ELKHART BRASS

A **Clarience Technologies** Company

# Installation, Operating, & Maintenance Instructions

**Model 8294-04**

# *Scorpion*® Electric Monitor

DOCUMENT NUMBER
98167000 REVISION - D

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# I. PRODUCT SAFETY

**Important:**

**Before installing and operating this equipment, read & study this manual thoroughly. Proper installation is essential to safe operation. In addition, the following points should be adhered to in order to ensure the safety of equipment and personnel:**

1. All personnel who may be expected to use this equipment must be thoroughly trained in its safe and proper use.

2. Before flowing water from this device, check that all personnel (fire service and civilian) are out of the stream path. Also, check to make sure stream direction will not cause avoidable property damage.

3. Become thoroughly familiar with the hydraulic characteristics of this equipment, and the pumping system used to supply it. To produce effective fire streams, operating personnel must be properly trained.

4. Whenever possible, this equipment should be operated from a remote location. Do not needlessly expose personnel to dangerous fire conditions.

5. Open water valve supplying this equipment slowly, so that the piping fills slowly, thus preventing possible water hammer occurrence.

6. After each use, and on a scheduled basis, inspect equipment per instructions in section VII.

7. Any modifications to the enclosure will destroy the NEMA 4 rating and void warranty coverage of the enclosure and all components within.

# II. SYSTEM FEATURES

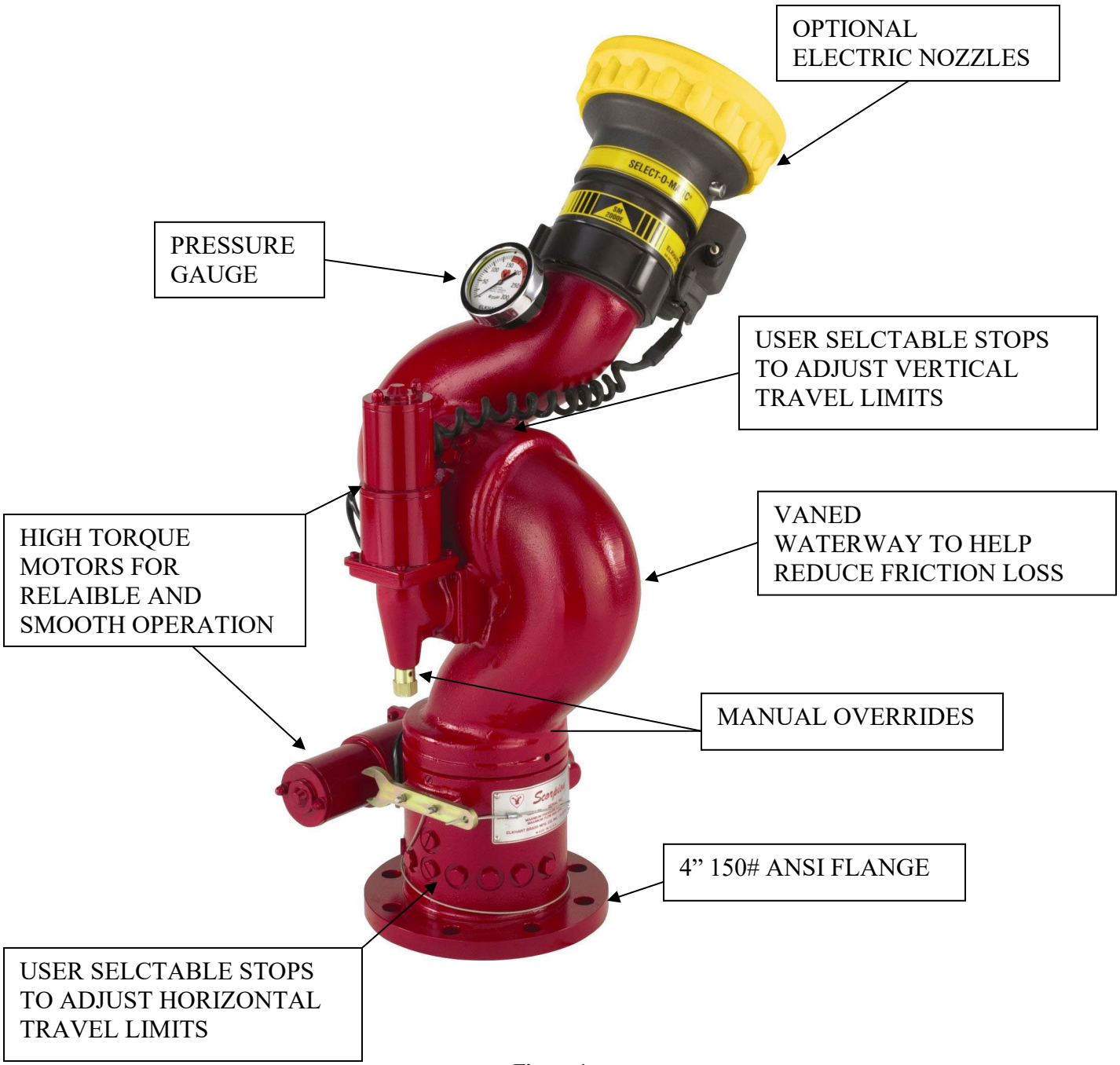



**Figure 1**
**8294-04 Scorpion and SM-2000E Nozzle**

# III. SYSTEM COMPONENT DESCRIPTIONS

## A. 8294-04 Scorpion Monitor

(Figure 2) The 8294-04 Scorpion is a cast aluminum monitor with 4" waterway. The waterway contains a central vane to minimize large-scale turbulence and provide superior fire streams. Monitor water supply connection is a 4 inch 150 lb. ANSI pattern flange. The discharge nozzle connection is 3-1/2 inch National Hose thread. Nozzle stream direction is controlled by two permanent magnet type planetary gear motors, one controlling rotation about the axis of the water inlet, and the other controlling nozzle elevation and depression. Right angle gear cases between the gear motor and the monitor allow for convenient manual override of the electric motors in the event of a power failure during firefighting operations. All gearing is enclosed within the monitor housings.

