TYPE 45FS1/45UVFS1
MODEL 1000, 1001
FLAME
SIGNATURE
SCANNER™

DESCRIPTION

The FIREYE® Type 45FS1 and 45UVFS1 *Signature Scanner*™ flame detectors incorporate an innovative flame detection method to determine the presence or absence of a target flame in a single or multiple burner environment. Both scanners utilize a software algorithm that constantly compares the amplitude-frequency characteristics of the target flame with the amplitude-frequency characteristics that they learn during a setup procedure. This amplitude-frequency characteristic will be referred to as the signature of the target flame. During the learn mode the scanner performs "real time" analysis of the frequency spectrum of the AC signal of the target flame to determine the type of flame being sensed (e.g. burner flame-on, flame tips from adjacent burners, background flame, no flames, etc.) and determines a specific shape or *Flame Signature* of the flame's frequency spectrum. When the scanner is put in the run mode, the *Signature Scanner* controls constantly compare the targeted flame signal with the learned signatures to determine the status of the flame.

The 45FS1/45UVFS1 then provides a pulsed output to indicate that the flame signal matches its learned flame signature. This pulse output is analogous to the strength of the flame signal, allowing the scanner to be compatible with the 25SU3 and 25SU5 style flame amplifiers.

The main difference between the 45FS1 and 45UVFS1 scanners is the flame detector utilized in each scanner. The 45FS1 scanner incorporates a large area lead sulfide cell sensitive to the infra-red range more suitable for coal and/or oil type flames. This cell can detect a wide range of background brightness without experiencing cell washout. The 45UVFS1 scanner uses a super-blue silicon cell sensitive to the UV range, as well as an automatic signal amplification circuitry making it applicable for all fuel types (gas/oil/coal).

The *Signature Scanner* flame detectors have the ability for remote communication to review and program the system setpoints as well as download and upload the "learned" flame signature data from one scanner to another using an IBM compatible PC and the FS700 software program. Refer to Bulletin CU-39 for details.

The 45FS1/45UVFS1 Scanners have an eight (8) character LED display, a three (3) pushbutton keypad, and a program enable pushbutton to program and/or review the various system setpoints and operating parameters associated with the setup procedure and operation of the scanner. Flame signatures can be learned for a number of fuel types (gas, oil, coal, etc.). The selection of the flame signature is determined via the keypad or the remote file selector switches.

PROGRAMMING THE 45FS1/45UVFS1 FLAME SIGNATURE SCANNER

Information on the setup procedure and programming for the 45FS1/45UVFS1 flame *Signature Scanner* can be found later in this bulletin, as well as the programming primer (CU-33).

OPERATION

The 45FS1/45UVFS1 flame scanner utilizes a microcomputer which continually monitors the frequency spectrum of the sensed flame and compares it against the flame signature that is stored in its memory. The degree of uniformity of the measured flame to its signature determines the flames stability.

A Setup procedure in which the 45FS1/45UVFS1 scanner "Learns" the various conditions (e.g. burner on, burner off, etc.) is required for the proper operation of the scanner. See *Programming the Flame Signature Scanner and the Programming Primer (CU-33).*

The 45FS1/45UVFS1 flame scanners are compatible with the following Flame Safeguard controls:

— Fireye Type 25SU3, Model -2000, -2100, 4170, 4172, 5166, 5168, 5172, 5173

— Fireye Type 25SU5, Model 5011, 5012

(Refer to Figures 19, 20, and 21 for wiring diagrams).

APPLICATION

The type of burner and fuel will affect the frequency and amplitude characteristics of the flame. Gaseous flames (propane, methane, natural gas) tend to have a low flame amplitude, while solid pulverized (coal) and liquid (oil) flames have a high flame amplitude. The type of burner will affect the frequency of the flame (gun type = high flame frequency, low nox = low flame frequency).

A further explanation of the nature of flames will also assist in scanner selection. **Oil and coal flames** produce soot and flash respectively during the combustion process which makes these flames opaque in the infra-red range. An infra-red detector will recognize the infra-red radiation in the target flame but will not see through the flame to detect the infra-red radiation associated with the opposed flame. In the event of a flame out condition, the flame signature of the background radiation (e.g. opposed flame tips) should be unique enough to provide proper discrimination (See "Learn Flame On/Off - Setpoints Menu" and "Discrimination - Status Menu").

A **gas flame** is a very clean burning fuel that is mostly transparent to an infra-red detector. This means an infra-red detector will detect the infra-red radiation in the target flame but will also see directly through the flame and pick up any infra-red radiation associated with an opposed flame. Consequently, when an infra-red detector is used on a gas flame, care should be taken so the line of sight of the scanner does not pick up any other source of infra-red radiation (e.g. single burner or front fired applications are acceptable, opposed fired may cause discrimination problems).

A **gas flame** also emits a large amount of ultra-violet radiation. However, during the combustion process, water vapor is also produced at the leading edge of the gas flame. This water vapor will absorb most of the UV radiation. The water vapor now makes a gas flame opaque to an ultra-violet detector, allowing the UV detector to pick up the UV radiation within the target flame, but not see through the flame (due to the water vapor) to pick up UV radiation from opposed flames in an opposed fired burner. In the event of a flame out condition, the flame signature of the background radiation (e.g. opposed flame tips) should be unique enough to provide proper discrimination (See "Learn Flame On/Off - Setpoints Menu" and "Discrimination - Status Menu").

The **45FS1** scanner with its lead sulfide cell (infra-red detector) is best suited for providing reliable flame detection and discrimination on coal and/or oil flames, as well as single burner or front fired gas flames.

The **45UVFS1** scanner with its super-blue silicon cell (ultra-violet) sensitive to UV radiation prevalent in gaseous flames. In addition, the 45UVFS1 scanner possesses an automatic signal amplification circuitry to adjust for both high (coal and oil) and low (gas) amplitude flames. These two factors

make the 45UVFS1 scanner a logical choice for coal (when burning combination of gas/oil or gas/coal), oil, and gas burners.

> **CAUTION: The only sure way to determine if a flame scanner will provide proper flame detection and discrimination for a particular fuel type and burner type is to set up and test the scanner under a number of varying operating conditions (e.g. varying firing rates).**
>
> **CAUTION: The setting (high or low) of the automatic signal amplification circuitry is stored as part of the flame signature file (File A, B, or C). Care should be taken so that a file that has learned flame data associated with a gas flame (which requires high signal amplification) is not used when detecting a coal or oil flame, since the high amplification could indicate a flame on condition if any flame signal is present.**

The following application chart is provided as an initial reference guide (or starting point) to select the appropriate scanner for various flame scanning applications, based on burner type and fuel(s) being burned.

The rating of the application chart (High, Medium, Low) compares the 45FS1 against the 45UVFS1 for each particular burner type. The ratings are not an absolute rating. For example, on a front-fired gas burner, the 45UVFS1 scanner provides better flame detection/discrimination than the 45FS1 (High versus Medium). On an opposed fired gas burner, the 45UVFS1 is an even better choice (High versus Low). However, the high rating of the 45UVFS1 on both front-fired gas and opposed-fired gas does not mean the 45UVFS1 scanner will provide the same level of flame detecting/discrimination on both types of burners.

BOILER TYPE	FUEL TYPE	Discrimination Capability	
		45FS1	45UVFS1
FRONT FIRED	GAS	M	H
	OIL	H	H
	COAL	H	H
	GAS/OIL	M	H
	GAS/COAL	M	H
	OIL/COAL	H	H
	COAL/OIL/GAS	M	H
CORNER FIRED	GAS	L	H
	OIL	H	H
	COAL	H	H
	GAS/OIL	L	H
	GAS/COAL	L	H
	OIL/COAL	H	H
	COAL/OIL/GAS	L	H
OPPOSED FIRED	GAS	L	H
	OIL	M	M
	COAL	M	M
	GAS/OIL	L	M
	GAS/COAL	L	M
	OIL/COAL	L	M
	COAL/OIL/GAS	L	M
H = HIGH M = MEDIUM L = LOW			

DIMENSIONS

FIGURE 1.   TYPE 45FS1/45UVFS1
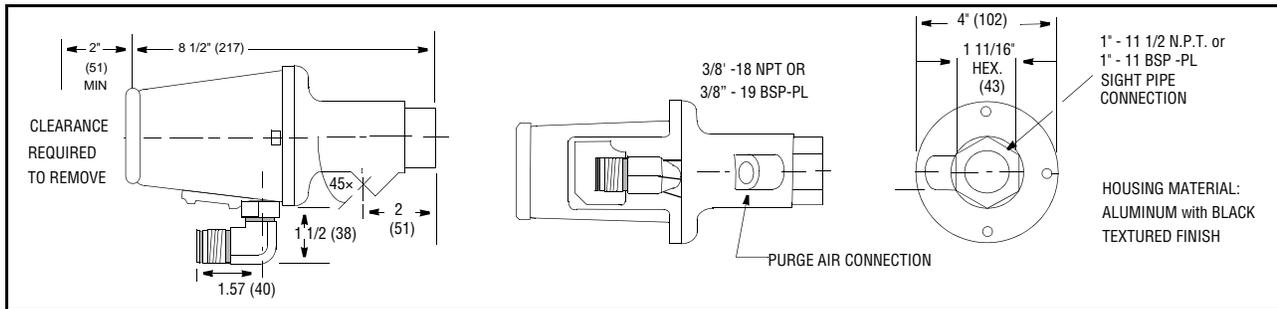
Optional Mounting Configurations for Hazardous Areas

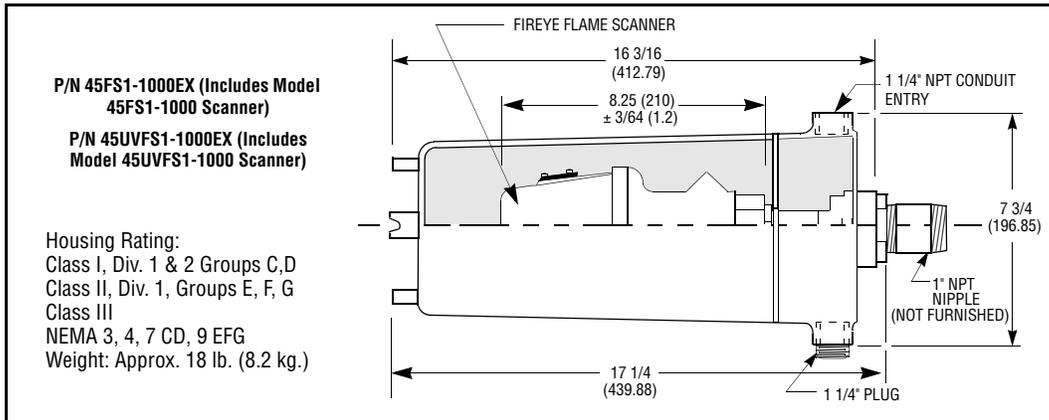**FIGURE 2.   45FS1/45UVFS1 SCANNER IN NEC/NEMA HAZARDOUS AREA HOUSING**

P/N 45FS1-1000EX (Includes Model 45FS1-1000 Scanner)

P/N 45UVFS1-1000EX (Includes Model 45UVFS1-1000 Scanner)

Housing Rating:
Class I, Div. 1 & 2 Groups C,D
Class II, Div. 1, Groups E, F, G
Class III
NEMA 3, 4, 7 CD, 9 EFG
Weight: Approx. 18 lb. (8.2 kg.)

FIGURE 3.   45FS1/45UVFS1 SCANNER IN CENELEC HAZARDOUS AREA HOUSING

P/N 45FS1-1000CEX (Includes Model 45FS1-1000 Scanner)

P/N 45UVFS1-1000CEX (Includes Model 45UVFS1-1000 Scanner)

Housing Rating:
EExd II C T 6
IP 66
Weight: Approx. 7.6 lb. (3.5 kg.)

DIMENSIONS IN INCHES (MM)
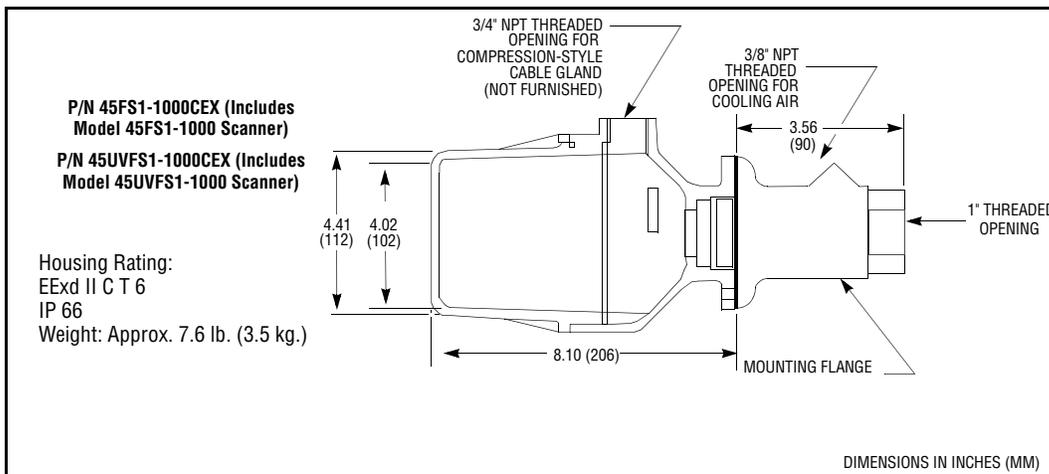
The "CEX" housing has a European approval (CENELEC) suitable for use in hazardous areas which include hydrogen gas.

AGENCY APPROVALS

PART NUMBER	AGENCY APPROVAL	MOUNTING THREADS
	FM	
45FS1-1000	X	1" NPT
45FS1-1001	X	1" BSP
61-6625 (45FS1)	X	FIBER OPTIC
45UVFS1-1000	X	1" NPT
45UVFS1-1001	X	1" BSP
61-6694-1 (45UVFS1)	X	FIBER OPTIC

SPECIFICATIONS

Mounting

Surface Mounted Models are provided with a 1" female thread mounting. Either US (NPT) or British Whitworth (BSP) threads are provided according to model. (See Table above). Heat Insulating Nipple: 1" NPT or 1" BSP provided with scanner.

Housing Including Mounting Flange

Material: Die Cast Aluminum with a black textured finish.

Design: Mounting flange, with purge air fitting to be permanently installed, carries two 1/4-20 screws which may be loosened for quick removal of the scanner electronics housing, such as for lens cleaning. Shipping Weight: 2.4 Lbs. (1.1 Kg)

Electrical

Power Requirements: +24 VDC from associated Fireye control or +24 VDC (+10%, - 15%) from an external power supply. Current rating: 100 mA per scanner.

Connection: Quick disconnect. The male connector is assembled with the scanner housing. The female (cable connector) is ordered separately (P/N 129-127-6).

Keypad/Display

- Eight (8) character alphanumeric LED Display (Scrolling Capability)

- Three (3) pushbutton style keys.

- Plastic gasketed filter covers keypad/display.

Program Enable Pushbutton

Temperature Range

Operating: - - 4° F to 150° F   (45UVFS1 rated to 131°F)
  - 20° C to +65° C (45UVFS1 rated to 55° C)

Humidity: 0 to 95% R.H. non-condensing

Purge Air

Source: Clean, Cool Ambient

Volume Required: 4 SCFM (113L/min) at 3/8 inch threaded housing inlet or 4 SCFM at 1 inch "Y" fitting in scanner sight pipe. Temperature near the upper limit of the scanner operating range and/or use with dirty fuels may require up to 15 SCFM (425L/min).

