

***LightHawk*[®] 560P** **Process Control Monitor** **Operations Manual**



(This page intentionally left blank.)

SERIAL NUMBER: _____

DOCUMENT NO.: 1860-0070-01 REV E

SEPTEMBER 2011

Proprietary Information. All rights reserved by Teledyne Monitor Labs Inc. No part of this book may be reproduced or copied in any form or by any means—graphic, electronic, or mechanical, including photocopying, taping, or information storage and retrieval systems—without written permission of the publisher.

Made in the United States of America

LonWorks® is a trademark of the ECHELON Corporation

Patent No. 7,715,009

TABLE OF CONTENTS

	Page
1.0 SYSTEM OVERVIEW	1-1
1.1 System Description, Standard Equipment.....	1-2
1.1.1 Optical Head Assembly	1-2
1.1.2 Retroreflector Assembly.....	1-2
1.1.3 Protective Purge Air System (Single).....	1-2
1.1.4 Calibration Kit.....	1-3
1.1.5 Attenuators.....	1-3
1.2 Specifications (Standard System)	1-4
1.3 Measurement Units	1-6
1.3.1 Correction for Exit Path Length	1-7
1.4 Safety.....	1-7
2.0 OPTIONAL EQUIPMENT	2-1
2.1 Protective Purge Air System (Dual).....	2-1
2.2 Weather Cover, Retro.....	2-1
2.3 Purge Shutter Assemblies.....	2-1
2.4 Instrument Air Purge.....	2-1
2.5 High Efficiency Purge Air Filtration System.....	2-1
2.6 Hinged Fiberglass Weather Covers	2-2
2.7 Purge Air Heater	2-2
2.8 Optical Head Dust Cover.....	2-2
2.9 High Temperature Operation.....	2-2
2.10 Heat Shield	2-2
2.11 Pressure and Temperature Input Interface	2-3
2.12 Optical Head Transport Cover.....	2-3
2.13 Alignment Scope, Mounting Flange	2-3
2.14 Ethernet Module	2-3
3.0 OPTICAL HEAD ASSEMBLY.....	3-1
3.1 Overview	3-1
3.2 Mechanical Description	3-1
3.3 Optical Description	3-1
3.4 Electrical Description	3-2
3.4.1 AC Power Connections	3-2
3.4.2 Signal Processing Electronics.....	3-2
3.5 User Interface Description.....	3-4
3.5.1 Six Character LED Display.....	3-4
3.5.2 Keypad	3-4
3.5.3 Status LED's	3-6
3.5.4 Data and Parameter Location Definitions	3-6
4.0 SIX POINT I/O BOARD FOR <i>LIGHTHAWK</i> [®] 560P SYSTEM.....	4-1
4.1 Overview	4-1
4.2 Analog Output Description.....	4-1
4.2.1 Analog Output Scaling	4-1
4.3 Jumpers That Effect Analog Outputs	4-2
4.4 Relay Outputs.....	4-3
4.5 Data Cables.....	4-3

TABLE OF CONTENTS

(Continued)

	PAGE
5.0 PURGE SYSTEM OVERVIEW.....	5-1
5.1 Mechanical Description	5-1
5.2 Electrical Description	5-1
5.3 Operation	5-2
5.4 Purge Status	5-2
5.5 Dual Protective Purge Air System (Dual) Blower Option	5-2
5.6 Purge Shutter Assembly Option	5-2
5.7 Instrument Air Purge Option	5-3
6.0 CALIBRATION KIT OVERVIEW.....	6-1
6.1 Operation	6-1
6.2 Storage	6-2
7.0 MAINTENANCE & ON-STACK CALIBRATION	7-1
7.1 Routine Maintenance.....	7-1
7.2 On-Stack Calibration	7-5
7.2.1 Procedure for On-Stack Calibration Checklist	7-5
8.0 OFF-STACK CALIBRATION	8-1
8.1 Factory Selection of Optical Elements	8-1
8.2 Generating an Optical Clear Path Opacity Signal	8-2
8.2.1 Simulating Installation Path Length on Test Stands	8-2
8.2.2 Actual Clear Path Conditions	8-3
8.3 Across Stack Alignment.....	8-3
8.3.1 Optical Head Assembly	8-3
8.3.2 Retroreflector Assembly	8-4
8.4 Cleaning the Optical Surfaces.....	8-5
8.4.1 Cleaning Materials	8-5
8.4.2 Cleaning Procedure	8-6
8.5 Optical Head Zero and One Hundred Percent Opacity	8-6
8.5.1 Setting the LED Current Level	8-6
8.5.2 Setting the Signal Gain	8-8
8.5.3 Final Calibration SET Function Routines	8-9
8.6 Adjusting Calibration Kit	8-10
8.7 Verify the Response of the Optical Head	8-13
8.8 Cal Kit Neutral Density Window Replacement	8-13
8.9 Off-Stack Calibration History	8-15
9.0 INSTALLATION	9-1
9.1 Flange Mounting.....	9-1
9.1.1 Mounting Pipe Considerations.....	9-1
9.2 Distance Determination	9-3
9.3 Power Requirements	9-4
9.4 Purge Air System.....	9-4
9.5 Data Cable.....	9-4
9.6 Purge Cable.....	9-4
9.7 Mounting the Optical Head and Retro Assemblies	9-4
10.0 TROUBLESHOOTING	10-1
10.1 Primary Status Code U3.....	10-1
10.2 Assistance	10-2

TABLE OF CONTENTS

(Continued)

APPENDIX A	SITE SPECIFICATION DATA SHEETS
APPENDIX B	MAINTENANCE CHECK SHEETS
APPENDIX C	SPARE PARTS

APPENDIX D DRAWINGS

<u>Drawing No.</u>	<u>Sheet</u>	<u>Rev</u>	<u>Description</u>
1800-0007	1 of 7	J	<i>LightHawk</i> [®] 560 Opacity w/Instr. Air System Installation
1800-0007	2 of 7	J	<i>LightHawk</i> [®] 560 Opacity Single Blower System Installation
1800-0007	3 of 7	J	<i>LightHawk</i> [®] 560 Opacity Dual Blower System Installation
1800-0007	4 of 7	J	<i>LightHawk</i> [®] 560 Dual Blower Hi-Temp System Installation
1800-0007	5 of 7	J	<i>LightHawk</i> [®] 560 Single Blower, Dual Covers System Installation
1800-0007	6 of 7	J	<i>LightHawk</i> [®] 560 Single Blower, Dual Covers Hi-Temp System Installation
1800-0007	7 of 7	J	<i>LightHawk</i> [®] 560 Opacity Dual Covers Instrument Air System Installation
1800-0013	1 of 2	A	<i>LightHawk</i> [®] 560 Opacity Monitor Flange Mtg. Methods
1800-0013	2 of 2	A	<i>LightHawk</i> [®] 560 Opacity Monitor Flange Mtg. Methods
1800-0085	1 of 2	-	<i>LightHawk</i> [®] 560 Opacity Single Cover System Installation, No Blowers
1800-0085	2 of 2	-	<i>LightHawk</i> [®] 560 Opacity Dual Covers System Installation, No Blowers
1800-0095	1 of 2	A	560P <i>LightHawk</i> [®] Spare Parts Location Drawing
1800-0095	2 of 2	A	560P <i>LightHawk</i> [®] Optical Head Spare Parts Location Drawing
1801-0015	1 of 3	B	<i>LightHawk</i> [®] 560 Optical Head Install (No Shutter)
1801-0015	2 of 3	B	<i>LightHawk</i> [®] 560 Optical Head Install (With Shutter)
1801-0015	3 of 3	B	<i>LightHawk</i> [®] 560 Optical Head Install (With Shutter Hi-Temp)
1802-0015	1 of 3	D	<i>LightHawk</i> [®] 560 Retro Installation (No Shutter)
1802-0015	2 of 3	D	<i>LightHawk</i> [®] 560 Retro Installation (With Shutter)
1802-0015	3 of 3	D	<i>LightHawk</i> [®] 560 Retro Installation (With Shutter Hi-Temp)
1860-0003	1 of 2	A	Wiring Diagram <i>LightHawk</i> [®] Process Opacity 560P with Blower(s)
1860-0003	2 of 2	A	Wiring Diagram <i>LightHawk</i> [®] Process Opacity 560P w/Inst Air Supplied
1860-0900	2 of 2	J	External Interface PC Board Assembly Schematic
1860-2500	2 of 2	H	<i>LightHawk</i> [®] Process Opacity 560P Optical Head Wiring Diagram
1903-2060	1 of 1	C	Ethernet/Gateway Module

(This page intentionally left blank.)

1.0 SYSTEM OVERVIEW

This manual describes the installation, operation, calibration and routine maintenance of the *LightHawk*[®] 560P Process Control 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*[®] 560P system consists of the following standard equipment:

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

As shown on the *LightHawk*[®] Installation Drawing, the first 3 are located on the stack. A Calibration Kit and Filter Pouch are also provided.

Optional items include:

- ❑ Protective Purge Air System (Dual)
- ❑ Weather Cover, Retro
- ❑ Purge Shutter Assembly (Optical Head and Retroreflector)
- ❑ Instrument Air Purge System
- ❑ Hinged Fiberglass Weather Covers
- ❑ Purge Air Heater
- ❑ Optical Head Dust Cover
- ❑ High Temperature Operation (500 °F to 1500 °F)

- ❑ Heat Shield
- ❑ 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. Data transfer with the Enhanced Remote Panel, or other optional components, is via a commercial network communication protocol.

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)

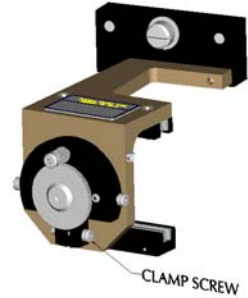
The purge air system provides filtered air to the Optical Head and Retroreflector Assemblies. The Purge Air System consists of the blower motor, hose, air filter,

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 (STANDARD SYSTEM)

PHYSICAL DIMENSIONS	Optical Head (w/o Purge Shutter)	17"(L) X 9-1/4"(W) X 15"(H)(43.2x23.5x38.1 CM)
	Optical Head (with Purge Shutter)	22"(L) X 9-1/4"(W) X 15"(H)(55.9x23.5x38.1 CM)
	Retro Assembly (w/o Purge Shutter)	10"(L) X 7" (Diameter)(25.4 x 17.8 CM)
	Retro Assembly (with Purge Shutter)	15"(L) X 7" (Diameter)(38.1 x 17.8 CM)
	Single Purge Blower Assembly	22-1/4"(L) X 20"(W) X 33"(H)(56.5x50.8x83.8 CM)
	Dual Purge Blower Assembly	2 assemblies with Single Purge Blower dimensions
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 Error (Mean Error + Confidence Coefficient)	2.0% Opacity Maximum
	Stability Over Operating Temperature Range	±2.0% Opacity Maximum per 40°F change in temperature (as per ASTM D6216)
	Stability Over Operating Mains Voltage Range	±1.0% Opacity Maximum (as per ASTM D6216)
	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 Max.
	Single Purge Blower System	115VAC/230VAC, 60/50 Hz, Single Phase, 414 VA Max.
	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 (startup) -25 to +140°F (operating) Relative Humidity Range: 0 to 100% condensing
MEASUREMENT MEDIUM CONDITIONS	Static Pressure Range ***	Single Purge Blower: -15.0 to +5.0 inches H2O Gauge Dual Purge Blower: -15.0 to +15.0 inches H2O Gauge >+15inches H2O consult factory
	Gas Composition	not critical
	Humidity	must be noncondensing for valid measurement
	Maximum Temperature ***	+500°F (without High Temperature Option) +1500°F (with High Temperature Option) Consult factory for higher temperature operation
OPTICAL HEAD HMI CHARACTERISTICS	Display Type	Six 7 Segment LED's
	Indicating LED's	Fault, Set, In Cal, Power
	User Input Controls	10-key keypad
Wiring Requirements	Cable Type 1	4/TSP, 24 AWG, PVC Insul., .33" Dia
	Cable Type 2	4/C, 20 AWG, PVC Insul., .168 Dia

SIX POINT I/O
BOARD
CHARACTERISTICS

ANALOG OUTPUTS	
Number	2
Output Type	4-20mA with live 4mA zero, OR 0-20mA w/o live zero
Maximum Load Resistance	900 ohms
Minimum Isolation Voltage	500V _{peak} *, 500VDC*
Isolation Type	Optical & capacitive barriers; channel to channel, channel to circuit common & earth
Maximum Offset	±0.05% of full scale
Total Output Error	±0.30% of full scale
RELAY OUTPUTS	
Number & Type	2 SPST, N.O. OR N.C. (Single Pole Single Throw, Normally Open OR Normally Closed [jumper selectable])
Minimum Isolation	500V _{rms} *
Maximum Contact Voltage	250VAC*
Maximum Contact Current	1Amp AC, 1Amp DC

* I/O wiring with respect to earth.

** Measurement based on single pass response with a PLCF of 1.00.

*** Specification applies only to systems with Purge Blowers.

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:

$$\text{TRANSMITTANCE} = 100\% \quad \text{OPACITY} = 0\%$$

For a *BLOCKED STACK* condition:

$$\text{TRANSMITTANCE} = 0\% \quad \text{OPACITY} = 100\%$$

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

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

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*® 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/m³).

1.3.1 Correction for Exit Path Length

In many applications the pathlength where the effluent exits to the atmosphere is different from of the pathlength 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)

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

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.

(This page intentionally left blank.)

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

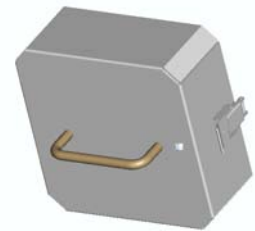
A Heat Shield is available for installations where radiant heat is a problem. This is typically necessary for stack temperatures of 1000° F (538° C) or more but in some instances may not be required when the stack is very well insulated. (Consult factory.)

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.

(This page intentionally left blank.)

3.0 OPTICAL HEAD ASSEMBLY

3.1 OVERVIEW

This section describes the Optical Head mechanical, optical, electrical and user interface configurations. It also defines the Optical Head status and mode codes and status LED's. A numeric display and keypad are mounted directly on the *LightHawk*[®] 560 Optical Head.

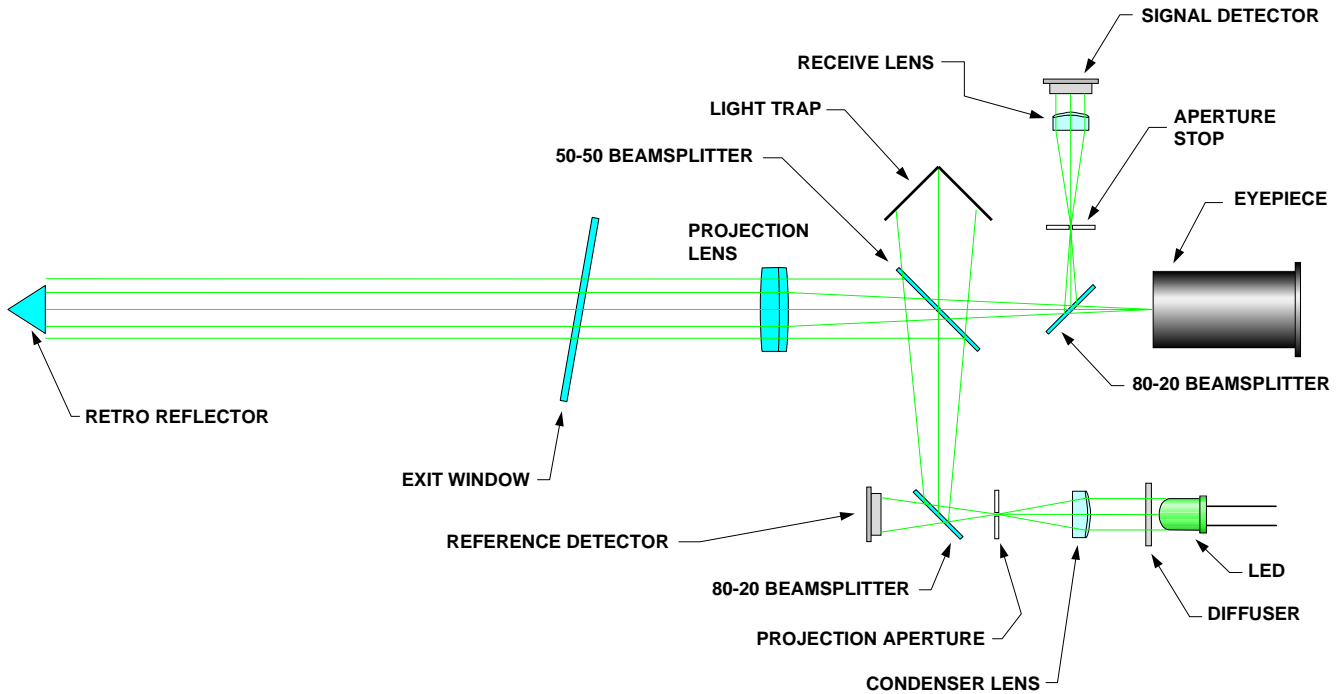
3.2 MECHANICAL DESCRIPTION

The Optical Head Assembly is constructed primarily of cast aluminum. It is comprised of a Rear Optical Section, and Integral Junction Box. 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. Access to the 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. The following is a schematic diagram of the *LightHawk*[®] 560 optical system. (*See the optical diagram on the next page.*)



3.4 ELECTRICAL DESCRIPTION

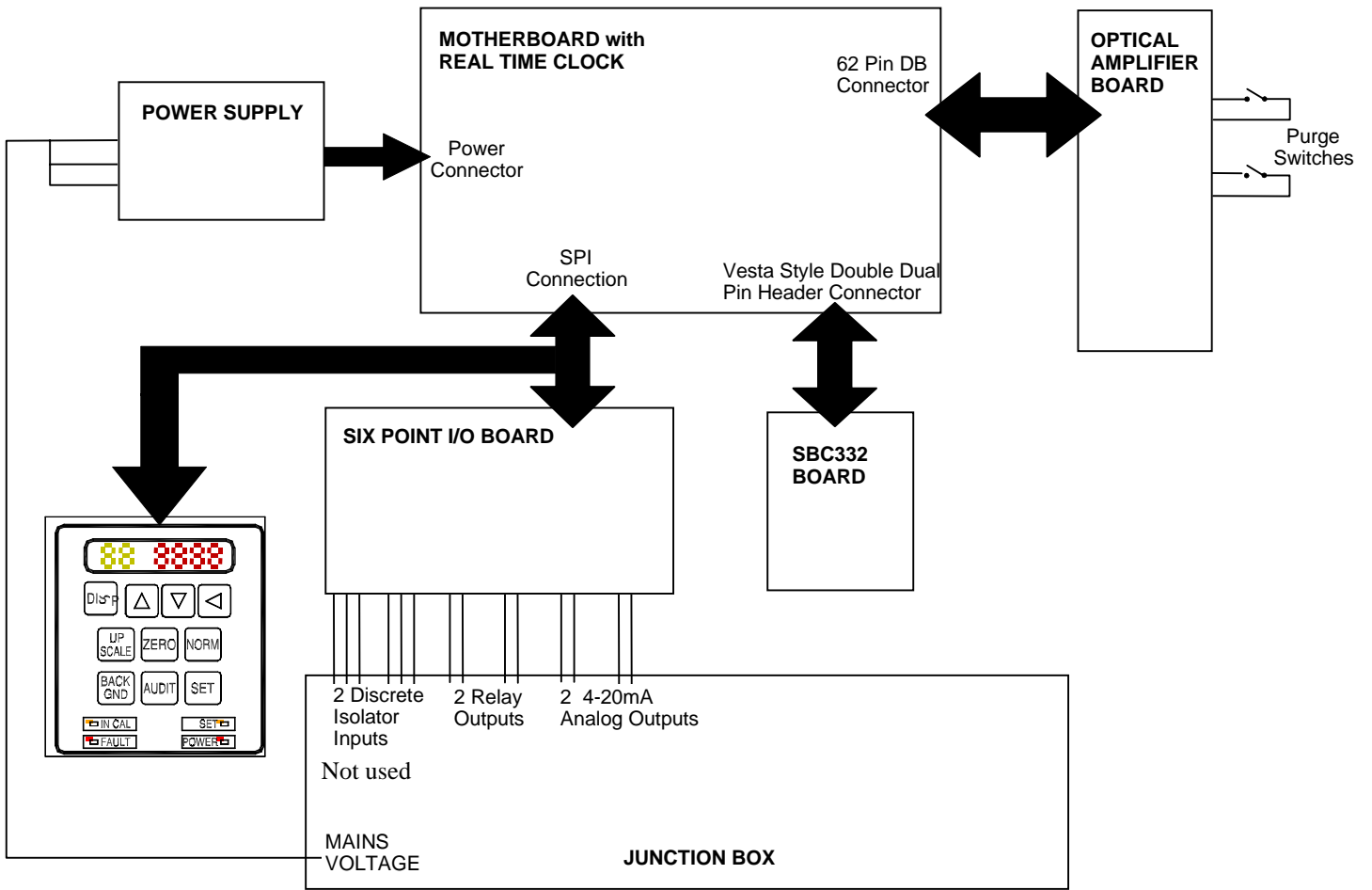
The electrical configuration of the Optical Head includes connections for AC power wiring from user supplied circuits, and internal signal processing electronics.

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 wiring between the Optical Head Assembly and customer equipment 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 in the diagram on the following page.)



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

"A" - Auxiliary parameters

3.5.2 Keypad

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 while a data field is currently displayed, there is no effect. When pressed and held simultaneously with "NORMAL" 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 to select the character column for data input. Shifts the display to the next bank when pressed in conjunction with the "DISP" key.
	"UPSCALE":	No effect.
	"ZERO":	No effect.
	"NORM":	No effect.
	"BACKGND":	Has no function when used alone. Used in conjunction with the SET key to perform a BACK GROUND SET function during maintenance or calibration.
	"AUDIT":	No effect.

3.5.2.2 Combinations of Keys

SET*ZERO:	No effect.
SET*BACKGND:	Initiates a BACKGROUND SET function.
SET*NORMAL:	Initiates a Clear Stack SET.
UPSCALE*ZERO:	No effect.
DISPLAY*LEFT:	Toggles the display from User data (U) to Service data (S) and parameter (F, 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:	No effect.
AUDIT*NORM:	No effect.
AUDIT*UPSCALE:	No effect.
AUDIT*BACKGND:	No effect.

3.5.3 Status LED's

The status LED's in the Optical Head overlay are defined as follows:

IN CAL:	Not used.
FAULT:	Lights when an instrument malfunction occurs.
SET:	Lights when NORMAL, or BACKGROUND sets are in progress or when parameter changes have been accepted. Blinks when 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"

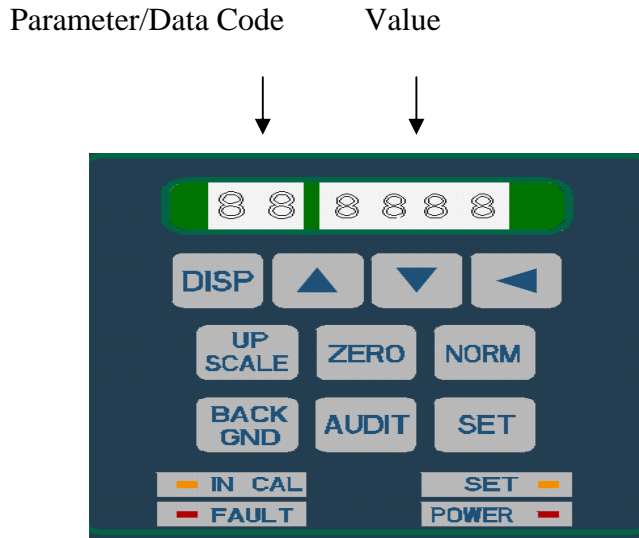
The value of the data in location U2 will be displayed on the RED 4-digit display to the right of the location identifier.

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 = Not used

X 4 X X = CLEAR STACK SET in progress

X 2 X X = Not used

X 1 X X = Not used

X X 4 X = Not used

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 = Not used

X X X 4 = Not used

X X X 2 = Not used

X X X 1 = Not used

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 = Not used

XXX1 = NORMAL (Stack) Mode

XXX2 = Not used

XXX3 = Not used

Audit Mode Filter Value

X0XX = Not used

X1XX = Not used

X2XX = Not used

X3XX = Not used

Audit Mode Condition

0XXX = Not in Audit Mode

1XXX = Not used

2XXX = Not used

3XXX = Not used

4XXX = Not used

5XXX = Not used

U6: Not used

- U7: Not used
- U8: Not used
- U9: Not used
- UA: 332 Version -- Software version of 68332 microprocessor code
- UB: Not used

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: Not used
- S5: BACKGROUND SET Voltage
- S6: Optical Head Temperature, °C
- S7: Not used
- 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: Not used
- SE: Not used

3.5.4.2 Parameter Codes

Parameters are configuration-oriented variables. All are user configurable only after password entry. They are divided into F, and A Banks, where F represents Fundamental, 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: Not used
- F5: 6PIO 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 (Current Value)
- F8: Signal Gain
- F9: Reference Gain
- FA: Common Gain
- FB: Averaging Interval, minutes
- FC: Not used
- FD: Not used
- FE: Six Point I/O Full Scale (may be % opacity, optical density, or mg/³ depending on Measurement Unit [F0])
- FF: Not used

3.5.4.2.2 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/m³

A5: X2, Input Point #2, Optical Density

A6: Y2, Output Point #2, Particulate Mass, mg/m³

A7: X3, Input Point #3, Optical Density

A8: Y3, Output Point #3, Particulate Mass, mg/m³

4.0 SIX POINT I/O BOARD FOR *LIGHTHAWK*[®] 560P SYSTEM

4.1 OVERVIEW

This section describes the behavior of the Six Point I/O Board (6PIO) in the *LightHawk*[®] 560P system. The Six Point I/O Board used in the *LightHawk*[®] 560P is packaged in the Optical Head. External connections are made through the External Interface PC Board. See Wiring Diagram for connections.

4.2 ANALOG OUTPUT DESCRIPTION

There are two analog outputs. They are isolated from each other and circuit common.

DAC 1 (Channel 1 or Out 1) is always dedicated to the Instantaneous value.

