (NO/NC)	K2 COM	ISO1 (+)	ISO1 (-)	DGND	ISO2 (+)	ISO2 (-)	DGND
1	2	3	4	5	6	7	8	9	10

TB3

NET A (TXD)	NET B (RCD)	NET A (TXD)	NET B (RCD)	DGND	DAC1 (+)	DAC1 (-)	FGND	DAC2 (-)	DAC2 (+)	FGND
1	2	3	4	5	6	7	8	9	10	11

TB2

H	N	G
1	2	3

TB1

ESD PROTECTOR
1860-0006-01 (REF)

J8-(4)-M P8-(4)-F — 1801-0150-02 POSITION SENSOR

J4-M P4-F — SMB — 1810-0230-01 SIGNAL DETECTOR

J9-(3)M P9-(3)F — MOTOR 1860-0160-01

J1-(7)M P1-(7)F — 1860-1600-01 — ENCODER

J6-(6)M P6-(6)F — 1860-1700-01 — PURGE SWITCH 1

PURGE SWITCH 2
TERM. STRIP

J3-(5)M P3-(5)F — REFERENCE DETECTOR 601-1000-02

P2-(2)F J2-(2)M — LED 1860-0250-01

3" P2-(17)-FEM. J2-(17)-MALE 4" 1860-0190-01 KEYPAD

NOTES: 1. TERMINATE DRAIN WIRE(S) TO LONGER MOUNTING SCREW OF THIS CONNECTOR, WITH NUT AND WASHER.

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	DCH	5-27-99
CHECKED	ELM	6-5-00
DESIGNED	ELM	2-18-00
ENGINEERED	ELM	2-18-00
PRODUCTION	MAR	2-18-00
Q.A.	AAS	2-18-00

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01/02	1860-1000

TITLE
LightHawk OPACITY
OPTICAL HEAD
WIRING DIAGRAM

MAT'L.
FINISH
JIG NO.
SCALE N/A
SHEET 2 OF 2

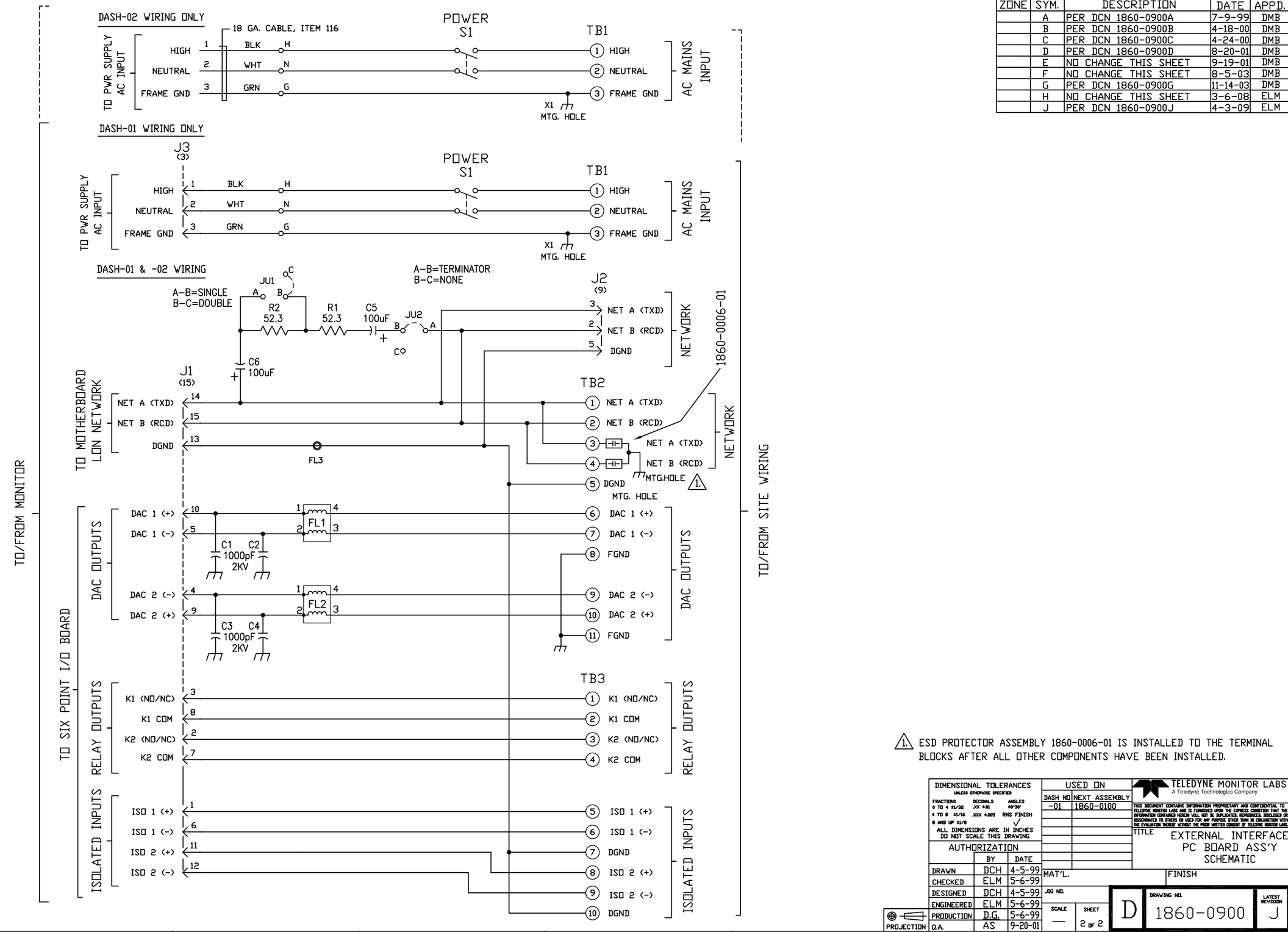
DRAWING NO. 1860-0100
LATEST REVISION P
D