INSTALLATION

⚠ **CAUTION: Due to the micro-processor based design of the 45FS1/45UVFS1 scanner, the heat insulating nipple (P/N 35-127-1 or 35-127-3) must be used to insulate the scanner from ground and to reduce conducted energy and noise. Failure to do so could result in erratic operation of the scanner.**

The 45FS1/45UVFS1 flame signature scanners determine the presence or absence of flame by monitoring the frequency spectrum of the AC signal of the flame to determine the type of flame being sensed. The scanner should initially be mounted so that the primary combustion zone is within the scanner's line of sight.

⚠ **WARNING: An acceptable scanner location must ensure the following:**

1. **Reliable main flame and/or ignitor flame detection at all air flow and furnace loads (ranges of fuel firing).**
2. **Rejection of the ignitor flame if too short or in the wrong position to ignite the main flame reliably, thus prohibiting the delivery of fuel to the burner.**

The location and sighting instructions listed above and in the following section are rough guidelines for the location of the scanner. The 45FS1/45UVFS1 scanner also provides feed- back via its LED display to assist in the adjustment and proper alignment of the flame scanner. Refer to the setpoint "AIM" under Setpoints Menu.

INSTALLATION PROCEDURE

⚠ **WARNING: Protective filtered lenses should be worn when viewing flame. Infrared and ultraviolet energy from the flame can be damaging to the eyes.**

1. The best results are obtained when the scanner is aimed so that the scanner's line of sight intersects the burner center at a slight angle (e.g. 5 degrees) and sees a maximum of the primary combustion zone, as shown in Figure 4. If only one scanner is used per burner, the line of sight should also intersect the igniting flame.
2. For installations where separate scanners are used to monitor main and ignitor flames, the main flame scanner should be sighted so it does not detect the ignitor flame.
3. The scanner should have an unrestricted view of flame as far as possible. Physical obstructions such as air register blades, interfering vanes, or other hardware should be cut away or notched so they do not fall within the scanner's line of sight as shown in Figures 4 and 6.

*Note: Always check with the burner manufacturer **before** you trim the register blades.*

FIGURE 4.   SINGLE BURNER SCANNER SIGHTING
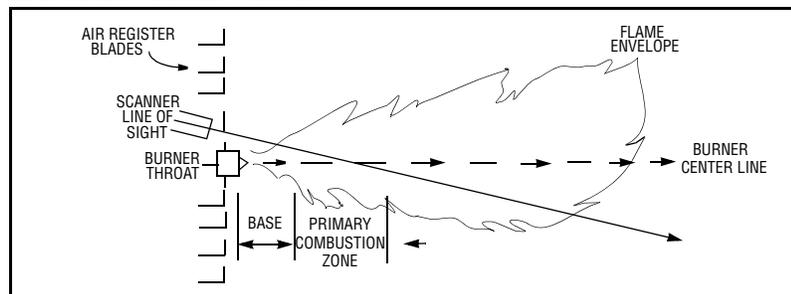
4. Consideration must be given to burner secondary air rotation (some burners have clockwise air rotation and others have counterclockwise). If combustion air enters the furnace with a rotational movement of sufficient velocity to deflect the ignitor flame in the direction of rotation, position the scanner 10 to 30 degrees downstream of the ignitor as shown in Figure 5 and close to the periphery of the burner throat (See Figure 4).

FIGURE 5.   **SCANNER LOCATION VS. SECONDARY AIR ROTATION**
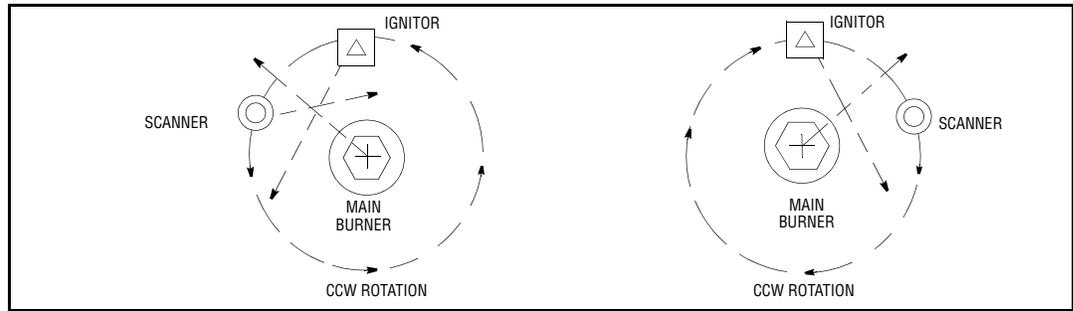
5. Having determined the approximate location for the sight pipe, cut a clearance hole for a 2 inch pipe through the burner plate. Look through the hole. If register vanes interfere with the desired line of sight, the interfering vane(s) should be trimmed to assure an unrestricted viewing path at all firing levels.
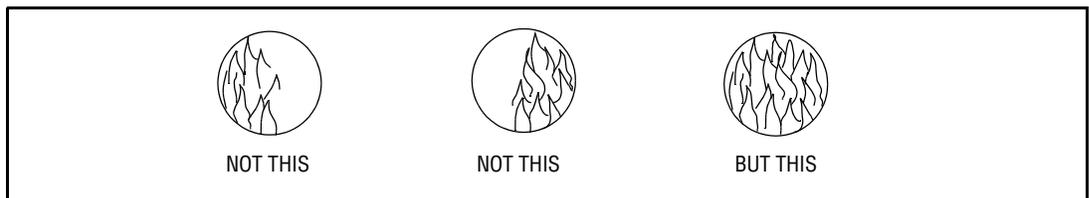
   *Note: Always check with the burner manufacturer **before** you trim register vanes.*

FIGURE 6.   **FLAME MUST COMPLETELY COVER SIGHT OPENING**

6. The preferred method for mounting surface mounted scanners requires the use of a swivel mount, P/N 60-1664-3 (NPT). Center the swivel mount over the two inch hole in the burner plate and secure using three hexed cap screws (not provided). Install the sight pipe on the swivel mount. If a swivel is not used, insert the end of the sight pipe into the hole, align the hole to the desired viewing angle and tack weld (welding must be adequate to temporarily support the weight of the installed scanner). The sight pipe should be arranged to slant downward so that dirt and dust will not collect inside.

⚠ **CAUTION: Use no more than one foot of one inch diameter sight pipe. Increase the sight pipe diameter one inch for every additional foot of sight pipe length used to avoid restricting the scanner's field of view.**

Note: The 45FS1/45UVFS1 scanner provides feedback via its LED display to assist in the adjustment and proper alignment of the flame scanner. Refer to the setpoint AIM under "Programming the Flame Signature Scanner" and the "Programming Primer" (Publication CU-33).

7. When a satisfactory sighting has been confirmed by operational testing, secure the swivel mount's ball position in place by tightening the three hex head cap screws located on the swivel mount ring.

8. For ease of use, the scanner should be installed on the sight pipe so the LED display can easily be read. If this is not possible, install the scanner with the quick disconnect facing downward.

Note: Operation of the LED display is independent of position.

9. Due to the micro-processor-based design of the 45FS1/45UVFS1 scanner, the heat insulating nipple (P/N 35-127-1 or 35-127-3) **must be used** to isolate the scanner from ground.

⚠ **CAUTION: Due to the micro-processor based design of the 45FS1/45UVFS1 scanner, the heat insulating nipple (P/N 35-127-1 or 35-127-3) must be used to insulate the scanner from ground and to reduce conducted energy and noise. Failure to do so could result in erratic operation of the scanner.**

10. The scanner lens must be kept free of contaminants (oil, ash, soot, dirt) and the scanner temperature must not exceed its maximum rating of 150° F (65° C) for 45FS1 or 131°F (55°C) for 45UVFS1. Excessive temperatures will shorten scanner life. Both requirements will be satisfied by a continuous injection of purge air at either the 3/8" housing inlet or the 1" "Y" connection ahead of the swivel mount as shown in Figures 7 and 8.

Note: Internal scanner temperature is available via the LED display. See "Status Menu" under "Programming the Scanner."

The scanner mounting may be made with provision for purge air through only the 3/8" opening as shown in Figure 9 or for purge air through either the 3/8" opening or the 1" "Y" connection as shown in Figure 8. In the latter arrangements, normally only one of the two connections is provided with purge air and the other connection is plugged. When a sealing union is used as shown in Figure 7, the 1" "Y" connection is used for the purge air and the 3/8" opening is plugged.

It is good practice to use the sealing union (P/N 60-1199 with NPT threads) on all installations to insure against unwanted boiler pressures from damaging the scanner lens.

Under normal conditions, with clean burning fuels and moderate ambient temperature conditions, purge air flow of approximately 4 SCFM (133L/min) is generally adequate. Up to 15 SCFM (425L/min) may be required for fuels that produce high levels of ash or soot, or for hot environments to maintain the scanner's internal temperature within specification. Flexible conduit should be used to wire the scanner from a grounded service box to the scanner.

FIGURE 7.

PART NUMBER

A. SWIVEL MOUNT   60-1664-3 (NPT)
                      60-1664-4 (BSP)

B. 1" WYE   35-200 (NPT)

C. 1" CLOSE NIPPLE   35-201 (NPT)

D. SEALING UNION W/QUARTZ WINDOW
                      60-1199 (NPT)

E. HEAT INSULATING NIPPLE 35-127-1 (NPT)
                      35-127-3 (BSP)

F. 3/8" PLUG   35-202 (NPT)

20" (500) MAX*

*NOTE: SCANNER SHOWN IN PHOTOGRAPH IS NOT A 45FS1 SIGNATURE SCANNER.

FIGURE 8.

PART NUMBER

A. SWIVEL MOUNT   60-1664-
   3 (NPT)
                      60-1664-
   4 (BSP)

B. 1" WYE   35-200 (NPT)

C. HEAT INSULATING NIPPLE 35-127-1
    (NPT)
                      35-127-3
    (BSP)

D. 3/8" PLUG   35-202 (NPT)

18 3/4" (475) MAX*

*NOTE: SCANNER SHOWN IN PHOTOGRAPH IS NOT A 45FS1 SIGNATURE SCANNER.

FIGURE 9.

PART NUMBER

A. SWIVEL MOUNT   60-1664-3 (NPT)
                                      60-1664-4 (BSP)
B. HEAT INSULATING NIPPLE 35-127-1 (NPT)
                                      35-127-3 (BSP)
C. 3/8" THREADED OPENING

13" (330) MAX*

B   C

A

*NOTE: SCANNER SHOWN IN PHOTOGRAPH IS NOT A 45FS1 SIGNATURE SCANNER.

FIGURE 10.

PART NUMBER

A. SWIVEL MOUNT   60-1664-3 (NPT)
    SWIVEL MOUNT   60-1664-4 (BSP)
B. SEALING UNION W/QUARTZ WINDOW
                                  60-1199 (NPT)
C. SCANNER CABLE   59-470, 59-471

A   B

C

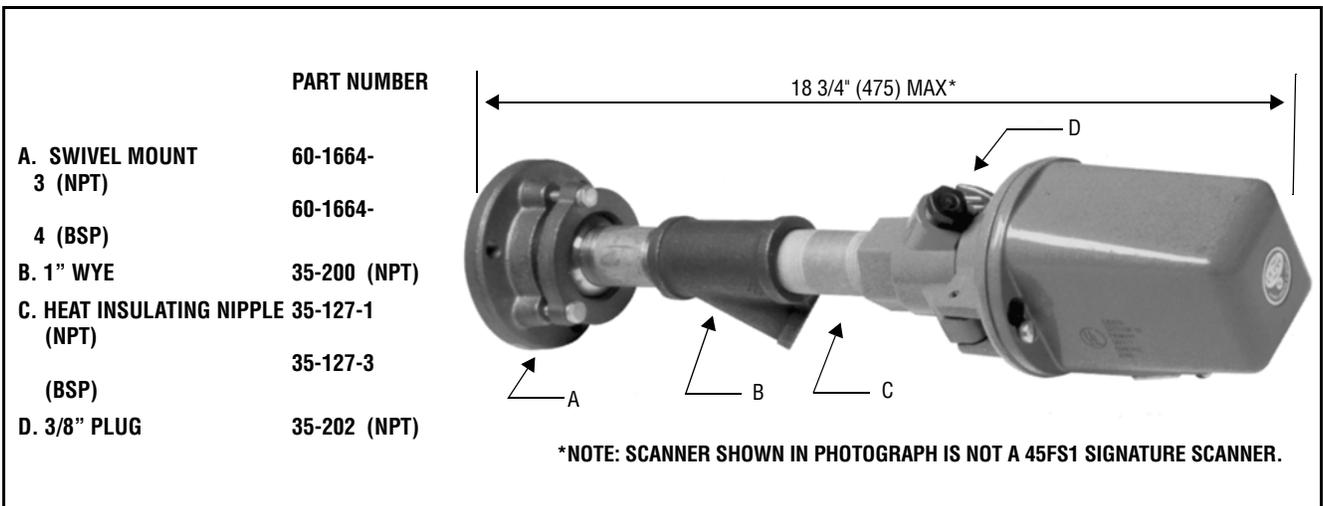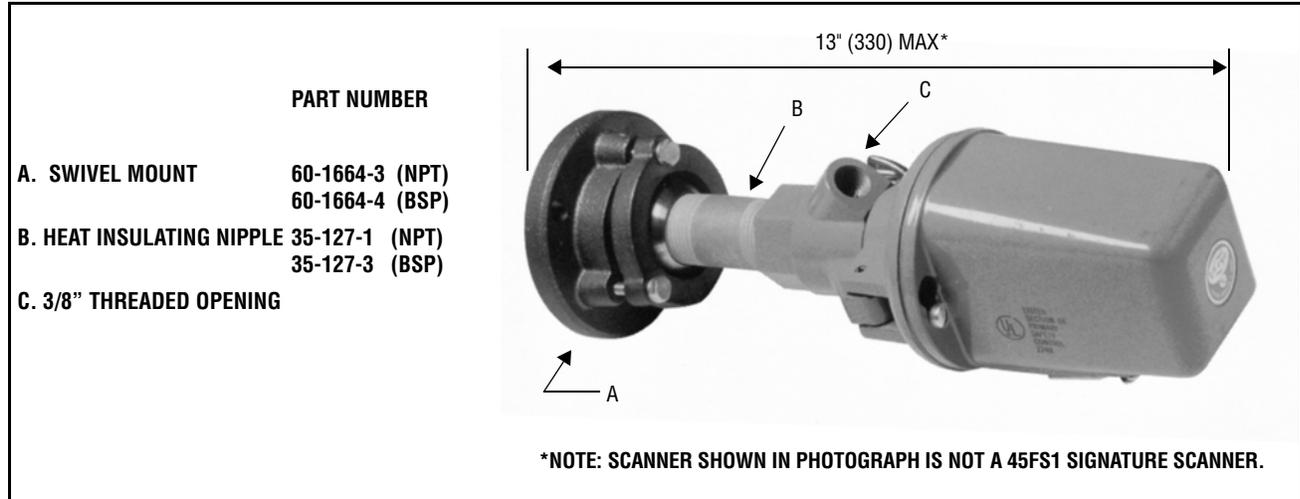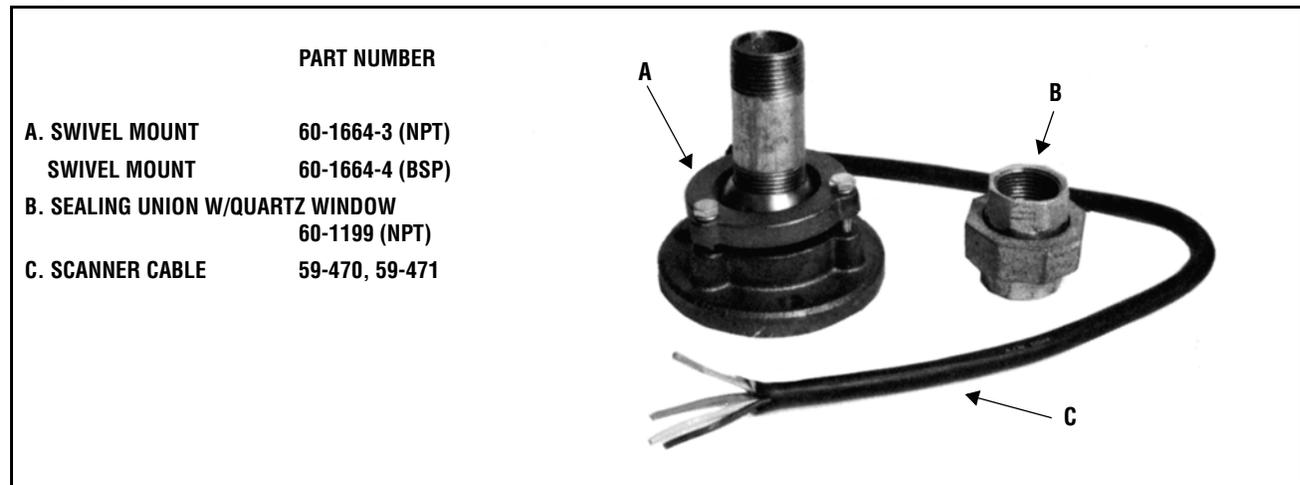## USE OF SCANNER ACCESSORIES

Swivel Mount

The scanner swivel mount, P/N 60-1664-3 (NPT) (see Figure 10, Item A), is used to adjust the scanner sighting angle after the scanner has been installed, The swivel mount is used as indicated in Figures 7, 8, and 9.