DAC 2 (Channel 2 or Out 2) is always Selectable Average.

The DAC 1 and 2 output scaling may be based on either Opacity, Optical Density or Dust Mass depending on the Measurement Unit parameter value; whatever the user has selected for the LED display will be assumed to be the desired analog output variable. For example, if Measurement Unit (F0 location) = 1, the LED display and analog outputs will take their inputs from Opacity, if Measurement Unit = 2, they will use Optical Density, etc.

4.2.1 Analog Output Scaling

- If ((Measurement Unit Parameter F0 = 1) **AND** (6PIO Jumper JU9 = 4)):
 - 4mA = 0% Opacity
 - 20mA = 100% Opacity
- If ((Measurement Unit Parameter F0 = 1) **AND** (6PIO Jumper JU9 = 0)):
 - 0mA = 0% Opacity
 - 20mA = 100% Opacity
- If ((Measurement Unit Parameter F0 = 2) **AND** (6PIO Jumper JU9 = 4)):
 - 4mA = Optical Density of 0
 - 20mA = Optical Density of 2
- If ((Measurement Unit Parameter F0 = 2) **AND** (6PIO Jumper JU9 = 0)):
 - 0mA = Optical Density of 0

20mA = Optical Density of 2

- If ((Measurement Unit Parameter F0 = 3) **AND** (6PIO Jumper JU9 = 4)):

4mA = Dust Mass of 0 mg/m³

20mA = Dust Mass of (2 * Dust Mass Gain Factor) mg/m³

- If ((Measurement Unit Parameter F0 = 3) **AND** (6PIO Jumper JU9 = 0)):

0mA = Dust Mass of 0 mg/m³

20mA = Dust Mass of (2 * Dust Mass Gain Factor) mg/m³

4.3 JUMPERS THAT EFFECT ANALOG OUTPUTS

- **0/4 (JU9):** This jumper is used to select between 0-20mA and 4-20mA ranges for the analog outputs. Only the 4-20mA range possesses live zero capability.
- **TEST ZERO SCALE (JU10):** This jumper is used to set both analog outputs to ZERO SCALE which can be either 0 or 4mA depending on the setting of the 0/4 jumper. Potentiometer R11 is used to adjust output #1, and R23 to adjust output #2 for zero scale.
- **TEST FULL SCALE (JU11):** This jumper is used to set both analog outputs to FULL SCALE (20mA). Potentiometer R10 is used to adjust output #1, and R22 to adjust output #2 for full scale.
- **TEST ZERO SCALE AND TEST FULL SCALE:** When both of these jumpers are actuated simultaneously, both the analog outputs go to MID SCALE (12mA if the 0/4 jumper is set to 4, 10mA if the 0/4 jumper is set to 0).
- **JU1, JU2, JU3, AND JU4:** These jumpers are used to setup internal measurement parameters for the 6PIO. 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" & JU11 "FS"	Test Mid Scale
JU1 = 0 JU2 = 1 JU3 = 0 JU4 = 1	Internal Ranging (Do not move)

Table 4.1
Output Jumper Configuration

4.4 RELAY OUTPUTS

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

K1 JU12	K2 JU13	Function
A	A	Not used
B	B	Instrument Malfunction
C	C	Instantaneous Alarm 1 Actuated
D	D	Selectable Average Alarm 1 Actuated
E	E	Not used
F	F	Not used
G	G	Purge Failure
H	H	Not used

Table 4.2
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 4.3
Relay Contact Configuration Jumpers

4.5 DATA CABLES

Two data cables are needed to interconnect the 6PIO to external devices. One is a 4 conductor #20 AWG (0.5 mm²) cable for connecting the contacts from the two relays. The other one Teledyne Monitor Labs recommends is a 6-pair #24 AWG (0.25 mm²) shielded cable for connection to the two analog outputs. This would leave four pairs as spares for future use. See Wiring Diagram for details on external connections to the 6PIO PC Board.

(This page intentionally left blank.)

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.

(This page intentionally left blank.)

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 and Retroreflector.

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 standard Purge Air System has an air filter 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. Refer to Appendix C of this manual for replacement filter part numbers.

Purge Shutters are optional equipment and may not be present on your *LightHawk*® 560P. The Purge Air Shutters are not included on an upgrade from the LS541, 1100M, or MC2000. 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. 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 and the surface of the Retroreflector windows need to be cleaned.

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.

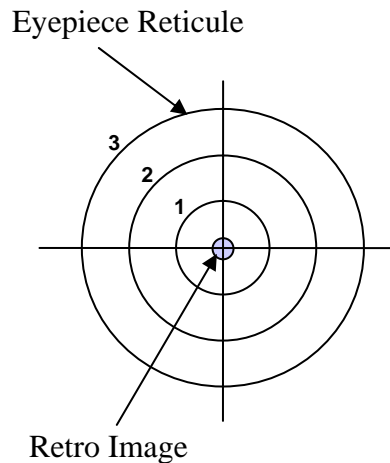


Figure 7-1

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.

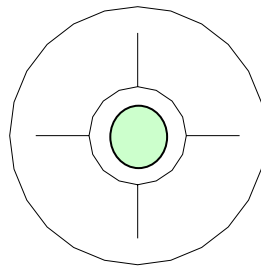


Figure 7-2

- 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.

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*® 560P 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 then finishes at the DAS/recorder. Begin the checklist by filling in the information regarding serial number, location, date, and service person.

(1) Reason for Service

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) Final Output Device Checks

A. Current Readings

Record the "As Found" opacity readings from the user's final output device display, DAS or recorder.

B. Fault Indicators

Record the status, ON or OFF, of any user's Malfunction or Alarm indicators.

(3) ON-STACK CHECKS

A. 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 the LS541, 1100M, or MC2000. 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 desiccator is mounted on the top right of the front plate. If the desiccator is still useable, it will indicate a blue to blue/white color. When the desiccator indicates a pink color, it is completely spent. The desiccator 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.
- 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.

B. Comments

Provide any comments that help to describe the general condition of the stack mounted equipment in the space available.

C. Clean

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.

D. 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.

E. 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.*

F. 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.*

G. 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.

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

Where the actual value = Labeled %opacity / 100

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

Install the weather cover. At this time all stack checks are completed. Return to the permanent recording device location.

(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 Section 3. Compare these values with the corrected attenuator values for the absolute difference. Enter this difference in the table. It should be $\leq 2\%$ opacity.

B. Fill in Section 2 "AS LEFT"

- Record the instantaneous and average opacity values “**AS LEFT**” in Section 2.

(This page intentionally left blank.)

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 ($\pm 10\%$) 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 $\pm 10\%$ 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. The Retroreflector Assembly cover is not available on an upgrade from the LS541, 1100M, or MC2000.

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.*

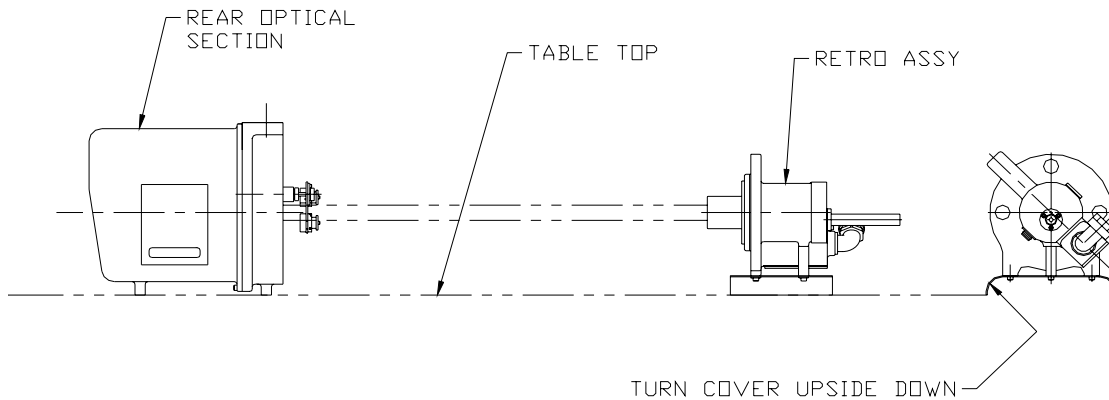


Figure 8-1

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.

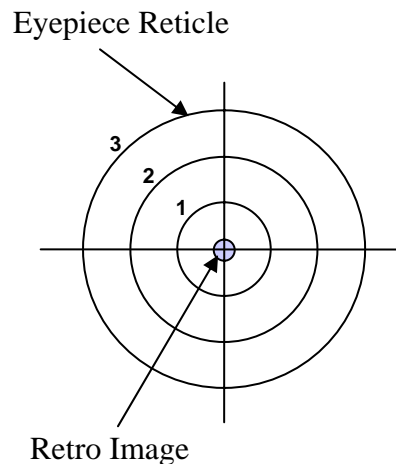


Figure 8-2

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.

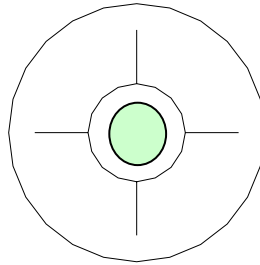


Figure 8-3

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 increased opacity by the instrument. Under normal conditions, only the Exit Window of the Optical Head Assembly and the Retroreflector Surface 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 contaminants 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

Two surfaces must be cleaned before calibration. Both 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

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 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**

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 Technical 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.*

$$\text{New Gain} = (\text{Present Gain}) (6.5 / \text{Present Signal Voltage})$$

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.

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)*
- *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.

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 $\pm 0.2\%$ 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 8-4.

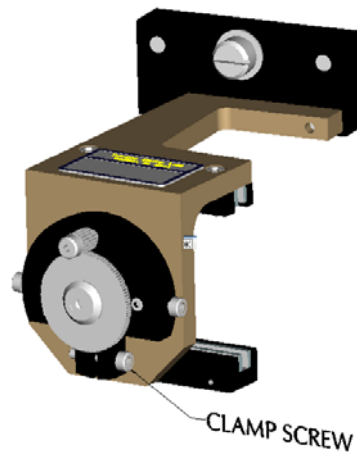


Figure 8-4

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 8-5 showing the cover and gear clamp temporarily installed.

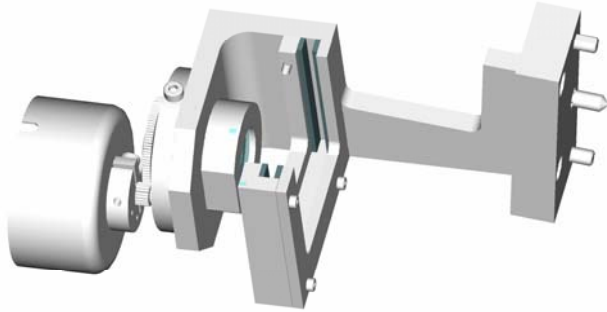


Figure 8-5

7. Rotate the cover until the analyzer U0 display value is 0.0% ($\pm 0.2\%$) 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 $\pm 0.2\%$ 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 8.8 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.

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

EXAMPLE: Marked value 20% opacity

$$\text{PLCF} = 0.900$$

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

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

$$\text{Exit value} = 1 - 0.818$$

$$\text{Exit value} = 0.182$$

$$\text{Exit value} = 18.2 \% \text{ opacity}$$

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

8.8 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 8-6.

2. Remove the gear screw, collar and gear. See Figure 8-6.
3. Remove the 2 Allen head screws holding the ND Cover. See Figure 8-6.
4. Remove the ND cover, front gasket, ND window and rear gasket. See Figure 8-6.
5. Re-assemble the rear gasket, new ND window, front gasket and ND cover as shown in Figure 8-6. **Note: The ND window must be installed with the coating side IN toward the rear gasket.**
6. Re-install the gear, collar and gear screw. See Figure 8-6.
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.

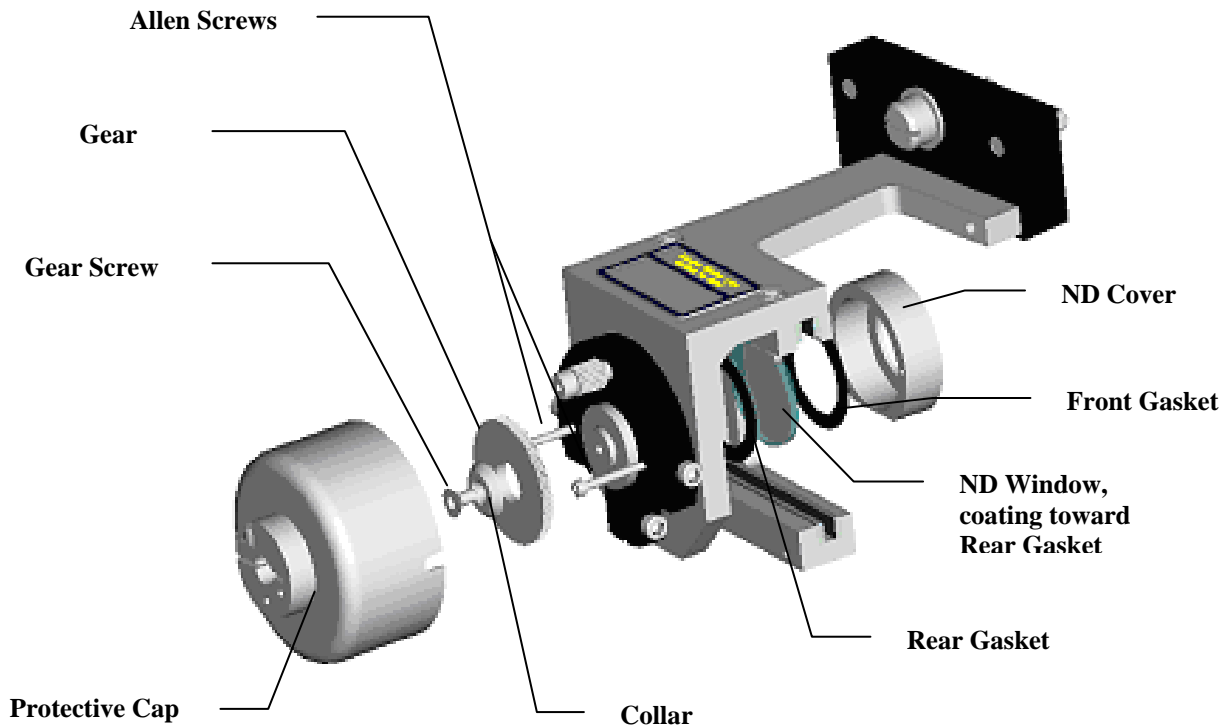


Figure 8-6

8.9 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					
Cal Kit Iris Diameter					
Cal Kit ND Window					

¹The precise distance between the opposing faces of the mounting flanges for the monitor

²The precise distance between the Optical Exit Window and the Retroreflector Surface Window

³Parameter location F9

⁴Parameter location F8

Table 8-1

(This page intentionally left blank.)

9.0 INSTALLATION

The installation overview of the *LightHawk*[®] 560P 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 Opacity Monitor *LightHawk*[®] 560 Flange Mtg. Method 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:

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

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

Example:

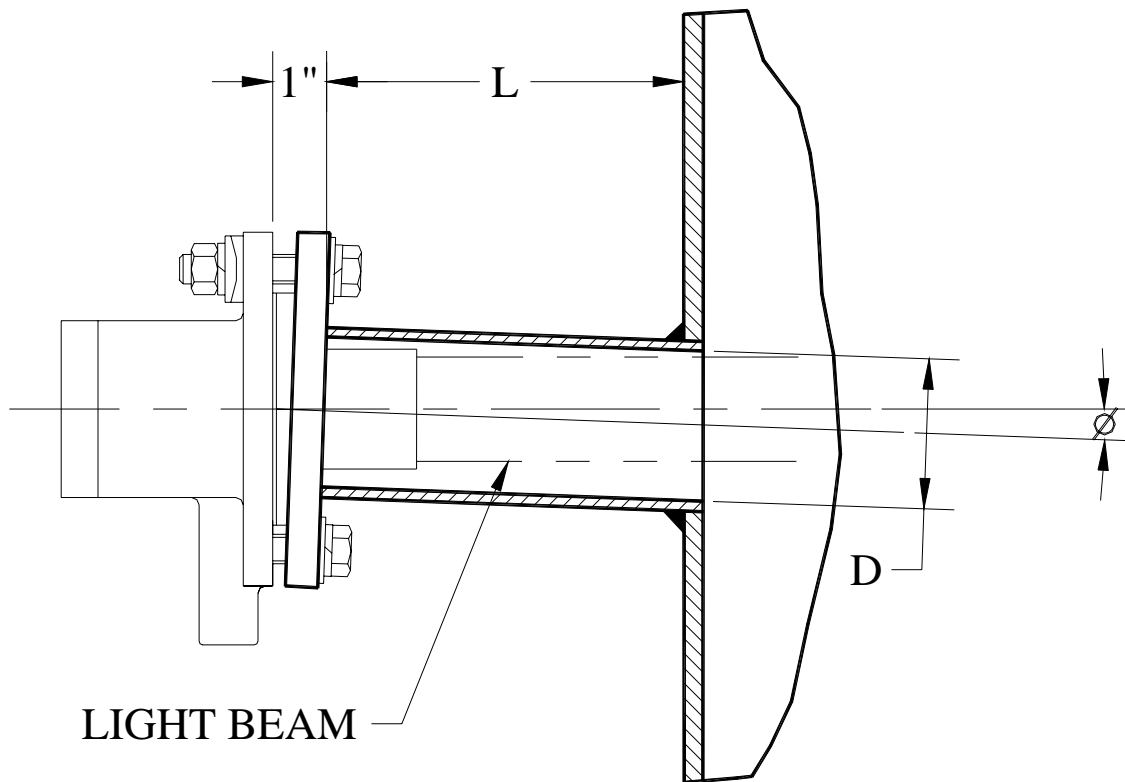
$$\phi = \text{ARC SIN} \left[\frac{\{(2/2) - .5\}}{(5.5+1'')} \right]$$

$$\phi = \text{ARC SIN} .5/6.5$$

$$\phi = 4.41^\circ$$

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.



560 Opacity Port Alignment

Figure 9-1

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.)*

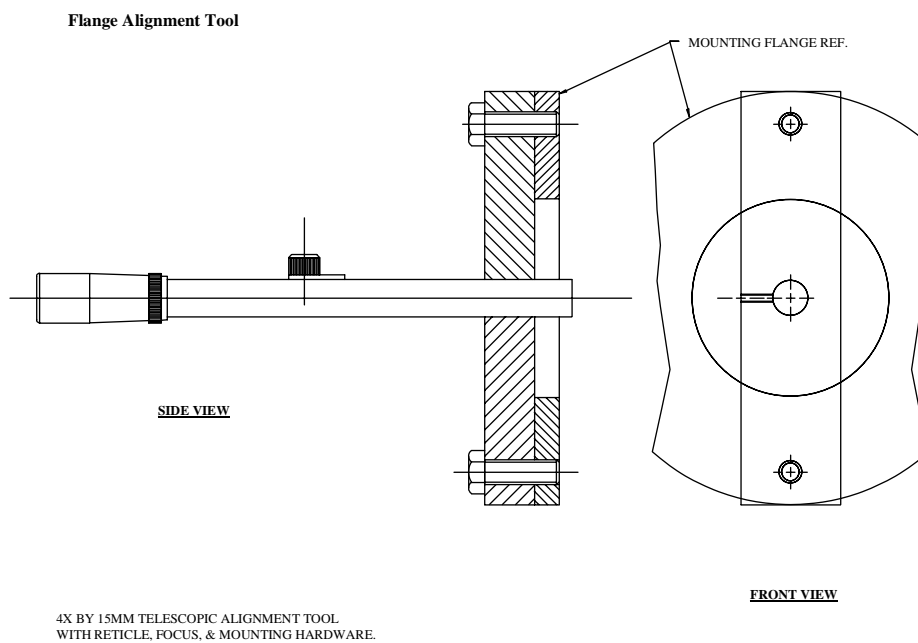


Figure 9-2

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*® 560P 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 BEFORE 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 CABLE

Two data cables are typically used between the Integral Junction Box and the user's permanent display device. One should consist of a 6 twisted pair with shield composed of #24 AWG wires and suitable jacket material for the analog signals and the digital input signals. The other should consist of 4 twisted pairs of #20 AWG wires and suitable jacket material for the relay output connections. See the Wiring Diagram-Model 560P Opacity drawing and the Model 560P Specification section of this manual for details about the cable.

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.

(This page intentionally left blank.)

10.0 TROUBLESHOOTING

The Primary Status Code (U3) 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 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*[®] 560P 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 Technical 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 Not Used

X1XX Not Used

X2XX Not Used

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

1XXX Not Used

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 ASSISTANCE

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

APPENDIX A
SITE SPECIFICATION DATA SHEETS

(This page intentionally left blank.)

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 _____

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	

(This page intentionally left blank.)

APPENDIX B
MAINTENANCE CHECK SHEETS

(This page intentionally left blank.)

TELEDYNE MONITOR LABS
MAINTENANCE CHECK SHEETS for *LightHawk*® 560P OPACITY SYSTEM

PLANT NAME _____ LOCATION _____
 SERVICE PERSON _____ SERIAL # _____
 DATE _____ TIME _____

(1) **A. REASON FOR SERVICE**
 ROUTINE EMERGENCY INSTALL OTHER
 EXPLAIN: _____

(2) **Final Output Device Checks**

A. Current Opacity Readings (MAIN DISPLAY)

	INST OPACITY	AVG OPACITY
AS FOUND	_____ %	_____ %
AS LEFT	_____ %	_____ %

B. RELAY INDICATOR'S FAULT OR ALARM (2 OF 4 CHOICES ONLY)

	Inst. Mal'f	Purge Fail	Inst. Alm	Avg. Alm
ON	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
OFF	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(3) **On-Stack Checks**

A. INSPECT

	PURGE AIR FILTERS	FLEX HOSES	MOUNTING TUBES	PURGE SHUTTERS	DESIC-CATOR
OK	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CLEANED	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
REPLACED	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>

	OPTICAL ALIGNMENT	
	HEAD	RETRO
OK	<input type="radio"/>	<input type="radio"/>
ADJUSTED	<input type="radio"/>	<input type="radio"/>

B. COMMENTS: _____

C. CLEAN: RETRO EXIT WINDOW CAL KIT

D. **INSTALL** CAL KIT FIXTURE OK

E. PERFORM BACKGROUND SET OK

F. PERFORM NORMAL SET OK

G. CAL KIT READINGS PLCF = _____

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

H. **REMOVE** CAL KIT FIXTURE OK

(4) DATA COLLECTION

A. RECHECK OUTPUT DEVICE OK
VALUES ABOVE

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

NOTES OR RECOMMENDATIONS :

APPENDIX C
SPARE PARTS

(This page intentionally left blank.)

RECOMMENDED SPARE PARTS

Recommended spare parts for the *LightHawk*[®] 560P Opacity Monitor are organized into three categories. User can stock the appropriate parts for their level of maintenance. The three lists do not overlap. For the highest level of maintenance all three lists should be stocked. For normal maintenance the start-up and normal lists should be stocked. The three 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.

“Start Up/Operational” Spare Parts

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

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

TELEDYNE MONITOR LABS (TML) LIGHTHAWK® 560P “STARTUP/OPERATIONAL” RECOMMENDED SPARE PARTS								
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Cal Kit</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Off-stack</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Mean Time</u> <u>Between</u> <u>Replacement</u>
			<u>1 on Site</u>	<u>2 – 5 on</u> <u>Site</u>	<u>5 – 10 on</u> <u>Site</u>			
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
* 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

NOTE: * 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) <i>LIGHTHAWK</i> [®] 560P "MAINTENANCE" RECOMMENDED SPARE PARTS								
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Cal Kit</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Off-Stack</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Estimated</u> <u>Mean Time</u> <u>Between</u> <u>Failures</u>
			<u>1 on Site</u>	<u>2 - 5 on</u> <u>Site</u>	<u>5 - 10 on</u> <u>Site</u>			
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 Motherboard	1	2	3	No	No	3-5 Yrs

NOTE: * 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® 560P "EMERGENCY/QUICK RESPONSE" RECOMMENDED SPARE PARTS								
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking</u>	<u>Stocking</u>	<u>Stocking</u>	<u>Cal Kit</u>	<u>Off-Stack</u>	<u>Estimated</u>
			<u>Quantity</u>	<u>Quantity</u>	<u>Quantity</u>			
			<u>1 on Site</u>	<u>2 - 5 on Site</u>	<u>5 - 10 on Site</u>	<u>Required</u>	<u>Required</u>	<u>Between</u>
						<u>After</u>	<u>After</u>	<u>Replacement</u>
						<u>Replacement</u>	<u>Replacement</u>	
Optical Amplifier PCB	1860-0400-01	Optical Head	1	1	1	Yes	No	N/A
560 Mother Board PCB	1860-0500-02	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
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
** 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

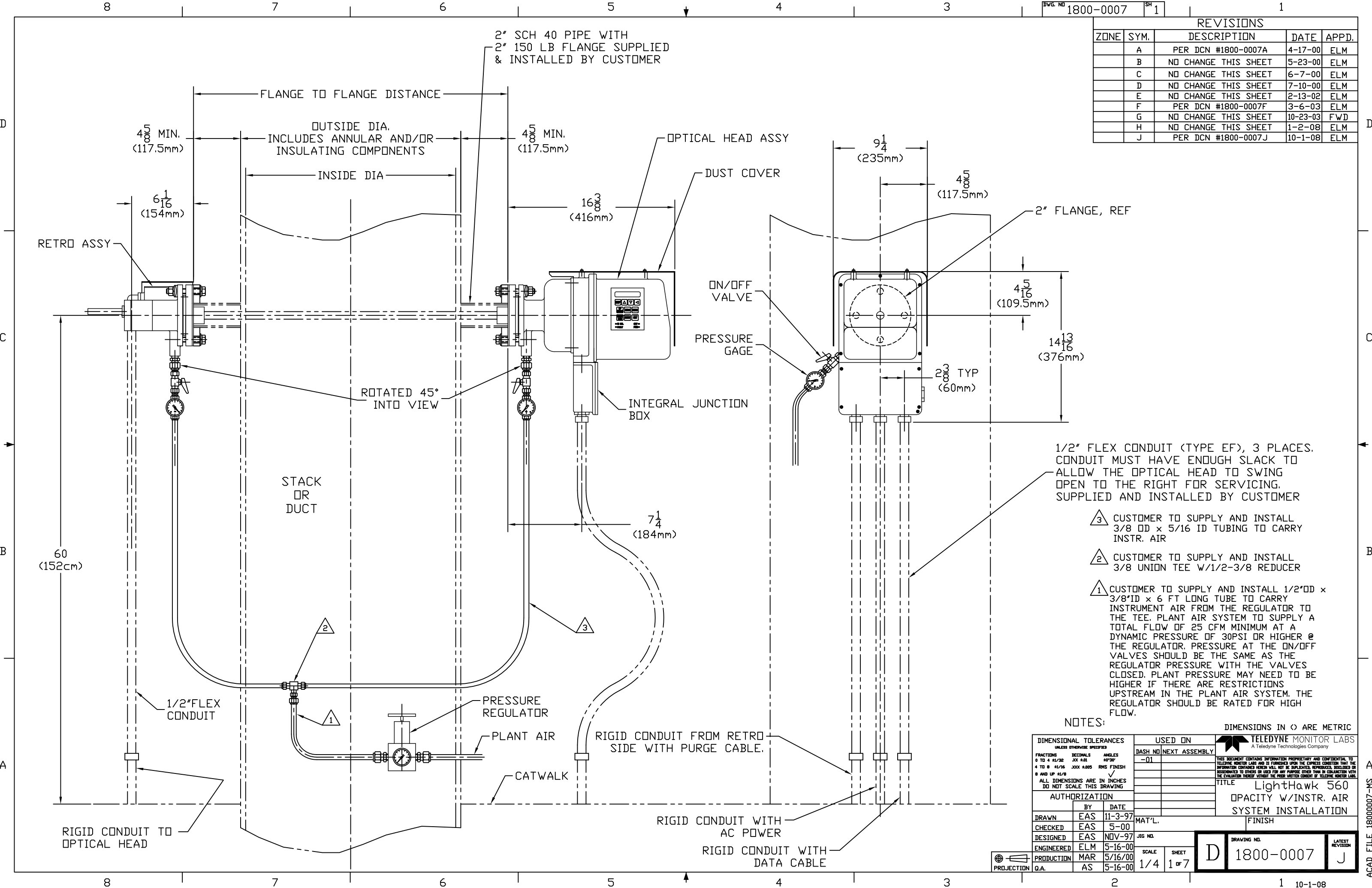
NOTES: * Each monitor at a particular site may have a different Retro Cap. Review the site specification data for each monitor to insure that the proper Retro Cap is ordered.