5-25-11

ACAD2007 FILE 18600100-S2

DVG. NO 1860-0900 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN 1860-0900A	7-9-99	DMB
	B	PER DCN 1860-0900B	4-18-00	DMB
	C	PER DCN 1860-0900C	4-24-00	DMB
	D	PER DCN 1860-0900D	8-20-01	DMB
	E	NO CHANGE THIS SHEET	9-19-01	DMB
	F	NO CHANGE THIS SHEET	8-5-03	DMB
	G	PER DCN 1860-0900G	11-14-03	DMB
	H	NO CHANGE THIS SHEET	3-6-08	ELM
	J	PER DCN 1860-0900J	4-3-09	ELM



1. ESD PROTECTOR ASSEMBLY 1860-0006-01 IS INSTALLED TO THE TERMINAL BLOCKS AFTER ALL OTHER COMPONENTS HAVE BEEN INSTALLED.

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS: 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS: .XX ±.01; .XXX ±.005
ANGLES: ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION

	BY	DATE
DRAWN	DCH	4-5-99
CHECKED	ELM	5-6-99
DESIGNED	DCH	4-5-99
ENGINEERED	ELM	5-6-99
PRODUCTION	D.G.	5-6-99
Q.A.	AS	9-20-01

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	1860-0100

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE: EXTERNAL INTERFACE PC BOARD ASS'Y SCHEMATIC

MAT'L. | FINISH | JIG NO.

SCALE: — | SHEET: 2 OF 2

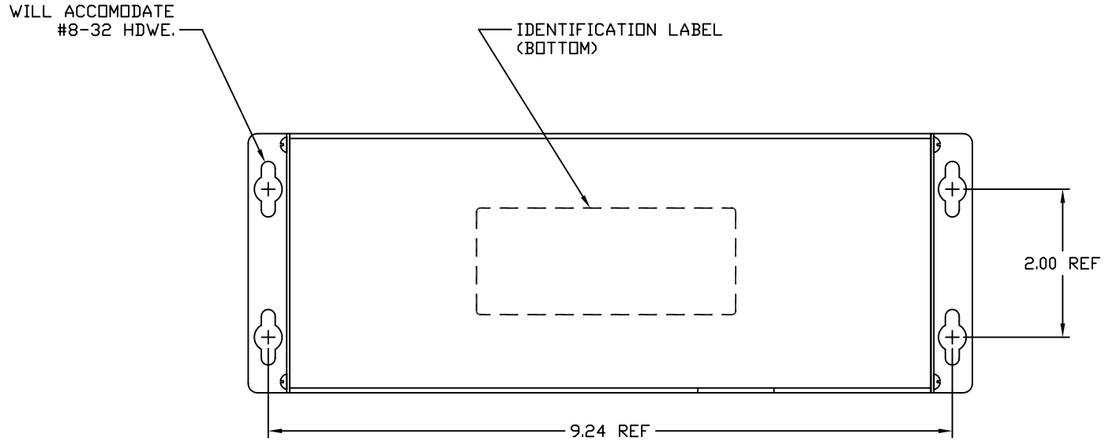
DRAWING NO. D 1860-0900 | LATEST REVISION: J