**Figure 2**
**8294-04 Monitor with SM-2000E Nozzle**

The maximum monitor flow capacity is 2000 gallons per minute. Monitors are normally supplied with the SM-1250E STREAM constant pressure (automatic) type master stream nozzle. This nozzle has a flow range of 300 to 1250gpm@80psi, and has an electric drive mechanism for remote control of the spray pattern from a straight stream to wide fog. Other STREAM nozzles that my be used on this monitor are:

- SM-1000E 300 to 1000gpm@80psi
- SM-1500E 500 to 1500gpm@75psi
- SM-2000E 500 to 2000gpm@80psi.

For optimum straight stream performance, stream shapers are provided as part of the monitor and nozzle system. Solid stream nozzles are also available for use with this monitor

## B. 81480001 Center-Stow, 81480011 Left-Stow, & 81480021 Right-Stow Relay Control Module

The monitor control circuit uses a state-of-the-art PIC (**P**rogrammable **I**ntegrated **C**ircuit) chip design. This device allows numerous control features while keeping circuit board size to a minimum. Relays within this box provide motor reversing control for the up-down, left-right and straight stream-fog functions. The control module provides motor protection with the use of electronic current sensing circuitry. When monitor travel limits are reached, this circuitry senses motor stall current within a few milliseconds, and automatically shuts off power to the motor. As soon as the control switch is released, the circuit resets to allow subsequent operation of the monitor.

In an effort to eliminate the need for the installer to open the relay control module, we ship the assembly with pre-installed cables for connection to the primary and secondary switch boxes, and to the monitor wiring harness. The enclosure is NEMA 4 rated (drench proof), and suitable for installation at any location on the apparatus other than high temperature areas such as the engine compartment.

The following additional functions/features are provided in the relay control box:

- **Reverse Polarity Protection**: If battery connections are reversed, this feature prevents power from being applied to circuits, and prevents damage to electronic components.

- **Control Override Capability:** This feature provides compliance with NFPA 1901. The controls at the aerial operator's position override secondary controls (i.e. at ladder tip).

- **Circuit Board Moisture Protection:** The circuit board and circuit components are protected from moisture by an acrylic resin conformal coating. All relays have sealed covers.

- **Indicator Lights for Control System Trouble Shooting:** LED indicator lights are located on circuit board inside relay box for purpose of checking control circuits and PIC chip operational status.

- **Stow Feature:** See document 98284060 (Found in instruction packet 98421001 included with 81480001, 81480011, or 81480021 Relay Control Module) for a complete description of the stow feature including a description of the stow indicator output.

- **Electronic Current Sensing (ECS):** The control system also provides secondary motor protection with the use of ECS circuitry. If the monitor encounters an obstruction before reaching a limit, this circuitry quickly senses motor stall current and automatically shuts off power to the motor. As soon as the control switch is released, the circuit resets to allow subsequent operation of the monitor.

**Caution:**
Any modification of the enclosure will destroy the NEMA 4 rating, and will void the warranty coverage of the remote control.

## C. 81421001 Primary Panel Mount Switch Module With Stow

(Figure 3) This component is a panel mount type configuration with controls to operate the monitor. Three separate sealed three position toggle switches are used as inputs to the controller as well as a single sealed momentary switch to initiate the stow feature. The switches are ON-OFF-ON momentary type switches. The module has a NEMA 4 rating and is suitable to install anywhere on the apparatus except for the tip of the aerial or inside the engine compartment.

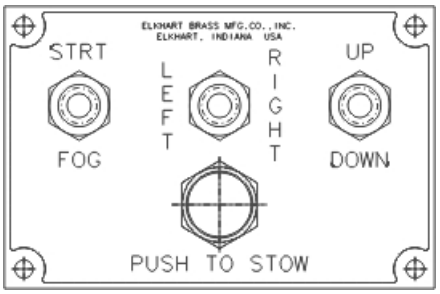



**Figure 3**
**Primary Panel Mount Switch Module with Stow**

## D. 81339001 Primary Panel Mount Switch Module

(Figure 4) This component is a panel mount type configuration with controls to operate the monitor. Separate sealed three position toggle switches are used as inputs to the controller. The switches are ON-OFF-ON momentary type switches. The module has a NEMA 4 rating and is suitable to install anywhere on the apparatus except for the tip of the aerial or inside the engine compartment.

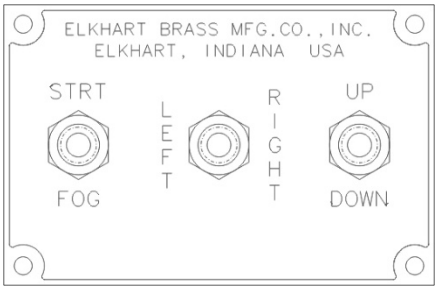



**Figure 4**
**Primary Panel Mount Switch Module**

## E. 81340001 Secondary Switch Box

(Figure 5) This component is a surface mount type switch box with controls for operation of the monitor. Separate sealed toggle switches are furnished for up-down, left-right, and straight-fog functions. The box has a NEMA 4 rating, and can be installed at the top of the ladder in aerial applications, or as a secondary controller on deck gun applications. A terminal strip inside the enclosure allows for connection of the control cable, and a watertight strain relief fitting provides for sealing around the cable entry.

**Figure 5**
**Secondary Switch Box**

## F. 81242001 Receptacle for Hand-Held Remote Control

(Figure 6) This device consists of a Deutsch HD10 Series nine-conductor receptacle mounted in an escutcheon plate for attachment to a pump control panel or other convenient location on the apparatus. Wire leads from the receptacle terminate in a 10-conductor Packard Metri-Pak 150 Series male connector. If required, a dual 81242001 installation (i.e. one receptacle on each side of apparatus) can be accomplished with the use of two 36805000 wye harnesses and a 36804000 extension harness.