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

APPENDIX D
DRAWINGS

(This page intentionally left blank.)

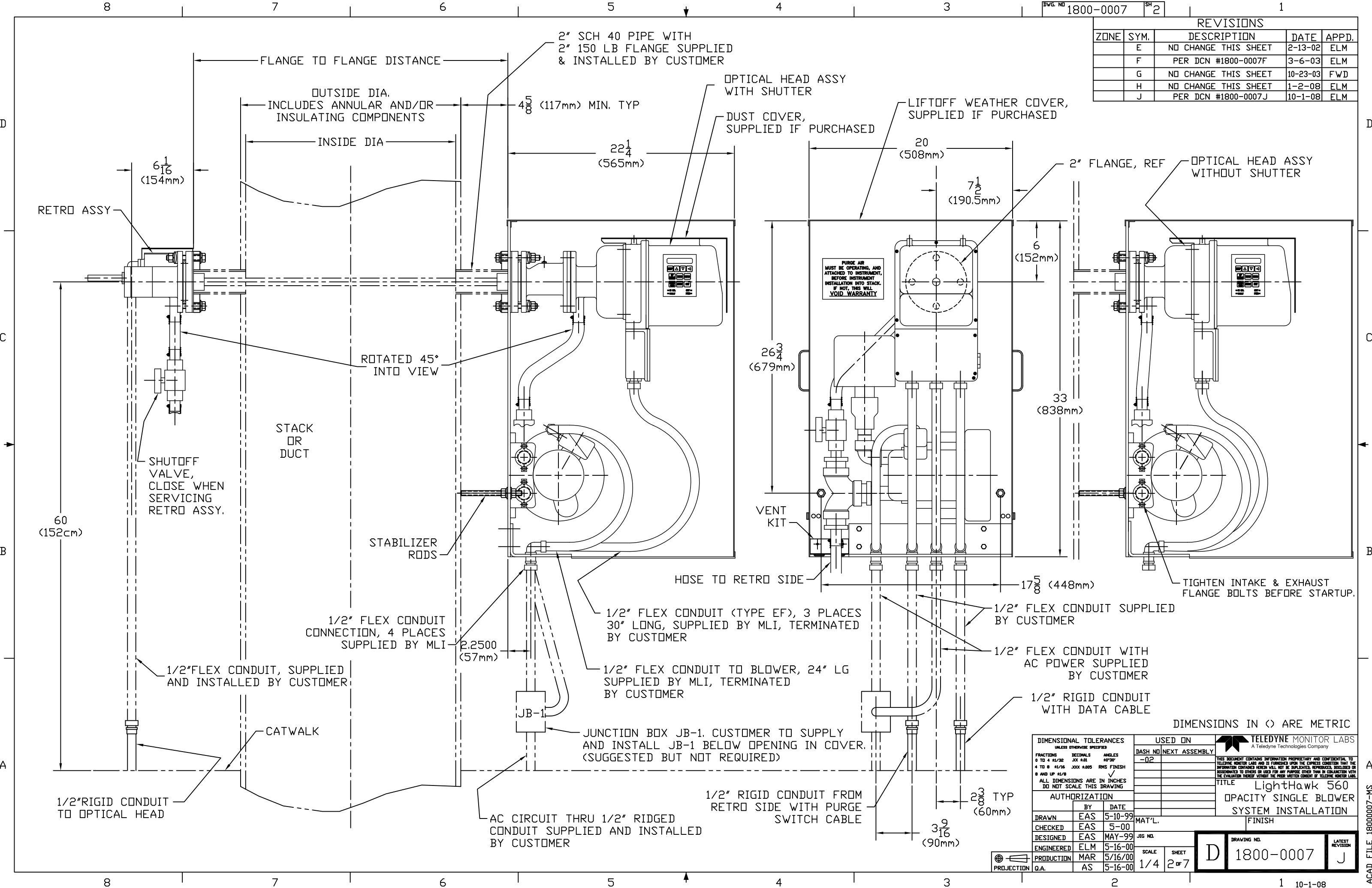
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0007A	4-17-00	ELM
	B	NO CHANGE THIS SHEET	5-23-00	ELM
	C	NO CHANGE THIS SHEET	6-7-00	ELM
	D	NO CHANGE THIS SHEET	7-10-00	ELM
	E	NO CHANGE THIS SHEET	2-13-02	ELM
	F	PER DCN #1800-0007F	3-6-03	ELM
	G	NO CHANGE THIS SHEET	10-23-03	FWD
	H	NO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



DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 41/32 .001 45° .001 4 TO 8 41/64 .001 90° .001 8 AND UP 1/16 .001 RNS FINISH ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -01	TELEDYNE MONITOR LABS A Teledyne Technologies Company THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPHRASED, SOLELIED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS. TITLE LightHawk 560 OPACITY W/INSTR. AIR SYSTEM INSTALLATION FINISH
AUTHORIZATION 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		MAT'L. JIG NO. SCALE 1/4 SHEET 1 OF 7	DRAWING NO. 1800-0007 LATEST REVISION J

ACAD FILE 18000007-MS

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



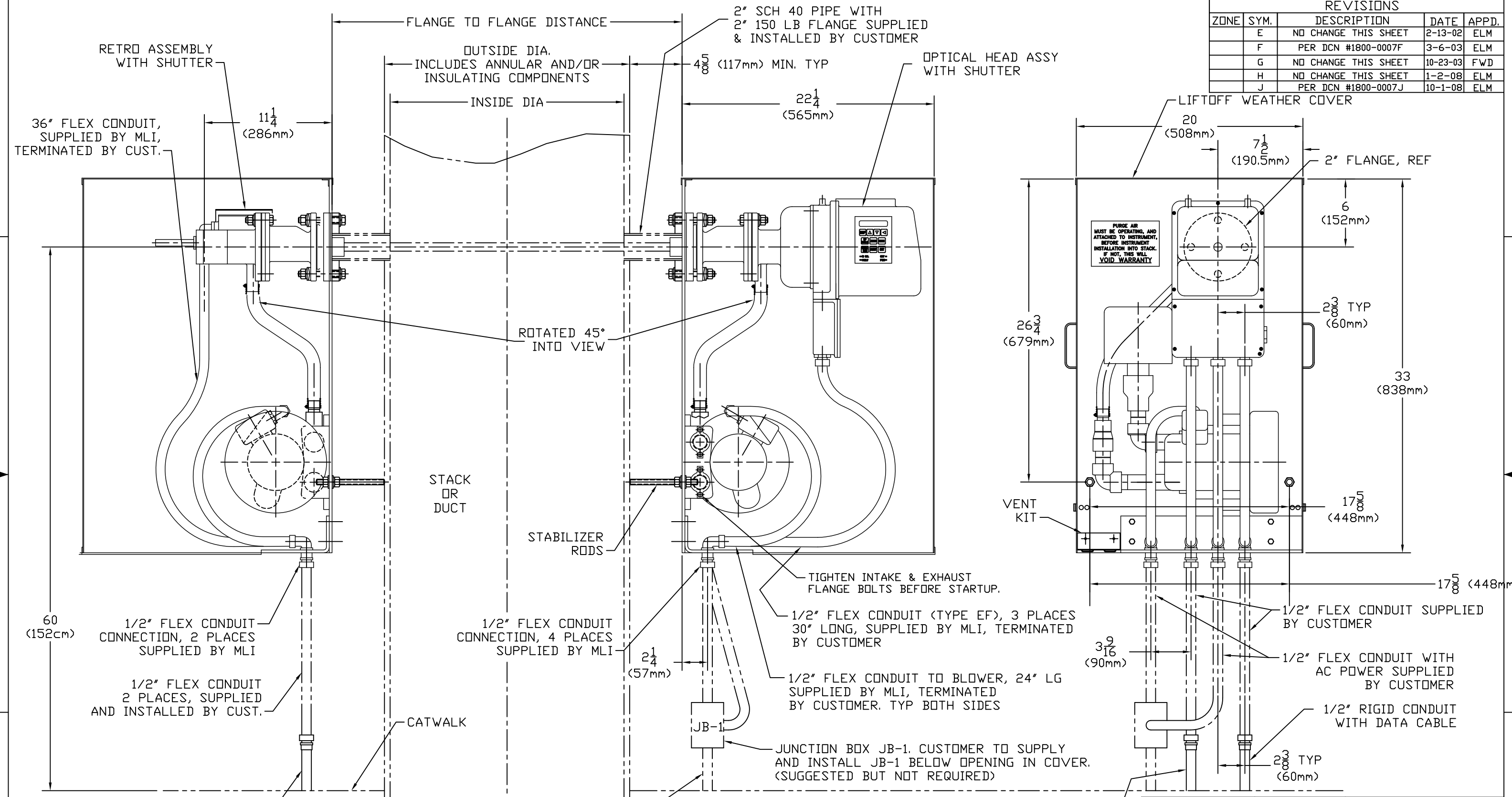
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 41/32	.XX .XX	±30°
4 TO 8 41/16	.XX .XX	RMS FINISH
8 AND UP 41/8	.XX .XX	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		
AUTHORIZATION		
DRAWN	EAS	5-10-99
CHECKED	EAS	5-00
DESIGNED	EAS	MAY-99
ENGINEERED	ELM	5-16-00
PRODUCTION	MAR	5/16/00
Q.A.	AS	5-16-00

USED ON		TELEDYNE MONITOR LABS A Teledyne Technologies Company	
DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPHRASED, COPIED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
-02		TITLE LightHawk 560 OPACITY SINGLE BLOWER SYSTEM INSTALLATION	
FINISH		DRAWING NO. 1800-0007	
SCALE		SHEET 2 OF 7	
1/4		LATEST REVISION J	



PROJECTION

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
		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

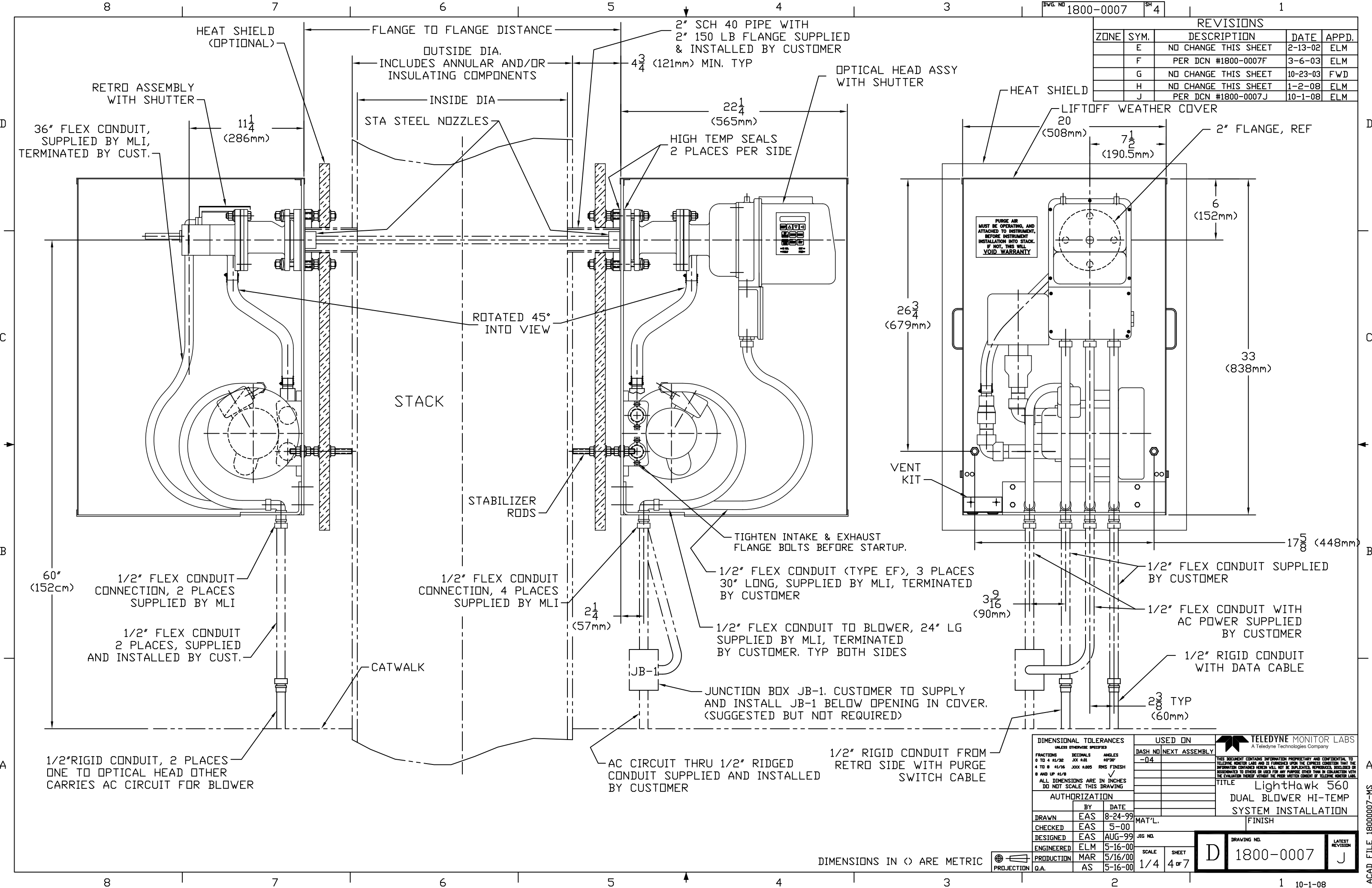


DIMENSIONAL TOLERANCES <small>UNLESS OTHERWISE SPECIFIED</small> FRACTIONS DECIMALS ANGLES 0 TO 4 41/32 .001 4:1 4 TO 8 41/64 .002 4:005 RMS FINISH 8 AND UP 41/8 .005 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY	A Teledyne Technologies Company <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPAIRED, COPIED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</small> TITLE LightHawk 560 OPACITY DUAL BLOWER SYSTEM INSTALLATION FINISH													
AUTHORIZATION <table border="1"> <tr> <th>BY</th> <th>DATE</th> </tr> <tr> <td>DRAWN</td> <td>EAS 8-19-99</td> </tr> <tr> <td>CHECKED</td> <td>EAS 5-00</td> </tr> <tr> <td>DESIGNED</td> <td>EAS AUG-99</td> </tr> <tr> <td>ENGINEERED</td> <td>ELM 5-16-00</td> </tr> <tr> <td>PRODUCTION</td> <td>MAR 5/16/00</td> </tr> <tr> <td>Q.A.</td> <td>AS 5-16-00</td> </tr> </table>		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
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															

DIMENSIONS IN () ARE METRIC

D	1800-0007	J
---	-----------	---

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



36" FLEX CONDUIT, SUPPLIED BY MLI, TERMINATED BY CUST.

HEAT SHIELD (OPTIONAL)

FLANGE TO FLANGE DISTANCE

OUTSIDE DIA. INCLUDES ANNULAR AND/OR INSULATING COMPONENTS

INSIDE DIA.

STA STEEL NOZZLES

2" SCH 40 PIPE WITH 2" 150 LB FLANGE SUPPLIED & INSTALLED BY CUSTOMER

4 3/4 (121mm) MIN. TYP

OPTICAL HEAD ASSY WITH SHUTTER

22 1/4 (565mm)

HIGH TEMP SEALS 2 PLACES PER SIDE

HEAT SHIELD

LIFTOFF WEATHER COVER

20 (508mm)

7 1/2 (190.5mm)

2" FLANGE, REF

6 (152mm)

26 3/4 (679mm)

33 (838mm)

17 5/8 (448mm)

1/2" FLEX CONDUIT CONNECTION, 2 PLACES SUPPLIED BY MLI

1/2" FLEX CONDUIT 2 PLACES, SUPPLIED AND INSTALLED BY CUST.

CATWALK

1/2" FLEX CONDUIT CONNECTION, 4 PLACES SUPPLIED BY MLI

2 1/4 (57mm)

1/2" FLEX CONDUIT (TYPE EF), 3 PLACES 30" LONG, SUPPLIED BY MLI, TERMINATED BY CUSTOMER

1/2" FLEX CONDUIT TO BLOWER, 24" LG SUPPLIED BY MLI, TERMINATED BY CUSTOMER. TYP BOTH SIDES

JB-1

JUNCTION BOX JB-1. CUSTOMER TO SUPPLY AND INSTALL JB-1 BELOW OPENING IN COVER. (SUGGESTED BUT NOT REQUIRED)

TIGHTEN INTAKE & EXHAUST FLANGE BOLTS BEFORE STARTUP.

VENT KIT

1/2" FLEX CONDUIT SUPPLIED BY CUSTOMER

1/2" FLEX CONDUIT WITH AC POWER SUPPLIED BY CUSTOMER

1/2" RIGID CONDUIT WITH DATA CABLE

3 9/16 (90mm)

2 3/8 (60mm) TYP

1/2" RIGID CONDUIT, 2 PLACES ONE TO OPTICAL HEAD OTHER CARRIES AC CIRCUIT FOR BLOWER

AC CIRCUIT THRU 1/2" RIDGED CONDUIT SUPPLIED AND INSTALLED BY CUSTOMER

1/2" RIGID CONDUIT FROM RETRO SIDE WITH PURGE SWITCH CABLE

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 31/32	.XX ±.01	±.005
4 TO 8 31/16	.XX ±.005	RHS FINISH
8 AND UP 31/8	.XX ±.01	

USED ON	
DASH NO	NEXT ASSEMBLY
-04	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.

TITLE LightHawk 560
DUAL BLOWER HI-TEMP
SYSTEM INSTALLATION
FINISH

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

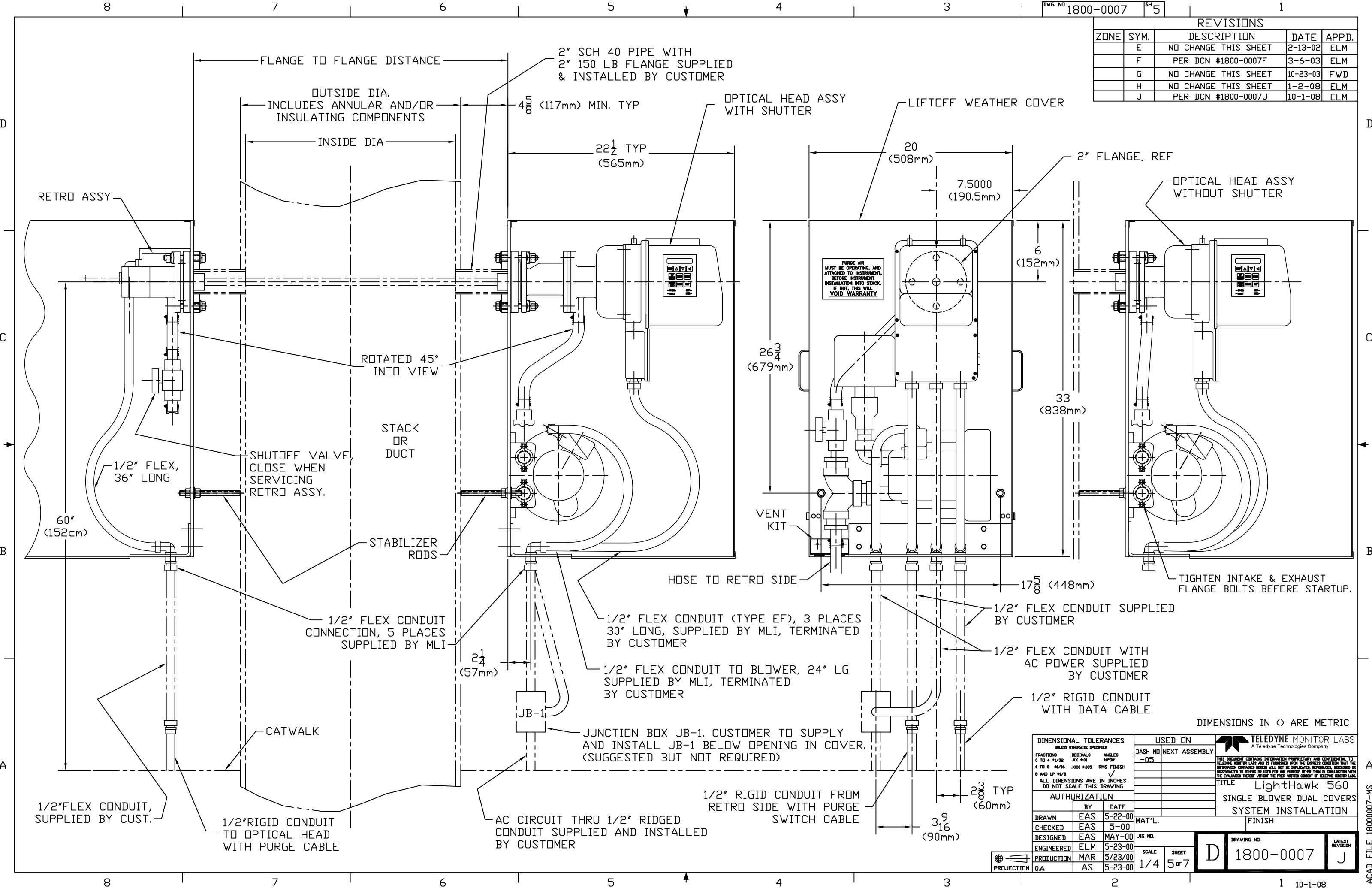
SCALE	SHEET
1/4	4 OF 7

DRAWING NO.	LATEST REVISION
D 1800-0007	J

DIMENSIONS IN () ARE METRIC



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



DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 41/32	.XX .XX	±30°
4 TO 8 41/16	.XX .XX	RHS FINISH
8 AND UP 41/8	.XX .XX	

USED ON	
DASH NO	NEXT ASSEMBLY
-05	

TELEDYNE MONITOR LABS A Teledyne Technologies Company	
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
TITLE LightHawk 560	
SINGLE BLOWER DUAL COVERS	
SYSTEM INSTALLATION	
FINISH	
BY	DATE
EAS	5-22-00
CHECKED	5-00
DESIGNED	MAY-00
ENGINEERED	ELM 5-23-00
PRODUCTION	MAR 5/23/00
Q.A.	AS 5-23-00