Heat Insulating Nipple

Heat Insulating nipple, P/N 35-127-1 (NPT), or P/N 35-127-3 (BSP) (see Figure 9, Item B), is used to prevent heat transfer from the hot sight pipe to the scanner head as well as electrically isolate the scanner from ground. The appropriate nipple (NPT or BSP) is shipped *with* the scanner.

Sealing Union with Quartz Window

The sealing union, P/N 60-1199 (see Figure 10, Item B), is used whenever a coupling or a seal is required for scanner piping. The quartz window blocks furnace pressure, heat gasses and soot from coming in contact with the scanner and contaminating the lens. The size is one inch U.S. standard taper pipe thread (Schedule 40, 1" - 11 $^1/_2$ NPT). When the sealing union is used, a 1" "Y" fitting must be used down stream of it for connection of a purge air supply (plug $^3/_8$" opening). See Figure 7 for piping with the sealing union, Item D.

ELECTRICAL ACCESSORIES

Scanner Cable (P/N 59-470)

The number of conductors required for wiring the 45FS1/45UVFS1 scanner to the associated amplifier is dependent on the functions utilized by the scanner. Fireye offers a six (6) conductor cable (P/N 59-470) that can be used for most applications. The 59-470 cable is made up of four (4) #18 AWG conductors and two (2) #22 AWG conductors. All six wires are enclosed with a mylar tape wrap shield and drain wire. The cable jacket is made of Hypalon, with an overall outside diameter of .425" (max).

The Fireye scanner cable (59-470) is color coded as follows for connection to the quick disconnect of the 45FS1/45UVFS1 scanner or wiring harness (if required):

59-470 Cable Color	Function	Pin Number of Quick Disconnect	Terminal Number of Scanner Harness
Black	+24 VDC	1	1
Red	Shutter	2	2
White	Common	⏚	⏚
Green	Flame Signal	3	3
Blue	* RFS 1	5	5
Yellow	* RFS 2	7	7

* RFS = Remote file select.

Scanner Cable (P/N 59-471)

Fireye offers an eight (8) conductor cable (P/N 59-471) that is used for remote communications **when the distance from the scanner to the amplifier is less than 200 feet**. When the distance is greater than 200 feet, the wiring harness (or equivalent) must be used for remote communications. The
59-471 cable is made up of four (4) #18 AWG conductors and four (4) #22 AWG conductors. Two of the 22 AWG wires are a twisted pair for remote communications. All eight wires are enclosed with a mylar tape wrap shield and drain wire. The cable jacket is made of Hypalon, with an overall outside diameter of .550" (max).

The Fireye scanner cable (59-471) is color coded as follows for connection to the quick disconnect of the 45FS1/45UVFS1 scanner or wiring harness (if required)

59-471 Cable Color	Function	Pin Number of Quick Disconnect	Terminal Number of Scanner Harness
Black	+24 VDC	1	1
Red	Shutter	2	2
White	Common	⏚	⏚
Green	Flame Signal	3	3
Blue	* RFS 1	5	5
Yellow	* RFS 2	7	7
Brown	COM A	4	4
Orange	COM B	6	6

* RFS = Remote file select.
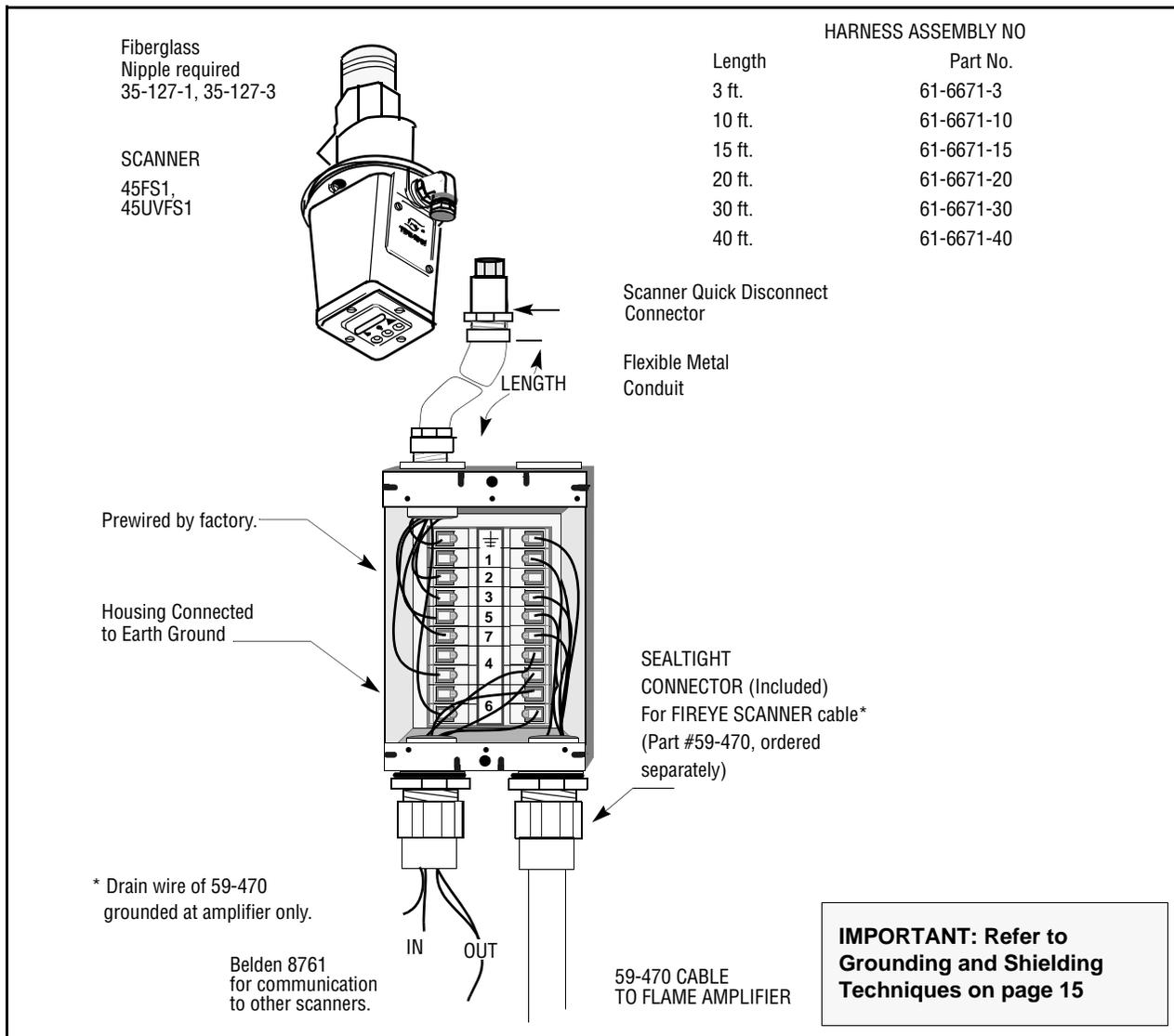
Note: Brown and orange wires are a twisted pair.

Note: If you retrofit to older Fireye 4-conductor cable 59-221, connect the four wires (black, red, white, green) as shown above. Remote file select, and remote communications are not possible with this cable.

Wiring Harness (P/N 61-6671-XX)

The wiring harness provides an easy method for wiring to the 45FS1/45UVFS1 scanner when remote communications are required and the distance from scanner to amplifier exceeds 200 feet. **With remote communications greater than 200 feet**, it is necessary to run the two wires used for communications in a "multi-drop" wiring configuration. Do not directly run the communication wires back to the flame amplifier. To assist in a "Multi-drop" wiring arrangement, Fireye offers a wiring harness available in several lengths. The harness has a female quick disconnect to plug into the quick disconnect on the scanner. The other end has a conduit box with a twenty (20) connector terminal strip. Eight (8) connectors are pre-wired to the female quick disconnect. The remaining twelve (12) connectors are used for wiring the Fireye 6 conductor cable (59-470) back to the flame amplifier (for +24 VDC Power, Shutter, Common, Flame Signal, Remote File Select 1 & 2), and multi-drop the 2 conductor Belden cable (22 AWG, #8761) between scanners.

The terminal strip uses push-type cage clamp connectors. Use a small screwdriver or similar device to depress the slot beside the connector to open the connector and then insert the wire. Remove the screwdriver to secure the wire. The connector will accept up to 14 gauge wire.

FIGURE 11.   SCANNER WIRING HARNESS

HARNESS ASSEMBLY NO	
Length	Part No.
3 ft.	61-6671-3
10 ft.	61-6671-10
15 ft.	61-6671-15
20 ft.	61-6671-20
30 ft.	61-6671-30
40 ft.	61-6671-40

Fiberglass Nipple required 35-127-1, 35-127-3

SCANNER 45FS1, 45UVFS1

Scanner Quick Disconnect Connector

Flexible Metal Conduit

LENGTH

Prewired by factory.

Housing Connected to Earth Ground

SEALTIGHT CONNECTOR (Included) For FIREYE SCANNER cable* (Part #59-470, ordered separately)

* Drain wire of 59-470 grounded at amplifier only.

Belden 8761 for communication to other scanners.

IN   OUT

59-470 CABLE TO FLAME AMPLIFIER

IMPORTANT: Refer to Grounding and Shielding Techniques on page 15

CONTROL AND SCANNER WIRING

> ⚠ **CAUTION: The 45FS1/45UVFS1 flame scanner requires 24 VDC power for operation. Connection to a 24 VAC or 120 VAC power source will damage the scanner. Refer to wiring diagrams.**
>
> **All wiring to the scanner should be rated at 90°C. For runs less than 1000 feet, the use of Scanner Cable, P/N 59-470 (6 wire) is recommended. For runs in excess of 1000 feet, consult the factory.**

Note: Two (2) additional wires are required for remote communication.

To reduce electrical noise interference, the scanner cable should be installed in rigid or flexible conduit. Take precautions to keep the scanner cable away from any high inductive wiring associated with high inductive loads or high voltage, high energy spark ignition systems. The quick disconnect kit
(P/N 129-127-6) includes an adaptor for connection to a 1/2" flexible conduit.

QUICK DISCONNECT KIT P/N 129-127-6 (Ordered Separately)

For ease of installation and removal, a quick disconnect is used with the 45FS1, 45UVFS1, 61-6625, 61-6694 scanners. The male connector is factory mounted on the scanner. The female cable connector kit, P/N 129-127-6, is ordered separately. This assembly procedure applies to Fireye six-conductor cable (P/N 59-470), eight-conductor cables (P/N 59-471), and obsolete four-conductor cable (P/N 59-221).

The connector kit contains both a cord-grip strain relief fitting, and an adapter for use with 1/2" flexible conduit (refer to figure 16, options 1 and 2). The installer must select either one style fitting or the other.

Referring to Figure 13, locate the end of the cable where the red wire is *clockwise* with respect to the white wire. For ease of assembly, this end should be connected to the scanner quick disconnect.

Refer to bulletin CU-56 for operation of the FS700W software and wiring to the IBM compatible PC.

ASSEMBLY (Refer to Figure 14)

1. Before stripping cable jacket, test the rubber cable seal for proper fit, (part of cable seal kit). Depending on the cable used, it may be necessary to remove inner ring(s) to provide a snug fit. Set aside until step 8.
2. Strip the outer cable jacket 2 1/2 inch (64 mm).
3. Trim insulated conductors to 1 3/8 inch (35 mm), leave the shield drain wire 2 1/2."
4. Strip individual conductor insulation 5/16 inch (8 mm).
5. Select either the Option #1 or the Option #2 fittings (see figure 16).
   Option #1: Slide the cord-grip strain relief fitting onto the scanner cable. (The fitting contains an internal bushing suitable for Fireye six-conductor cable, p/n 59-470. If Fireye eight-conductor cable is used, p/n 59-471, use the larger bushing provided in the kit).
   Option #2: Slide the PG16 to 1/2" Flexible Conduit Adapter and the PG11/PG16 thread adapter onto the scanner cable.
6. From the cable seal kit, install the first of two flat washers onto the cable.
7. Fold the shield drain wire back along the cable outer jacket.
8. From the cable seal kit, slide the rubber seal and second flat washer, (part of cable seal kit), onto the cable o*ver* the shield drain wire. Leave the rubber seal on top of the *end* of the drain wire until step 15. Discard the nut from the cable seal kit.
9. Solder the female contacts onto the individual conductors, (use the *least* amount of solder). Install the smaller female contacts on the smaller 22 AWG scanner wires (blue, yellow, brown, orange) if used.
10. Install the connector hood on the cable, making sure the hood nut is removed.

11. Install the contacts into the female insert in the appropriate order. When properly installed, the contacts will "click" into the insert. Verify by pulling slightly on each wire.

12. Place the threaded hood nut over the female insert.

13. Slide the connector hood over the female insert, aligning the hood locating "key" with the wide groove on the female insert.

14. Tighten the threaded hood nut.

15. Slide the second flat washer and the rubber seal into the connector hood. Push into place until firmly seated.

16. Wrap the shield drain wire around the cable jacket *one* turn only, (between the rubber seal and the first washer, wrapped *clockwise* as viewed from the conduit or strain relief adapter), and trim any excess length.

17. Slide the first flat washer into the connector hood, on top of the drain wire.

18. Thread either the Option 1 or Option 2 fittings and tighten firmly to properly compress the rubber seal. This also compresses the first washer against the drain wire, electrically connecting the shield to the connector hood. Torque to 35 inch pounds.

Before applying power, perform a continuity check on each conductor to confirm proper assembly. Confirm that you have continuity between the cable shield (at the amplifier end of the cable) and the quick disconnect hood (metal housing).

FIGURE 12.   QUICK DISCONNECT TERMINALS

FIGURE 13.   FOR EASE OF CONNECTOR ASSEMBLY, INSTALL ON END SHOWN

FIGURE 14.