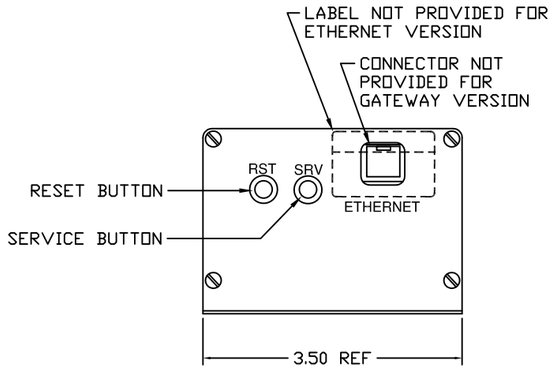
4-3-09

ACAD2008 FILE 18600900-S2

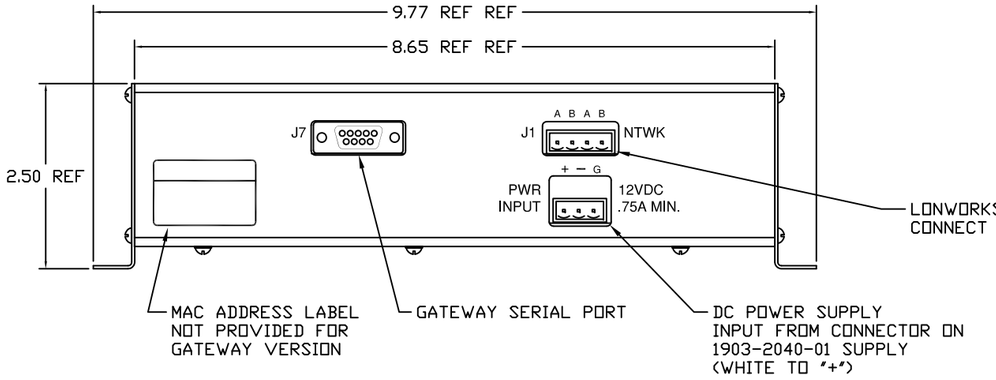
DWG. NO	SH
1903-2060	1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASED FOR PRODUCTION	10-11-06	ELM
	B	NO CHANGE THIS SHEET	11-21-07	ELM
	C	NO CHANGE THIS SHEET	3-18-08	DMB

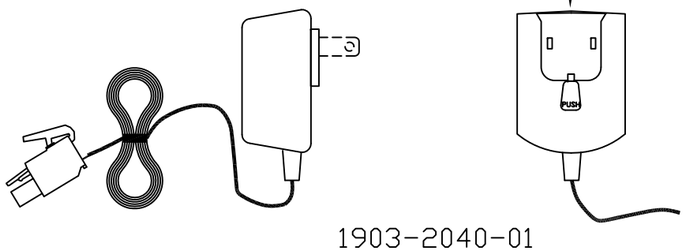




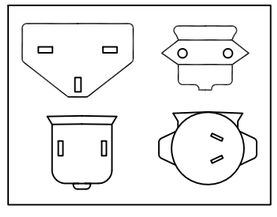
END VIEW



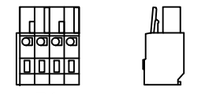
FRONT VIEW
1903-2050-XX
STAND ALONE ETHERNET OR GATEWAY MODULE



1903-2040-01
PLUG-IN WALL MOUNT POWER SUPPLY
100-240vac, 50-60Hz/12vdc, 1250ma
(115VAC PLUG SHOWN)



523887
UNIVERSAL AC PLUG KIT. SLIDE
PLUG FOR DESIRED SERVICE ONTO 1903-2040-01
SUPPLY AT LEFT.



P1

526680
P1 (MATING CONNECTOR FOR J1)

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	XX ±.01	±0°30'
4 TO 8 ±1/16	XXX ±.005	RMS FINISH
8 AND UP ±1/8		✓

ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	DCH	9-29-06
CHECKED	ELM	11-27-06
DESIGNED	DCH	9-29-06
ENGINEERED	ELM	11-27-06
PRODUCTION	G.A	11-27-06
Q.A.	A.S.	11-27-06

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-01	560 GATEWAY
-02	150 GATEWAY
-04	560 BRIDGE
-05	560 ETHERNET
-06	150 ETHERNET
-07	360 ETHERNET
-08	560 8B GATWY

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
CUSTOMER DRAWING,
1903-2050-xx STAND ALONE
ETHERNET/GATEWAY MODULE

MAT'L.
FINISH
JIG NO.
SCALE 1:1
SHEET 1 OF 1

SIZE	DRAWING NO.	LATEST REVISION
D	1903-2060	C

3-18-08

ACAD2007 FILE 19032060 A