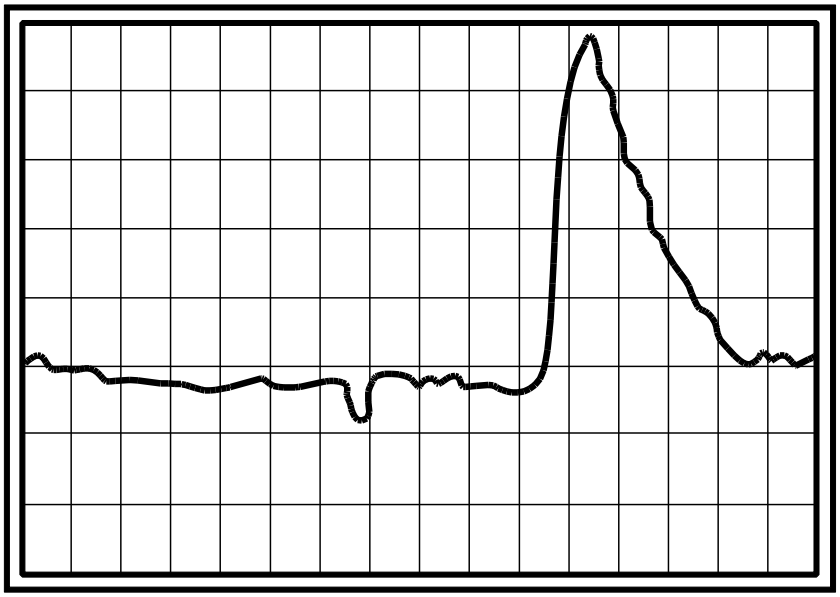
PAL-AT®

INSTALLATION MANUAL



PERMALERT

Environmental Specialty Products, Inc.

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Please check the PermAlert website, www.permalert.com, for the latest revision of this manual.

The manual is typically revised at least once a year. The revision date is on the back cover.

Table of Contents

1 Introduction

1.1 General Description

This PAL-AT® Installation Manual is intended for use as a general installation guide for PAL-AT alarm/locator panels, sensor cable, cable connectors, and probes. Users (installers) should independently evaluate the suitability of this information and PermAlert's products for their application and specific installation. If you receive a PermAlert product that is not described in this manual, contact PermAlert for the appropriate instructions. Refer to the website, permalert.com (permapipe.com), for the latest revision of manuals and product data sheets.

1.2 Applications

The PAL-AT system consists of an electronic microprocessor-based alarm/locator panel that monitors sensor cables and/or probes. The sensor cable may be installed in many applications including: secondary contained piping, directly in the ground adjacent to pipes or tanks; computer room subfloors; cleanroom subfloors, or any area where liquids need to be detected. There are several PAL-AT models available including:

AT20C: Monitors 1 cable up to 2,000 feet.

AT50C: Monitors 1 cable up to 5,000 feet.

AT20K: Monitors up to 2 cables each up to 7,500 feet.

AT40K: Monitors up to 8 cables each up to 5,000 feet.

AT80K: Monitors up to 8 cables each up to 7,500 feet.

1.3 Receiving and Handling Precautions

The following general precautions should be observed:

1. Read this manual carefully before beginning any work. **Do not use substitute materials or short cut recommended procedures**. Understanding and following this guide is essential to avoid installation problems.
2. Collect the needed quantities of all materials well in advance of scheduled work.
3. Check the packing list against received items. **Report immediately any shortages or damaged materials to PermAlert's delivering carrier.**
4. All cable must be tested immediately upon receipt following the cable test procedures contained in this manual. Report immediately to PermAlert any cables that fail this quality control test. Failure to report within ten workdays of receipt of goods shall waive the purchaser's right to file a warranty claim.
5. Care must be taken to store all PAL-AT components in a dry and protected area at all times. Electronic alarm/locator units and sensor cable should be wrapped and sealed with plastic.
6. System drawings, provided by the designer, should indicate the extent, general location, and arrangement of leak detection equipment, cable, and probes. The contractor (installer) should become familiar with all details of the installation before proceeding.
7. Electrical work should be performed by a qualified electrician.

1.4 Materials and Equipment Normally Supplied by PermAlert

Each system may include the following items as quoted:

1. Leak detection/location alarm panel
2. Leak sensor cable
3. Jumper cable
4. Cable connector assemblies
5. Adhesive backed cable mounts (CMA) furnished for attachment of sensor cable to flat surfaces

6. Probe assembly, including a PT10 Probe Integrator installed in a NEMA 4X junction box with 60' of jumper cable and one cable connector assembly
7. Watertight junction boxes conforming to NEMA 4X

Maximum No. of Cable Connectors in Enclosure	Enclosure Dimensions
1	6" x 6" x 4"
2	8" x 6" x 4"
4	10" x 8" x 4"

8. Watertight cord grips
9. Shrink tubing for cable connectors
10. RTV adhesive/sealant for cable connectors

1.5 Materials and Equipment Normally Supplied by Installing Contractor

Each system may require the installing contractor to supply the following items:

1. Pull rope, 1/8" diameter, 7 strands, steel wire rope aircraft cable. For installation of cable in DOUBLE QUIK®, fiberglass, or other plastic piping systems use plastic coated (non-vinyl) wire rope. Provide pull rope in quantities equal to 120% of system length. (Included with PermAlert piping systems)
2. Cable spool rack or stand
3. PVC electrical tape
4. Miscellaneous pipe nipples, unions, and fittings, as required to provide watertight jumper cable connections to sensor cable.
5. 1" rigid or liquid-tight flexible electrical conduit, as required, for installation of jumper cable within manholes, pits, and buildings. Use 1" conduit hub, OZ Gedney CH-100, connection to junction boxes.
6. Electrical conduit, junction boxes, and wiring, as required.
7. Ohmmeter for testing jumper cables and sensor cables.
8. 500 volt megger for testing ATP cable only.
9. Hole saw
10. Construction adhesive mastic for attachment of cable mounts to unsealed concrete surfaces
11. Hot air gun for shrink tube application on cable connector assemblies