(Note 1)
(Note 5)

OPTION 1

ALTERNATE BUSHING
FOR STRAIN RELIEF

CORD GRIP
STRAIN RELIEF

OPTION 2

PG16 TO 1/2" FLEXIBLE
CONDUIT ADAPTER

PG11/PG16
ADAPTER

CABLE
SEAL KIT
(Notes 2, 3)

HOOD

FEMALE CONTACT

FEMALE
INSERT

HOOD
NUT

2.50" (64mm)
SHIELD DRAIN WIRE

1.375"
(35mm)

STRIP 5/16" (8mm)
FROM
INDIVIDUAL
WIRES

59-471
ONLY

1.375"
(35mm)

OPTION 1

ALTERNATE BUSHING
FOR STRAIN RELIEF

CORD GRIP
STRAIN RELIEF

CABLE SEAL KIT

SHIELD DRAIN WIRE (Note 4)

OPTION 2

PG16 TO 1/2" FLEXIBLE
CONDUIT ADAPTER

PG11/PG16
ADAPTER

WASHER

RUBBER
SEAL

WASHER

NOTE 1:   SELECT EITHER OPTION 1 OR OPTION 2 FITTINGS.
NOTE 2:   THE NUT FROM THE CABLE SEAL KIT IS NOT USED.
NOTE 3:   REMOVE INNER RING(S) FROM RUBBER SEAL FOR PROPER FIT ONTO CABLE.
NOTE 4:   WRAP DRAIN WIRE 1 TURN CLOCKWISE AROUND CABLE JACKET.
NOTE 5:   OPTION #1: THE CORD GRIP STRAIN RELIEF CONTAINS A BUSHING SUITABLE FOR FIREYE 59-470 CABLE
               (0.375"- 0.438" O.D.). IF FIREYE 59-471 CABLE IS USED, SUBSTITUTE THE ALTERNATE BUSHING (0.500"- 0.562" O.D.).
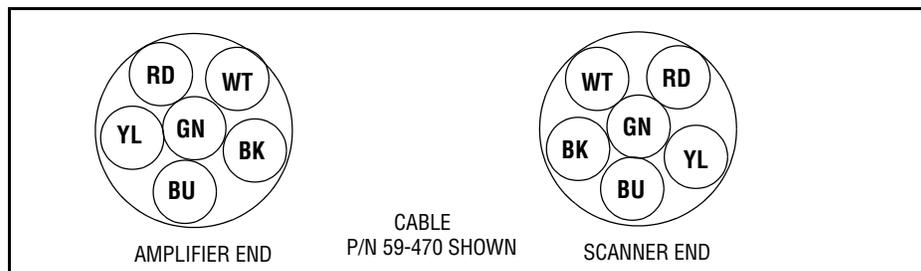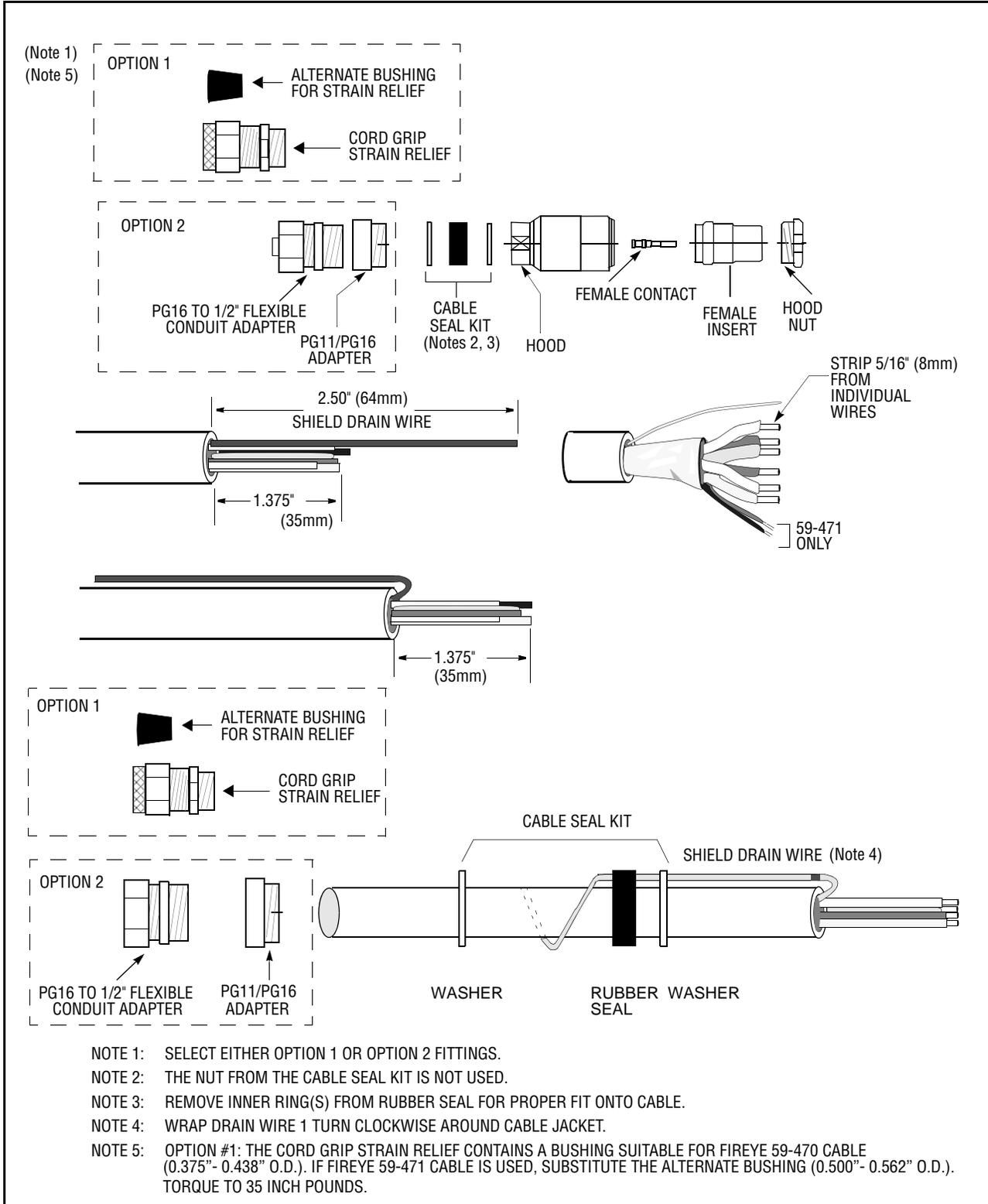   TORQUE TO 35 INCH POUNDS.

Note: Refer to Figures 19, 20, and 21 for proper wiring of the scanner cable to the appropriate controls.

GROUNDING AND SHIELDING TECHNIQUES

FOR USE ON SCANNERS OR SCANNER CABLE LOCATED WITHIN 12" OF A HIGH ENERGY OR HIGH VOLTAGE SOURCE.

1. The scanner and scanner cable (preferably within flexible conduit) MUST be located at least one foot (1') from the ignition source.

2. Run a ground wire from the ignition transformer chassis to the ignitor assembly.

3. Replace all frayed, cracked, or dirty (oily) ignition wire. Ignition wire must be in good working condition.

4. Electrically isolate the scanner from the burner using a heat insulating nipple provided with the scanner, (P/N 35-127-1 or 35-127-3).

Note: If purge air is required, PURGE AIR must be electrically isolated from the scanner (e.g. isolated short rubber hose).

5. **IMPORTANT: The shield from EACH INDIVIDUAL WIRING RUN (e.g. scanner to flame amplifier, or flame scanner to computer for RS485 communications). MUST BE GROUNDED AT ONE END ONLY. See below for shielding techniques based on the various scanner wiring configurations.**

SCANNER TO AMPLIFIER	SHIELDING TECHNIQUES
45FS1/45UVFS1 with scanner cable (59-470) directly back to amplifier. See below for remote communications.	Attach drain wire to scanner quick disconnect as described. Use heat insulating nipple on scanner. Connect drain wire of 59-470 to earth ground at amplifier.
61-6625/61-6694 (fiber optic version) with scanner cable (59-470) directly back to amplifier. See below for remote communications.	Do not connect drain wire to scanner quick disconnect. Connect drain wire of 59-470 to earth ground at amplifier. If communication problems arise, install nylon scanner mounting screws ($1/4$ -20 x 1 $1/4$") attaching the scanner to the inner carrier assembly and connect drain wire to scanner quick disconnect.
45FS1/45UVFS1 or fiber-optic version with wiring harness or junction box and scanner cable (59-470) directly back to amplifier. See below for remote communications.	Attach drain wire to scanner quick disconnect as described. Use heat insulating nipple on scanner. (Does not apply to fiber optic version). Connect 59-470 shield to harness shield at wiring harness or junction box. Connect drain wire to earth ground at amplifier.
REMOTE COMMUNICATIONS: LESS THAN 200 FEET	
45FS1/45UVFS1 with scanner cable (59-471) directly back to amplifier.	Attach drain wire to scanner quick disconnect as described. Use heat insulating nipple on scanner. Connect drain wire of 59-471 to earth ground at amplifier.
61-6625/61-6694 (fiber optic version) with scanner cable (59-471)directly back to amplifier.	Do not connect drain wire to scanner quick disconnect. Connect drain wire of 59-471 to earth ground at amplifier. If communication problems arise, install nylon scanner mounting screws ($1/4$ -20 x 1 $1/4$") attaching the scanner to the inner carrier assembly, and connect drain wire to scanner quick disconnect.
REMOTE COMMUNICATIONS: GREATER THAN 200 FEET	
RS485 communications for 45FS1/45UVFS1 scanners or fiber optic version wired in a multi-drop configuration (Belden 8761) using wiring harness or junction box.	Attach drain wire to scanner quick disconnect as described. Use heat insulating nipple on scanner (does not apply to the fiber optic version). Connect drain wire of 59-471 to earth ground at amplifier. Twist together and tape (to electrically isolate) drain shields from Belden 8761 cables inside each wiring harness or junction box. Connect shield drain to earth ground at RS485 source (e.g. IBM computer).

WIRING FOR REMOTE COMMUNICATIONS:

Remote communications with the 45FS1/45UVFS1 scanner uses an RS485 Interface to carry the communication signals. An IBM compatible PC running the communication software is required to communicate with the 45FS1/45UVFS1 scanners. **The wiring configuration for remote communications is dependent on the distance between the scanner and amplifier. For distances less than 200 feet**, wire the Fireye cable 59-471 to the female quick disconnect in the following manner and run the cable directly back to the flame amplifier.

59-471 Cable Color	Function	PIN Number of Quick Disconnect	
Black	+24 VDC	1	
Red	Shutter	2	
White	Common	⊥	Wire directly to flame amplifier
Green	Flame Signal	3	
Blue	RFS 1	5	
Yellow	RFS 2	7	
Brown	COM A	4	Wire to IBM PC
Orange	COM B	6	

Note: Brown and orange wires are a twisted pair.

For wiring distances greater than 200 feet, remote communications requires wiring a twisted, shielded pair of wires in a "multi-drop" wiring configuration, and then use a terminating resistor at the scanner located farthest from the communication source. See "Using Fireye Wiring Harness."

Note: The maximum distance for the communication wiring for all associated 45FS1/45UVFS1 scanners is 4,000 feet. The maximum number of scanners connected to the communication link is 32 scanners. Exceeding this total wiring length or number of scanners requires the installation of bi-directional repeaters or amplifiers. Consult factory for additional information.

Note: Refer to bulletin CU-56 for operation of the FS700W communication software and wiring to the IBM compatible PC.

Using Fireye Wiring Harness (P/N 61-6671 -3, -10, -15, -20, -30)

To provide an easy method to wire the 45FS1/45UVFS1 scanners in a "Multi-drop" wiring configuration for remote communications, Fireye offers a wiring harness in 5 different lengths (3',10', 15', 20', and 30'). The harness has a pre-wired female quick disconnect to plug into the quick disconnect on the scanner. The other end of the wiring harness has a conduit box with a 18 connector terminal strip. Eight (8) connectors are pre-wired to the female quick disconnect. The remaining ten (10) connectors are used for wiring the Fireye 6 conductor cable (59-470) back to the flame amplifier (for +24 VDC Power, Shutter, Common, Flame Signal, Remote File Select 1 & 2), and multi-drop the 2 conductor Belden cable (22 AWG, #8761) between scanners and finally back to the communication source to complete the "Multi-drop" wiring configuration. The terminal strip inside the conduit box should be wired in the following manner:

Cable	Color	Function	Wiring Harness	Wire cable
59-470 Cable	Black	+24VDC	1	Back to Flame Amp
	Red	Shutter	2	
	White	Common	⊥	
	Green	Flame Signal	3	
	Blue	RFS1	5	
	Yellow	RFS2	7	
Belden 8761	Black	RS485 COM A	4	To next flame scanner
	Clear	RS485 COM B	6	
Belden 8761	Black	RS485 COM A	4	To previous flame scanner (or EC485 converter)
	Clear	RS485 COM B	6	