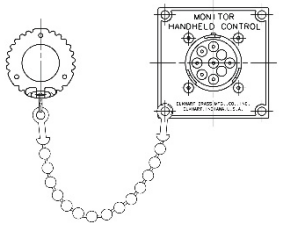



**Figure 6**
**Handheld Remote Control Receptacle**

## G. 81221001 Tethered Handheld Remote Control

(Figure 7) The optional sealed hand-held remote control has a 50’ tethered nine-conductor cable that attaches to the Receptacle for Hand-Held remote control (81242001.). The hand-held remote control has controls to operate the right/left, up/down, and fog/straight stream operations of the monitor. This option allows the operator to obtain a better viewing position for directing the placement of the monitor stream.

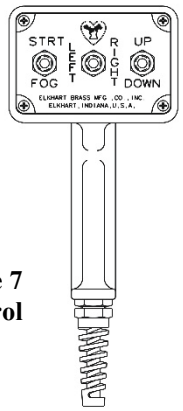



**Figure 7**
**Tethered Handheld Remote Control**

## H. 81466001 Auxiliary Battery Pack

(Figure 8) A 12-volt, 12 amp-hr. sealed lead-acid battery pack is available to allow operation of the monitor in case of vehicle electrical system failure. These battery packs are also used as a means to minimize the required size of conductors routed up aerial ladders and towers. This is accomplished by mounting the battery pack near the monitor, with a small trickle-charge conductor to the battery from the vehicle system. Optional harness lengths of 1’, 3’ and 6’ are available.

**Figure 8**
**Auxiliary Battery Pack**

# IV. CONTROL SYSTEM SPECIFICATIONS

## Controller Specifications

- Power requirements — 12VDC (9VDC to 14VDC)
- Control current — 0.15 A
- Monitor motor run current for left-right — 4.5 - 5 A* @ 200psi
- Monitor motor run current for up-down — 4.5 - 5 A* @ 200psi
- Monitor motor stall current — 27 A
- Current limit trip-out — 6 A
- Nozzle motor run current — 0.5 A
- Recommended Fuse — 40 A
- Operating temperature range — -40°F (-40°C) to 176°F (80°C)

## Shock:

- 30 G's (55 Hz. @ .2 inch double amplitude)

## Vibration:

- 15.5 G's (55 Hz. @ .05 inch double amplitude) continuous operation

## Environmental:

- All enclosures have a NEMA 4 rating (must withstand a 1 inch stream of water (65GPM) from a distance of ten feet for five minutes, with no water entering the enclosure).

# V. INSTALLATION

## A. Component Mounting

See system layout drawing number 8294040 (part number 98284040) for pictorial of system layout.

### 1. Monitor

Attach 4" 150 lb. class ANSI pattern companion flange to water supply pipe so that bolt pattern will allow monitor to be installed with the "straight ahead" position properly aligned. Alignment is correct when the "straight ahead" direction is centered between adjacent flange holes.

Attach monitor inlet flange to companion flange on water supply pipe with eight (8) 5/8-11 UNC grade 5 carbon steel or stainless steel bolts, 2-1/2 inches long, with nuts. If a wafer type butterfly valve is installed between the monitor and the companion flange, required bolt length will be 4-1/2 inches. Seal flange joint with gasket, or suitable flange sealant. Most wafer type butterfly valves have seats that serve as flange gaskets, and separate gaskets or sealant is not required. Apply Loctite® #242 to bolt threads, then thread on nuts, and torque to 60-70 ft-lbs.

**Warning:** When installing monitor on a raised face companion flange, it is critical that bolts be tightened uniformly to prevent cocking of the monitor relative to the flange or valve. If the monitor becomes cocked, (see Figure 9) the monitor cast flange base will fracture and fail when the bolts on the "high" side are tightened.

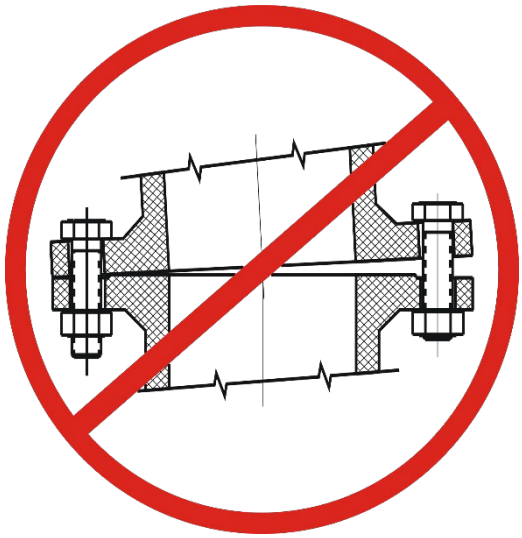


**Figure 9**
**Improper Flange Installation**

## 2. Relay Box (Center-Stow 81480001, Left-Stow 81480011, & Right-Stow 81480021)

Locate relay box enclosure close enough to monitor so that the properly secured cable will reach the monitor harness connection. The cable length is 36 inches.

Note: If longer cable is needed, the following extension cable lengths are available:

| Relay Box to Monitor Extension Cables | |
|---|---|
| **Part No.** | **Length (Ft.)** |
| 81066000 | 2 |
| 81136000 | 4 |
| 81137000 | 6 |
| 81138000 | 8 |
| 81139000 | 10 |

- Mark enclosure-mounting holes on panel or bracket to which enclosure will be mounted per dimensions in Figure 10.
- Drill (4) 11/32" diameter holes in panel or bracket.
- Remove (4) 5/16-18 bolts and lock washers from back of enclosure. Apply Loctite® #242 to bolts and install through panel or bracket into back of enclosure. Tighten bolts.
- Attach six-pin cable connector to monitor harness near base of monitor.
- Secure cable to ladder or platform framing with cushioned wire clips in a manner to prevent snagging by personnel, tools or equipment.