2 PAL-AT Alarm/Locator Panel

2.1 Alarm/Locator Panel Installation

1. The standard PAL-AT alarm panel must be permanently mounted indoors in a dry area. If the alarm panel is located outside, it must be installed in a NEMA 3R or 4X enclosure. If PAL-AT is installed inside another enclosure, a fan is usually required inside the enclosure. The enclosure must not be located in direct sunlight to prevent excessive heat buildup. **In all installations the ambient temperature must not be less than 0°F and not exceed 120°F**
2. A hole is provided for the power conduit entrance (½" conduit) into the alarm unit's enclosure. Use a knockout punch if larger conduit is required. Inspect and clean the interior of the enclosure before continuing. Connect all electrical conduits.
3. Wire the unit to an isolated (circuit breaker protected) 120/240 VAC 50/60 Hz circuit. Refer to Figures 1, 2 or 3 for PAL-AT alarm units wiring diagrams.
4. The PAL-AT alarm unit is connected to the sensor cable using jumper cable (Type JMP-U, JMP-UD, JPL, or JPP). **At least 50' of jumper cable (65' if JPP) must be strung or coiled between the alarm unit and the connection to the sensor cable.** It is recommended to run jumper cable in a separate conduit for protection of the cable.
5. Remove the partition (cover) over the BNC connector on the PAL-AT panel by removing the 3 mounting screws.
6. Install a standard connector on the jumper cable using the instructions in this manual. A BNC/UHF adapter is supplied to connect the jumper cable to the BNC connector located under the metal partition in the PAL-AT panel. The cable must exit the enclosure through the ½" conduit opening provided. (Use a knockout punch if a larger conduit is required.) Cut the jumper cable to the required length (minimum 50'), and install a standard coaxial connector as described above. Replace the partition over the jumper cable connector (see Figures 1, 2 or 3).