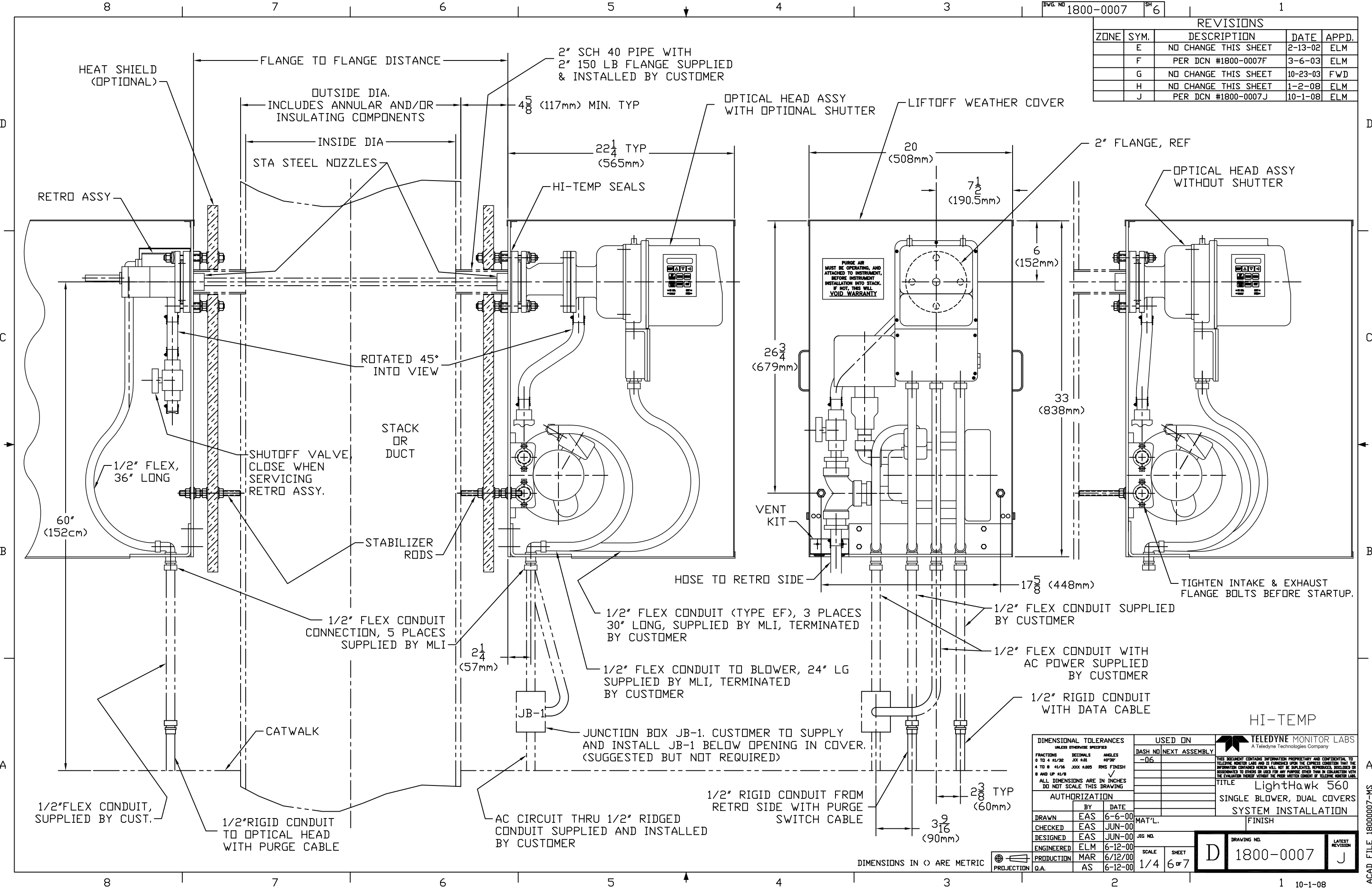
SCALE	SHEET
1/4	5 OF 7

DRAWING NO.	LATEST REVISION
D 1800-0007	J

DIMENSIONS IN () ARE METRIC

ACAD FILE 18000007-MS

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



DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED

FRACTIONS	DECIMALS	ANGLES
0 TO 4 41/32	.XX .XX	±30°
4 TO 8 41/32	.XX .XX	RMS FINISH
8 AND UP 41/8	.XX .XX	

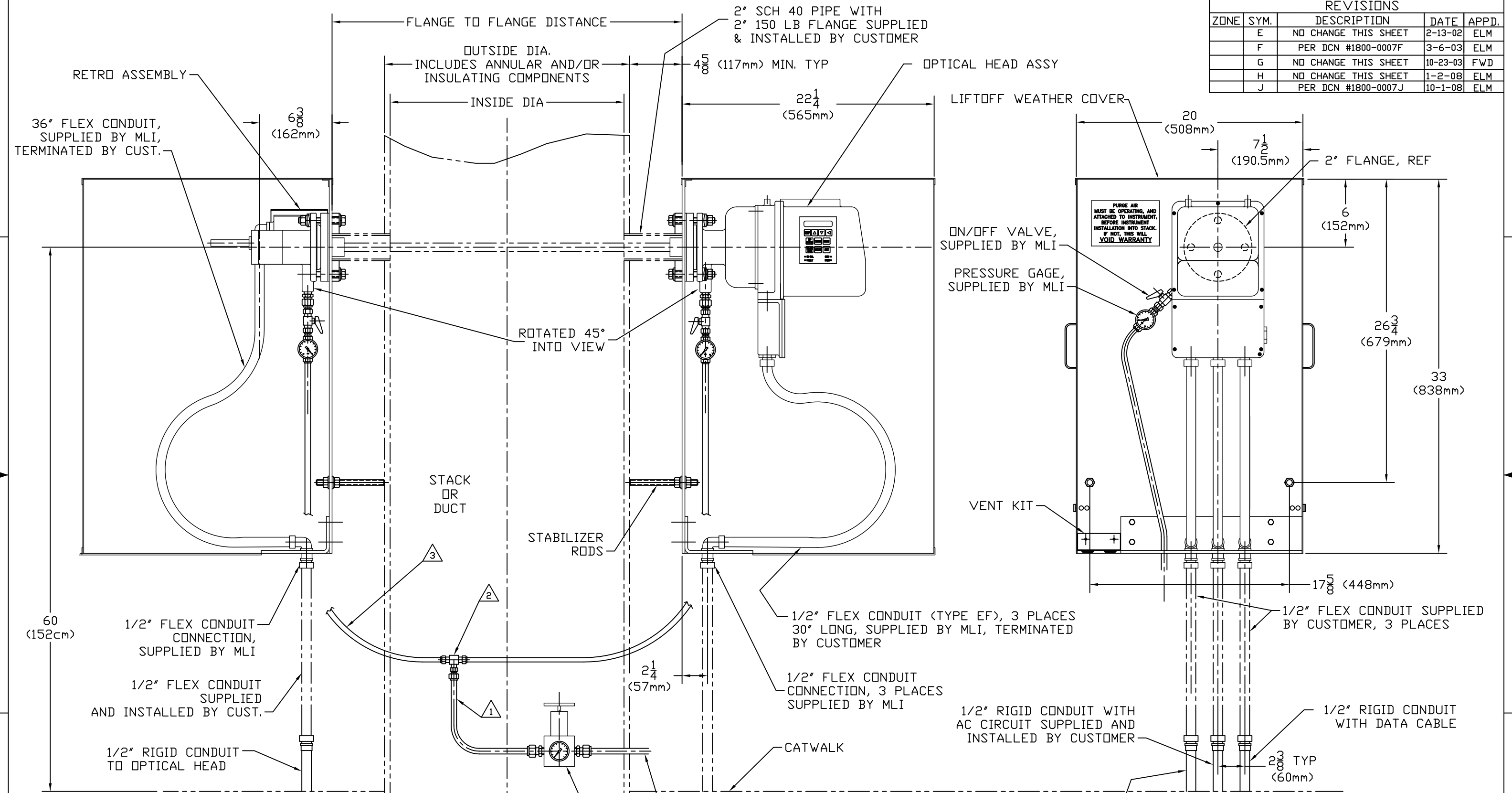
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION		
BY	DATE	
EAS	6-6-00	
EAS	JUN-00	
EAS	JUN-00	
ELM	6-12-00	
MAR	6/12/00	
AS	6-12-00	

USED ON	DASH NO/NEXT ASSEMBLY	-06
TELEDYNE MONITOR LABS A Teledyne Technologies Company		
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELETYPE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE WRITTEN CONSENT OF TELETYPE MONITOR LABS.		
TITLE LightHawk 560		
SINGLE BLOWER, DUAL COVERS		
SYSTEM INSTALLATION		
FINISH		
SCALE	SHEET	D 1800-0007 J
1/4	6 OF 7	

DIMENSIONS IN ◊ ARE METRIC

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.

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

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

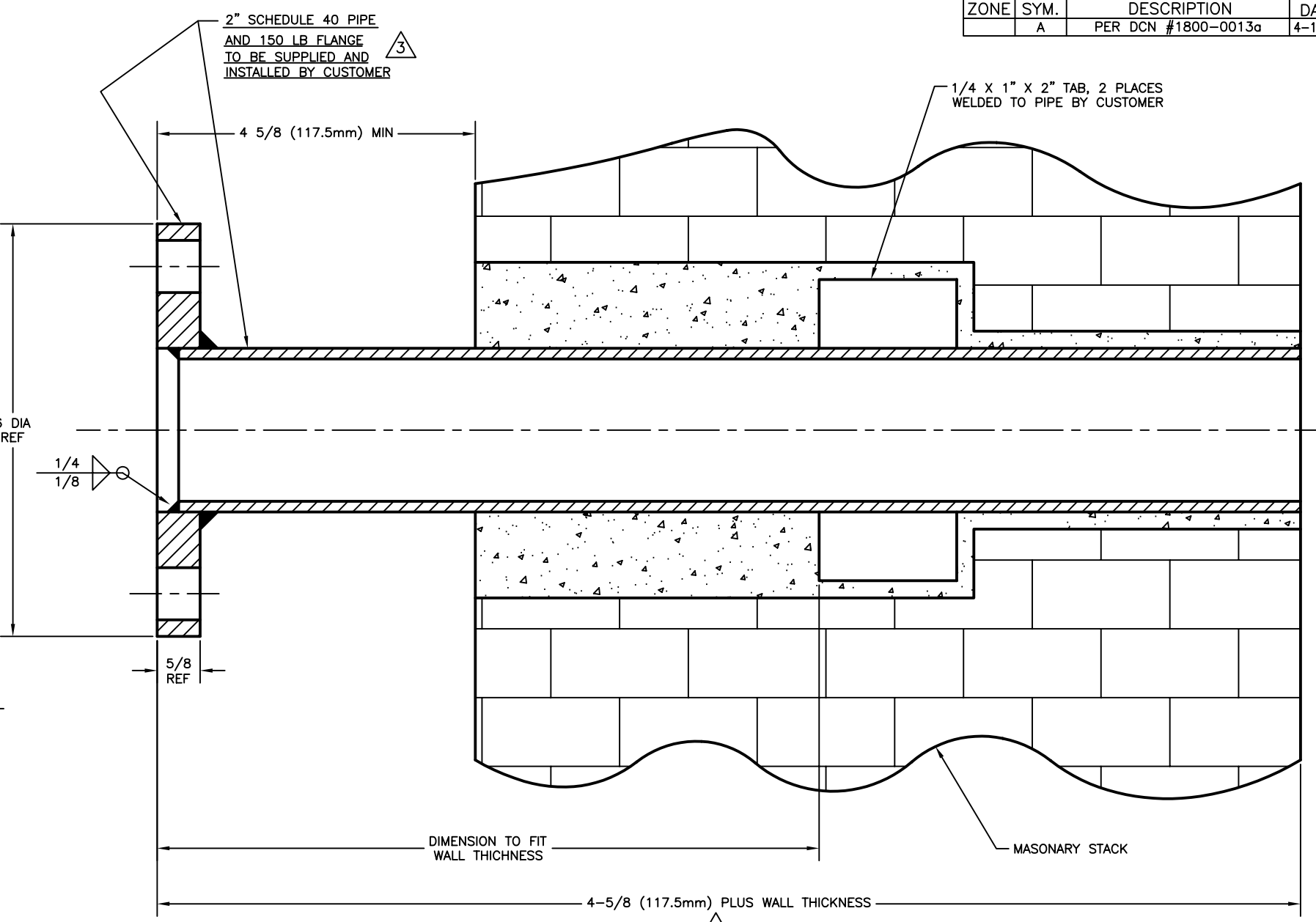
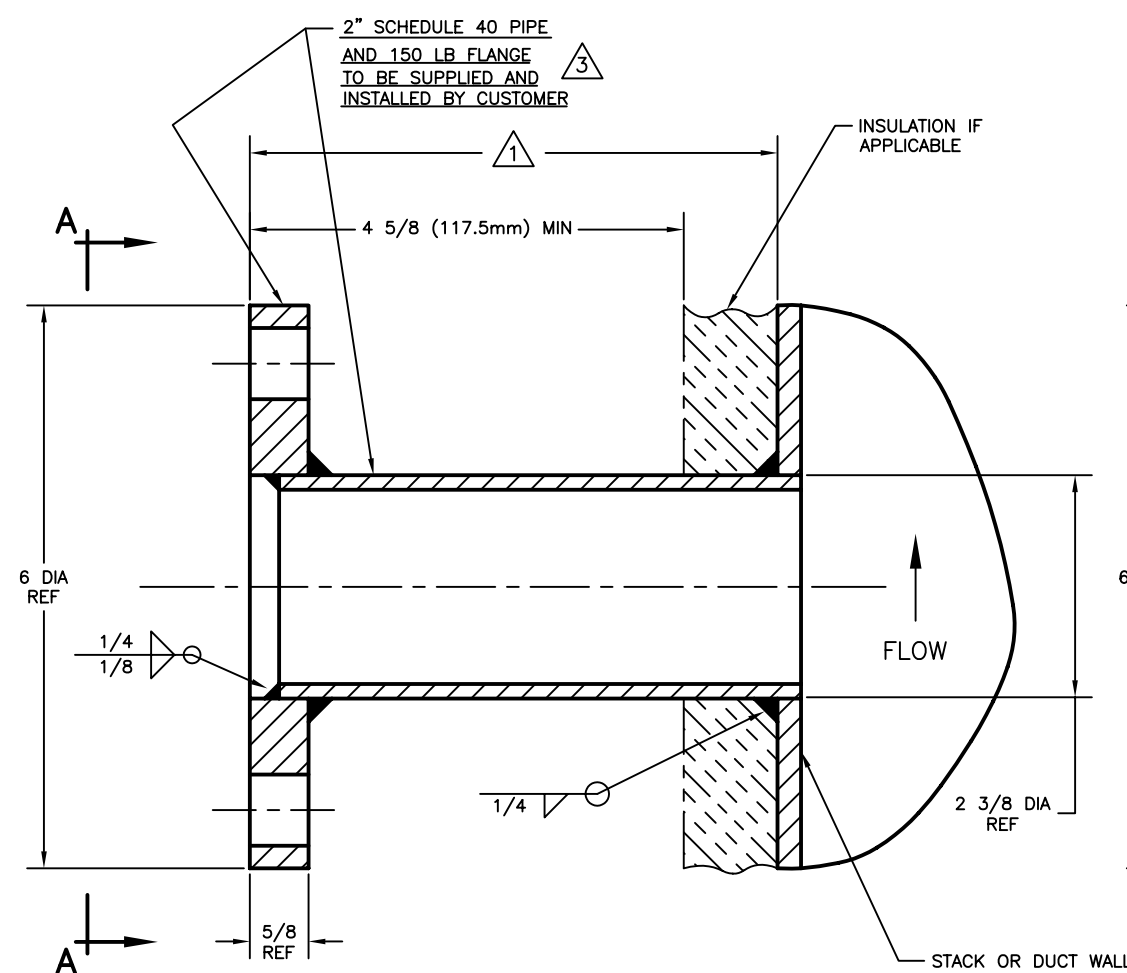
1/2" RIGID CONDUIT FROM RETRO SIDE WITH PURGE SWITCH CABLE

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			USED ON	
FRACTIONS	DECIMALS	ANGLES	DASH NO	NEXT ASSEMBLY
0 TO 4 41/32	.XX	±.01	-07	
4 TO 8 41/32	.XX	±.01		
8 AND UP 41/8	.XX	±.01		
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			TITLE	
AUTHORIZATION			TELEDYNE MONITOR LABS A Teledyne Technologies Company	
BY DATE			THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELETYPE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELETYPE MONITOR LABS.	
DRAWN	EAS	2-13-02	TITLE	
CHECKED	EAS	FEB-02	LightHawk 560	
DESIGNED	EAS	FEB-02	OPACITY DUAL COVERS	
ENGINEERED	ELM	5-15-02	INSTR AIR SYS INSTALL	
PRODUCTION	PD	5-15-02	FINISH	
Q.A.	AS	5-15-02		
SCALE			DRAWING NO.	
1/4			1800-0007	
SHEET			LATEST REVISION	
7 OF 7			J	

DIMENSIONS IN () ARE METRIC

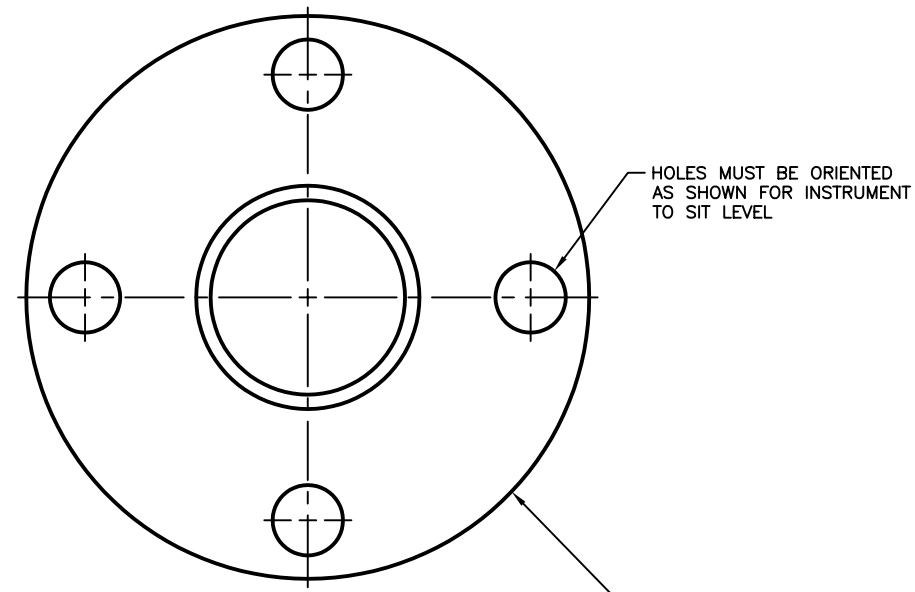
NOTES:

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°

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

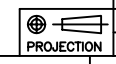


VERTICAL
VIEW "A-A"

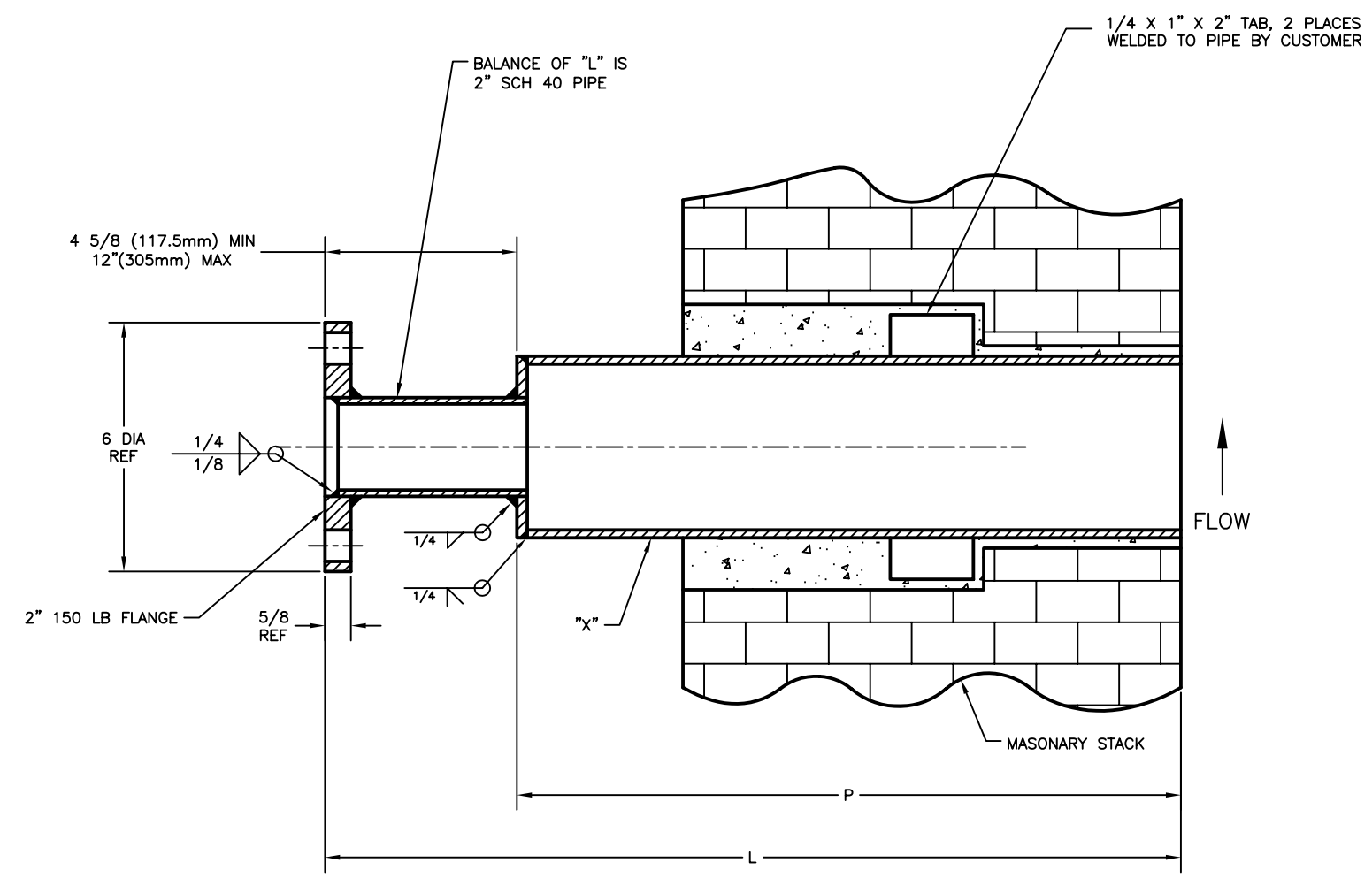
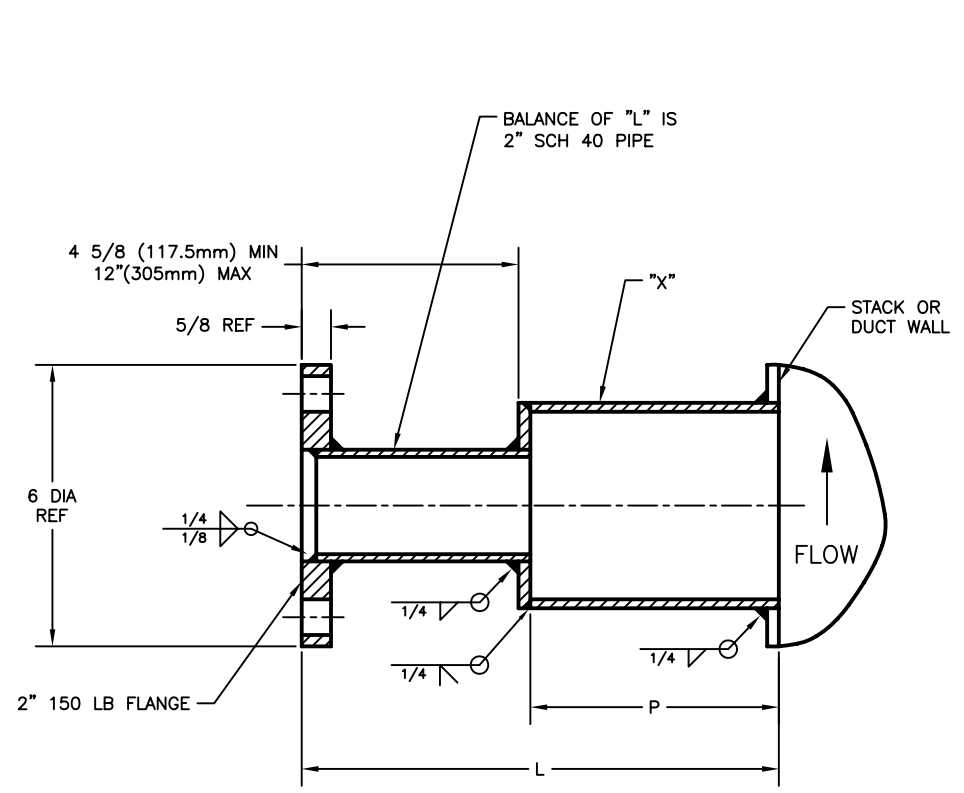
- 4. ADAPTER PLATES ARE AVAILABLE FOR 3" THRU 6" PIPE WITH 150# FLANGES.
- ③ PIPE SIZES ARE AMERICAN STANDARD.
- ② SEE SHEET 2 IF THIS DISTANCE EXCEEDS 18" (457mm).
- ① SEE SHEET 2 IF THIS DISTANCE EXCEEDS 12" (305mm).