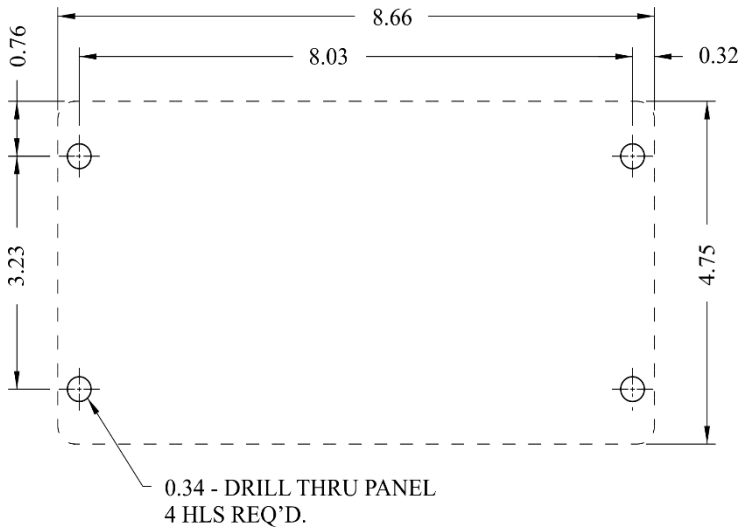



**Figure 10**
**Relay Box Mounting Bolt Pattern**

## 3. Primary Panel Mount Switch Module (81421001 and 81339001)

- Mark panel cutout and mounting screw pattern per dimensions in Figure 11.
- Cut rectangular clearance opening and drill four .140 in. diameter (#28 drill) holes.
- Insert cable connector, cable and switches through panel cutout. Secure unit to panel with four (4) #8-32 type "F" thread cutting screws.

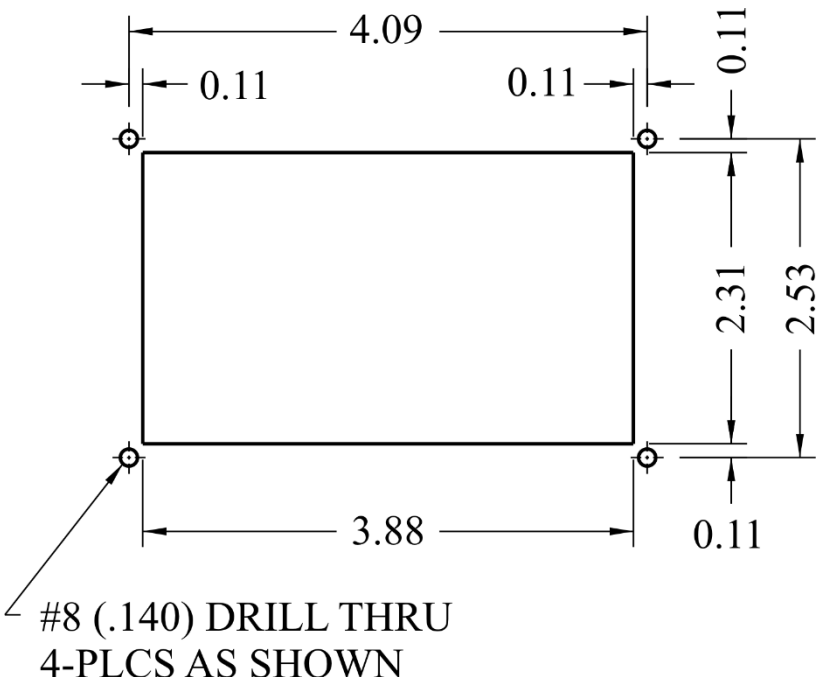



Figure 11
**Panel Cutout and Mounting Hole Pattern for**
**81412001 and 81339001 Panel Mount Switch Module**

## 4. 81340001 Secondary Switch Box

- Mark mounting holes on panel or bracket per dimensions in Figure 12.
- Drill two 9/32" diameter holes in panel or bracket.
- Remove 1/4-20 screws and lock washers from back of box. Insert screws with lock washers through backside of panel or bracket into mounting holes in box. Tighten screws.

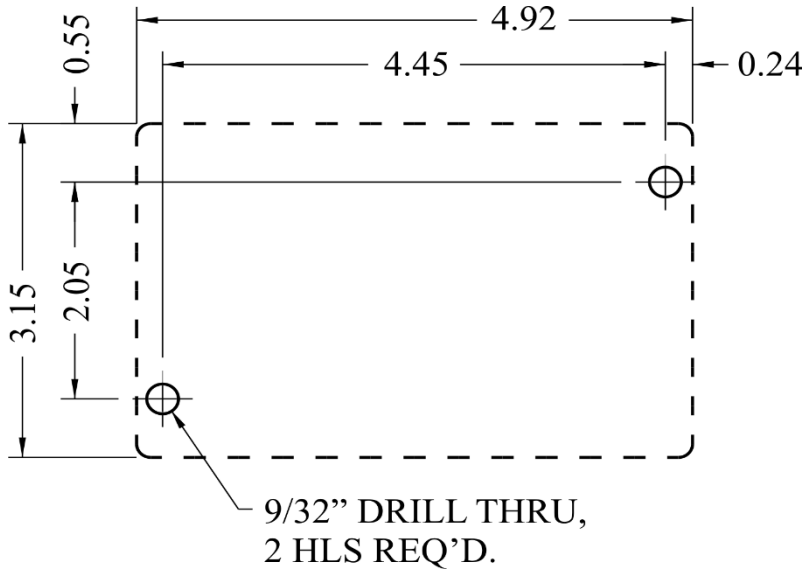



**Figure 12**
**81340001 Secondary Control Switch Box Mounting Bolt Pattern**

## 5. 81466001 Auxiliary Battery

- Mark locations of mounting holes on mounting surface or bracket per Figure 13
- Drill four (4) 21/64" diameter mounting holes.
- Open hinged cover of battery enclosure by loosening the four screws. Insert one 5/16-18 UNC socket head cap screw from the inside of the enclosure through each of the four (4) mounting holes of the enclosure and into the corresponding holes in the mounting surface or bracket. Assemble nuts and lock washers to each mounting screw then tighten.