2 PAL-AT Alarm/Locator Panel

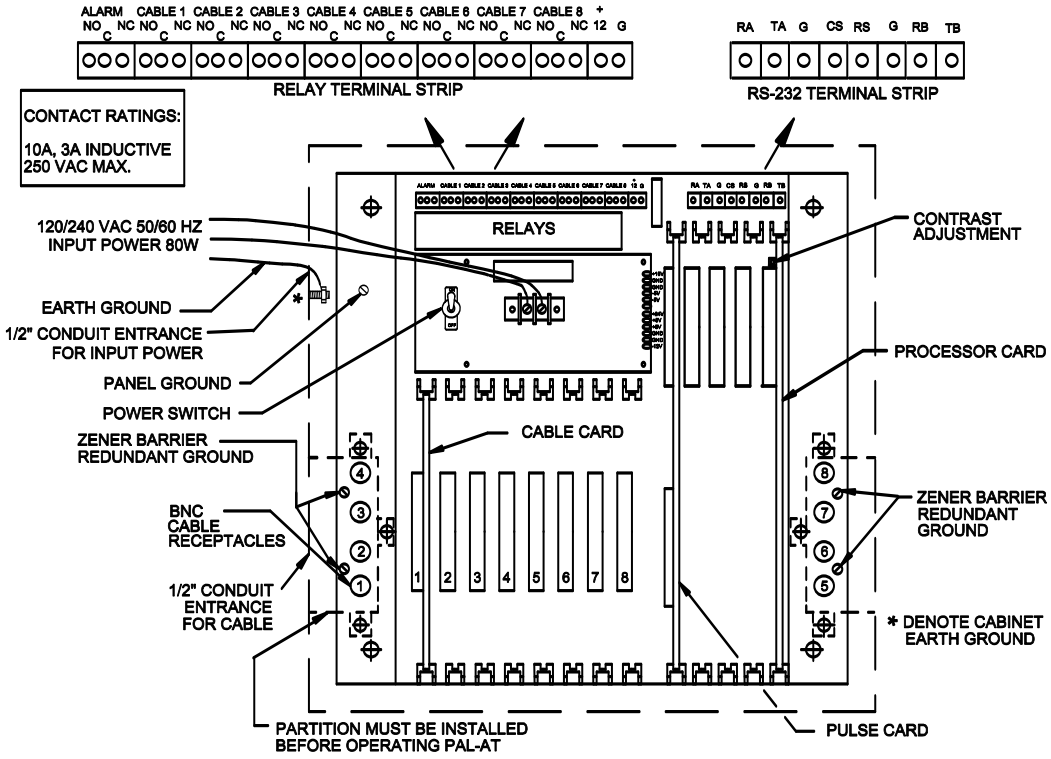


Figure 1
Wiring Diagram for PAL-AT Model AT40K & AT80K

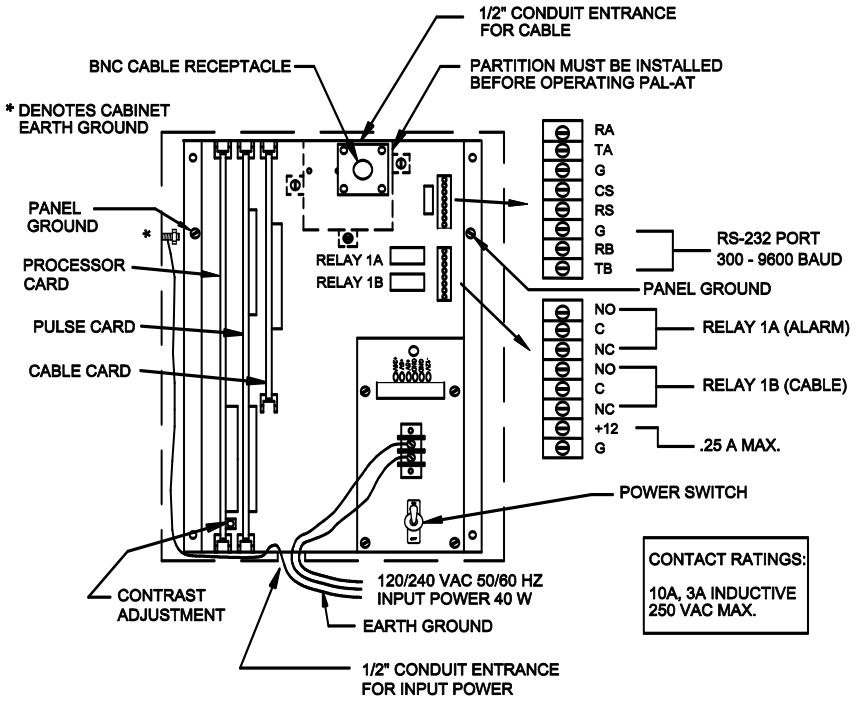


Figure 2
Wiring Diagram for PAL-AT Model AT20C & AT50C

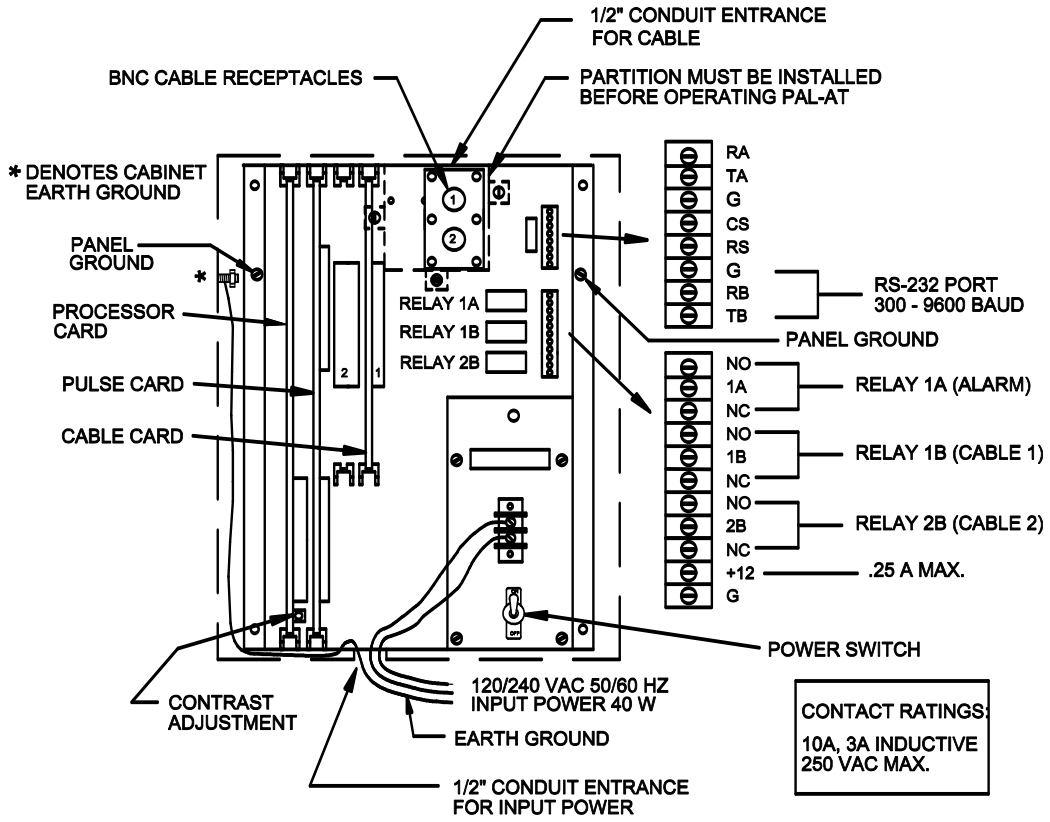


Figure 3
Wiring Diagram for PAL-AT Model AT20K

2.2 Internal Wiring

PAL-AT is shipped with a green LED (power), and a red LED (alarm), on the door of the panel. An optional horn (90dB or chime) is available. The wiring for the lights and horn is a 5-wire cable connected to a connector on the processor card. The green LED is illuminated when the panel is powered. The green LED flashes slowly when the system is not monitoring and is continuously on when it is monitoring. The red LED is illuminated when any cable is in alarm.

2.3 Control Relays

When PAL-AT detects a fault condition, it switches two SPDT output relays rated for 250VAC, 10A. On the AT40K and AT80K, they are labeled "alarm" relay and "cable" relay for the appropriate cable number (see Figure 1). The AT20C, AT50C, and the AT20K relays are labeled "1A", "1B", and "2B" (AT20K only) (see Figures 2 and 3). **PAL-AT is shipped with the relays configured to operate in a normally energized mode, so they de-energize in the alarm state** (see Section 2.9.1 of the "PAL-AT Operating Manual" for setting relay configuration).

When PAL-AT is in alarm, the # key can be pressed to return the alarm relay to its normal state. If an audible alarm or other device is connected to these contacts it is deactivated**.** When an optional audible alarm is ordered with PAL-AT it will be prewired to the processor card. **All panels must have cable card 1 installed for the alarm relay to operate, but the cable card does not have to be on-line.**

The cable relay remains switched until the fault is cleared or a new reference map is taken and the system is monitoring the cable again. **Control devices or auxiliary equipment should be connected to the cable relay so they will not be reactivated when the alarm is silenced.**

2.4 RS-232 Port

PAL-AT is provided with an RS-232 communications port. Refer to Figures 1, 2 and 3 for the terminal strip location and connector pin designation. There is a 40-pin ribbon cable connected to the processor card. A 10-pin ribbon section branches off the main cable and must be connected to the socket on the motherboard next to the terminal strip.

2.5 Intrinsically Safe - UL / FMRC

The PAL-AT is listed by Underwriters Laboratories, Inc. and approved by Factory Mutual Research Company. PAL-AT provides intrinsically safe output circuits for use in Class 1, Division 1 Groups C and D hazardous locations when used with PAL-AT sensor cables and probes, and installed in accordance with the instructions in this manual. The sensor cables include AGW-Gold, AGT-Gold, and TFH. Refer to Section 8, "Probes" for specific probe UL and FMRC requirements. Also, refer to PAL-AT control drawing, Figure 4, for intrinsic safety requirements.

THE MAXIMUM OPERATING VOLTAGE ALLOWED IN THE PAL-AT PANEL IS 250VAC. IN ADDITION, THE VOLTAGE ON ANY WIRES TO THE CONTROL RELAYS MUST BE LIMITED TO 250VAC.

The partition (cage) must be installed over the jumper cable BNC connector(s) before operating the system.

2.6 FCC

The user is cautioned that any changes or modifications, not expressly approved by the party responsible for FCC compliance, could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Each Model AT40K and AT80K is supplied with 2 "ferrite blocks" (PermAlert part # 8058205) to comply with FCC regulations. The jumper cable must pass thru the block in the enclosure. Each block may have up to 4 cables (see Figure 5).