NOTES:

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE INSTRUMENTS MONITOR LABS	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEMONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPROCESSED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEMONITOR LABS.	
0 TO 4 ±1/32	.XX ±.01	-01	1860-0000	TITLE LightHawk 560 OPACITY MONITOR FLANGE MTG. METHODS	
4 TO 8 ±1/16	.XXX ±.005			FINISH	
8 AND UP ±1/8				JIG NO.	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				DRAWING NO. 1800-0013	
AUTHORIZATION				LATEST REVISION A	
BY	DATE			SCALE 1:1	
DRAWN EAS	9-30-99			SHEET 1 OF 2	
CHECKED EAS	5-00			DATE 4-11-03	
DESIGNED EAS	Sept-99				
ENGINEERED ELM	5-16-00				
PRODUCTION MAR	5/16/00				
Q.A. AS	5-16-00				



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°

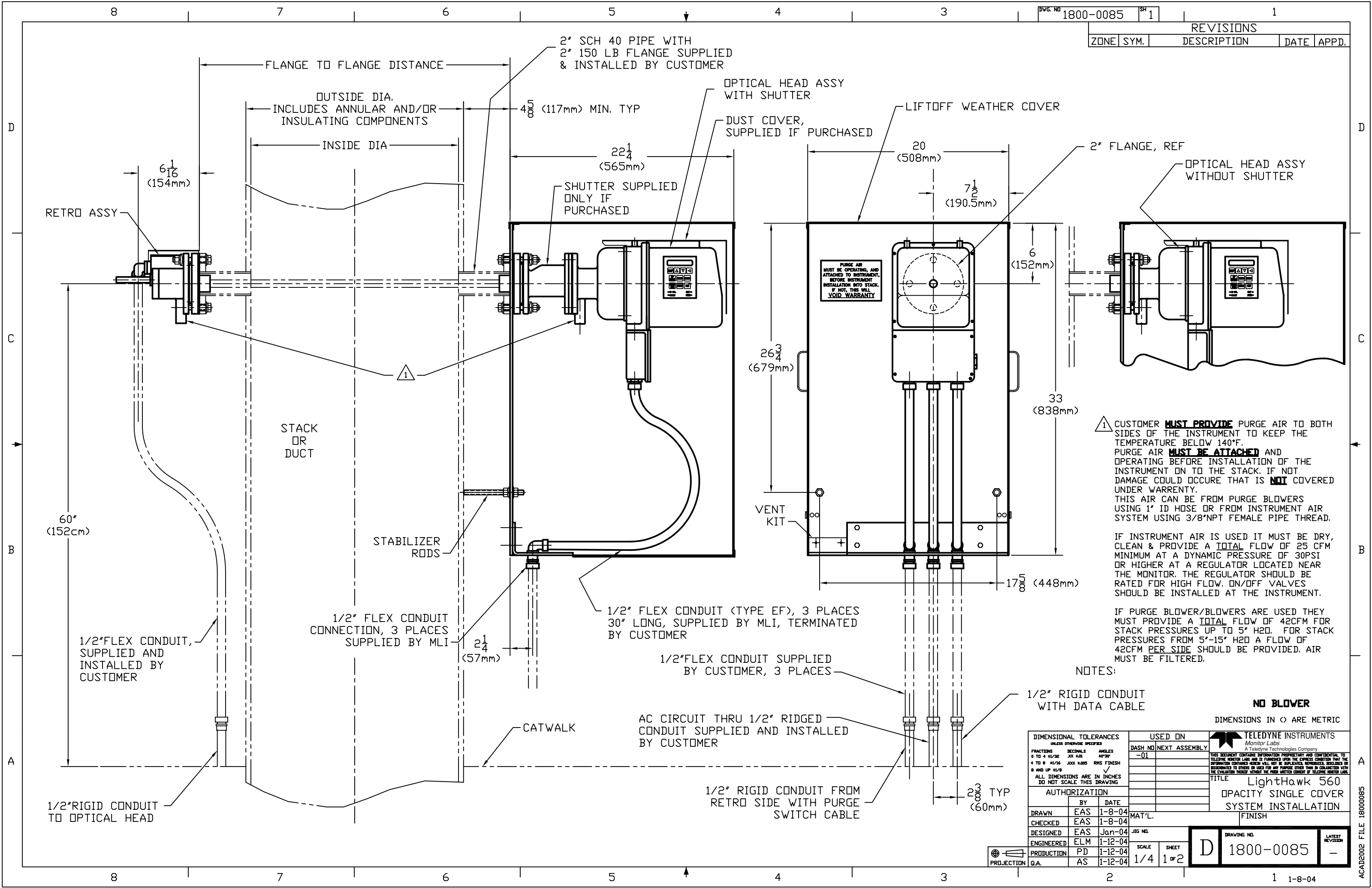
THIS CHART IS SUGGESTED PIPE SIZES FOR PORTS OVER 12" IN LENGTH. THIS WILL ALLOW A REASONABLE PORT TO PORT MISALIGNMENT. IF TIGHTER TOLERANCES CAN BE MET, PIPE SIZES CAN BE DECREASED. CONSULT FACTORY IF ASSISTANCE IS NEEDED

SEE SHEET 1 FOR NOTES

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE INSTRUMENTS MONITOR LABS	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEPHONE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EQUIPMENT THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEPHONE MONITOR LABS.	
0 TO 4 ±1/32	.01 ±.01	-01	1860-0000	TITLE LightHawk 560 OPACITY MONITOR FLANGE MTG. METHODS	
4 TO 8 ±1/16	.005 ±.005			FINISH	
8 AND UP ±1/8				MAT'L.	
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		
		SCALE	SHEET	DRAWING NO.	
		1/2	2 OF 2	D 1800-0013	
				LATEST REVISION A	

PROJECTION

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' H2O. FOR STACK PRESSURES FROM 5'-15' H2O A FLOW OF 42CFM PER SIDE SHOULD BE PROVIDED. AIR MUST BE FILTERED.

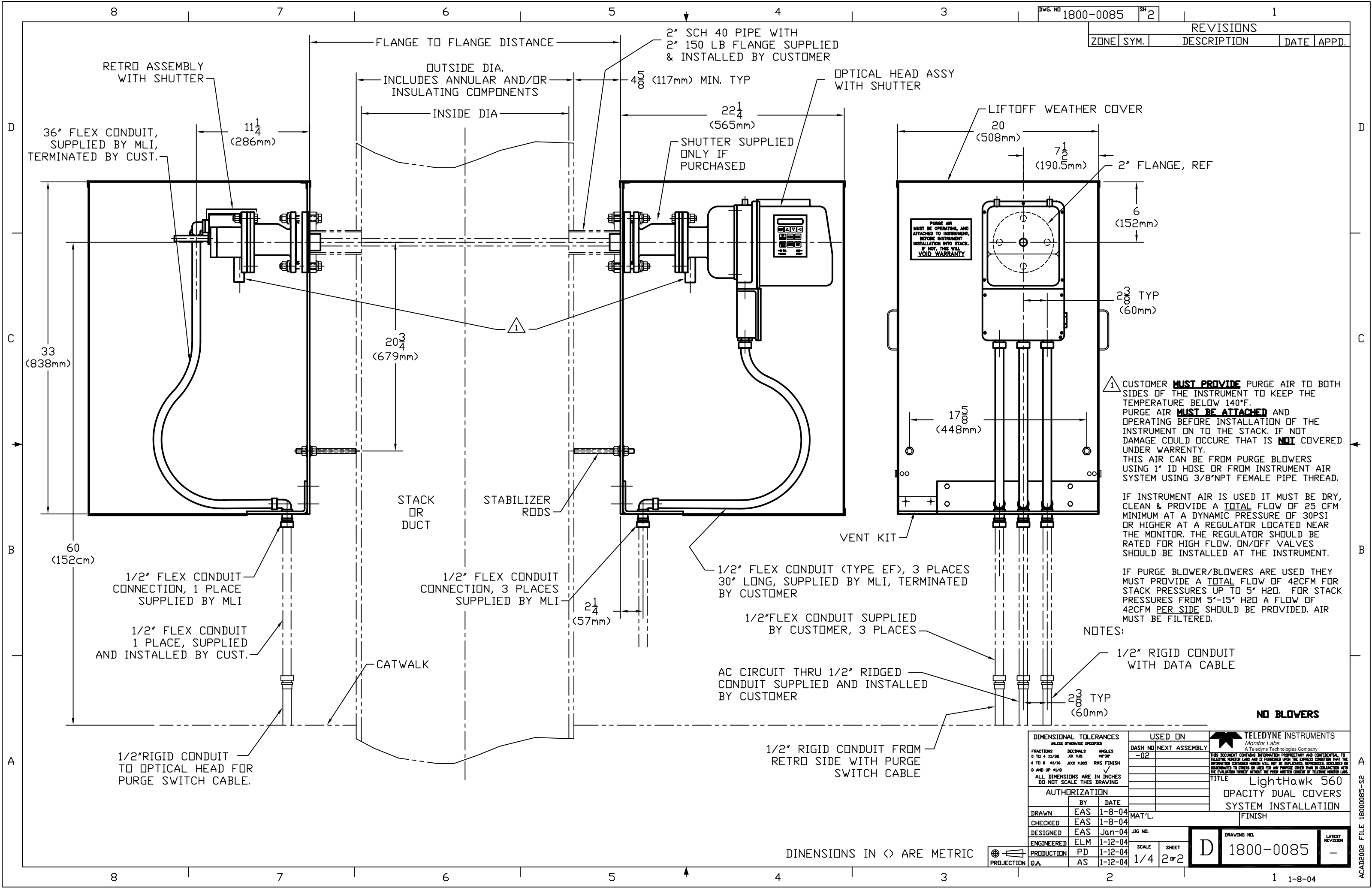
NOTES:
NO BLOWER
 DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 1/32 .001 30° 30' 4 TO 8 1/16 .002 30° 30' 8 AND UP 1/8 .005 RNS FINISH ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO/NEXT ASSEMBLY -01	TELEDYNE INSTRUMENTS Monitor Labs A Teledyne Technologies Company THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE INSTRUMENTS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRINTERED, COPIED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN THAT AUTHORIZED BY THE EVALUATION SERVICE WITHOUT THE WRITTEN CONSENT OF TELEDYNE INSTRUMENTS.
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		MAT'L. FINISH	TITLE LightHawk 560 OPACITY SINGLE COVER SYSTEM INSTALLATION
DRAWING NO. 1800-0085		SCALE 1/4	SHEET 1 OF 2



ACAD2002 FILE 18000085

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" H2O. FOR STACK PRESSURES FROM 5"-15" H2O A FLOW OF 42CFM PER SIDE SHOULD BE PROVIDED. AIR MUST BE FILTERED.

NOTES:

1/2" RIGID CONDUIT WITH DATA CABLE

NO BLOWERS

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 41/32	.005	±30"
4 TO 8 41/16	.005	RHS FINISH
8 AND UP 41/8		

ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

USED ON	
DASH NO	NEXT ASSEMBLY
-02	

TELEDYNE INSTRUMENTS
Monitor Labs
A Teledyne Technologies Company

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEPHONE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEPHONE MONITOR LABS.

TITLE: **LightHawk 560**
OPACITY DUAL COVERS
SYSTEM INSTALLATION

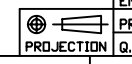
BY: EAS DATE: 1-8-04
 CHECKED: EAS DATE: 1-8-04
 DESIGNED: EAS DATE: Jan-04
 ENGINEERED: ELM DATE: 1-12-04
 PRODUCTION: PD DATE: 1-12-04
 Q.A.: AS DATE: 1-12-04

MAT'L. FINISH

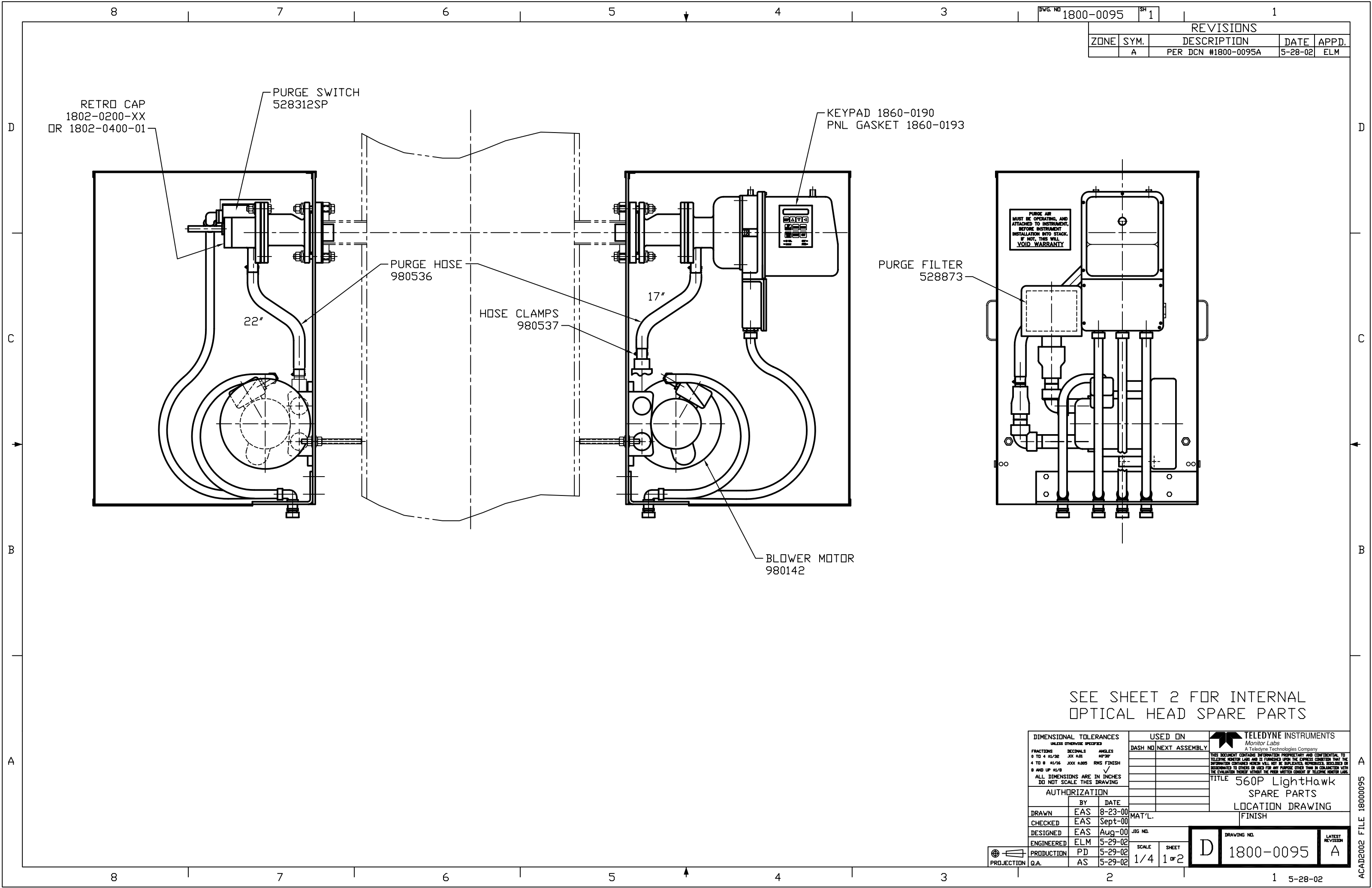
JIG NO. SCALE: 1/4 SHEET: 2 OF 2

DRAWING NO. **1800-0085** LATEST REVISION: -

DIMENSIONS IN () ARE METRIC



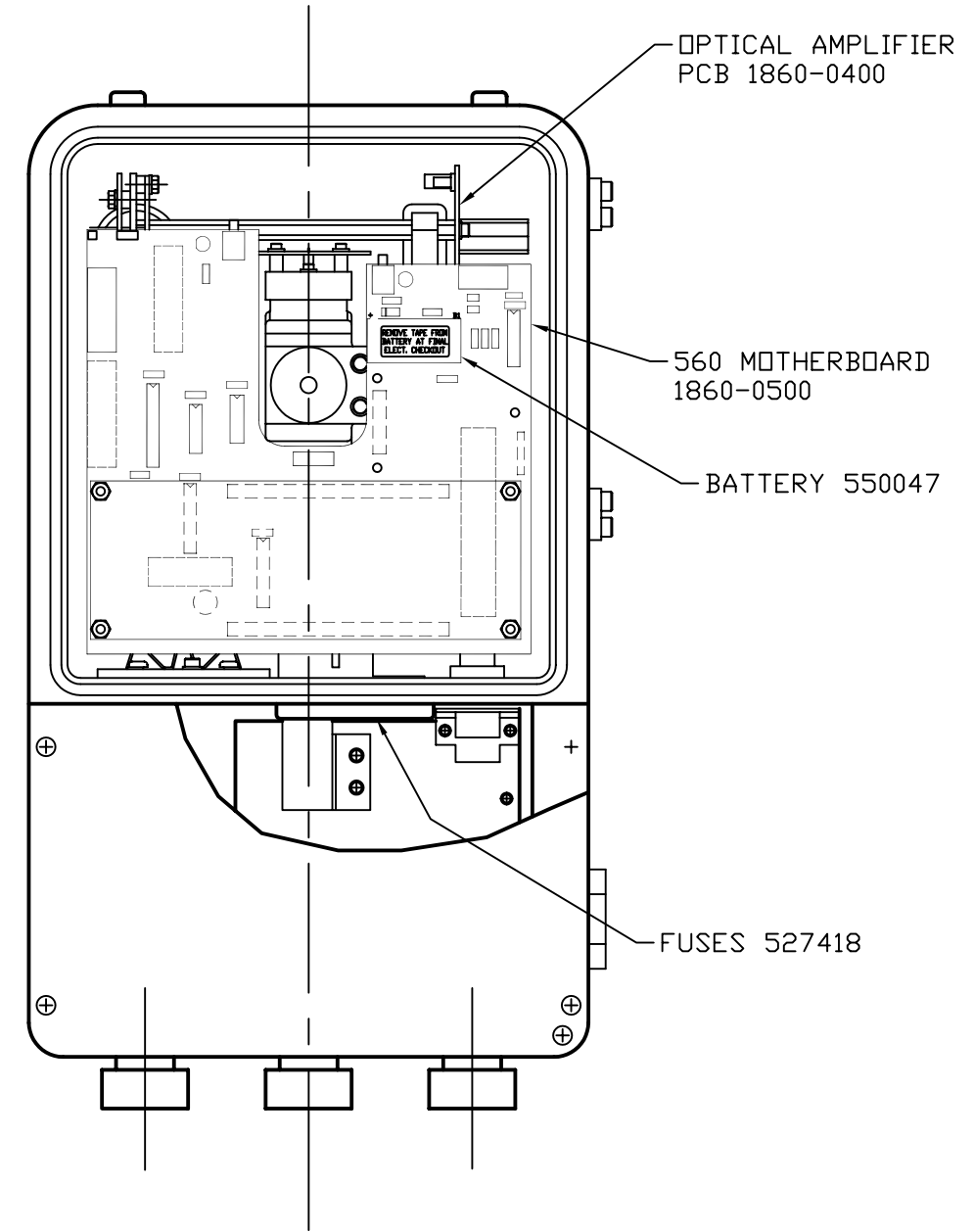
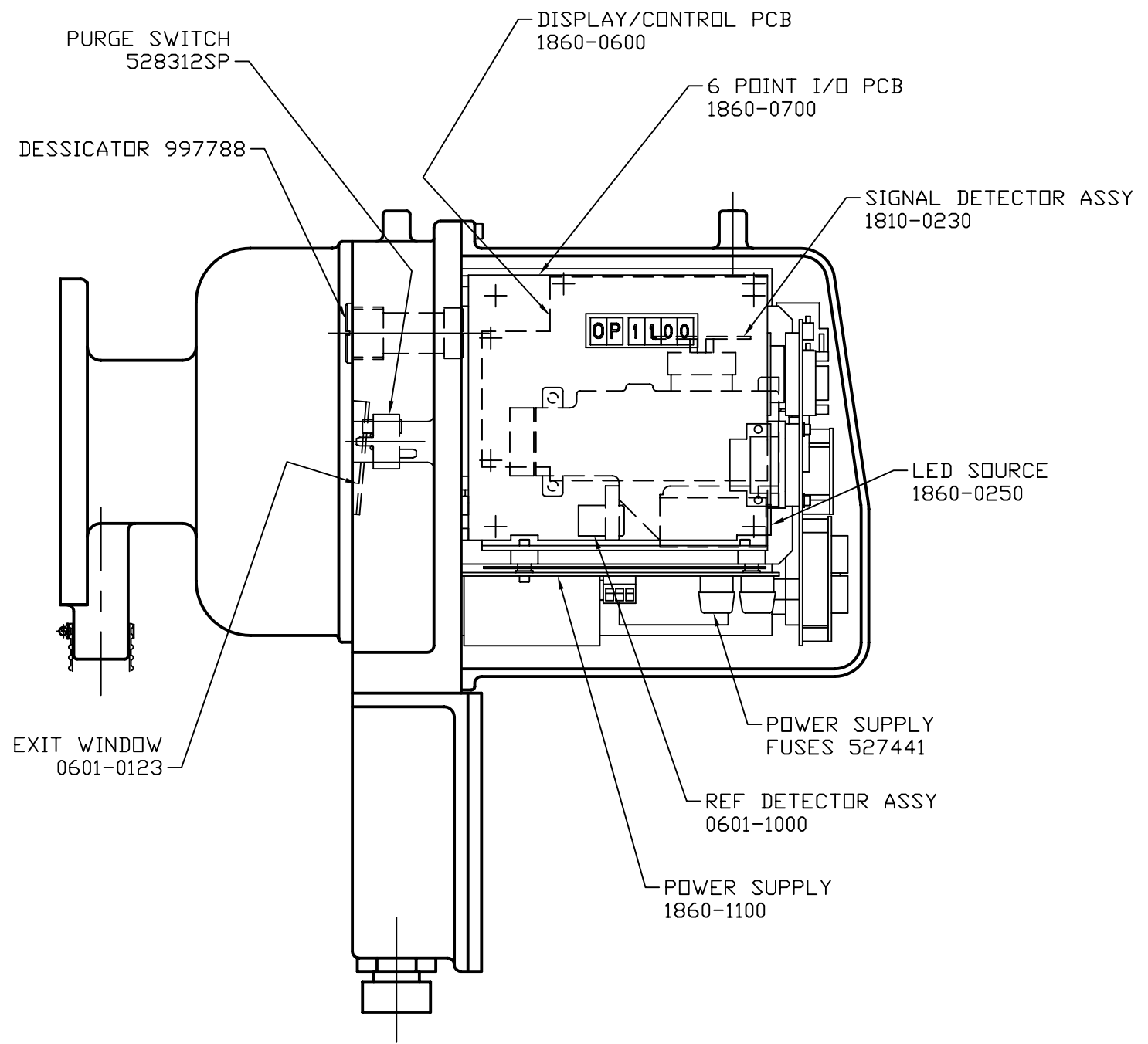
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0095A	5-28-02	ELM



SEE SHEET 2 FOR INTERNAL OPTICAL HEAD SPARE PARTS

DIMENSIONAL TOLERANCES <small>UNLESS OTHERWISE SPECIFIED</small> FRACTIONS DECIMALS ANGLES 0 TO 4 41/32 .001 .015 40°/30° 4 TO 8 41/16 .002 .015 RNS FINISH 8 AND UP 41/8 .005 .015 RNS FINISH ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY		TELEDYNE INSTRUMENTS Monitor Labs <small>A Teledyne Technologies Company</small> THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE INSTRUMENTS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPERMITS, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE INSTRUMENTS.	
AUTHORIZATION BY DATE DRAWN EAS 8-23-00 CHECKED EAS Sept-00 DESIGNED EAS Aug-00 ENGINEERED ELM 5-29-02 PRODUCTION PD 5-29-02 Q.A. AS 5-29-02		MAT'L. JIG NO. SCALE SHEET 1/4 1 OF 2		TITLE 560P LightHawk SPARE PARTS LOCATION DRAWING FINISH	
PROJECTION		DRAWING NO. D 1800-0095		LATEST REVISION A	

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN #1800-0095A	5-28-02	ELM

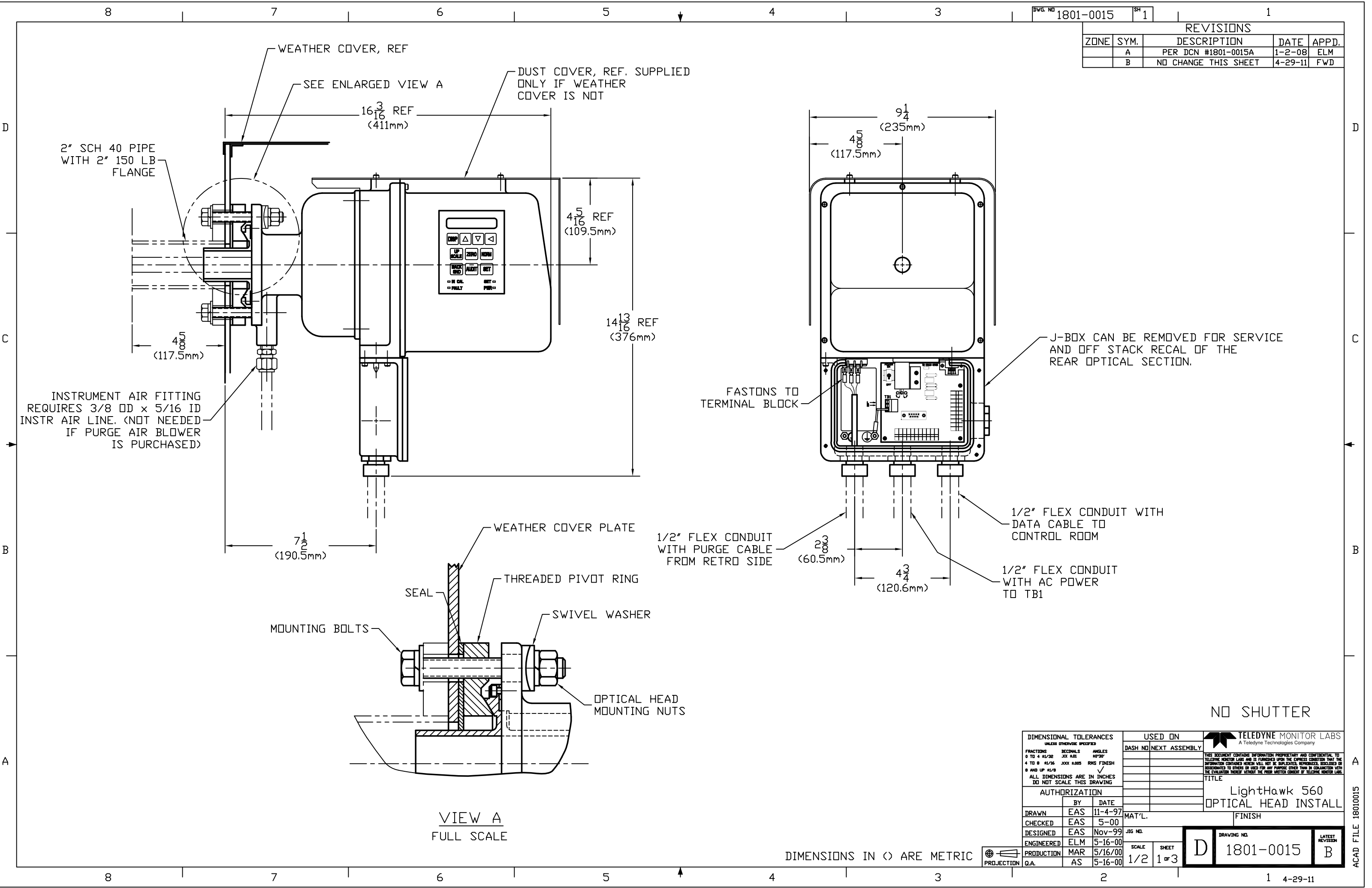


DIMENSIONAL TOLERANCES <small>UNLESS OTHERWISE SPECIFIED</small> FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .001 30° 30' 4 TO 8 ±1/16 .002 30° 30' 8 AND UP ±1/8 .003 30° 30' ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY		TELEDYNE INSTRUMENTS <small>Monitor Labs</small> <small>A Teledyne Technologies Company</small> <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELETYPE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPARATED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELETYPE MONITOR LABS.</small> TITLE 560P LightHawk OPTICAL HEAD SPARE PARTS LOCATION DRAWING	
AUTHORIZATION BY DATE DRAWN EAS 8-23-00 CHECKED EAS Sept-00 DESIGNED EAS Aug-00 ENGINEERED ELM 5-29-02 PRODUCTION PD 5-29-02 Q.A. AS 5-29-02		MAT'L. JIG NO. SCALE SHEET 3/4 2 OF 2		DRAWING NO. 1800-0095 LATEST REVISION A	