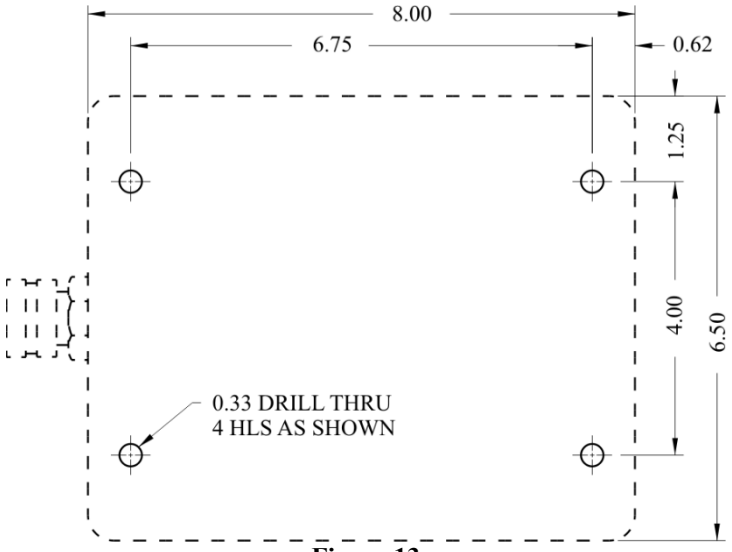



**Figure 13**
**Auxiliary Battery Mounting Hole Pattern**

## 6. 81242001 Receptacle for Optional Hand-Held Control

- Mark locations of mounting holes on mounting surface or bracket per Figure 14
- Cut 2.0” diameter clearance hole and drill, (4) 3/16" diameter, mounting holes.
- Insert Packard connector and harness through clearance hole. Align escutcheon plate screw holes with the mounting holes and secure panel with four #8-32 self-tapping screws.

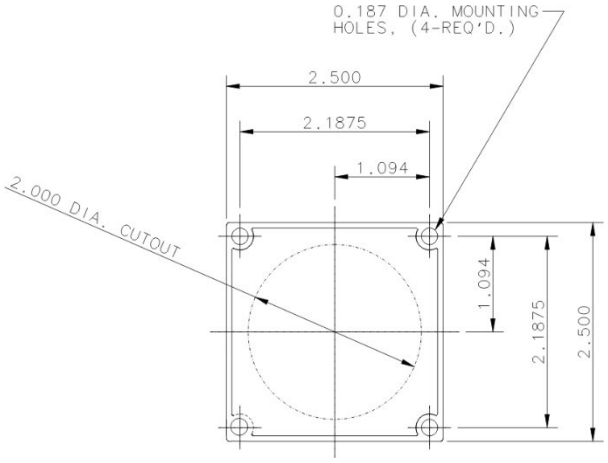



**Figure 14**
**81242001 Receptacle for Optional Hand-Held Control**

## B. Electrical Connections

### 1. System Wiring Diagrams

Refer to the appropriate wiring diagram (Found in instruction packet 98421001 included with 81480001, 81480011, or 81480021 Relay Control Module)

- Drawing Number 30189000 (Part Number 98284010) With Stow and OEM supplied primary controls
- Drawing Number 30194000 (Part Number 98284020) No Stow with Elkhart Brass supplied primary controls
- Drawing Number 30205000 (Part Number 98284030) With Stow and Elkhart Brass supplied primary controls

### 2. Monitor to (81480001 Center-Stow, 81480011 Left-Stow, or 81480021 Right-Stow) Relay Control Module

- Route cable with 6-conductor molded connector from relay box to corresponding connector on monitor harness near inlet flange. Plug connector halves together.
- Use cushioned clamps to secure cable to appropriate structural members, being sure to locate cable in protected areas.

### 3. 81339001 Primary Control Switch Module to (81480001 Center-Stow, 81480011 Left-Stow, or 81480021 Right-Stow) Relay Control Module

- Route remaining unused cable from relay box to weather proof junction box (installer supplied). Insert cable through weather proof strain relief into box, and tighten strain relief nut.
- If junction box is within four feet cable length of 81339001 control switch module, use Elkhart #36802000 harness assembly. (If cable distance from control switch module to junction box exceeds four feet, use 36804000 extension harness (10ft.).) Join Packard Metri-Pak connector on harness to mating connector on switch control module, and route harness to junction box. Insert harness through weather proof strain relief fitting into junction box. Strip off suitable length of outer jacket from both cables in junction box, then strip each individual conductor. Make secure, insulated splices of matching color wires. Install junction box lid.
- If dual switch modules are required (i.e. one control on each pump panel), see wiring diagram for required wye harness and extension harness.

### 4. 81340001 Secondary Switch Box to (81480001 Center-Stow, 81480011 Left-Stow, or 81480021 Right-Stow) Relay Control Module

- Route 9-conductor cable (with warning tag) from relay box to switch box, and secure cable with cushioned clamps.
- Remove lid from switch box by loosening the four screws at corners, loosen nut on cable strain relief fitting, and insert cable through fitting approximately 6 inches.

- Strip off outer jacket of cable to a length of 4 inches. Pull cable back through strain relief so that just 1/4" of the cable jacket protrudes into the box. Tighten strain relief fitting nut securely.
- Strip 1/4" of insulation off seven of the nine individual 18AWG conductors. Violet and black will **not** be used. Clip them off as close to the end of the cable jacket as possible. Attach an insulated (red) fork style crimp connector to each of the remaining seven wires.
- Attach the seven wires to the terminal strip in the bottom of the box per Table 1.

| Label | Wire Color |
|---|---|
| Not used | Black |
| +12V | Red |
| Not used | Violet |
| STRT | Orange |
| FOG | Green |
| UP | White |
| DOWN | Blue |
| LEFT | Yellow |
| RIGHT | Brown |

**Table 1 - Secondary Harness Wire Descriptions**

- Make sure gasket in box lid is free of dirt, cuts, or other damage. Reattach lid to box and tighten four screws securely.