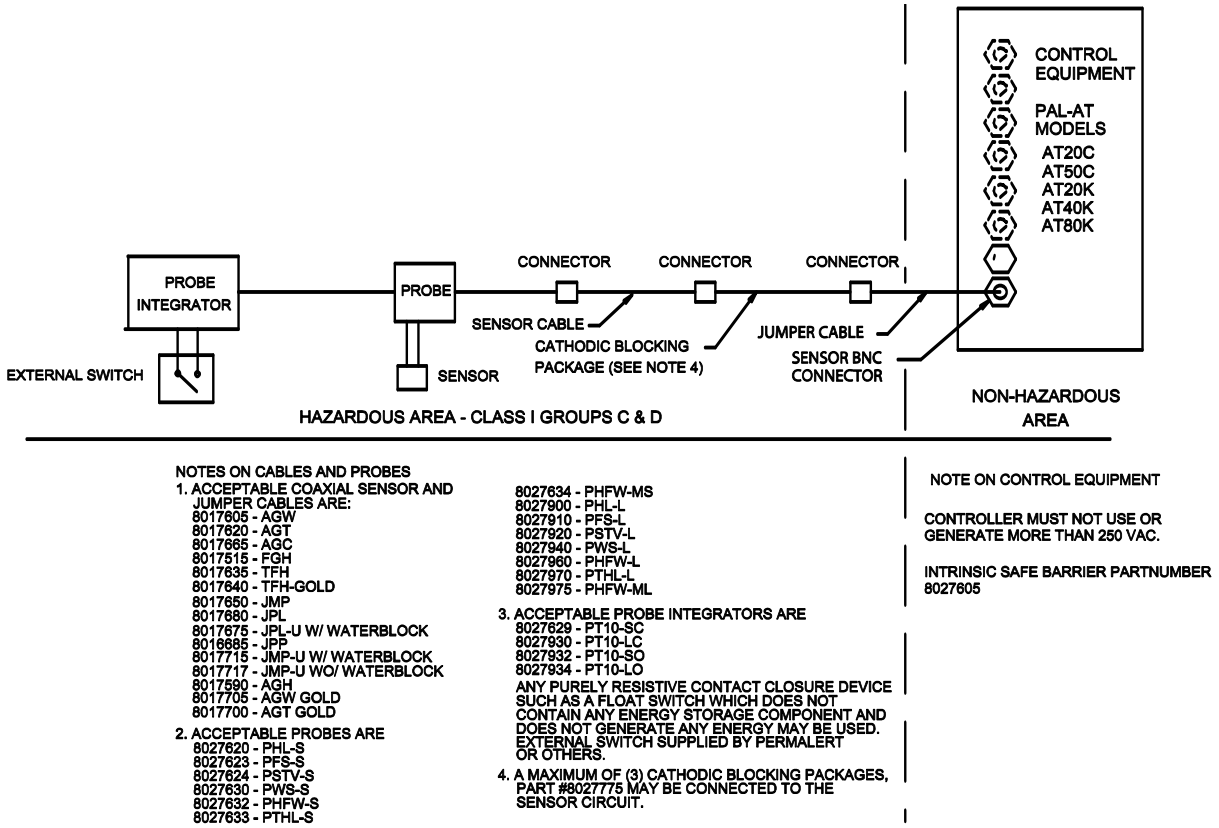


Figure 4
PAL-AT Control Drawing

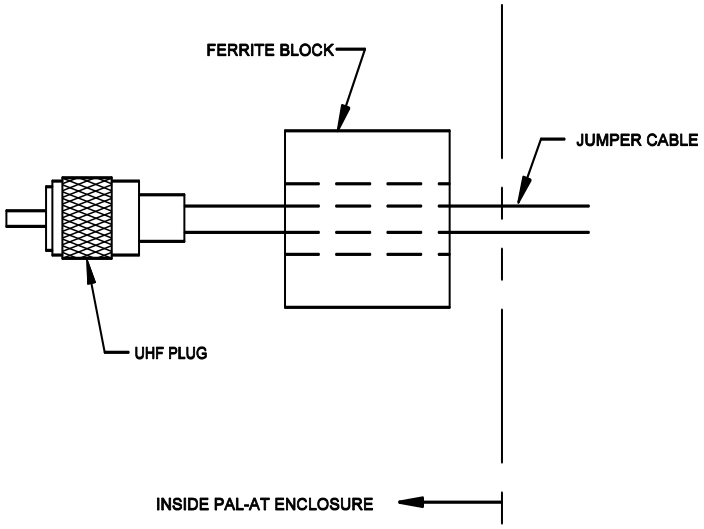
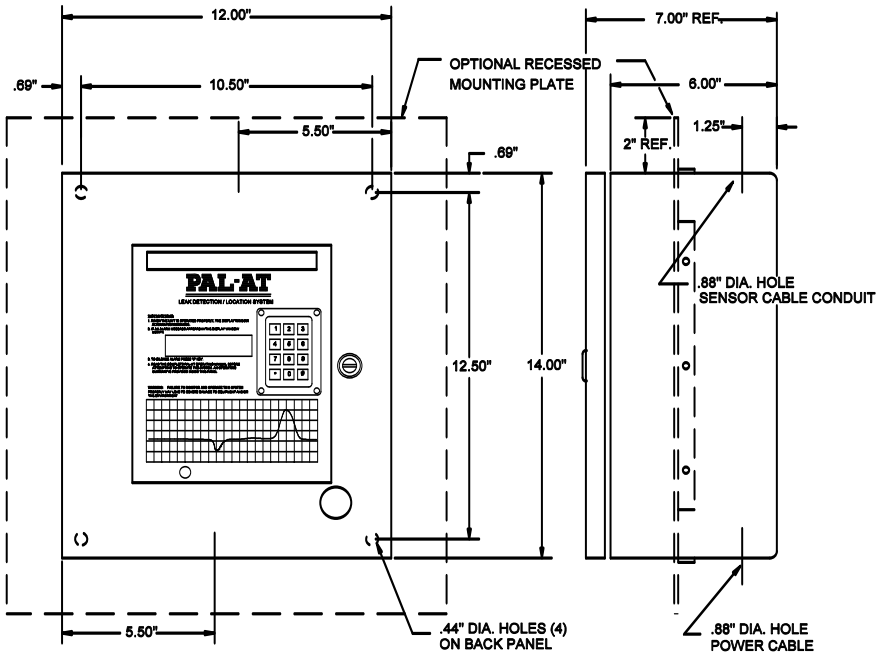