ACAD2002 FILE 18000095-S2

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

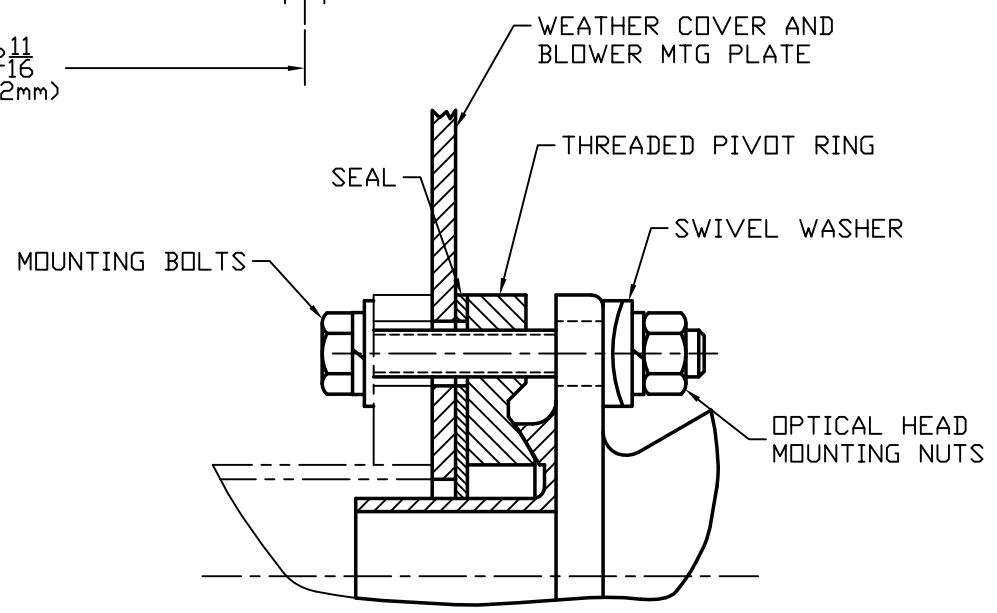
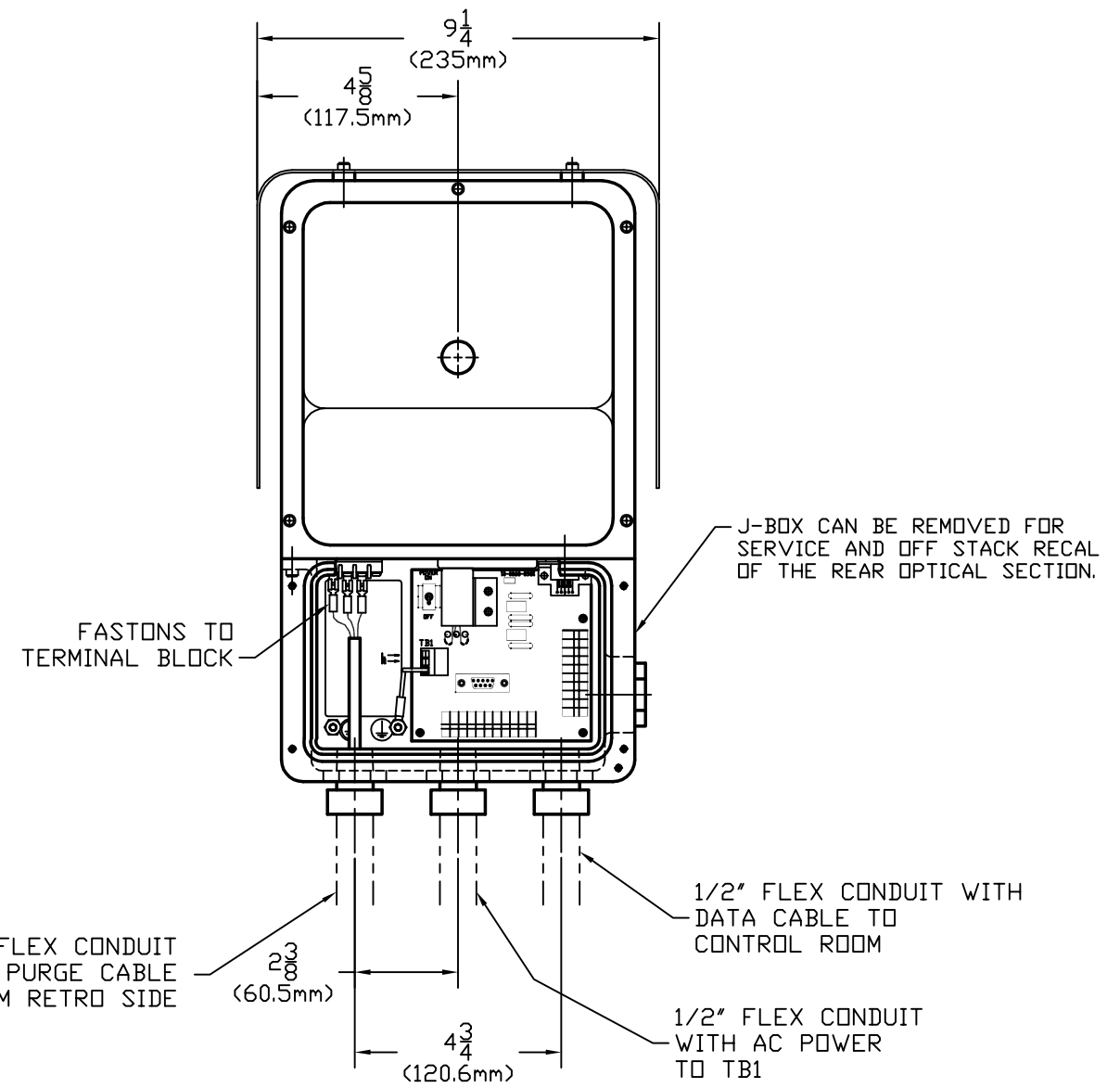
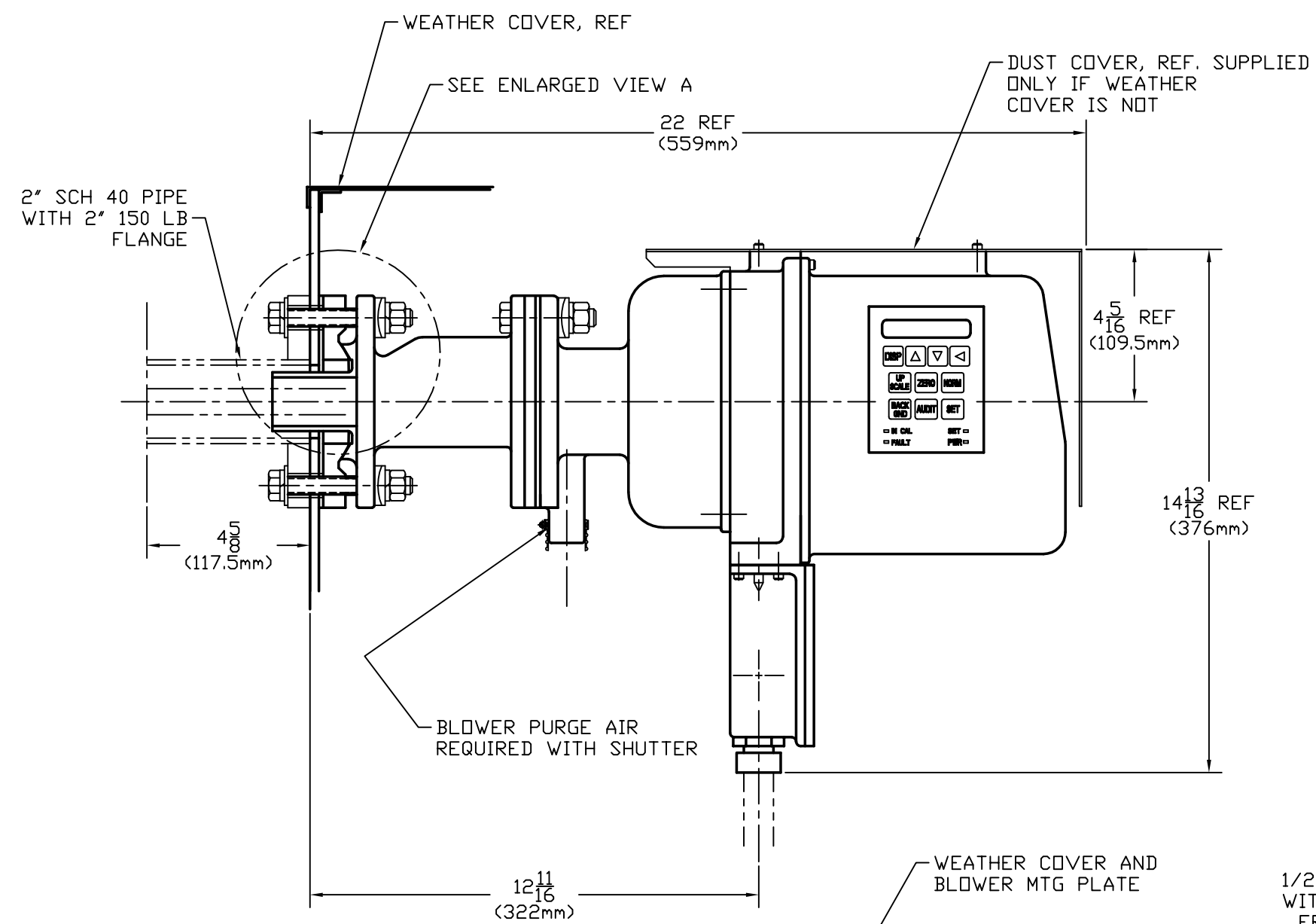


NO SHUTTER

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .001 .010 4 TO 8 ±1/62 .0005 .005 RNS FINISH 8 AND UP ±1/8 .015 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			USED ON DASH NO NEXT ASSEMBLY		TELEDYNE MONITOR LABS A Teledyne Technologies Company <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED WITH THE EXPRESS UNDERSTANDING THAT INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, DISCLOSED OR REPRODUCED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</small> TITLE LightHawk 560 OPTICAL HEAD INSTALL
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			MAT'L. FINISH JIG NO. SCALE SHEET 1/2 1 OF 3		
DRAWING NO. 1801-0015			LATEST REVISION B		

ACAD FILE 18010015

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

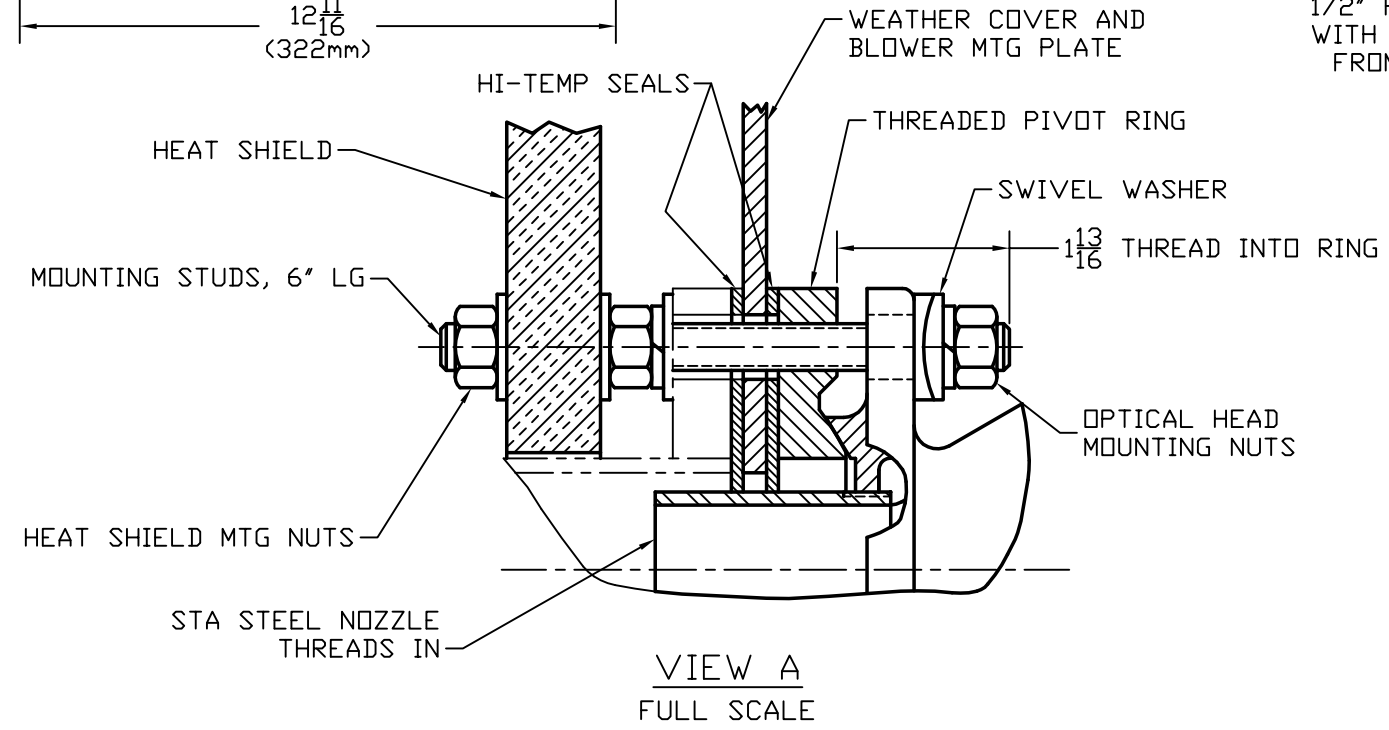
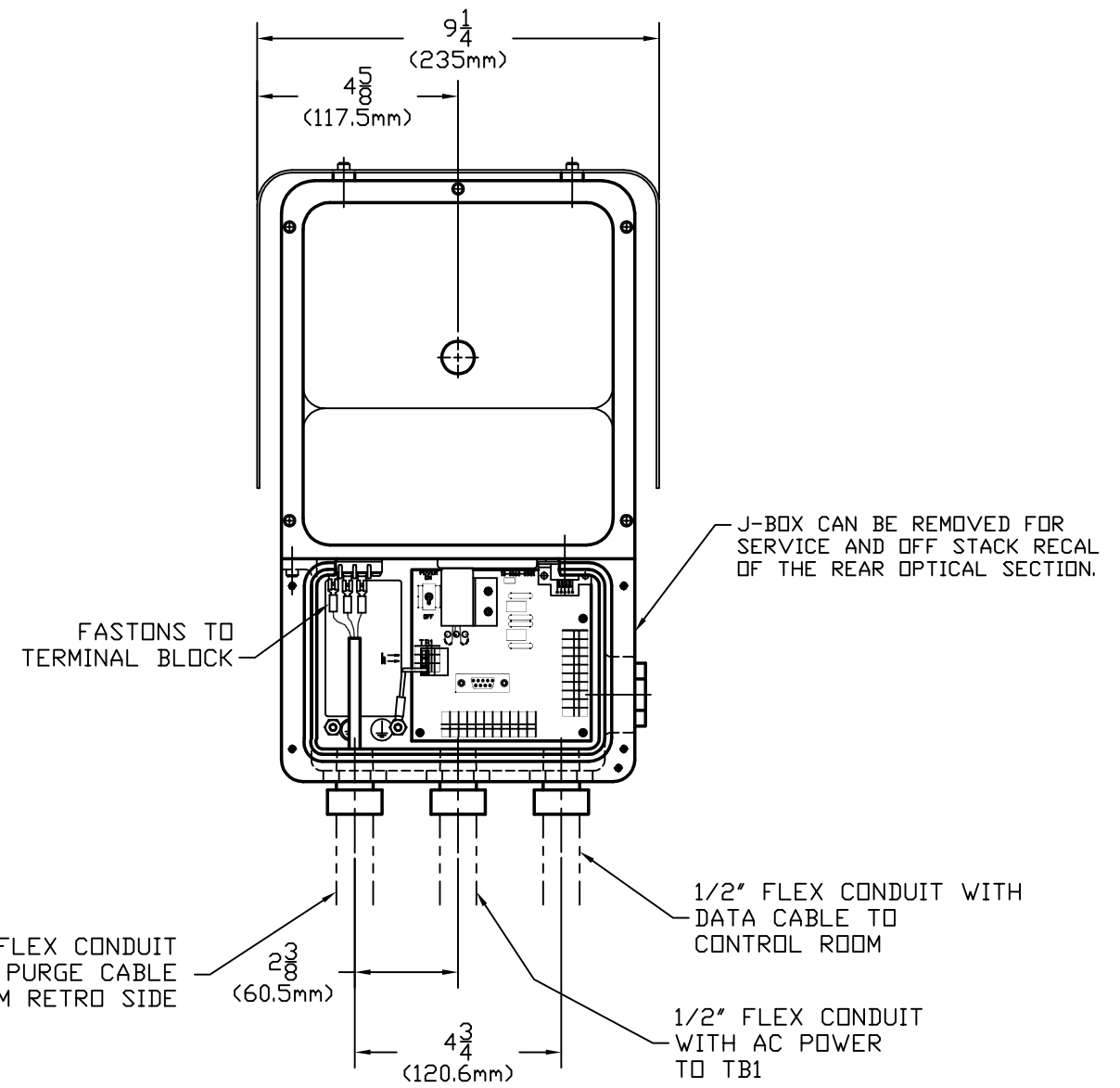
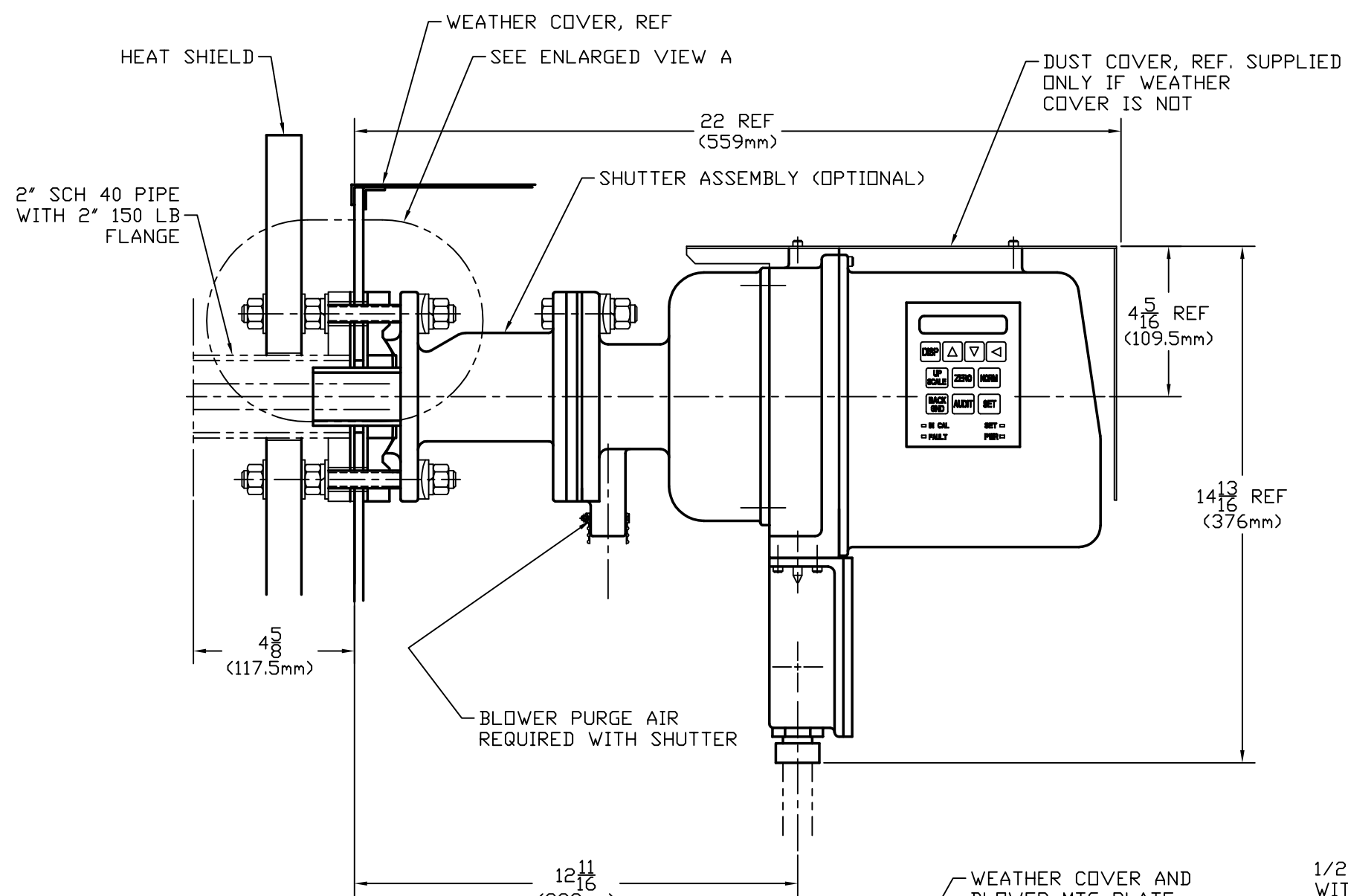
DIMENSIONS IN () ARE METRIC

WITH SHUTTER

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .XX ±.01 90°/30° 4 TO 8 ±1/16 .XX ±.005 RMS FINISH 8 AND UP ±1/8 ✓ ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			USED ON DASH NO NEXT ASSEMBLY		TELEDYNE INSTRUMENTS Monitor Labs A Teledyne Technologies Company <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE INSTRUMENTS LABS AND IS FURNISHED WITH THE EXPRESS UNDERSTANDING THAT INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, DISCLOSED OR TRANSMITTED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE INSTRUMENTS LABS.</small> TITLE LightHawk 560 OPTICAL HEAD INSTALL
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			MAT'L. FINISH JIG NO. SCALE SHEET 1/2 2 OF 3		