## 5. 81242001 Receptacle for Hand-Held Remote Control to (81480001 Center-Stow, 81480011 Left-Stow, 81480021 Right-Stow) Relay Control Module

- If receptacle is mounted within 24 inches of the 81339001 switch control module, insert 36805000 wye harness between the Packard connector of the switch control module and the wiring harness leading to the relay box. Attach connector on 81242001 receptacle harness to mating connector on extra leg of wye harness.
- See wiring diagram for required harness configurations for various combinations of single and multiple switch modules and hand held remote control receptacles.

## 6. 81466001 Auxiliary Battery to (81480001 Center-Stow, 81480011 Left-Stow, 81480021 Right-Stow) Relay Control Module

- Loosen nut on strain relief fitting on battery box and remove yellow cable. Remove cap from battery receptacle on relay box. Attach 90° molded-end cable connector to relay box, and route cable to battery box, securing cable to structural members with cushioned clamps.
- Remove lid from battery box. Cut cable to length, allowing nine inches for insertion into box. Strip off eight inches of outer jacket, and insert cable through strain relief fitting into box. Tighten fitting nut securely.

- Strip 5/16" of insulation from the ends of the black and white wires. Crimp insulated female disconnect type connector (16-14AWG) securely onto each wire. Push connector of white wire onto positive (+) battery terminal, and push connector of black wire onto negative (-) battery terminal. Reattach box cover.

## C. Rotational Limits

FOR A DESCRIPTION OF ALL SETTINGS REFER TO DRAWING 98031010.

Visit
www.elkhartbrass.com
Look under "Service & Parts" then "Operating and Instruction Manuals"

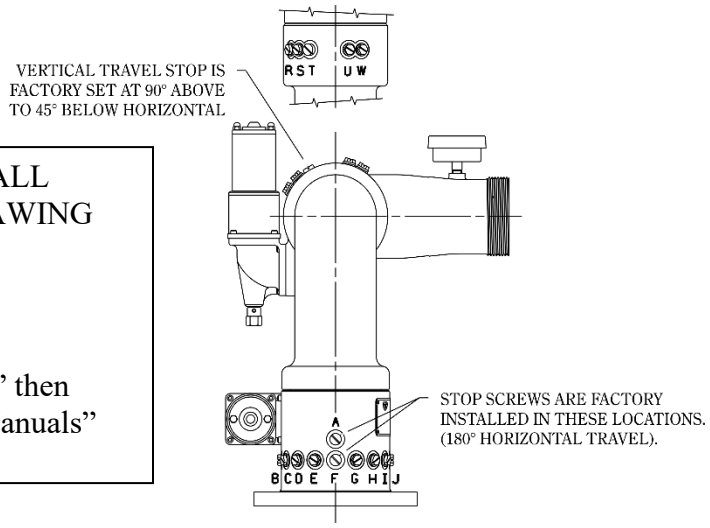



**Figure 15**
**Rotational Limit Settings for 8294-04**

| Application | Rotation Limits | Stop Screw Locations |
|---|---|---|
| Aerial Ladder, Elevating Platform, or Water Tower | 45°Left or Right of Straight Ahead | D & H |
| | 67.5°Left or Right of Straight Ahead | E & G |
| | 90°Left or Right of Straight Ahead | F |
| Deck Gun | 174°Left or Right of Straight Ahead | A |

**Table 2**
**Horizontal Settings for 8294-04**

| Application | Rotation Limits | Stop Screw Locations |
|---|---|---|
| Aerial Ladder or Deck Gun | 90° above horizontal to 45° below horizontal | T |
| Elevating Platform | 45° above horizontal to 45° below horizontal | T & U |

**Table 3**
**Vertical Settings for 8294-04**

*Consult the current edition of NFPA 1901 for minimum angles of rotation for aerial device monitors:

# VI. OPERATING INSTRUCTIONS

## A. Normal Operation

The monitor and nozzle are controlled with three toggle switches at each control point. These switches are marked "STRT-FOG", "LEFT-RIGHT", AND "UP-DOWN". The switches are of the three position, momentary contact, center-off type. Simply push and hold the switch(es) to move the monitor to the desired stream direction, or to adjust the nozzle to the desired spray pattern*. Release switch when proper stream position or spray pattern is achieved.

## B. Manual Override

In the event of power failure to the monitor, the motors may be actuated manually. To operate a function manually, simply apply a ¾" ratcheting type wrench (either socket type or ratcheting box end type) to the hex fitting on the motor shaft.

**Caution:**
Do not use impact drivers to operate manual override nuts. Serious damage to motor gear heads will result.

***Note:** The SM-xxxxE nozzles have a unique ball screw drive that allows the motor to "free wheel" at the end of pattern travel in either the straight stream or wide fog positions. No slip clutch or current limiting feature is used with these nozzle drives.

## C. Storing the 8294 Monitor (If available)

See document 98284060 (Found in instruction packet 98421001 included with 81480001, 81480011, or 81480021 Relay Control Module) for a complete description of the operation of the stow feature.

**Warning:**
Never activate the "Stow" feature while water is flowing. Serious injury to personnel and damage to apparatus could result.

Note - Any directional command (left, right, up, or down) will cancel the "stow" command. To continue the command, reactivate the "Stow" feature.

Note – In the event power is cycled in the middle of a stow operation; when the processor powers up the stow output will show that the monitor is NOT stored.

# VII. MAINTENANCE & INSPECTION

For repair parts information see assembly-drawing number 08294041 (part number 98080000.)

## A. Preventive Monitor Maintenance

The complete monitor and control system should be inspected during each apparatus check. Careful inspection for damage to the monitor or nozzle is especially important after use in emergency operations.

- Operate each function (left-right, up-down, stream-fog, stow) with each of the controllers.
- Remove nozzle and check for debris lodged between the nozzle stem and body, or in the stream shaper inlet. Remove debris.
- During nozzle flow test, inspect monitor swivel joints for leaks.
- With the water off, operate the stow function, looking for any possible obstructions and check the final stow position.
- Inspect all exposed wiring for signs of damage.

**Note:** Grease fittings are provided for the up-down and left-right gear cases, routine greasing should be performed to expel water & other contaminants that can get into the rotation joints & gear cases. If the monitor is exposed to a high level of radiant heat for a prolonged period, it may be possible for the factory grease to thin and run out of the gear cases. In such an event, fresh grease should be applied. Use Mobilux EP2 or equivalent.