Figure 5
Ferrite Block Assembly

2 PAL-AT Alarm/Locator Panel

Models AT20C, AT50C and AT20K



Models AT40K and AT80K

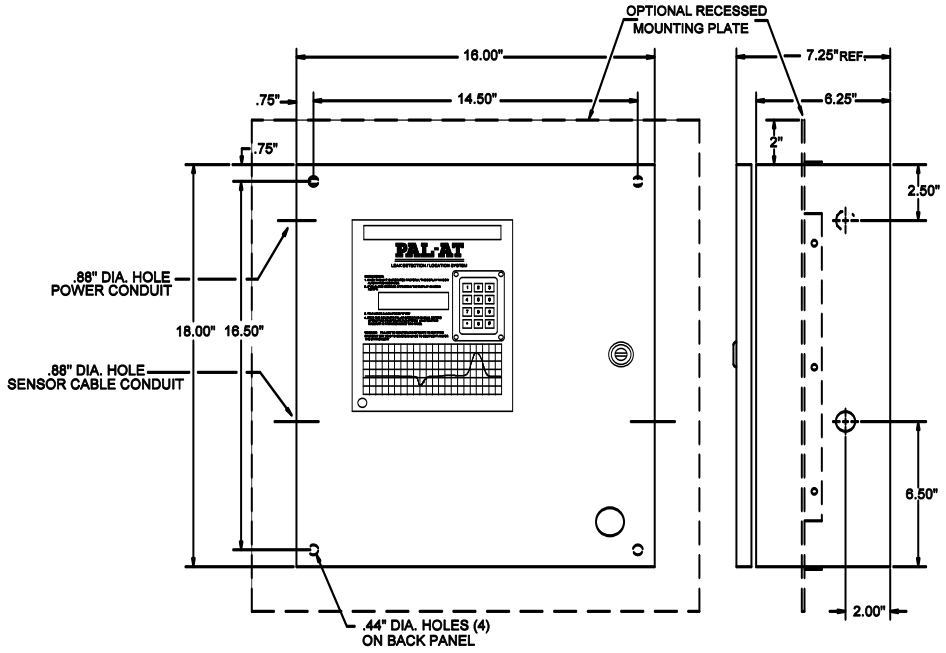


Figure 6
Metal Enclosure Dimensions

3 Jumper Cable and Junction Box Installation

3.1 Jumper Cable

1. Jumper cable (types JMP-U, JMP-UD, JPL-U, JPL-UD, or JPP) is used to connect sensor cable segments and probes in series to form the sensing circuit (string). Jumper cable is not affected by occasional contact with water and can be installed in building and vaults. In underground locations and areas where damage may occur to the jumper cable, it is recommended that electrical conduit be used to provide protection. In wet environments or areas subject to flooding, cable connectors on jumper cable should be located in watertight electrical junction boxes (NEMA 4 or 4X).
2. At least 50' of jumper cable (65' for type JPP) must be installed from the PAL-AT alarm panel before the first connection to sensor cable. Table 1 lists the length of jumper that should be installed at the very end of a sensing string. A cable connector must be installed to terminate the end of the last jumper cable section and a threaded plastic cap is supplied to cover that connector. Refer to Table 2 for additional jumper cable required in a probe section.
3. Where possible, jumper cable connections to sensor cable should be made within the monitored area. PermAlert recommends the use of OZ Gedney cord grips installed as shown in Figure 7. Cord grips must clamp only jumper cable or TFH cable. The outer braid on TFH cable must be pulled back so the cord grip is located on the smooth outer jacket.
4. Check the assembly with an ohmmeter following the cable testing procedures contained in this manual.

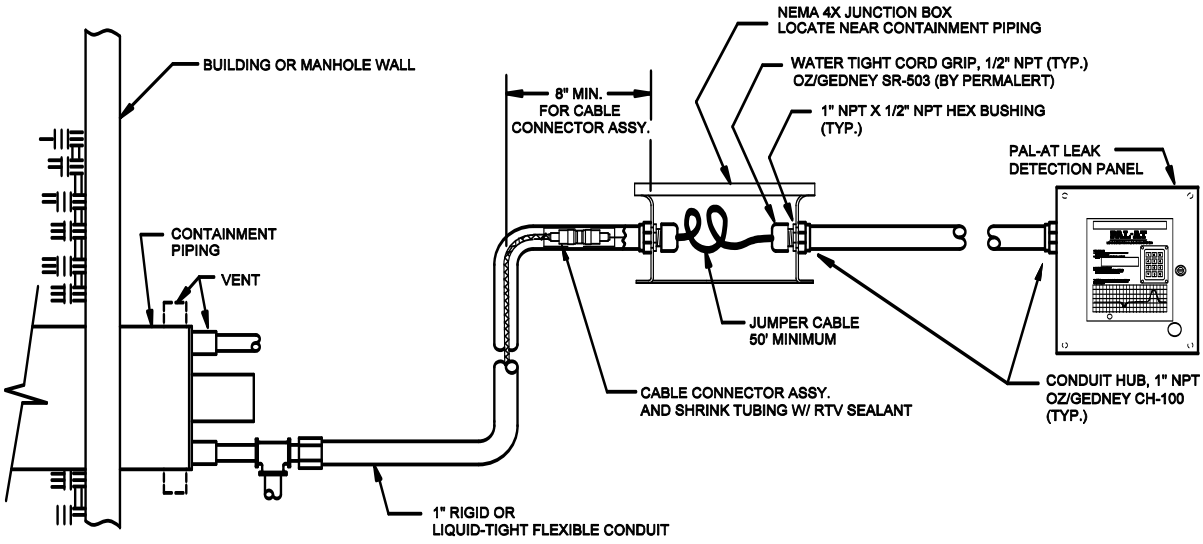


Figure 7
Typical Cable Connection in Monitored Areas with Junction Boxes

3.2 Calibration Points

1. During the initial setup and calibration of the alarm/locator unit, connectors at selected locations (calibration points) are temporarily disconnected. **Therefore, it is imperative to have accessibility to connectors at calibration points at all times until the system is brought on-line.**
2. Reported fault location accuracy of the first leak is dependent upon the use of and distance between calibration points. Calibration points are required at changes of cable types unless connected to short lengths of jumper cable (15' or less). Additional calibration intervals of 500' or less will result in location accuracy of within +/- 5'. Systems installed with calibration intervals exceeding 500' will result in location accuracy of less than +/- 1% of the cable length from the previous calibration point.

3.3 Junction Boxes

1. Locate and install all junction boxes before installing any cable. Locate junction boxes as indicated on system drawings or as required. These locations include calibration points, the start and end of cable runs, manholes, probes, etc. Care must be taken to prevent water from contaminating these areas.
2. Securely mount the junction boxes to a vertical wall. In manholes or pits that might collect and hold water, mount junction boxes as high as possible. Use NEMA 4X junction boxes at all locations.
3. Use a hole saw to cut the junction box as needed for conduit.
4. When jumper cable is installed in electrical conduit, use watertight conduit hubs and cord grips at junction boxes. Discard the male bushing supplied with the hub and use the cord grip supplied in its place. Depending upon the specific products used, a lock nut may be required on the cord grip's threads to pull the hub tight to the wall of the junction box.