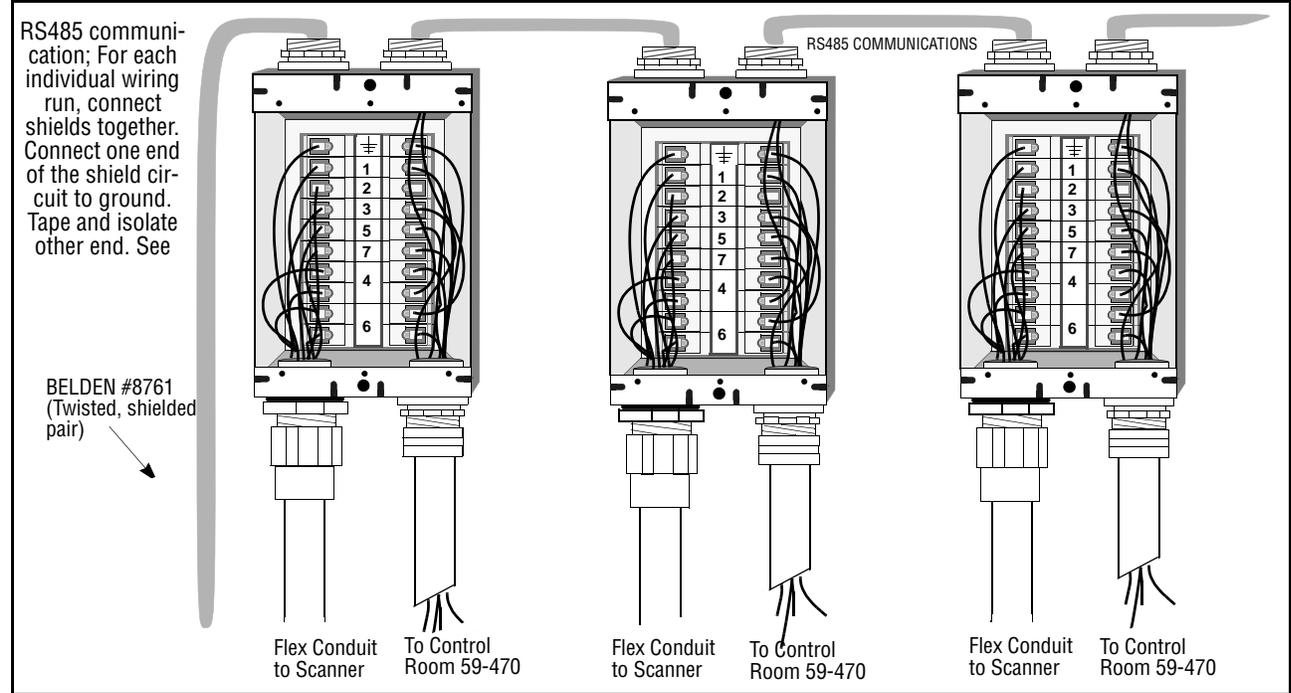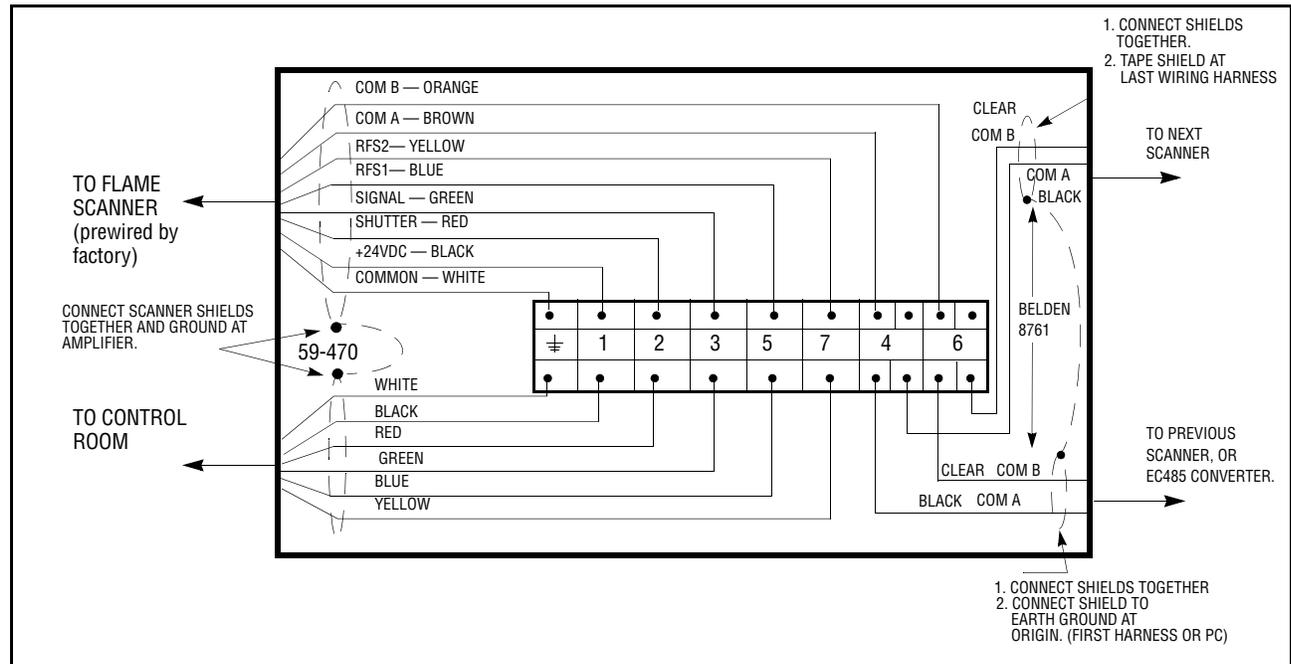**FIGURE 15.**   **SUGGESTED WIRING FOR 45FS1/45UVFS1 COMMUNICATIONS**

RS485 communication; For each individual wiring run, connect shields together. Connect one end of the shield circuit to ground. Tape and isolate other end. See

RS485 COMMUNICATIONS

BELDEN #8761 (Twisted, shielded pair)

Flex Conduit to Scanner   To Control Room 59-470   Flex Conduit to Scanner   To Control Room 59-470   Flex Conduit to Scanner   To Control Room 59-470

FIGURE 16.   **WIRING DIAGRAM FOR WIRING HARNESS**

1. CONNECT SHIELDS TOGETHER.
2. TAPE SHIELD AT LAST WIRING HARNESS

COM B — ORANGE
COM A — BROWN
RFS2— YELLOW
RFS1— BLUE
SIGNAL — GREEN
SHUTTER — RED
+24VDC — BLACK
COMMON — WHITE

CLEAR
COM B

TO NEXT SCANNER

COM A
BLACK

TO FLAME SCANNER (prewired by factory)

CONNECT SCANNER SHIELDS TOGETHER AND GROUND AT AMPLIFIER.

59-470

1   2   3   5   7   4   6

BELDEN 8761

WHITE
BLACK
RED
GREEN
BLUE
YELLOW

TO CONTROL ROOM

CLEAR   COM B
BLACK   COM A

TO PREVIOUS SCANNER, OR EC485 CONVERTER.

1. CONNECT SHIELDS TOGETHER
2. CONNECT SHIELD TO EARTH GROUND AT ORIGIN. (FIRST HARNESS OR PC)

Using Local Junction Box:

To provide remote communications without using the Fireye Wiring Harness, it is necessary to run the Fireye eight (8) conductor cable (59-471) a short distance from the scanner to a junction box. From the junction box, wire the Fireye 59-470 cable back to the appropriate amplifier. Then wire Belden 8761 (22 AWG, twisted shielded pair wire) between each junction box and finally back to the communication source to complete the "Multi-drop" wiring configuration.

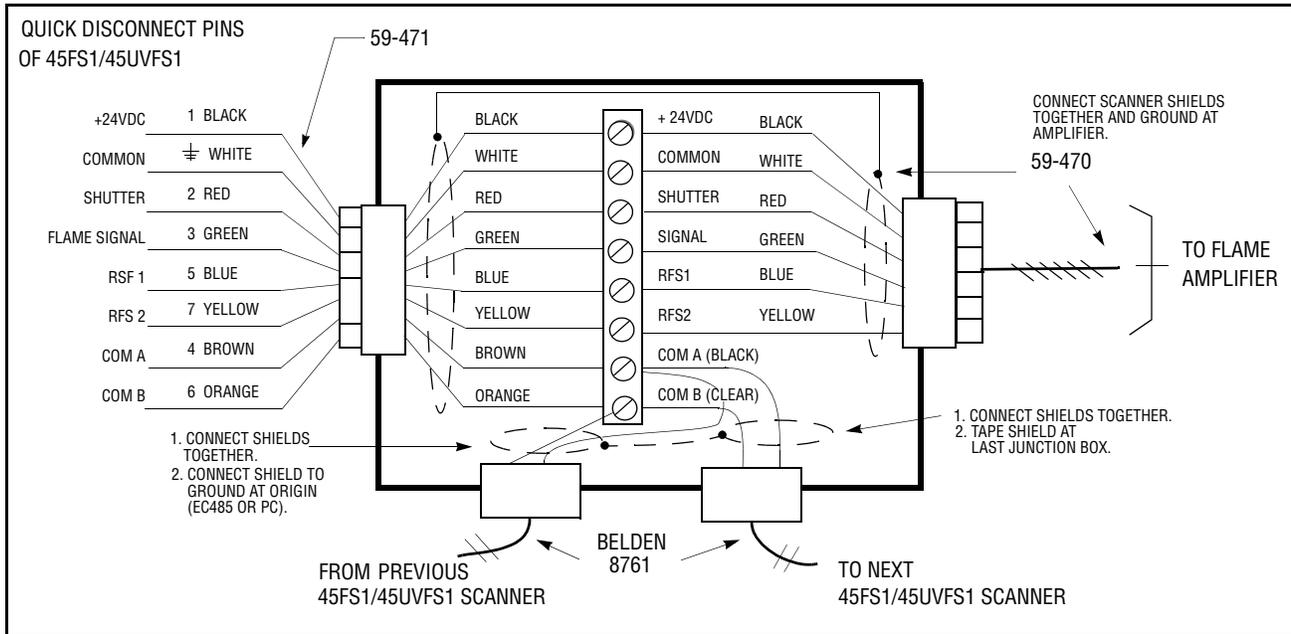**FIGURE 17.** **WIRING FOR REMOTE FILE SELECT AND/OR REMOTE COMMUNICATIONS USING LOCAL ELECTRICAL JUNCTION BOX**

QUICK DISCONNECT PINS OF 45FS1/45UVFS1

+24VDC	1 BLACK		
COMMON	WHITE		
SHUTTER	2 RED		
FLAME SIGNAL	3 GREEN		
RSF 1	5 BLUE		
RFS 2	7 YELLOW		
COM A	4 BROWN		
COM B	6 ORANGE		

59-471

BLACK +24VDC BLACK
WHITE COMMON WHITE
RED SHUTTER RED
GREEN SIGNAL GREEN
BLUE RFS1 BLUE
YELLOW RFS2 YELLOW
BROWN COM A (BLACK)
ORANGE COM B (CLEAR)

CONNECT SCANNER SHIELDS TOGETHER AND GROUND AT AMPLIFIER.