## B. Controller Circuit Board LED's

The circuit board within the relay box has 18 LED's to provide a comprehensive guide in troubleshooting problems with the monitor control system.

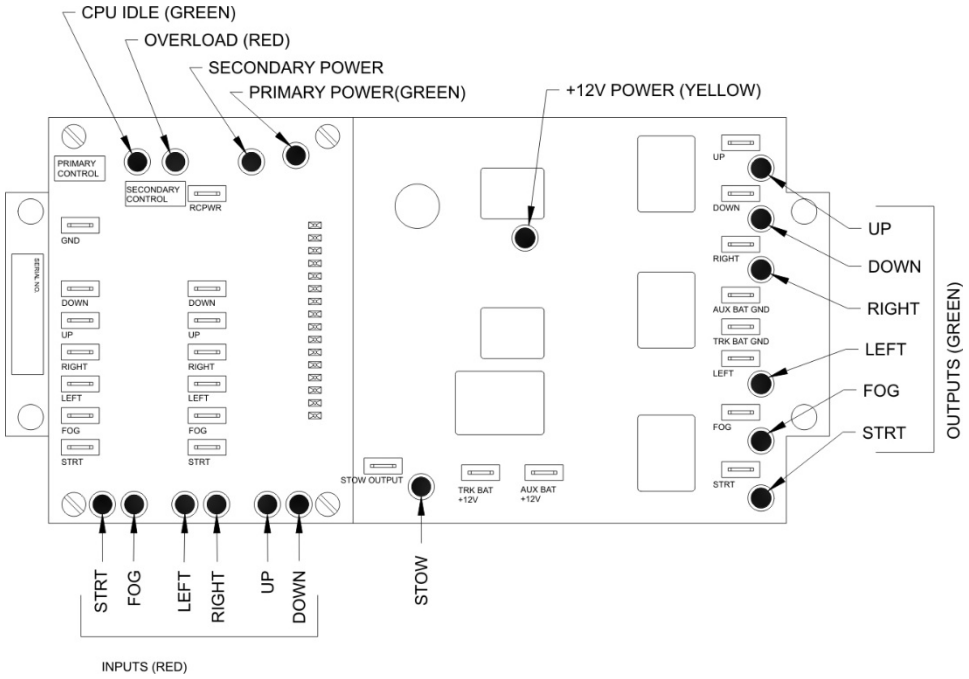


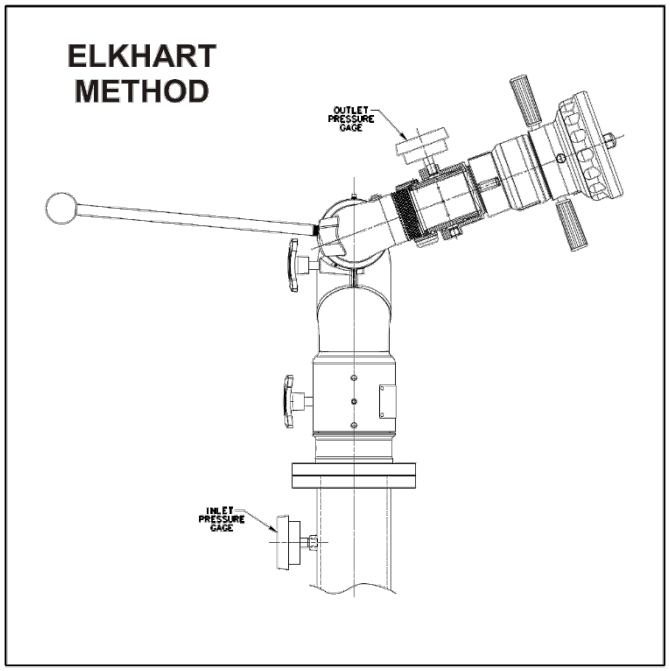

**Figure 16**
**LED Locations**

| LED Label | Color | Signal Significance |
|---|---|---|
| +12V Power | Yellow | When lit, 12VDC power is available for operation of unit. If this LED dims upon activation of a monitor function switch, the power source has a significant voltage drop due either to low battery charge or excessive line resistance. |
| CPU Idle | Green | This LED is located on the small daughter board. When power is applied to the circuit board, and the "+12V Power" LED is lit, this LED should also be lit. When lit, 5V power for the logic circuitry is available. If not lit, replace circuit board. |
| Overload | Red | This LED is located on the small daughter board. This LED is normally off. When lit, it signifies that one of the current sensors has sensed an overload condition and has shut off power to the corresponding motor. The LED should turn off when the function switch is released. This device will normally light whenever a monitor function reaches a travel limit. A low voltage condition at the power source may also cause this LED to light as a result of increased motor current at lowered voltage. |
| Primary Power | Green | This LED is located on the small daughter board. When power is applied to the circuit board, and the "+12V Power" LED is lit, this LED should also be lit. It indicates that power is available to the primary control switches. If not lit, replace circuit board. |
| Stow | Green | If the P20 jumper is set to do so this LED will blink during the stow sequence. In either case, the LED will come on continuously once the unit is stowed. It will remain on until the operator gives a positional command. The controller will remember the state of the "STOW" LED even if power is cycled. |
| Secondary Power | Green | When power is applied to circuit board, and the "+12V Power" LED is lit, this LED should also be lit. It indicates that power is available to the secondary control switches. If not lit, replace circuit board. |
| Inputs (6) | Red | These LED's are located on the small daughter circuit board. Each of these LED's is normally off. When a function switch is actuated the corresponding LED lights signifying that the input signal has reached the circuit board. If an LED fails to light, an open circuit situation probably exists in the wiring between the relay box and the switch, or the switch is defective. |
| Outputs (6) | Green | Each of these LED's is normally off. When a function switch is actuated, the corresponding LED lights up, signifying that the appropriate relay has actuated. If an output LED fails to light when the corresponding input LED is lit and the overload LED is not lit, replace circuit board. |

**Table 3 -- LED Descriptions**

# VIII. MONITOR & NOZZLE HYDRAULIC DATA

The following graphs offer the pressure losses for the monitor (and other devices) in terms of Total Static Pressure Drop. This Total Static Pressure Drop can be found by measuring the difference between the static inlet pressure and the static outlet pressure. The static pressure at either of these points can be found using a simple pressure gauge. An illustration of this method can be seen below.