   Caution: Always keep junction boxes and electrical conduits capped to prevent water from entering.

Table 1
End of System Jumper Cable Length

System Length ft/(m)	JMP-U/UD End Jumper Length ft/(m)	JPP End Jumper Length ft/(m)
0–2500/(0-750)	20/(6)	25/(8)
2500-5000/(750-1500)	50/(15)	65/(20)
5000-7500/(1500-2300)	100/(30)	125/(40)

Table 2
Additional Jumper Cable after Probe

Probe Location on Sensing String ft/(m)	Additional JMP-U/-UD At End of Probe ft/(m)			Additional JPP At End of Probe ft/(m)		
	Twin Lead Length			Twin Lead Length		
	20/(6)	15/(4.5)	10/(3)	20/(6)	15/(4.5)	10/(3)
0-3000/(0-900)	0/(0)	0/(0)	0/(0)	0/(0)	0/(0)	0/(0)
3001-4000/(900-1200)	20/(6)	0/(0)	0/(0)	25/(8)	0/(0)	0/(0)
4001-5000/(1200-1500)	60/(18)	25/(8)	20/(6)	80/(25)	35/(11)	25/(8)
Over 5000/(over 1500)	Contact Factory					

4 Cable Installation in Secondary Contained Piping

4.1 General

In secondary contained pipe applications, the sensor cable is installed in the bottom (6 o'clock position) of the air space between the product pipe(s) and secondary containment (outer casing or conduit). The leak detection cable is a sensitive sensor, capable of detecting small amounts of liquid. **Therefore, every effort must be made to keep the cable dry and prevent water from entering the air space. Also, long term accumulations of water, corrosive liquids, or hydrocarbon liquids in the containment pipe may degrade the containment or the leak detection system components.** The piping system must remain sealed during installation to prevent moisture entering the system. The installing contractor must install caps on the open ends of pipe installed in a trench to prevent liquids from entering the conduit or containment pipe. If the system becomes wet, if must be completely dried. Drying methods can consist of: pulling a vacuum on the interstitial space; using compressors; using desiccant dryers or other methods. Obtain guidance from your piping supplier on proper techniques to be used with your system.

This section is intended to cover installation methods typically employed with any fabricated secondary contained pipe systems. Typically, these manufactured products are custom fabricated with product pipes positioned by specially designed supports within the secondary containment. **All pipe supports and changes in direction that will have leak detection installed must have guides constructed out of stainless steel, minimum ¾" ID tubing, with flared ends. Plastic supports must be avoided when the carrier pipe is metal. Consult with the piping system manufacturer before installation to ensure that all provisions are being made for the cable installation.** Because the sensor cable installation is dependent upon the design provisions employed by the pipe manufacturer, it is recommended that the secondary pipe manufacturer supply the leak detection/location products. This sole source responsibility will greatly facilitate proper installation with lower cost.

The following charts are general references for installing a sensor cable into field-constructed secondary contained pipe system built with piping components. Typically, these systems are constructed using standard lengths of pipe and fittings for the product and secondary containment structures. Components of the piping system should be designed, manufactured, and installed to facilitate sensor cable installation. Because the sensor cable is placed on the bottom of the air space, there must be a continuous unobstructed passage for the cable(s) being pulled into the system. **PermAlert recommends a 1" air space. Pipe support design and alignment is critical. Pipe supports and other surfaces that the cable may come in contact with during "pulling" operations must be smooth to prevent snagging or damaging the cable. Flexible piping systems must include a perforated tube to install the sensor cable to prevent crushing.**

Field joint designs and procedures employed in the installation of the piping system must prevent damage to the pull rope and/or sensor cable.

Pull ropes must be installed as the pipe system is assembled together to facilitate the installation. Special stainless steel ¾" ID guide tubes must be installed in the air space of the containment straight, elbows, tees and wyes (lateral) at the factory. Pull points must be designed and provided at specific locations to facilitate the installation of the pull cable and leak detection cable.

Leak Detection Sizing Chart
Polypropylene / Polyethylene Piping SDR Sizes

Pipe Size	Casing Size	SDR11/SDR11	SDR11/SDR32.5
1.5	4	OK	OK
2	6	OK	OK
3	6	OK	OK
4	8	OK	OK
6	10	OK	OK
8	12	OK	OK
10	14	NO	OK
12	16	N/A	OK
14	18	N/A	OK
16	20	N/A	OK

Leak Detection Sizing Chart
For Standard Weight Steel and Fiberglass Pipe
(w/o insulation, 10 gauge steel or fiberglass containment)

Pipe Size	Casing Size
2	6
3	6
4	8
6	10
8	12
10	14
12	16

Note:

1. **Not all pipe types or sizes are shown in the above charts. For different systems contact PermAlert.**
2. **Chart is based on smooth pulling surfaces and installation of guide tubes.**
3. **Multi pipe system will require factory sizing.**

4.2 Pull Points

1. Sensor cable must be “pulled” into the monitored areas using a continuous pull rope free of splices between pull points. Surfaces in which the cable may come in contact with during “pulling” operations must be smooth to prevent hanging up or damaging of the cable.
2. Generally, pull points can be located at 500' intervals for straight runs. Each 90° fitting on the run reduces the interval by 150'. For example, a run of 50' with 3 elbows is allowable (500' - (3' x 150') = 50').
3. Pull point designs should be selected not only on the basis of accessibility during installation, but potential future cable replacement. When future cable replacement is a consideration, it is recommended that underground installations have watertight junction boxes or secondary contained access points installed at grade or in vaults (see Figure 8). **Caution: Pulling points often become**

calibration locations. When this occurs, accessibility to the cable connectors is necessary during the initial commissioning of the alarm panel and the system's setup procedures.