DRAWING NO.	LATEST REVISION

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

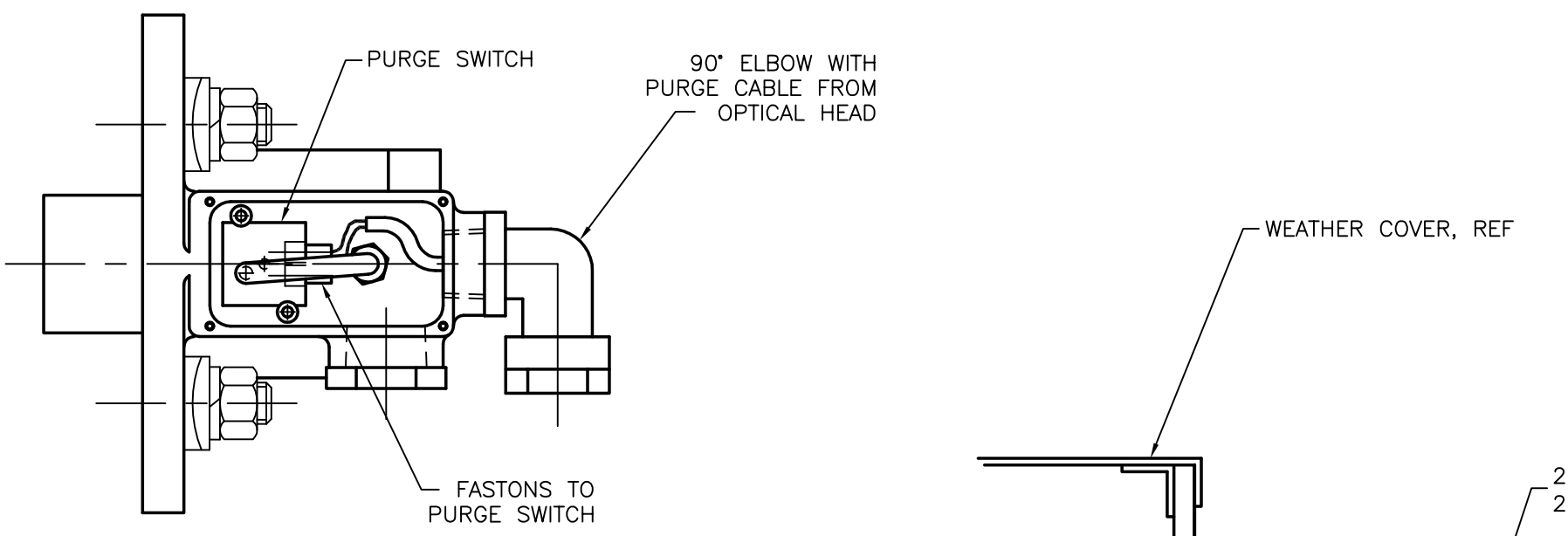


DIMENSIONS IN () ARE METRIC

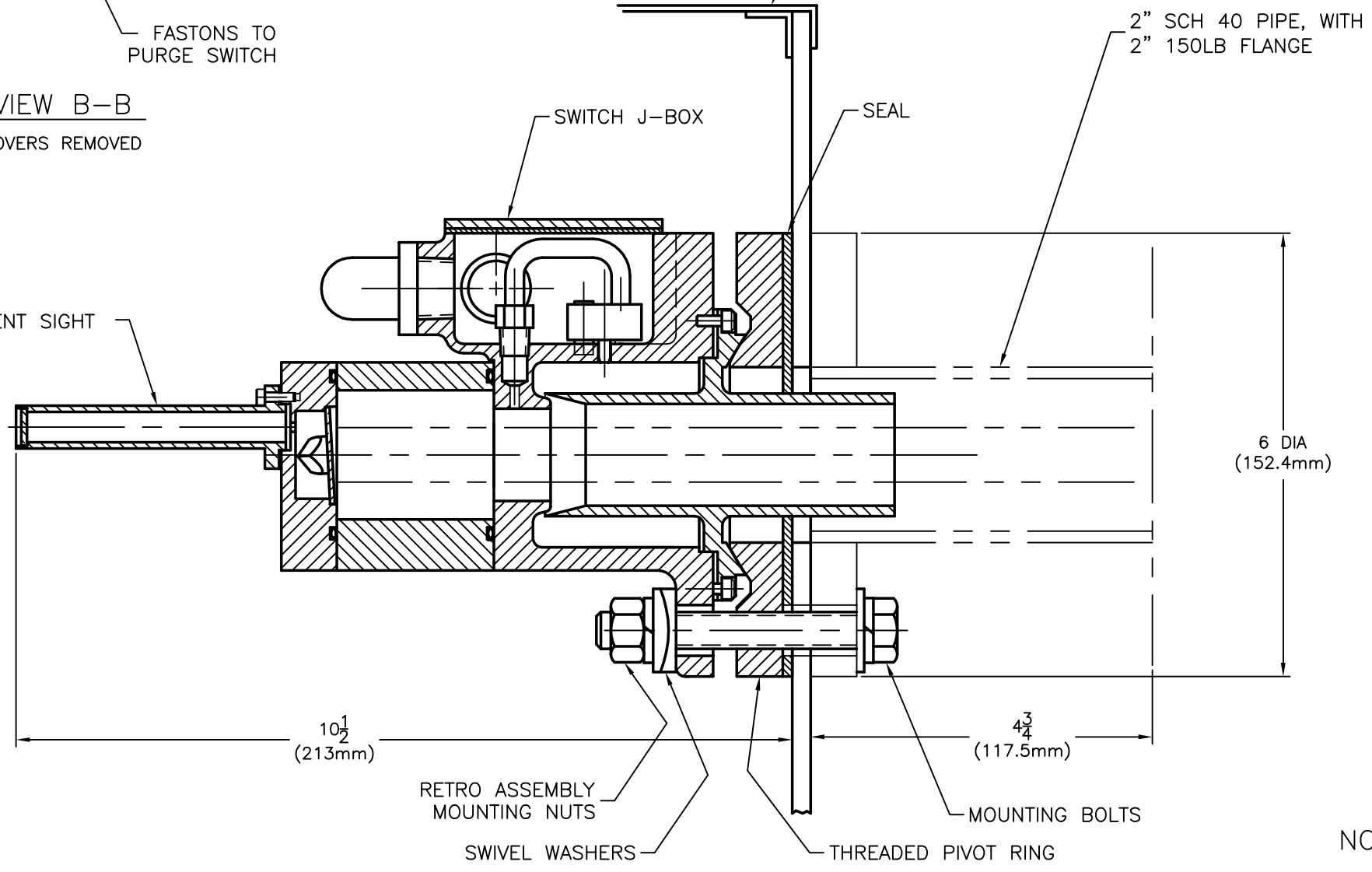
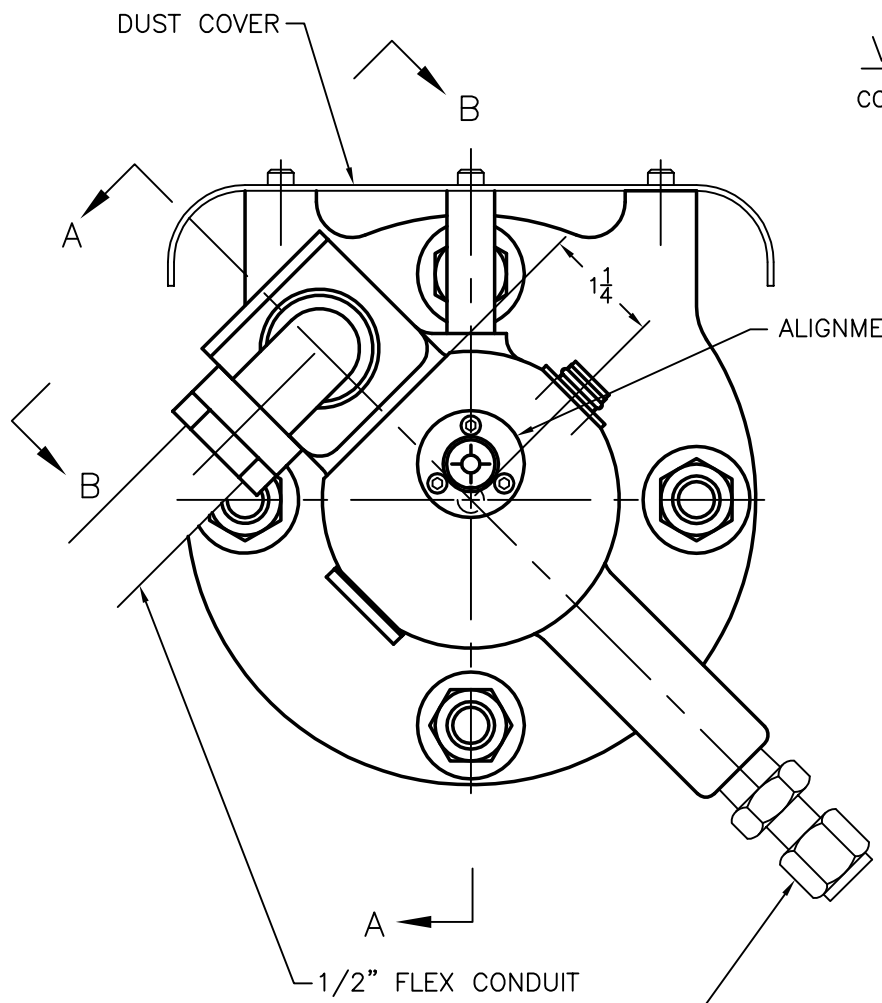
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .005 ±.01 90°/30° 4 TO 8 ±1/16 .005 ±.005 RMS FINISH 8 AND UP ±1/8 .005 ✓ ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY	TELEDYNE INSTRUMENTS Monitor Labs A Teledyne Technologies Company <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE INSTRUMENTS LABS AND IS FURNISHED FOR THE EXPRESS PURPOSE THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPLICATED, DISCLOSED OR TRANSMITTED IN ANY MANNER OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE INSTRUMENTS LABS.</small> TITLE LightHawk 560 OPTICAL HEAD INSTALL
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		MAT'L. FINISH JIG NO. SCALE SHEET 1/2 3 OF 3	
DRAWING NO. 1801-0015 LATEST REVISION B		4-29-11	

ACAD FILE 18010015-S3

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

PURGE AIR FITTING, REQUIRES 3/8 OD x 1/4 ID INSTR AIR LINE. (NOT NEEDED IF PURGE AIR BLOWER IS PURCHASED)

NO SHUTTER

DIMENSIONS IN () ARE METRIC

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

USED ON	
DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE EMPLOYED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.

TITLE
**LIGHTHAWK 560
RETRO INSTALLATION**

FINISH

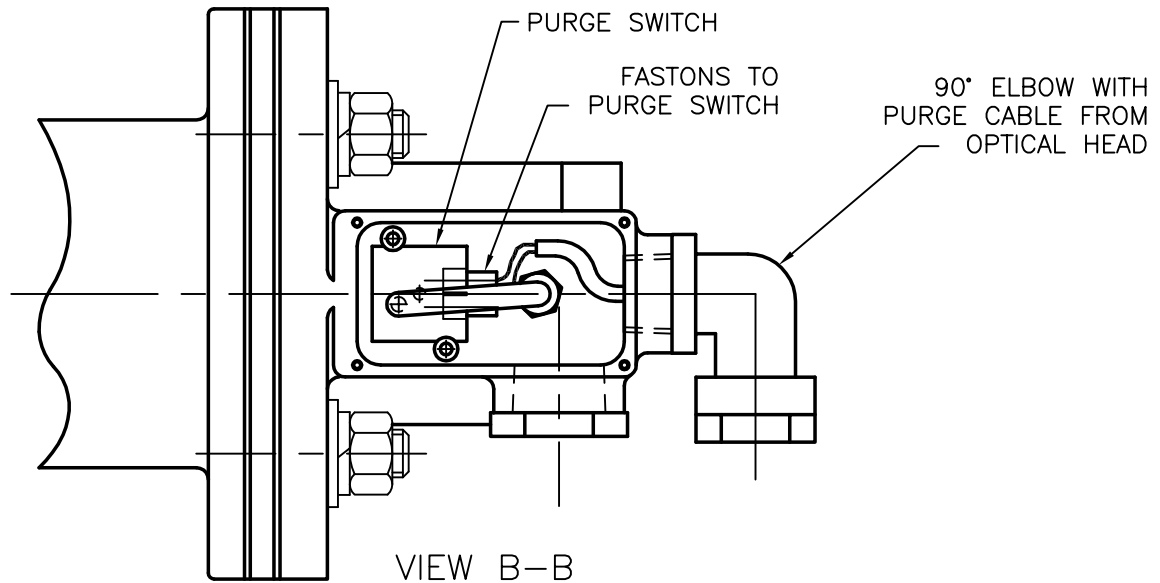
DRAWING NO. **D 1802-0015** LATEST REVISION **D**

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	

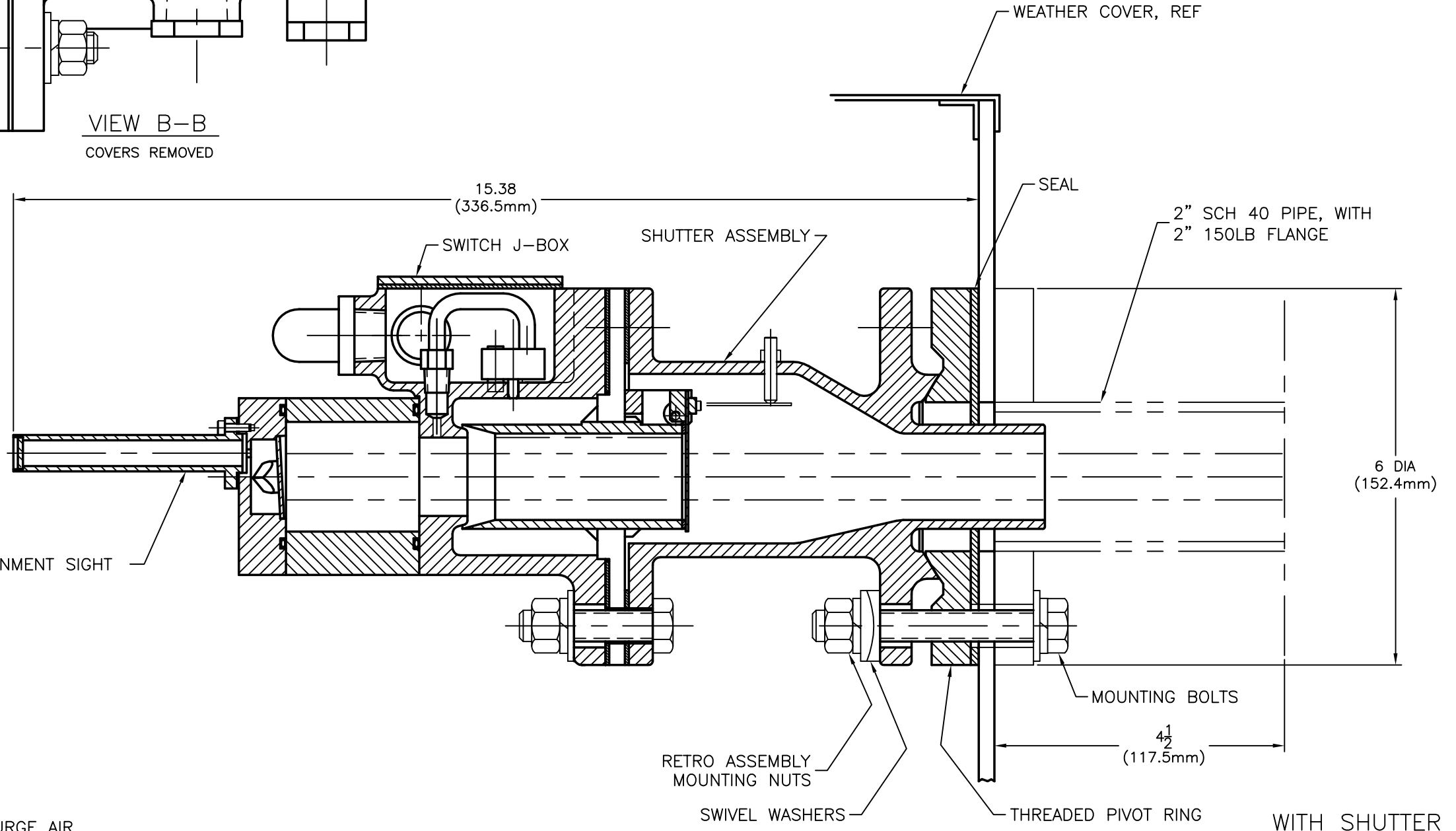
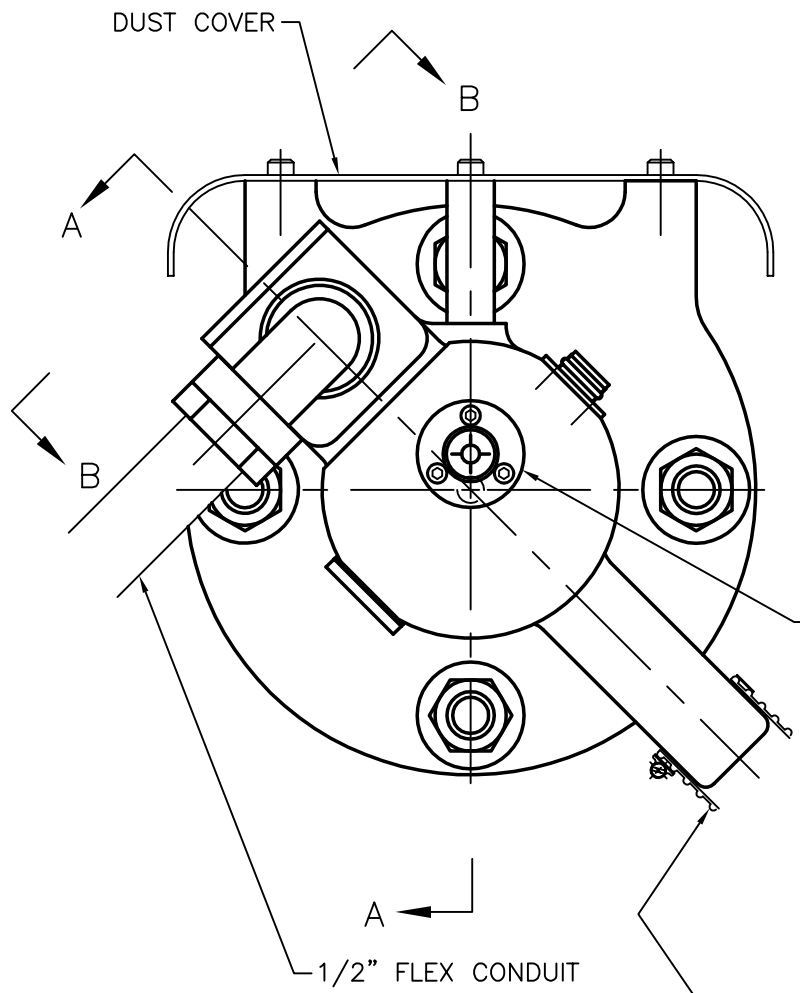


SCALE	SHEET
1:1	1 OF 3

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

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			USED ON	
FRACTIONS	DECIMALS	ANGLES	DASH NO	NEXT ASSEMBLY
9 TO 4 ±1/32	JXX ±.01	±30°	-01	
4 TO 8 ±1/16	JXX ±.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			

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.

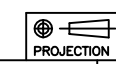
TITLE: LIGHTHAWK 560 RETRO INSTALLATION

FINISH: MAT'L.

DRAWING NO. 1802-0015

LATEST REVISION: D

DIMENSIONS IN () ARE METRIC

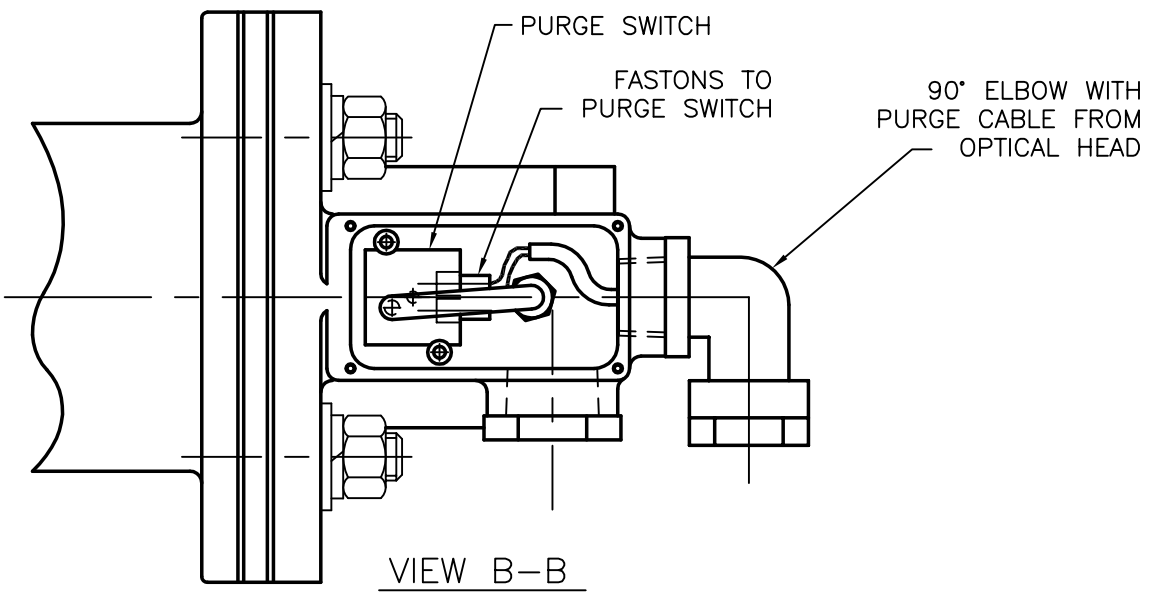


SCALE	SHEET
1:1	2 OF 3

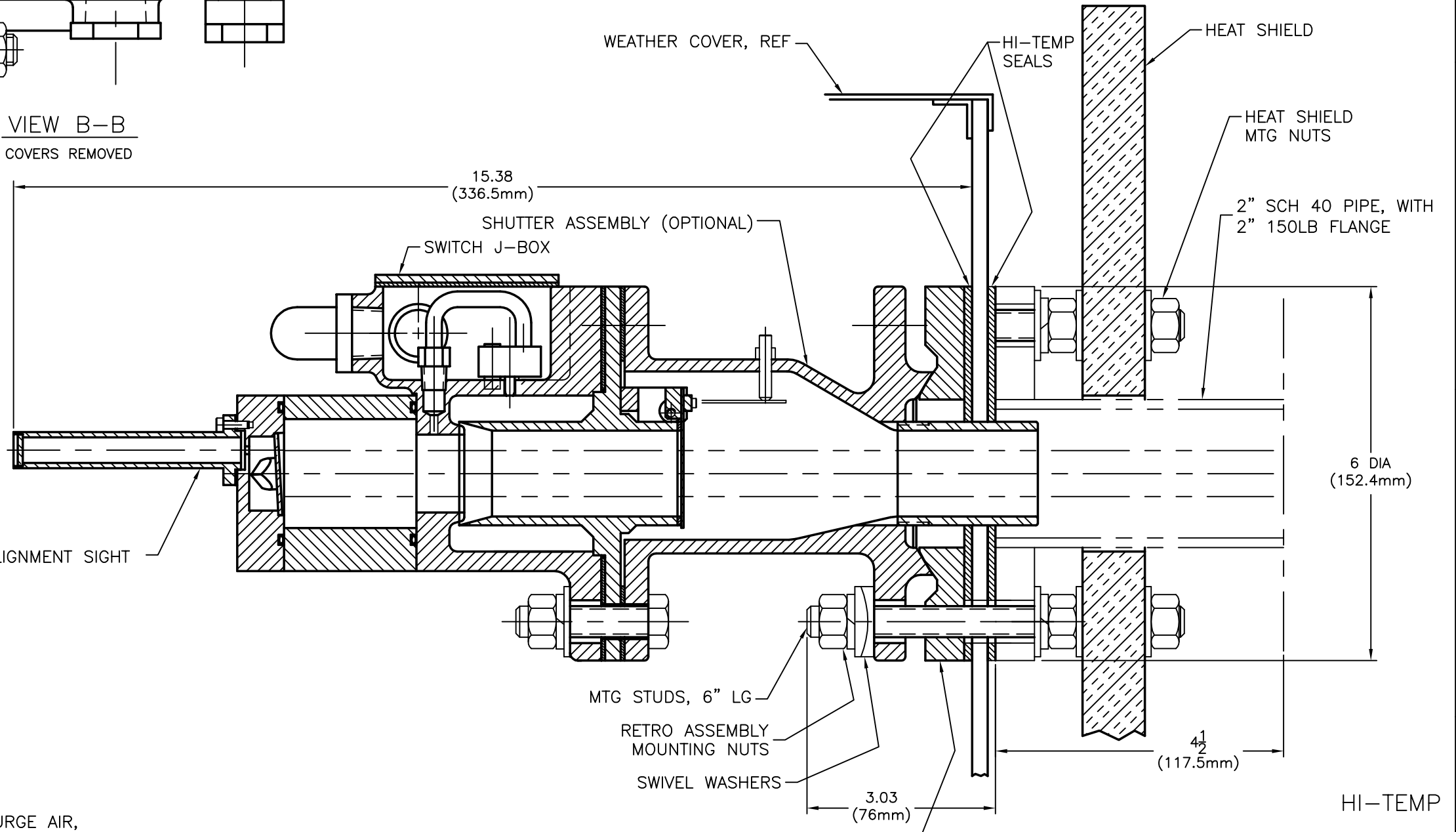
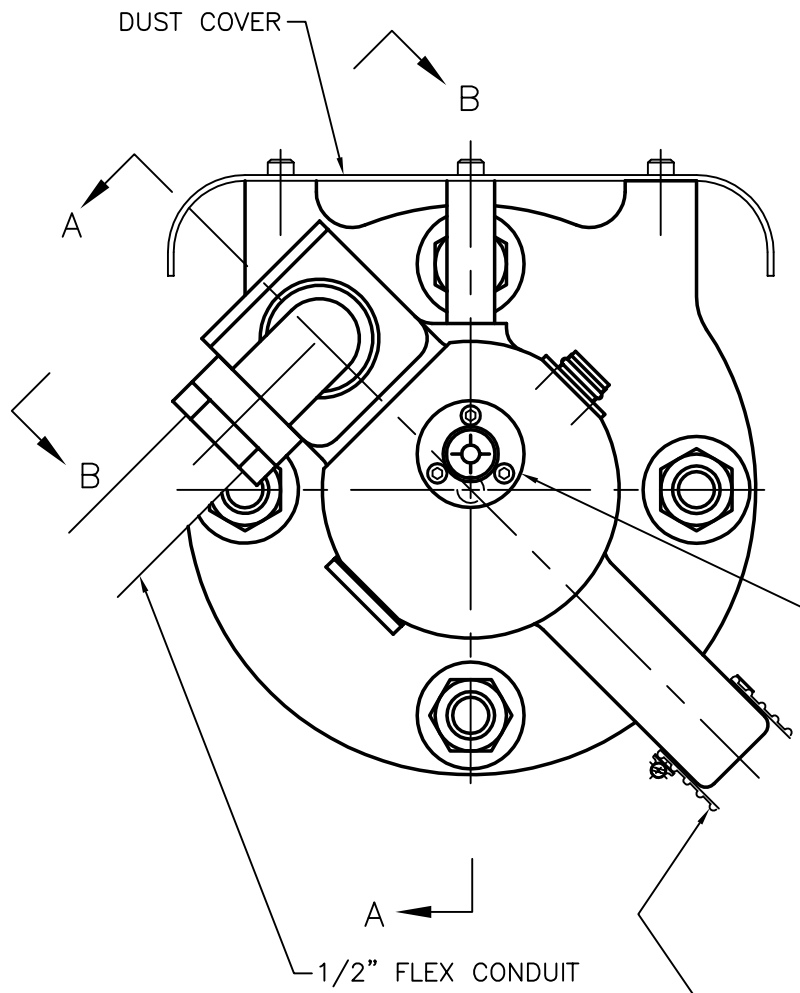
D	1802-0015	D
---	-----------	---