In mathematical terms, the Total Static Pressure Drop is the change in Velocity Pressure plus Friction Loss. The change in Velocity Pressure results from the change in velocity of water caused by the change in the cross section of a waterway. Friction Loss results from the drag and sidewall interference of the water through a device. A simple equation can be seen below.

$$\Delta P_S = H_F + \Delta P_V$$

$\Delta P_S$ = Total Static Pressure Drop
$H_F$ = Friction Loss
$\Delta P_V$ = Velocity Pressure Loss

In the firefighting industry, the terms Total Static Pressure Drop and Friction Loss tend to be used interchangeably. However, these are significantly different measurements. This misconception could ultimately lead to lower than anticipated performance from equipment. **When designing a system and determining performance, Total Static Pressure Drop is the value that should always be used.** The Friction Loss curve is also supplied in order to make a comparison with competitor products that may only supply Friction Loss curves. If there are any further questions regarding this matter, please contact Elkhart Brass.

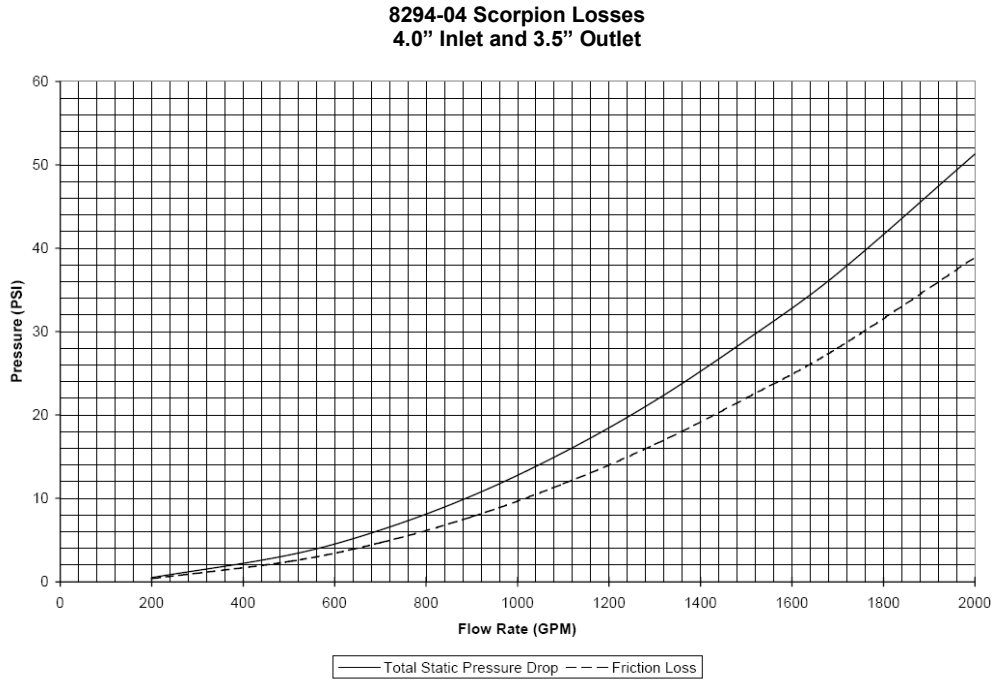



**Figure 17**
**8294-04 Scorpion Pressure Losses**

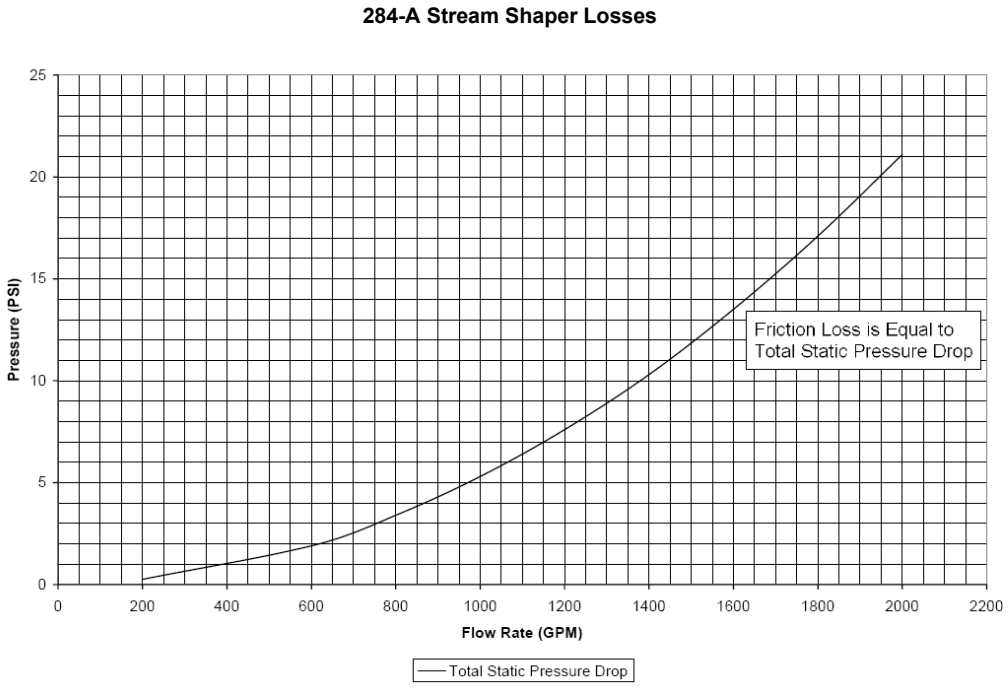



**Figure 18**
**284-A Stream Shaper Pressure Loss**

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