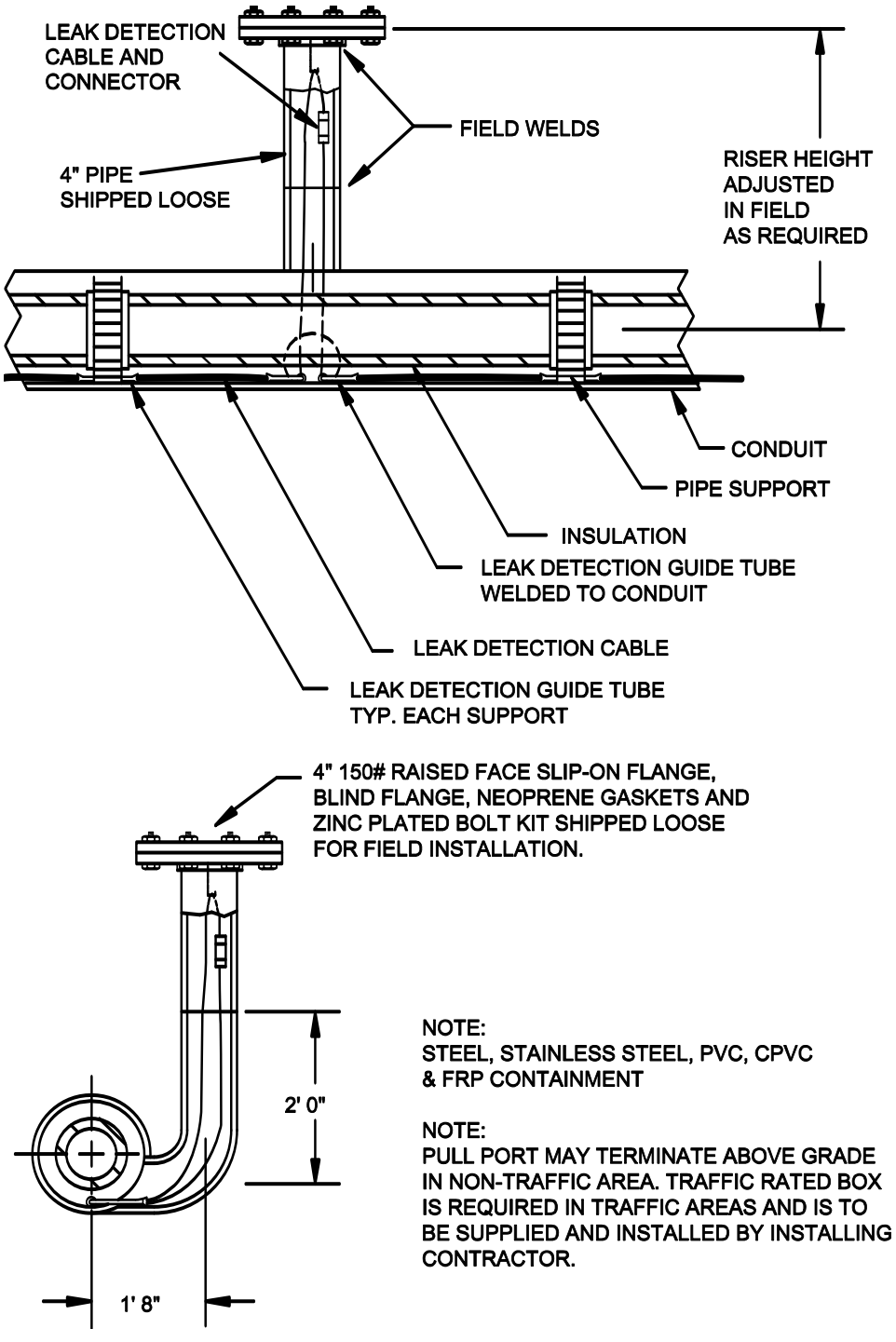


Figure 8
Detail of Pulling Point

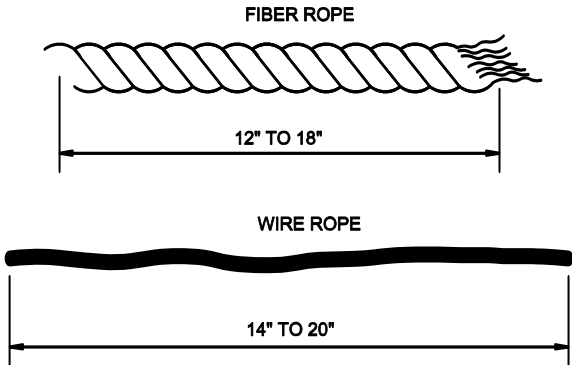
4.3 Cable Splices

Continuous pull rope and sensor cable are "pulled" into the secondary containment during certain stages of installation. Several splices are used to provide secure attachments to pull ropes and cable during this procedure. The following methods are recommended for splicing.

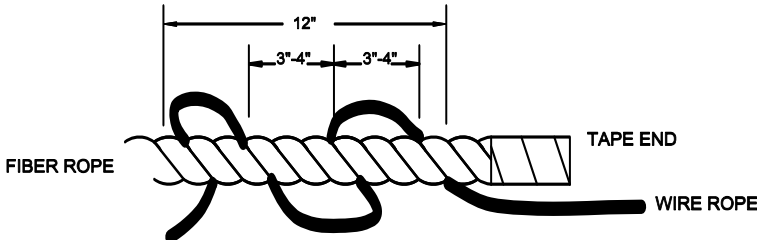
Note: When using tape to seal the splices, use only PVC electrical tape. PVC tape minimizes drag on the cable and reduces snags.

4.3.1 Factory Installed Fiber Pull Rope to Continuous Pull Wire Rope Splice

Step A Extend 12" to 18" of fiber rope and 14" to 20" of wire rope.

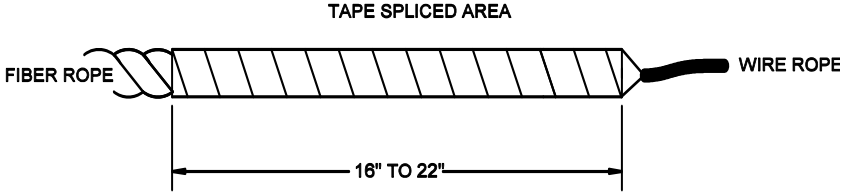


Step B Wrap a small amount of electrical tape around the fiber rope's end to prevent unraveling. Using a small pointed object (such as a nail), slightly separate the fiber rope braid and weave the wire rope into each opening of the braid as you go.



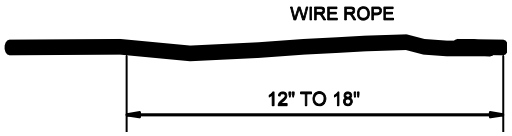
Step C Pull the wire rope tight, as it is woven into the braid.