59-470

TO FLAME AMPLIFIER

1. CONNECT SHIELDS TOGETHER.
2. CONNECT SHIELD TO GROUND AT ORIGIN (EC485 OR PC).

1. CONNECT SHIELDS TOGETHER.
2. TAPE SHIELD AT LAST JUNCTION BOX.

FROM PREVIOUS 45FS1/45UVFS1 SCANNER

BELDEN 8761

TO NEXT 45FS1/45UVFS1 SCANNER

FIGURE 18. **WIRING FOR REMOTE COMMUNICATIONS**

1. DISTANCE FROM SCANNER TO AMPLIFIER < 200 FEET.

59-471 CABLE

59-471 CABLE

59-471 CABLE

BELDEN 8761

BELDEN 8761

BELDEN 8761

AMPLIFIER

AMPLIFIER

AMPLIFIER

RS485-RS232 CONVERTER, P/N EC485 OR P/N IC485

IBM PC WITH FS700/FS700W SOFTWARE

2. DISTANCE FROM SCANNER TO AMPLIFIER >200 FEET.

61-6671-X WIRING HARNESS

BELDEN 8761

BELDEN 8761

BELDEN 8761

RS485 COM A COM B

59-470 CABLE

59-470 CABLE

59-470 CABLE

RS485-RS232 CONVERTER, P/N EC485 OR P/N IC485

IBM PC WITH FS700/FS700W SOFTWARE

AMPLIFIER

AMPLIFIER

AMPLIFIER

REFER TO BULLETIN CU-39 (FS700) OR CU-56 (FS700W) FOR DETAILED WIRING CONNECTIONS
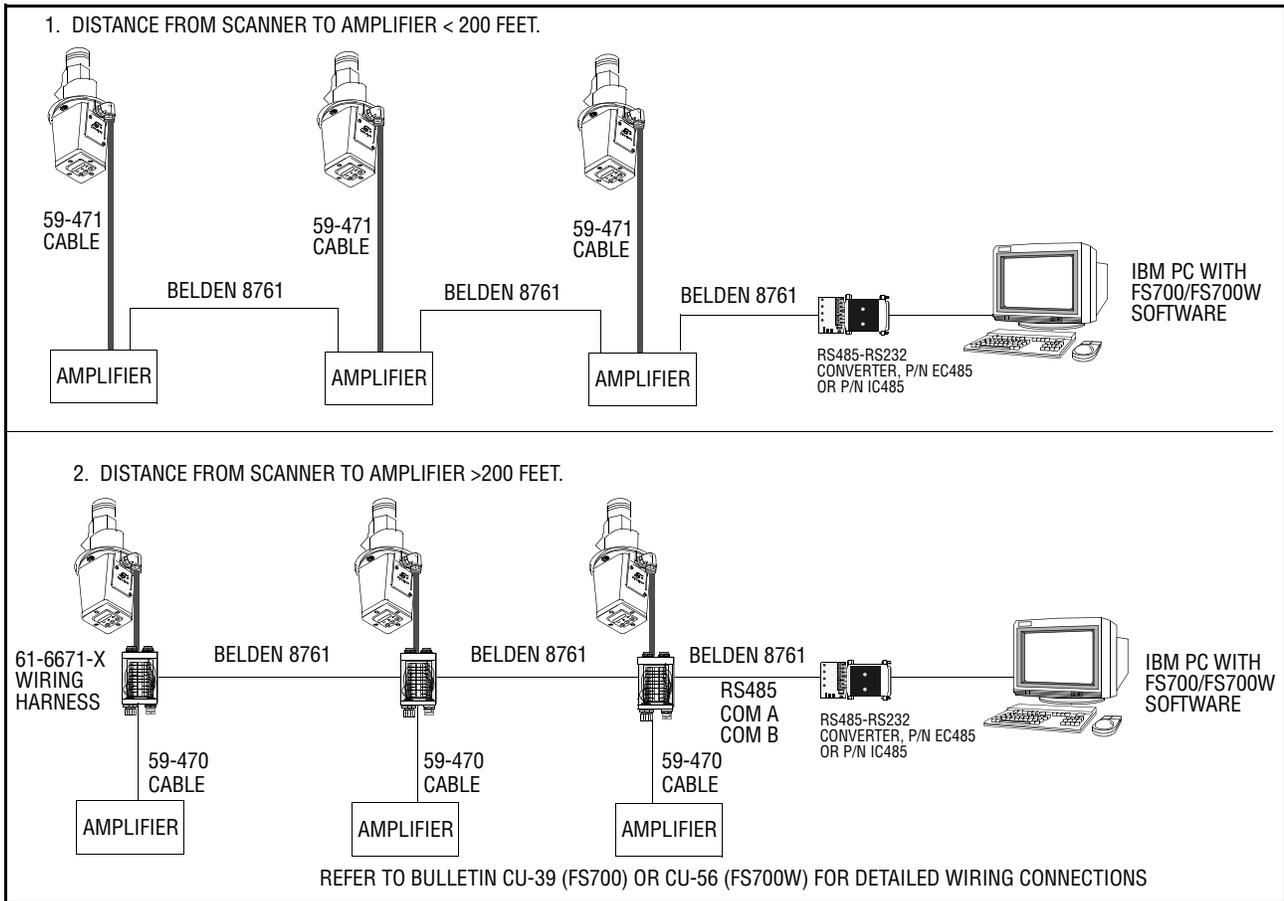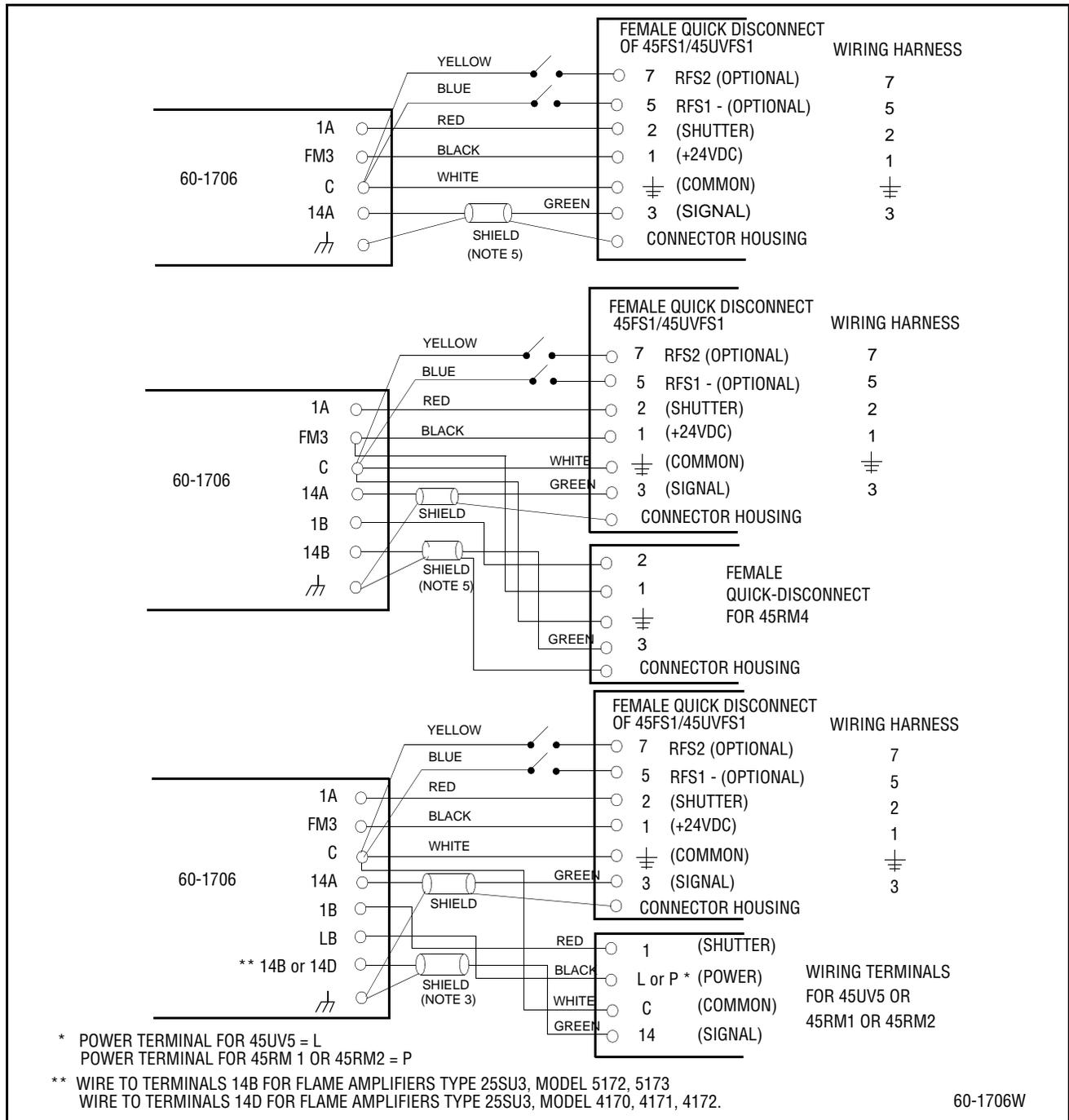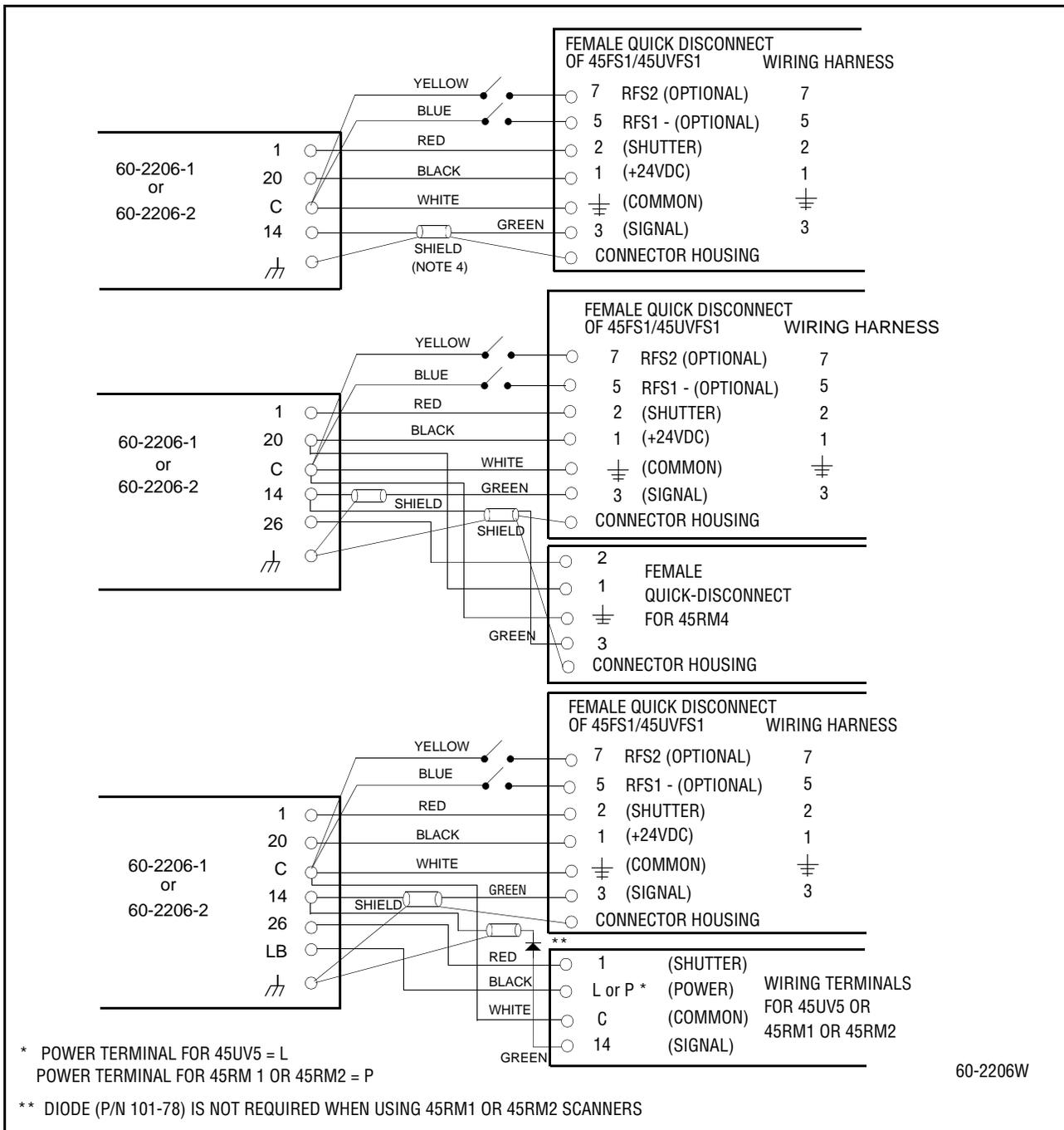
FIGURE 19. **WIRING COMBINATIONS TO P/N 60-1706 WIRING RACK TERMINALS USING 59-470 CABLE FOR THE FOLLOWING FLAME AMPLIFIERS: TYPE 25SU3, MODEL 4170, 4171, 5172, 5173 (or 25SU3-2000, -2100 with 192SU3 adapter)**

* POWER TERMINAL FOR 45UV5 = L
POWER TERMINAL FOR 45RM 1 OR 45RM2 = P

** WIRE TO TERMINALS 14B FOR FLAME AMPLIFIERS TYPE 25SU3, MODEL 5172, 5173
WIRE TO TERMINALS 14D FOR FLAME AMPLIFIERS TYPE 25SU3, MODEL 4170, 4171, 4172.

60-1706W

General Notes:

1. Connect the scanner cable's shield to the earth ground terminal at the control end only; the shield at the scanner end should be attached to female quick disconnect housing.
2. Flame amplifier rack, P/N 60-1706, has a blocking diode between terminals 14A and 14D.
3. Tape the shield at the 45UV5, 45RM1, 45RM2 scanner end.
4. Fireye recommends the use of shielded cable for the two remote file select switches (or relays). These controls should be rated for low current (3mA) operation.
5. **Cables 59-470 and 59-471 have overall shields. For illustration purposes, the shield is shown only on the signal (green) conductor, as was the case on the obsolete cable 59-221.**

FIGURE 20.   WIRING COMBINATIONS TO 60-2206-1 AND 60-2206-2 WIRING BASE USING 59-470 CABLE FOR THE FOLLOWING FLAME AMPLIFIERS: TYPE 25SU5, MODEL 5011, 5012 (60-2206-1) and TYPE 25SU3, MODEL 5166, 5168 (60-2206-2)

*   POWER TERMINAL FOR 45UV5 = L
     POWER TERMINAL FOR 45RM 1 OR 45RM2 = P

**   DIODE (P/N 101-78) IS NOT REQUIRED WHEN USING 45RM1 OR 45RM2 SCANNERS

60-2206W

1. For 45FS1/45UVFS1/45RM4 scanners, connect the scanner cable's shield to the earth ground terminal at the control end only. The shield at the scanner end should be connected to female quick-disconnect housing.

2. For 45UV5/ 45RM1/ 45RM2 scanners, connect the scanner cable's shield to the earth ground terminal at the control end only. The shield at the scanner end should be taped and isolated.

3. Fireye recommends the use of shielded cable for the two remote file select switches (or relays). These controls should be rated for low current (3mA) operation.

4. Cables 59-470 and 59-471 have overall shields. For illustration purposes, the shield is shown only on the signal (green) conductor, as was the case on the obsolete cable 59-221.

FIGURE 21.   **WIRING TO 25SU3-2100 AMPLIFIER RACKS USING 59-470 OR 59-471 CABLE**
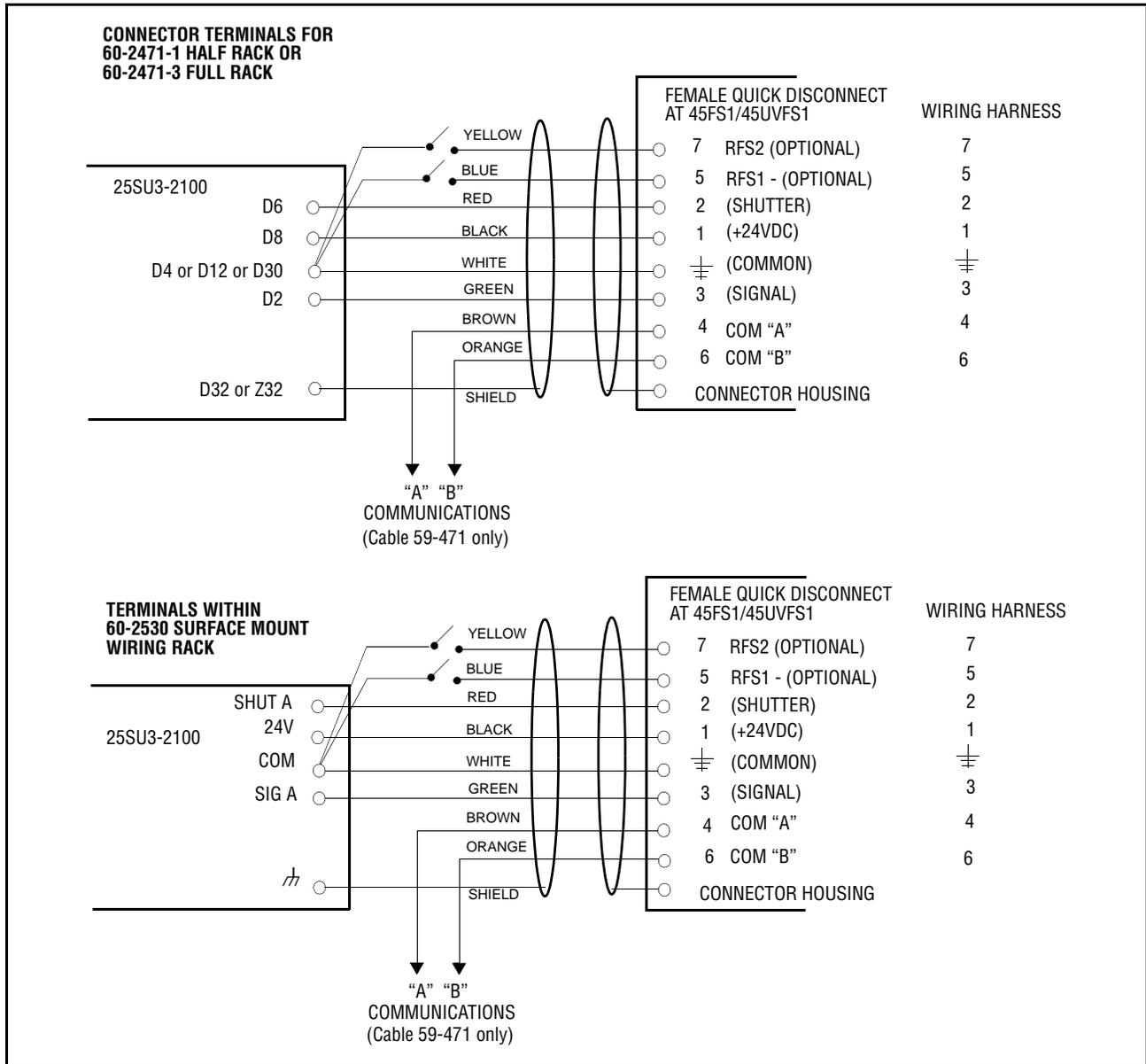
REMOTE FILE SELECTOR SWITCHES

Two (2) remote file selector switches can be wired into the 45FS1/45UVFS1 to select one of four files (A, B, C, and F) containing flame signature information to be used as the reference file. Files A, B, and C store "learned" flame information and File F is the default flame signature. **The setpoint RFS must be programmed ON for the remote file selector switches to be operational.** See Remote File Select (RFS) under "Setpoints Menu." With the setpoint RFS to be programmed "ON," the status of switches RFS1 and RFS2 will determine which file is selected in the following manner:

RFS2 (Yellow)	RFS1 (Blue)	FILE
Open	Open	A
Open	Closed	B
Closed	Open	C
Closed	Closed	F

Note: With the setpoint RFS programmed ON and no wires or switches wired into the scanner, the 45FS1/45UVFS1 will use File A (RFS1 and RFS2 are both Open).

A third selection for the setpoint RFS is COMM. With this selection, the file is selected via remote communication. Refer to Communications Address under Status menu.

Fireye recommends the use of shielded cable for the two remote file select switches (or relays). These controls should be rated for low current (3mA) operation.

PROGRAMMING THE FLAME SIGNATURE SCANNER

Keypad/Display:

The 45FS1/45UVFS1 Flame Signature Scanner uses an eight (8) character, alphanumeric, Light Emitting Diode (LED) Display and three (3) push-button to review and program the various setpoints and operating parameters. The functions of the push-button are:

Advance (➡) This allows the user to review each of the various setpoints and operating parameters associated with the scanner. Each time this key is pressed, the display will advance to the next setpoint or system status.

Help (?) - System status and setpoints use mnemonic abbreviations. This key will display the meaning and full length descriptor of the mnemonic.

Change (▲) This allows the user to modify the various setpoints and operating parameters. The **Program Enable** button must initially be pressed before the Change Key will operate.