ACAD 18020015-MS

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



SECTION A-A

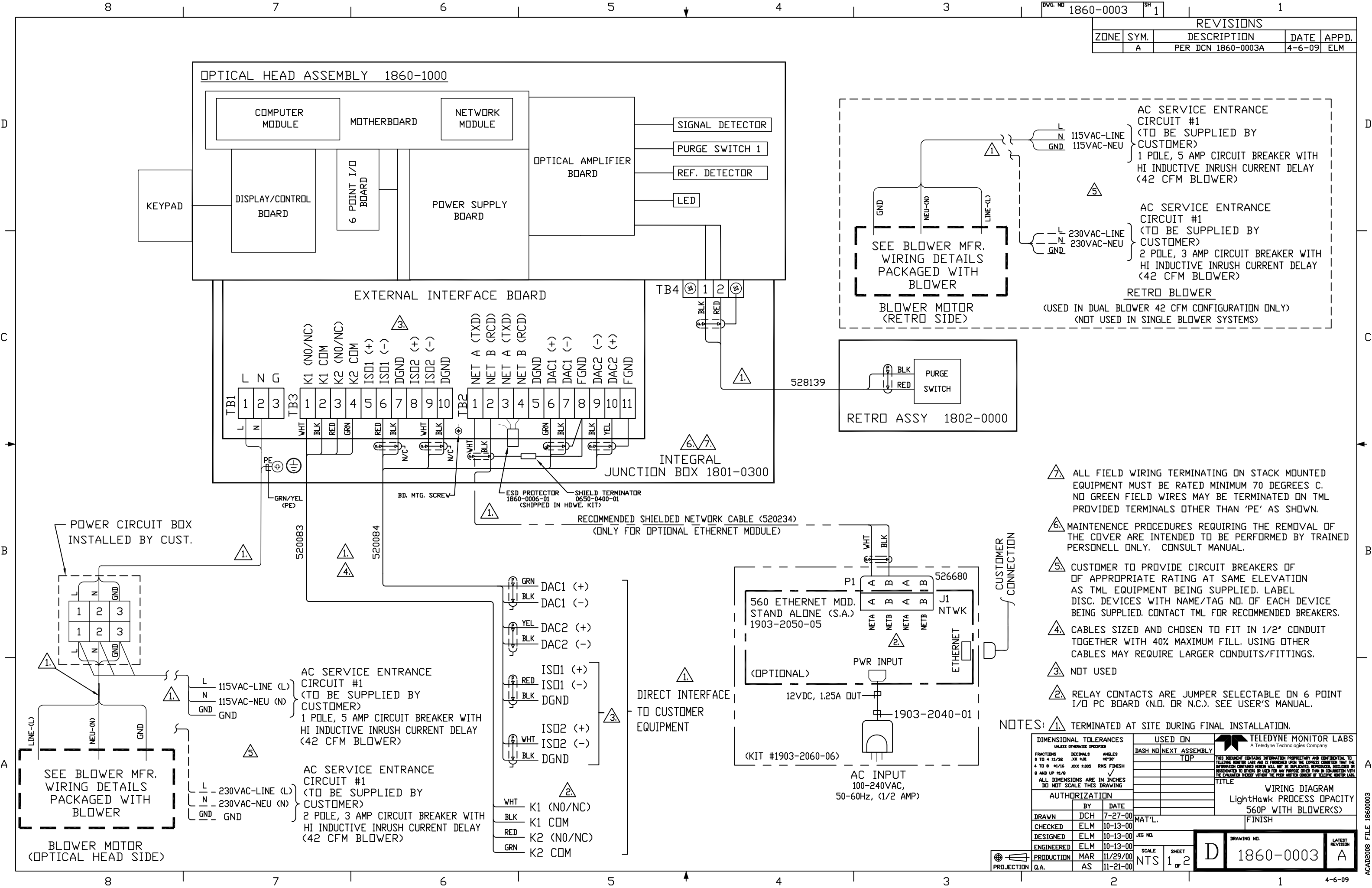
DIMENSIONS IN () ARE METRIC

<p>TELEDYNE MONITOR LABS A Teledyne Technologies Company</p>		<p>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE EMPLOYED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</p>															
<p>AUTHORIZATION</p> <table border="1"> <tr> <th>BY</th> <th>DATE</th> </tr> <tr> <td>EAS</td> <td>11-4-97</td> </tr> <tr> <td>EAS</td> <td>5-00</td> </tr> <tr> <td>EAS</td> <td>NOV-99</td> </tr> <tr> <td>ELM</td> <td>5-16-00</td> </tr> <tr> <td>MAR</td> <td>5/16/00</td> </tr> <tr> <td>AS</td> <td>5-16-00</td> </tr> </table>		BY	DATE	EAS	11-4-97	EAS	5-00	EAS	NOV-99	ELM	5-16-00	MAR	5/16/00	AS	5-16-00	<p>TITLE</p> <p>LIGHTHAWK 560 RETRO INSTALLATION</p>	
BY	DATE																
EAS	11-4-97																
EAS	5-00																
EAS	NOV-99																
ELM	5-16-00																
MAR	5/16/00																
AS	5-16-00																
<p>USED ON</p> <p>DASH NO NEXT ASSEMBLY</p> <p>-01</p>		<p>SCALE</p> <p>1:1</p>															
<p>PRODUCTION</p> <p>Q.A.</p>		<p>SHEET</p> <p>3 OF 3</p>															
<p>DRAWING NO.</p> <p>1802-0015</p>		<p>LATEST REVISION</p> <p>D</p>															



ACAD 18020015-MS

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN 1860-0003A	4-6-09	ELM



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)

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)

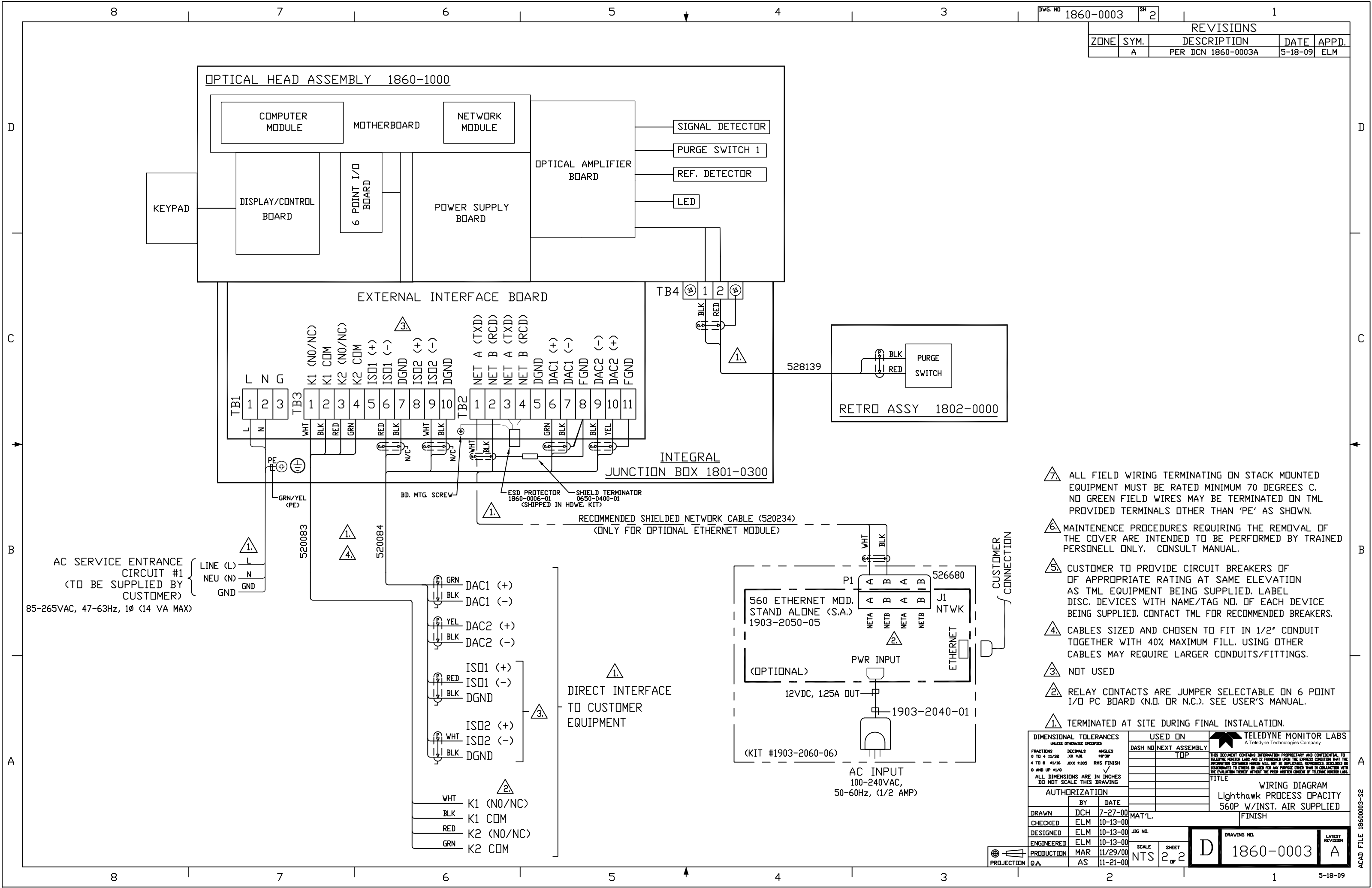
RETRO BLOWER (USED IN DUAL BLOWER 42 CFM CONFIGURATION ONLY) (NOT USED IN SINGLE BLOWER SYSTEMS)

- 1. 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.
- 2. MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 3. CUSTOMER TO PROVIDE CIRCUIT BREAKERS 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.
- 5. NOT USED
- 6. 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		USED ON		TELEDYNE MONITOR LABS A Teledyne Technologies Company	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION BELONGING TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPAIRED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
6 TO 4 41/32	.001		TOP	WIRING DIAGRAM LightHawk PROCESS OPACITY 560P WITH BLOWER(S)	
4 TO 8 41/16	.002				
8 AND UP 41/8	.005			TITLE	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING					
AUTHORIZATION					
DRAWN		BY		DATE	
CHECKED		BY		DATE	
DESIGNED		BY		DATE	
ENGINEERED		BY		DATE	
PRODUCTION		BY		DATE	
G.A.		BY		DATE	

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	PER DCN 1860-0003A	5-18-09	ELM

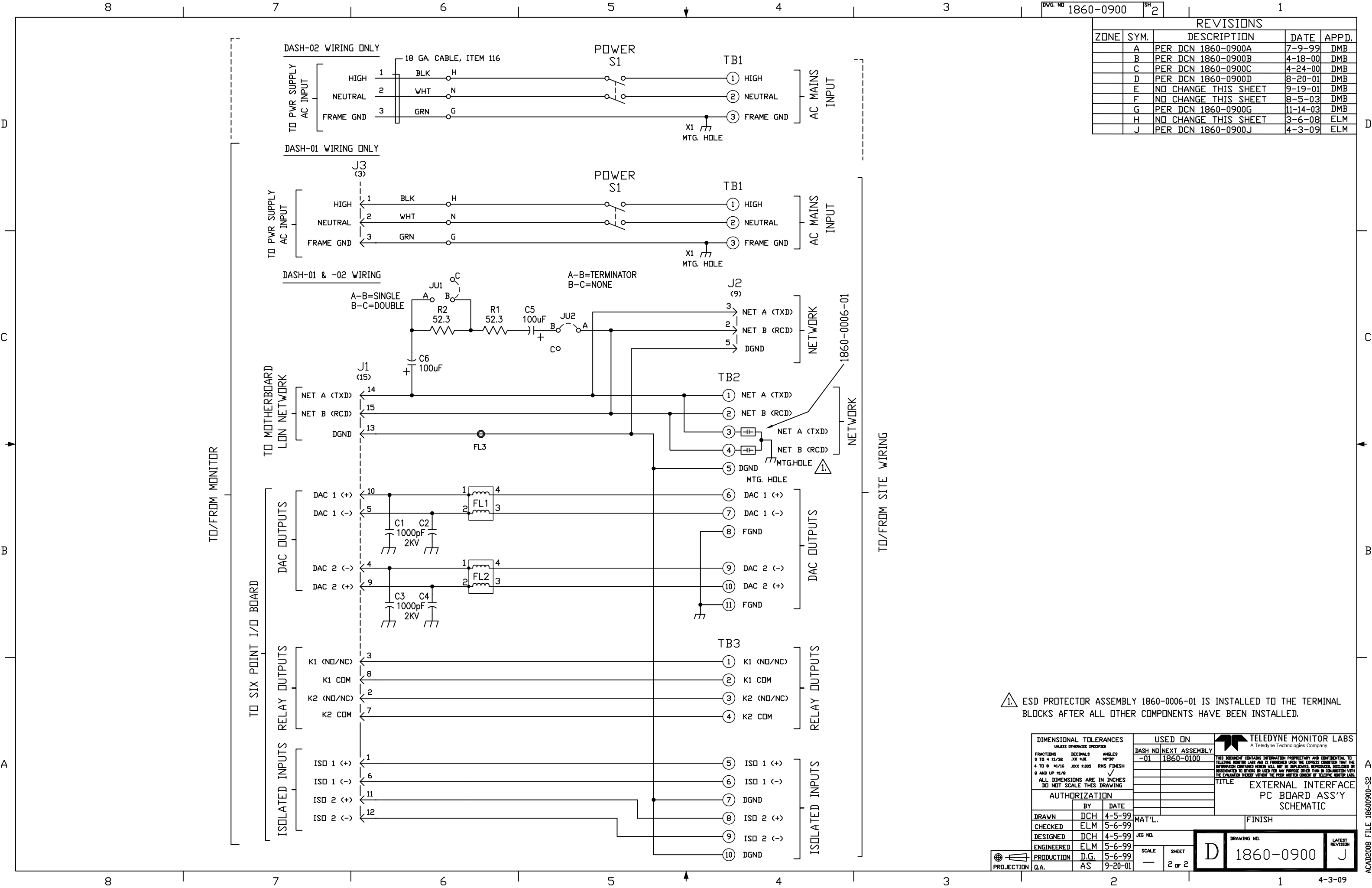


- 7. ALL FIELD WIRING TERMINATING ON STACK MOUNTED EQUIPMENT MUST BE RATED MINIMUM 70 DEGREES C. NO GREEN FIELD WIRES MAY BE TERMINATED ON TML PROVIDED TERMINALS OTHER THAN 'PE' AS SHOWN.
- 6. MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 5. CUSTOMER TO PROVIDE CIRCUIT BREAKERS 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. NOT USED
- 2. RELAY CONTACTS ARE JUMPER SELECTABLE ON 6 POINT I/O PC BOARD (N.O. OR N.C.). SEE USER'S MANUAL.
- 1. TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS A Teledyne Technologies Company	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPARATED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
0 TO 4	±1/32	JXX	AJL	TITLE	
4 TO 8	±1/16	JXX	±.005	WIRING DIAGRAM	
8 AND UP	±1/8	JXX	RMS FINISH	Lighthawk PROCESS OPACITY	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				560P W/INST. AIR SUPPLIED	
AUTHORIZATION				FINISH	
DRAWN		BY		DATE	
CHECKED		ELM		10-13-00	
DESIGNED		ELM		10-13-00	
ENGINEERED		ELM		10-13-00	
PRODUCTION		MAR		11/29/00	
G.A.		AS		11-21-00	
SCALE		SHEET		DRAWING NO.	
NTS		2 OF 2		1860-0003	
D		A		LATEST REVISION	

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



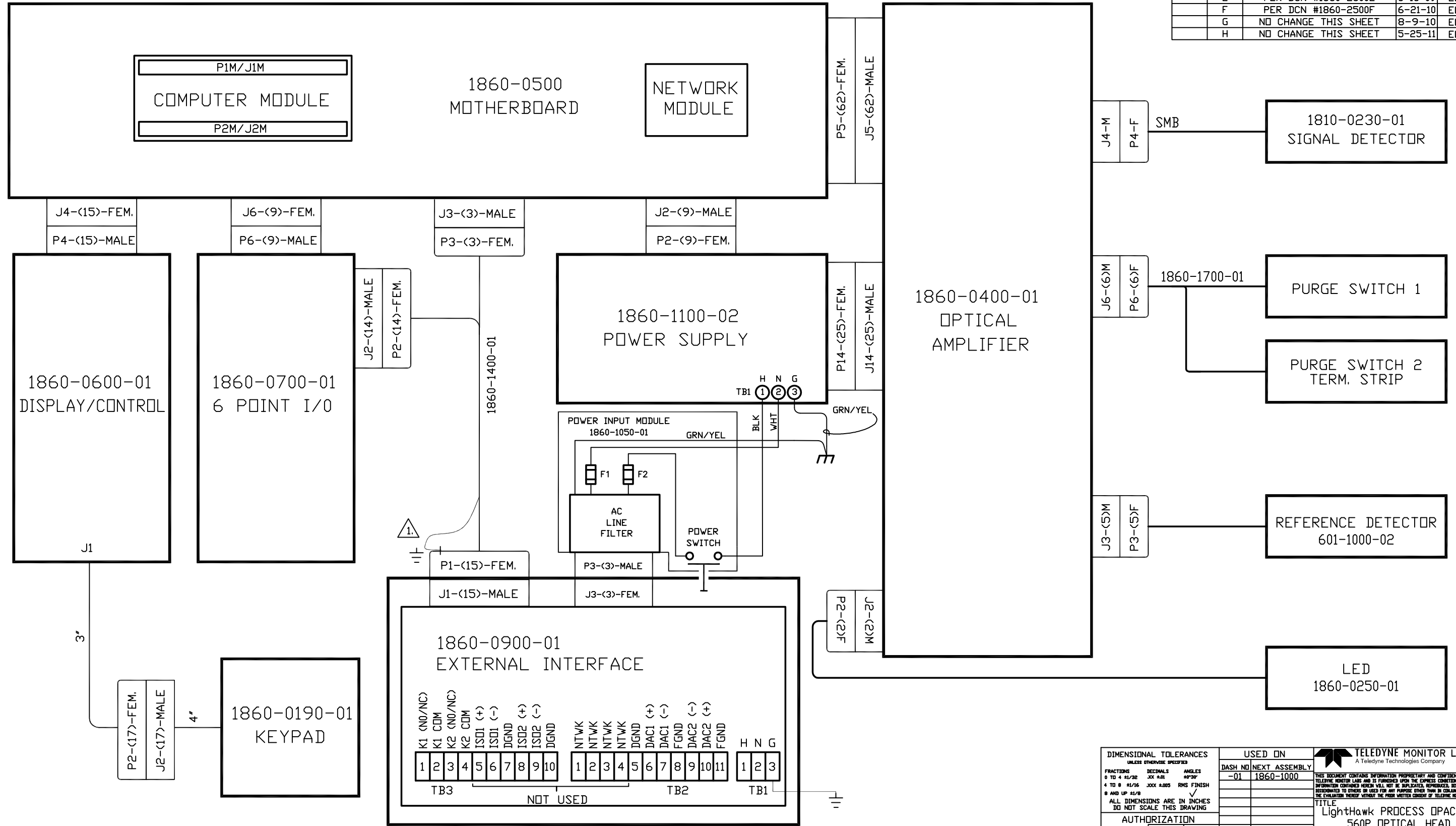
⚠ ESD PROTECTOR ASSEMBLY 1860-0006-01 IS INSTALLED TO THE TERMINAL BLOCKS AFTER ALL OTHER COMPONENTS HAVE BEEN INSTALLED.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS A Teledyne Technologies Company	
FRACTIONS	DECIMALS	ANGLES	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION BELONGING TO TELETYPE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRINTER, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELETYPE MONITOR LABS.
0 TO 4 1/32	.001	40°/30'	-01	1860-0100	
4 TO 8 1/16	.002				TITLE
8 AND UP 1/8	.005				EXTERNAL INTERFACE PC BOARD ASS'Y SCHEMATIC
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING					
AUTHORIZATION		MAT'L.		FINISH	
DRAWN	BY	DATE	JIG NO.		
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			
SCALE		SHEET		DRAWING NO.	
2 OF 2		2 OF 2		1860-0900	
				LATEST REVISION	
				J	



ACAD2008 FILE 18600900-S2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
A		NO CHANGE THIS SHEET	11-7-00	ELM
B		NO CHANGE THIS SHEET	6-11-02	ELM
C		NO CHANGE THIS SHEET	2-18-03	DMB
D		PER DCN #1860-2500D	4-24-07	ELM
E		PER DCN #1860-2500E	5-18-09	ELM
F		PER DCN #1860-2500F	6-21-10	ELM
G		NO CHANGE THIS SHEET	8-9-10	ELM
H		NO CHANGE THIS SHEET	5-25-11	ELM



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

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 JOX 4.01 49°30' 4 TO 8 ±1/16 JOX 4.05 RMS FINISH 8 AND UP ±1/8 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -01 1860-1000		TELEDYNE MONITOR LABS A Teledyne Technologies Company THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRICED, RESOLD OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
AUTHORIZATION BY DATE DRAWN DCH 7-28-00 CHECKED ELM 9-11-00 DESIGNED ELM 9-11-00 ENGINEERED ELM 9-11-00 PRODUCTION MAR 9/11/00 Q.A. AS 9-11-00		MAT'L. FINISH		TITLE LightHawk PROCESS OPACITY 560P OPTICAL HEAD WIRING DIAGRAM	
DRAWING NO. 1860-2500		SHEET 2 OF 2		LATEST REVISION H	

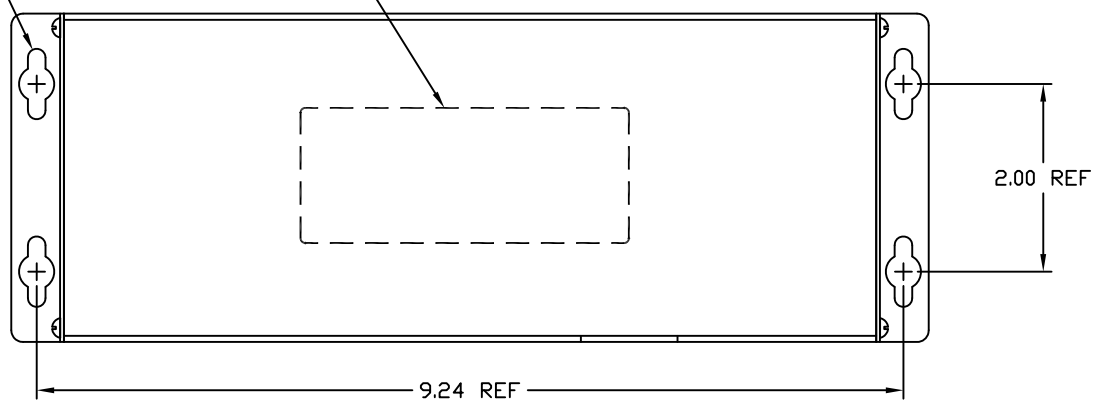


ACAD2010 18602500-S2

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

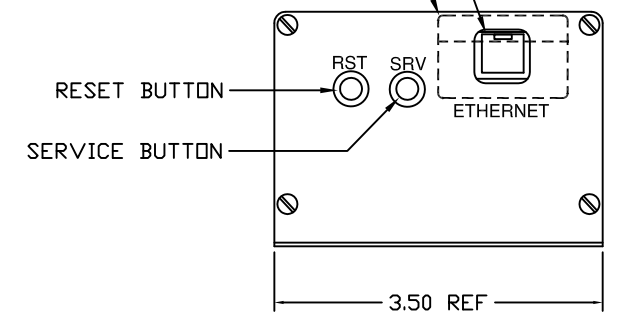
WILL ACCOMMODATE #8-32 HDWE.

IDENTIFICATION LABEL (BOTTOM)

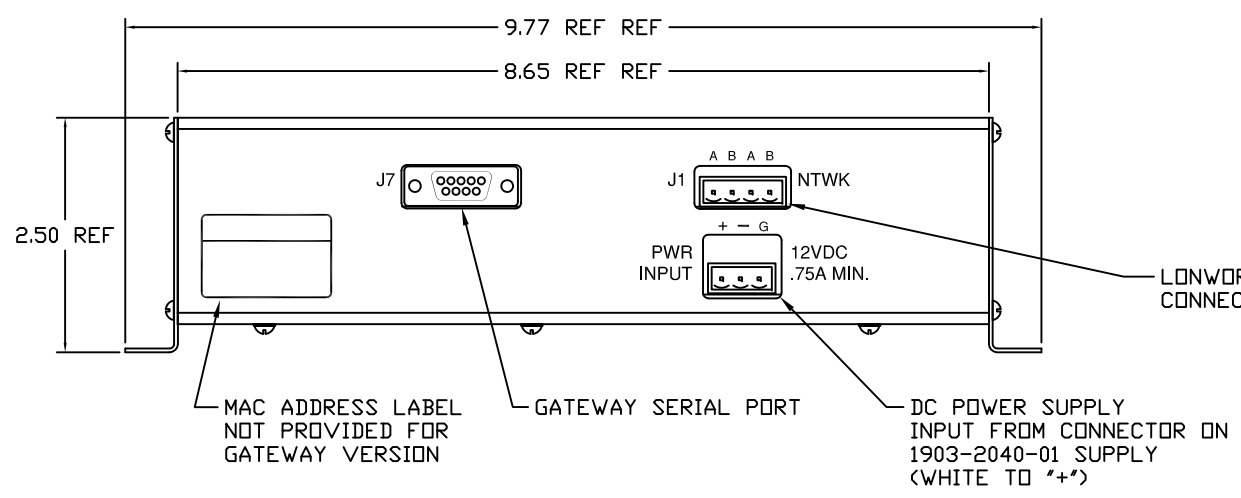


LABEL NOT PROVIDED FOR ETHERNET VERSION

CONNECTOR NOT PROVIDED FOR GATEWAY VERSION

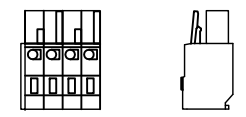


END VIEW

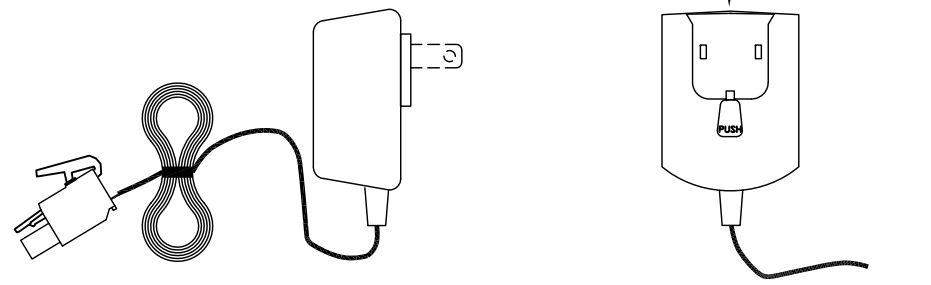


FRONT VIEW
1903-2050-XX
STAND ALONE ETHERNET OR GATEWAY MODULE

LONWORKS NETWORK CONNECT TO A & B, (USE P1)



526680
P1 (MATING CONNECTOR FOR J1)



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.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			USED ON		TELEDYNE MONITOR LABS A Teledyne Technologies Company
FRACTIONS	DECIMALS	ANGLES	DASH NO	NEXT ASSEMBLY	
0 TO 4 ±1/32	.XX ±.01	±30°	-01	560 GATEWAY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRINTER, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.
4 TO 8 ±1/16	.XX ±.005	RMS FINISH	-02	150 GATEWAY	
8 AND UP ±1/8			-04	560 BRIDGE	
			-05	560 ETHERNET	
			-06	150 ETHERNET	
			-07	360 ETHERNET	
			-08	560 8B GATWY	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			AUTHORIZATION		TITLE
DRAWN			BY DATE		CUSTOMER DRAWING, 1903-2050-xx STAND ALONE ETHERNET/GATEWAY MODULE
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			SCALE		DRAWING NO. 1903-2060
			1:1		
			SHEET		LATEST REVISION C
			1 OF 1		