Program Enable Button:

The Program Enable button is a red push-button located by removing the metal cover behind the quick disconnect. **THIS BUTTON MUST BE PRESSED TO ENTER THE PROGRAM MODE, DISPLAY THE SETPOINTS MENU, AND ENABLE THE CHANGE KEY (▲).** Once this button is pressed, the Change key (▲) can be used to modify the various setpoints. The Program Enable button is also needed to execute the Edit, Learn On New/Add, Learn Off New/Add, Aim, Save, Run, and Abort operations. (See Setpoints Menu). **If no key is pressed for a time period of twenty (20) minutes, the scanner will exit the Program Mode and the Change key will be disabled. The Program Enable button must be pressed again to continue programming.**

Status and Setpoint Menu

The 45FS1/45UVFS1 scanner has two levels of menus; one to display the current status of the flame scanner and monitored burner, and the other to display the various system setpoints. The status menu is for review only. The system setpoints menu is used to setup the operating parameters for a particular type of burner, fuel type, flame signature, etc. (See Programming Setpoints). The **Advance Key (➡)** scrolls through the menus. The system setpoints menu is displayed by pressing the Program Enable button.
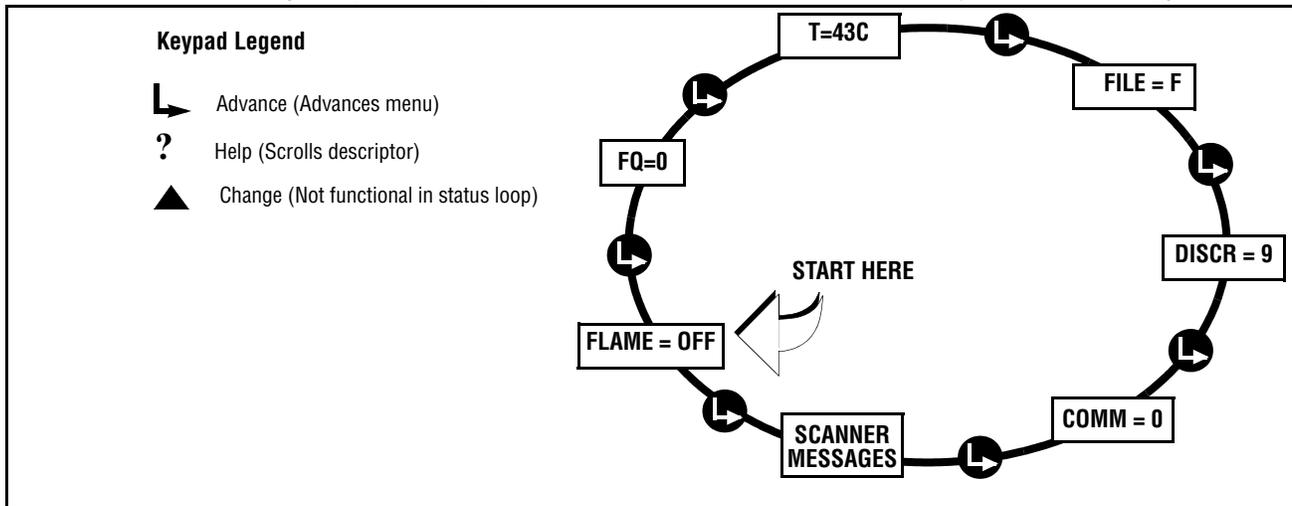
Status Menu

MNEMONIC CODE	DESCRIPTION	ALLOWABLE VALUES
Flame Off	The status of the monitored flame.	Flame On/Off
FQ = 0	Flame quality	0-100
T = 43 C	Internal flame scanner temperature	XX = °F or XX = °C
FILE =F	Reference flame data file	A, B, C, F, (:), (*) (See NOTE below)
DISCR = 9	Flame on/off discrimination ratio.	0 -9
COMM = 0	Communication Address	0 -127
Scanner Message	Will display any scanner messages, errors, or revision number.	See "Scanner Messages"
NOTE: A*, B*, C*, or F* is displayed when reference flame signature profile is selected via the remote file selector switch. See RFS under System Setpoints. A: B: C: F: is displayed when reference flame signature profile is selected via remote communications.		

Setpoint Menu

MNEMONIC CODE	DESCRIPTION	ALLOWABLE VALUES
EDIT = YES	Edit a File	YES/NO
EDIT = A	Select a file to edit.	A, B, C, F
COMM = 0	Communication Address.	0-127
FFRT = 3	Flame failure response time.	1-6 seconds
BFRT= 3	Background failure response time.	2-8 seconds (must be greater than or equal to FFRT)
OTD = 2	On time delay.	2-4 seconds
TEMP = C	Internal scanner temp. displayed.	Fahrenheit or Celsius
F = GAS	Type of Fuel.	Gas, Other, Oil, Coal
B= OFF	Type of burner.	Off, Mech, Gun, LowNox, Cane, Ring, Bucket, Grate, Other.
AMP = 5000	Type of amplifier.	Series 5000, R900, 2000, 4000,
RFS = OFF	Remote file select.	OFF, ON, COMM
AIM = 60	Scanner sighting aid.	Not programmable.
L ON NEW (or ADD)	Learn a NEW (or ADD to an existing) Flame On signature.	NEW, ADD
L OFF NEW (or ADD)	Learn a NEW (or ADD to an existing Flame Off signature.	NEW, ADD
SAVE@A	Save the flame signature to a file.	File A, B, or C.
RUN A	Run the flame signature in a file.	File A, B, C, or F.
ABORT	Abort program mode (Return to status menu).	Not programmable.

STATUS MENU LOOP (Except for temperature, all values shown are factory default setting)

Keypad Legend

Advance (Advances menu)

? Help (Scrolls descriptor)

▲ Change (Not functional in status loop)

T=43C

FILE = F

DISCR = 9

COMM = 0

SCANNER MESSAGES

FLAME = OFF

FQ=0

START HERE

MNEMONIC CODE	DESCRIPTION	ALLOWABLE VALUES
Flame OFF	The status of the monitored flame	Flame on/Flame off
FQ = 0	Flame quality	0-100
T = 43 C	Internal flame scanner temperature	Celsius or Fahrenheit
FILE = F	Reference flame signature file	A, B, C, F, (:), (*)
DISCR = 9	Flame on/ flame off discrimination ratio	0-9
COMM = 0	Communication Address	0-127
Scanner Messages	Will display any scanner messages, errors, or revision number.	See "Scanner Messages"

STATUS MENU

Following is a detailed description of each menu item:

Flame On/Off - Indicates whether or not the 45FS1/45UVFS1 scanner has detected the monitored flame.

Flame Quality (FQ) - Indication as to how close a match the signature of the monitored flame is to the parameters of the reference signature. The higher the number, the closer the parameters are matched. When the flame quality is 60 or above, the scanner Interprets a flame-on condition. When the flame quality is 40 or below, the scanner interprets a flame-off condition.

Internal Scanner Temperature (T) - Readout scanner temperature. Max. operating temperature for 45FS1 is 150°F (65°C). For 45UVFS1 the maximum operating temperature is 131°F (55°C). The temperature will display in either Fahrenheit or Celsius. Indication (F or C) is selected in Setpoints menu.

Reference Flame File (FILE) - Indicates the flame signature file the scanner is comparing the monitored burner against. Four (4) files are available for selection: A, B, C, or F. F represents the factory default values. When the reference profile is selected via the remote file selection switch [1], an asterisk will follow the letter (e.g. A* or C*). When the reference profile is selected via remote communications[2], a colon will follow the letter (e.g. A: or C:). The parameters for each reference signature is programmed in the Setpoints menu.

[1.] The Remote File Selector Switch must be programmed "ON" (See RFS under Setpoints Menu).
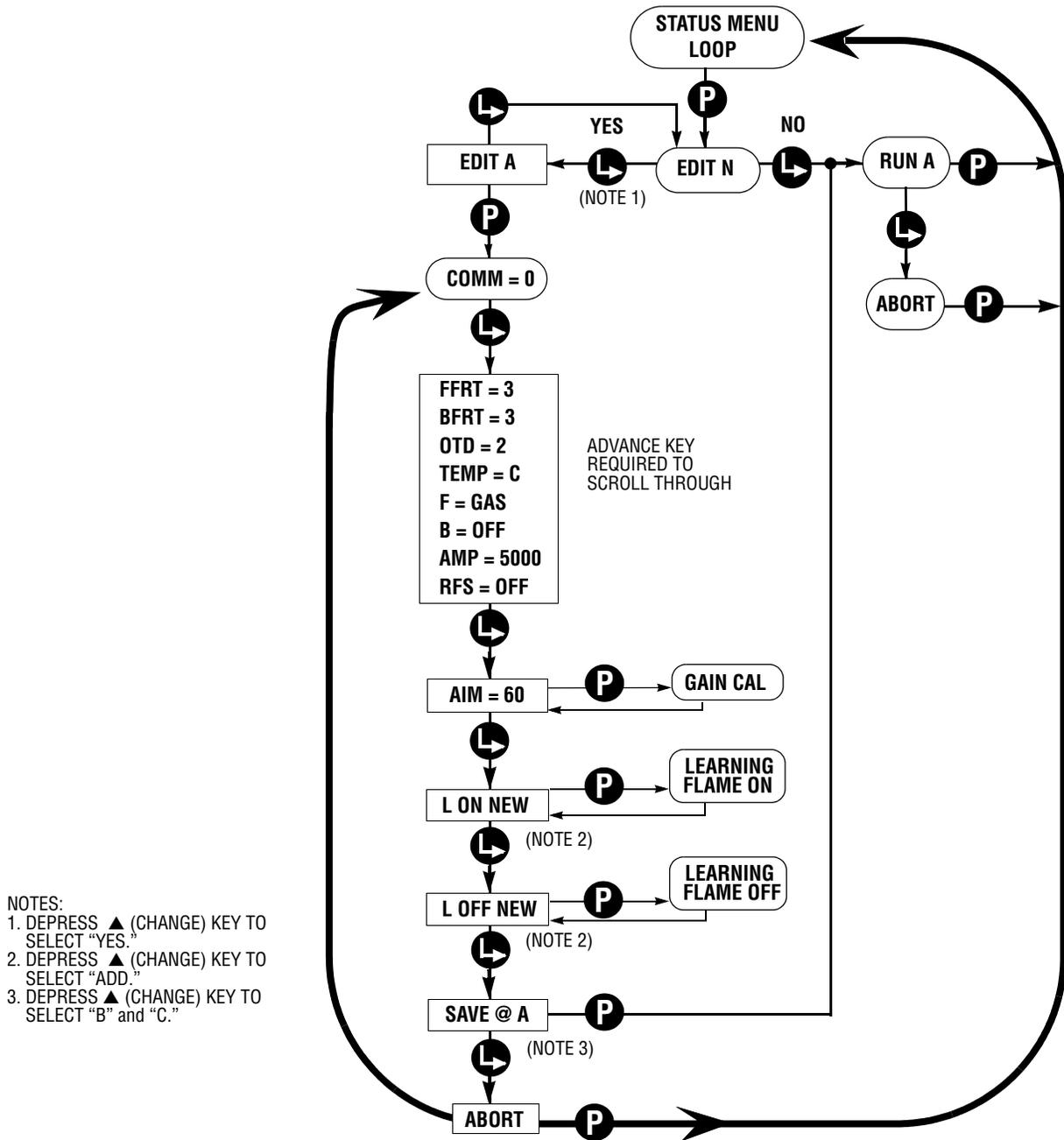[2.] RFS must be programmed "COMM" (see RFS under Setpoints).

Discrimination (DISC) - Indication of the quality of discrimination obtained from the Learned Flame On and Learned Flame off profiles. This menu item is very useful. During the setup procedure, the user should try to maximize this value. Allowable values are 0 to 9. Value should be at least 5 or higher for discrimination to occur. The larger the number, the better the discrimination.

Note: Since this setpoint depends on both the Flame On and Flame Off profiles, an incorrect value for this setpoint will be displayed until both the Learn Flame On and Learn Flame Off procedures are completed. The only exception would be a single burner application where the Flame Off condition is a black boiler.

Communication Address (COMM) - Displays the address of the scanner for remote communication to an IBM compatible PC. The available selections are 0 -127.

Scanner Messages - See "Scanner Messages" later in this document.

SETPOINT MENU LOOP (All values shown are factory default setting)

STATUS MENU LOOP

P

YES   NO

EDIT A ← **L** EDIT N **L** · · · RUN A **P**
(NOTE 1)

P   **L**

COMM = 0   ABORT **P**

L

FFRT = 3
BFRT = 3
OTD = 2   ADVANCE KEY
TEMP = C   REQUIRED TO
F = GAS   SCROLL THROUGH
B = OFF
AMP = 5000
RFS = OFF

L

AIM = 60 **P** → GAIN CAL

L

L ON NEW **P** → LEARNING FLAME ON

L (NOTE 2)

L OFF NEW **P** → LEARNING FLAME OFF

L (NOTE 2)

SAVE @ A **P**

L (NOTE 3)

ABORT **P**

NOTES:
1. DEPRESS ▲ (CHANGE) KEY TO SELECT "YES."
2. DEPRESS ▲ (CHANGE) KEY TO SELECT "ADD."
3. DEPRESS ▲ (CHANGE) KEY TO SELECT "B" and "C."

Keypad Legend

L   Advance (Advances menu)

?   Help (Scrolls descriptor)

▲   Change (Not functional in status loop)

P   Program Enable (Executes commands)

SETPOINT MENU LOOP (continued)

MNEMONIC CODE	DESCRIPTION	ALLOWABLE VALUES
EDIT N	Edit a file	Yes, No (Note 1)
EDIT A	Select the file to edit	A, B, C, F
COMM = 0	Communication Address	0 - 127
FFRT = 3	Flame failure response time	1-6 seconds
BFRT = 3	Background failure response time	2-8 seconds (Note 2)
OTD = 2	On time delay	2-4 seconds
TEMP = C	Temp displayed in Celsius (or Fahrenheit)	Celsius or Fahrenheit
F = GAS	Type of fuel	Gas, other, oil, coal
B = OFF	Type of burner	Off, mech, gun, lownox, cane, ring, bucket, grate, other
AMP = 5000	Type of amplifier	Series 5000, R900, 2000, 4000 amplifiers
RFS = OFF	Remote file select	Off, On, Comm
(Last six functions require activation of button to execute: Aim - Abort)		
AIM = 60	Scanner sighting aid	
L ON NEW	Learn a new flame-on signature	(Note 3)
L ON ADD	Learn and add to an existing flame-on signature	
L OFF NEW	Learn a new flame-off signature	(Note 3)
L OFF ADD	Learn and add to an existing flame-off signature	
SAVE@A	Save the flame signature to a file	File A, B, or C (Note 4)
RUN A	Run the flame signature in a file	File A, B, C, or F (Note 5)
ABORT	Abort program mode; return to Status Menu	
1. Depress ▲ (change) to select "yes" 2. BFRT cannot be set less than FFRT. 3. Depress ▲ (change) to select "ADD." 4. Depress ▲ (change) to select "B, C" 5. Depress ▲ (change) to select "B, C, F."		

SETPOINTS MENU

EDIT Y/N - This is the first prompt displayed once the program enable button is pressed in order to put the scanner in the Programming Menu. The change key (▲) will toggle between EDIT YES and EDIT NO. If EDIT NO is displayed, the Advance Key (➡) will then display the RUN A (or appropriate file) command. If EDIT YES is displayed, the Advance Key (➡) will then display the EDIT A (or appropriate file) command.

EDIT A - This prompt selects the file to edit or modify. Allowable values are A, B, C, or F. The **Program Enable** button is required to advance to the various setpoints. The Advance key will again display EDIT Y/N.

Communication Address (COMM = 1) - The address of the scanner for remote communications to an IBM compatible PC. The available selections are 0-127. **No two scanners on the same communication data link can have the same address.**

Flame Failure Response Time (FFRT) - Response time in the event the monitored flame goes from a Flame On to a total flame out (black boiler) condition. Allowable values are from 1 to 6 seconds.

CAUTION: The FFRT time of the 45FS1/45UVFS1 is ADDED to the FFRT time of the flame amplifier to determine total FFRT timing. For example, if the FFRT timing on 25SU3-5011 is set at 1 second and the FFRT of 45FS1/45UVFS1 is set at 3 seconds, then the total FFRT timing is 4 seconds.

Background Failure Response Time (BFRT) - Response time in the event the monitored flame goes from a "flame on" to a flame out condition with background flame signal (e.g. fireball). Allowable values are 2 to 8 seconds. The values for BFRT must be ≥ the values for FFRT.

Note: See "Learn Flame On New" Caution, page 29.

On Time Delay (OTD) - Response time on start up for the 45FS1/45UVFS1 scanner to detect a "flame on" condition before allowing the flame amplifier to pull in the flame relay (e.g. 45FS1/45UVFS1 will not allow pulses to the flame amplifier until a "flame on" condition has been detected for the programmed time). Allowable values are 2 to 4 seconds.

Type of Fuel (F) - In determining the flame signature profile of the monitored burner, programming the type of fuel helps "fine tune" the signature profile. This selection affects how the scanner responds to the low frequency characteristics of the flame. Selections are gas, oil, coal, and other. Other fuel type selections can be tried to determine if Discrimination (DISC on Status menu) is improved. (e.g. rice hulls may provide the highest discrimination if "Coal" is selected).

Note: See "Learn flame on new" page 29.

Type of Burner (B) - In determining the flame signature profile of the monitored burner, programming the type of burner also helps "fine tune" the signature profile. This selection affects how the scanner responds to the high frequency characteristics of the flame.

Select the value that most closely resembles the actual burner type. The possible selections are:

1. **Off -** This is the default value. **This setpoint (Type of Burner) must be programmed to a value other than the default value of Off before the 45FS1/45UVFS1 scanner will operate.** See Programming Primer (Publication CU-33).
2. MECH - Refers to a mechanically atomized oil burner.
3. Gun - Typically refers to an oil gun burner.
4. Lownox - Refers to boilers utilizing a lownox type of burner.
5. Cane - Typically refers to a cane style burner.
6. Ring - Typically refers to a ring style burner.
7. Bucket - Typically refers to a multi-port burner.
8. Grate - Typically refers to a coal or wood chip burner.
9. Other - Alternative catchall selection.

Other burner type selections can be tried to determine if Discrimination (DISC on Status menu) is improved. (e.g. a ring burner may provide the highest discrimination if *Bucket* is selected rather than *Ring*).

Note: See "Learn Flame On New" Caution, page 29.

Type of Amplifier (AMP) - This selects the type of amplifier the scanner will be used with. Selections are:

1. 5000 - Fireye Type 25SU3/25SU5, Series 5000 (e.g.: -5172, -5173, -5011, -5012, -5166).
2. R900 - Detector Electronics, Type R900/R910.
3. 2000 - Fireye Type 25SU3, Series 2000.
4. 4000 - Fireye Type 25SU3, Series 4000 (e.g. -4170, -4171, -4172).

Remote File Select (RFS): Enables or disables the remote file selection feature. When programmed for ON, two (2) external switches connected to terminals 5 and 7 of the quick disconnect or terminals 5 and 6 of the wiring harness determine the reference signature file (A, B, C, or F). When RFS=ON, an asterisk (*) will also be displayed with the appropriate letter (e.g. "A*" or "B*"). When RFS=ON the user cannot use the RUN setpoint to select a reference signature profile. When programmed for COMM, the selection of the reference signature file is via RS485 remote communications. When RFS = COMM, a colon (:) will be displayed with the appropriate letter (e.g. "A:" or "B:").

Note: The last six setpoint functions (AIM through ABORT) also require the Program Enable button to execute. See Programming Primer, Publication CU-33.

Scanner Sighting Aid (AIM) - Helps the user properly sight the 45FS1/45UVFS1 scanner. The scanner should be sighted during *Flame On* conditions. Allowable values are 0-60. The user should position the scanner to get the greatest difference in this setpoint during Flame On and Flame Off

conditions (e.g.: Flame On = 10, Flame Off = 40, difference = 30). The lower the value, the stronger the flame signal. During Flame On, a lower number is desirable; during Flame Off, a higher number is desirable. This setpoint also calculates the automatic gain adjustment. See Setup Procedure.

Note: This setpoint is not programmable.

Note: See Caution below.

Learn a "New" Flame On Signature (L ON NEW) - Learns a new *Flame On* signature profile (See Programming Primer, Publication CU-33). During the "learn" mode, the signature profile is stored in EDIT memory, erasing any existing *Flame On* signature profile already in EDIT memory.

Note: To display L ON NEW, press the change key (▲) when L ON ADD is displayed in order to toggle back and forth between L ON NEW and L ON ADD

Note: Signature profile must be saved to a file (A, B, or C) before use.

⚠ **CAUTION: If the setpoints FFRT, BFRT, Fuel Type, or Burner Type have been changed after the flame signature was learned, or the scanner was re-aimed, the user must perform "Learn Flame ON and Off New" procedures again to insure safe and proper operation.**

Learn and Add to an Existing Flame On Signature (L ON ADD) - Learns another *Flame On* signature profile (See Programming Primer, Publication CU-33).

Note: To display L ON ADD, press the change key (▲) when L ON NEW is displayed in order to toggle back and forth between L ON NEW and L ON ADD.

During the "learn" mode, the signature profile is stored in EDIT memory, adding to and modifying any existing *Flame On* signature profile already in EDIT memory. Additional *Flame On* information may improve flame detection.

Note: Signature profile must be saved to a file (A, B, or C) before use.

Learn a "New" Flame Off Signature (L OFF NEW) - Learns a new *Flame Off* signature profile (See Programming Primer, Publication CU-33). During the learn mode, the signature profile is stored in EDIT memory, erasing any existing Flame Off signature profile already in EDIT memory.

Note: To display L OFF NEW, press the change key (▲) and L OFF ADD is displayed in order to toggle back and forth between L OFF NEW and L OFF ADD.

Note: Signature must be saved to a file (A, B, or C) before use.

Learn and Add to an Existing Flame Off Signature (L OFF ADD) - Learns another Flame Off signature profile (See Programming Primer, Publication CU-33).

Note: To display L OFF ADD, press the change key (▲) when L OFF NEW is displayed in order to toggle back and forth between L OFF NEW and L OFF ADD.

During the learn mode, the signature is stored in EDIT memory, adding to and modifying any existing Flame Off signature profile already in EDIT memory. Additional Flame Off information may improve flame out detection.

Note: Signature profile must be saved to a file (A, B, or C) before use.

Save a Signature to a File (SAVE) - Saves a reference signature profile to a file (A, B, or C). This also saves the values of all of the other setpoints as well (e.g. FFRT. Type of Fuel, etc.).

Run the Reference Signature from a File (RUN) - Once a signature profile has been saved to a file, this command selects the reference signature profile (and the values of all the other setpoints saved as well, e.g. FFRT, Type of Fuel, etc.) stored in the indicated file for comparison against the monitored flame. This command sends the flame signature profile to RUN memory.

Abort and Exit the Setpoints Menu (ABORT) - Exits the Setpoints Menu.

PROGRAMMING ERRORS TO WATCH FOR

When programming the 45FS1/45UVFS1 scanners, there are several programming sequences that can cause apparent discrimination problems to the user. They are:

1. **Never** use the AIM or LEARN FLAME ON NEW setpoints when the target flame is **Off**.

2. The setpoint LEARN FLAME ON NEW **erases** any "Flame On and Flame Off" data previously stored for that file. On a multi-burner application, you must LEARN FLAME OFF NEW after a LEARN FLAME ON NEW.   There is LEARN FLAME ON ADD to append the flame on data (the same for LEARN FLAME OFF ADD).

3. If you only LEARN FLAME ON date without performing LEARN FLAME OFF data, the scanner will **always indicate a Discrimination factor of 9** (maximum discrimination). However, this may lead to a false sense of security, since the scanner could indicate "flame on" with the target flame off. To ensure proper discrimination on a multi-burner boiler, turn off the target burner and perform LEARN FLAME OFF NEW, and then cycle the burner on and off to test discrimination and proper operation.

4. Changing several setpoints **after** flame data has been learned can **adversely affect** flame discrimination values and flame detection capability. After you have LEARN FLAME ON NEW data, going back to that file and changing the setpoint Burner Type, Fuel Type, FFRT, or BFRT **will affect the way the scanner discriminates.** After modifying any of the above setpoints, you need to LEARN FLAME ON NEW and LEARN FLAME OFF NEW again.

    For example, if you originally LEARN FLAME ON NEW and LEARN FLAME OFF NEW with the setpoint FFRT = 3, and then edit that file and change the FFRT to 4, you must relearn LEARN FLAME ON NEW and LEARN FLAME OFF NEW.

5. If a very negative "AIM" number is displayed at the scanner (e.g. - 20) the scanner may periodically indicate "FLAME OFF" when a valid flame is present. The selection of "MECH" as a burner "TYPE" will correct this.

SCANNER MESSAGES

The following messages are associated with the operation of the scanner.

MESSAGE	DESCRIPTION	CORRECTIVE
[1] TOTAL FLAME FAILURE	Monitored flame went to black.	
[1] BACKGROUND FLAME FAILURE	Monitored flame went to the learned "flame off" condition.	
EEPROM FAIL	EEPROM Failure	
EPROM FAIL	EPROM Failure	
RAM FAIL	RAM Failure	
CPU FAIL	CPU Failure	
FAILSAFE CKT FAIL	Fail-safe Circuit Failure	Replace Scanner
SENSEBACK LOW FAIL	Fail-safe Circuit Failure	Replace Scanner
AC BIAS FAIL	Analog Circuit Failure	Replace Scanner
SHUTTER FAILURE	Shutter Failure	Replace Scanner
DETECTOR OHMS TOO LOW	Flame signal too high	Use orifice to reduce signal
DETECTOR OHMS TOO HIGH	Flame signal too low	Reposition scanner to increase signal.
TEMPERATURE FAILURE	Internal temperature too high	Use purge air or heat insulating nipple (P/N 35-127-1, 35-127-3)
FILE ERROR	Tried to load a file before saving	Save file before loading

[1] These messages are displayed until the next "flame on" condition, or the message is cleared.To clear a scanner message, press the Help key (?) and Change key (▲) **simultaneously.**
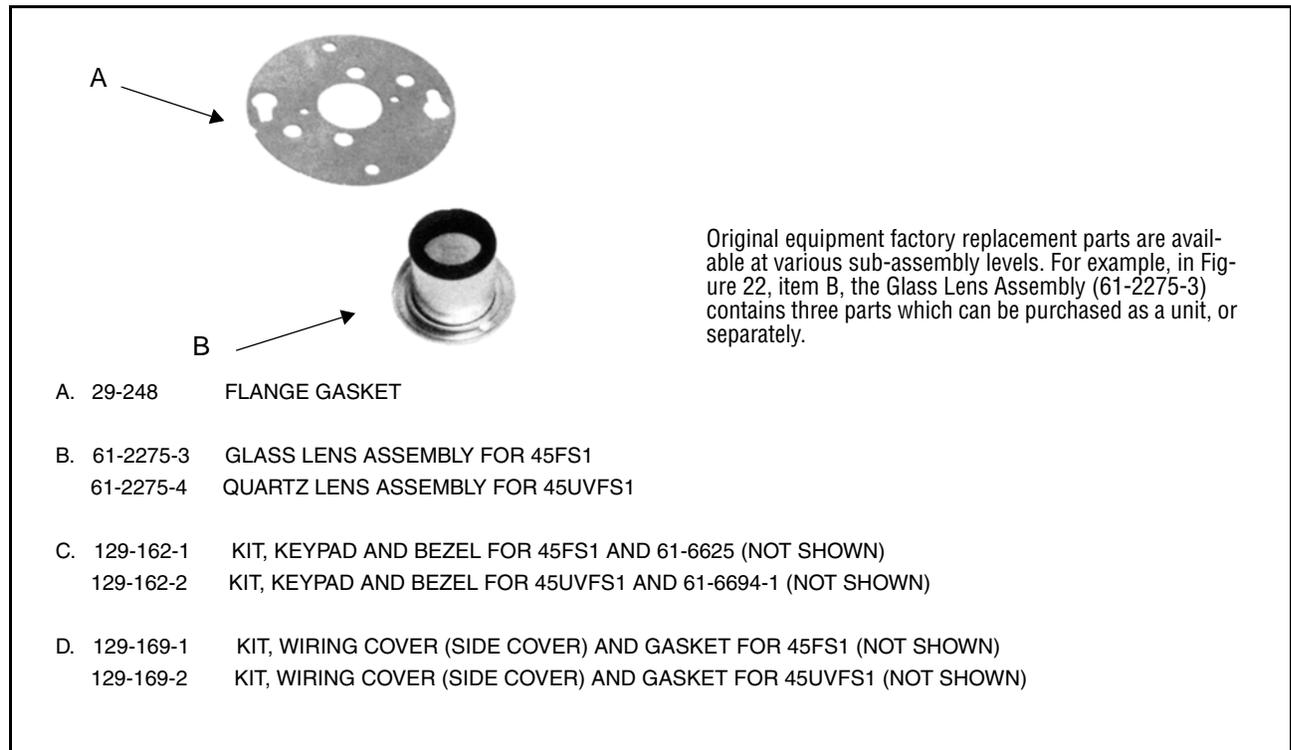
TROUBLESHOOTING

The 45FS1/45UVFS1 flame scanner contains certain diagnostic information helpful in troubleshooting the scanner. In the event of a problem where you need to contact the factory, please perform the following steps.

1. Press the Program Enable key to enter Setpoints Menu.
2. Press the Advance key (➡) until the Setpoint AIM is displayed.
3. Press the Help key (?) and Change key (▲) simultaneously until the screen displays

   X1 =   followed by a numeric value. Enter this value in the table below.

4. Press the Change key (▲) until the screen displays:

   X2 =   followed by a numeric value. Enter this value in the table below.

5. Each time the Change key is pressed the values advance to the next diagnostic. There are a total of 15 diagnostic values (X1 through XF). Enter all of the values in the table below.

NOTE: The value for XD will change.

6. After the diagnostic XF appears, the screen again displays the setpoint AIM. Repeating steps 3 through 5 will display the diagnostics again.

DIAGNOSTIC VALUES – TO BE COMPLETED BEFORE CONTACTING THE FACTORY

X1	X2	X3	X4	X5	X6	X7	X8	X9	XA	XB	XC	XD	XE	XF

FIGURE 22   REPLACEMENT PARTS

A

B

Original equipment factory replacement parts are available at various sub-assembly levels. For example, in Figure 22, item B, the Glass Lens Assembly (61-2275-3) contains three parts which can be purchased as a unit, or separately.

A. 29-248   FLANGE GASKET

B. 61-2275-3   GLASS LENS ASSEMBLY FOR 45FS1
    61-2275-4   QUARTZ LENS ASSEMBLY FOR 45UVFS1

C. 129-162-1   KIT, KEYPAD AND BEZEL FOR 45FS1 AND 61-6625 (NOT SHOWN)
    129-162-2   KIT, KEYPAD AND BEZEL FOR 45UVFS1 AND 61-6694-1 (NOT SHOWN)

D. 129-169-1   KIT, WIRING COVER (SIDE COVER) AND GASKET FOR 45FS1 (NOT SHOWN)
    129-169-2   KIT, WIRING COVER (SIDE COVER) AND GASKET FOR 45UVFS1 (NOT SHOWN)

NOTICE

When Fireye products are combined with equipment manufactured by others and/or integrated into systems designed or manufactured by others, the Fireye warranty, as stated it its General Terms and Conditions of Sale, pertains only to the Fireye products and not to any other equipment or to the combined system or its overall performance.

WARRANTIES

FIREYE guarantees for *one year from the date of installation or 18 months from date of manufacture* of its products to replace, or, at its option, to repair any product or part thereof (except lamps, electronic tubes and photocells) which is found defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of its sales order. **THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES AND FIREYE MAKES NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED.** Except as specifically stated in these general terms and conditions of sale, remedies with respect to any product or part number manufactured or sold by Fireye shall be limited exclusively to the right to replacement or repair as above provided. In no event shall Fireye be liable for consequential or special damages of any nature that may arise in connection with such product or part.