Step D Using electrical tape, wrap the entire length of the splice area. The tape should extend approximately 2" over each end of the splice.



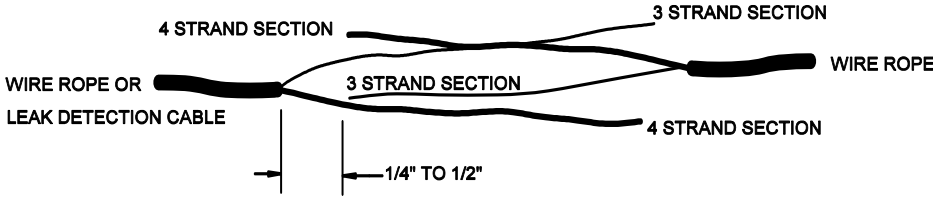
4.3.2 Wire Rope to Wire Rope Splice

Step A Extend 12" to 18" of each wire rope end for the splice.



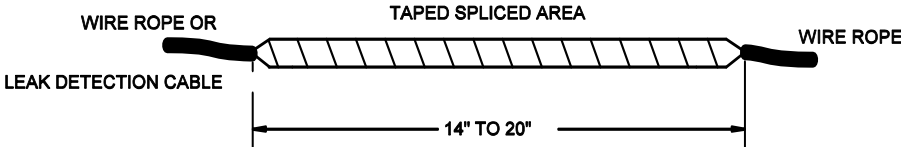
Step B Unravel each of the 12" to 18" ends into a 3 strand and a 4-strand section (approximately 50% in each), keeping the adjacent strands together.

Step C Starting approximately ¼" to ½" from the start of the wire rope's split, intertwine a section from each of the 2 ropes.



Step D Line up the 2 remaining sections and intertwine them together in a similar manner. In order to minimize the size of the splice, make sure that the starting points for each intertwining operation line up with each other.

Step E Starting at approximately 1" from the beginning of the splice, wrap electrical tape around the splice until the entire splice, plus 1" on each end, is covered. Normally only 1 wrap is needed. Make sure that both ends of the tape wrap are tapered and smooth in case the pull direction must be reversed.

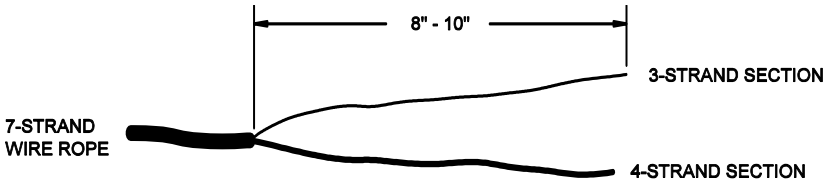


4.3.3 Wire Rope to Wire Rope Splice (alternate)

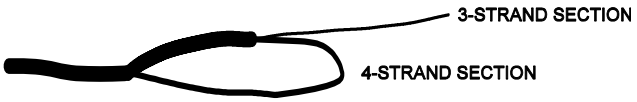
Note: Use this splice when splicing two different size wire ropes together

Step A Extend 8"-10" of each wire rope to be spliced.

Step B Unravel each of the 8"-10" sections (to approximately the same length) into two sections to form a Y with three adjacent spiral strands on one side, three adjacent spiral strands with center strand on the other.



Step C Taking one end of the first cable, fold over the 4-strand section of the Y to form a loop. Join the 3-strand section to the 4-strand section. Wrap the 3-strand section around the 4-strand section so the strands appear as in the original undisturbed cable.



Step D Take the second cable Y end and place the 4-strand end through the eye of the first cable loop.

Step E Repeat steps A through C.

Step F Using a pair of pliers, crimp the ends of the loops.

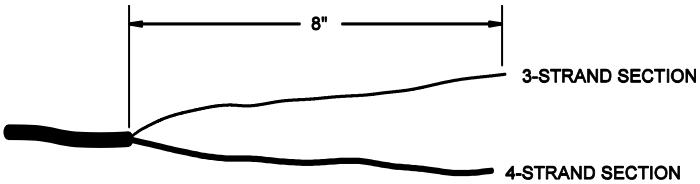
Step G Spiral wrap the splice tightly, using electrical tape.

4.3.4 Wire Rope to Leak Detection Cables

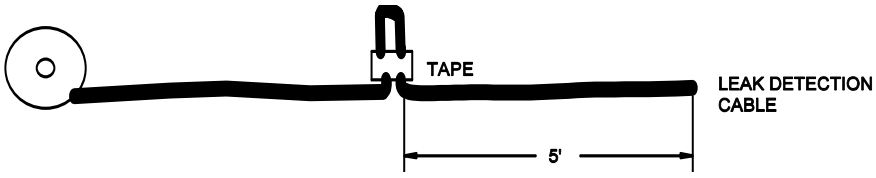
The following steps apply in general to all sensor and jumper cables. However, there may be slight variations to the steps presented depending on the cable selected. For example, the jumper cables have an outer jacket but no plastic overbraid, while the TFH cable has both a jacket and an overbraid.

Step A Extend the 7-strand 1/8" wire rope for splicing. Cut the end so that all strands are even.

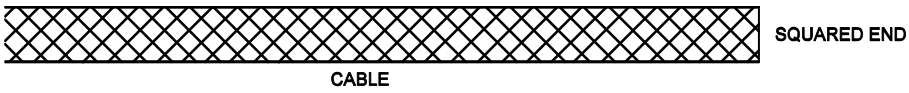
Step B Unravel 8" of the wire rope into two sections to form a "Y" with three adjacent spiral strands on one side and four strands on the other side.



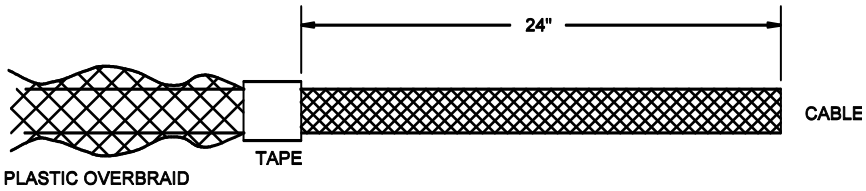
Step C Extend approximately 5' of cable for the splice. Form a small loop in the shape of a "U" 5' from the end of the cable and tape it in place tightly. Do not kink the cable when forming the "U" (Skip this step with jumper cables.)



Step D Cut the end of the cable so the plastic overbraid, jacket, metallic braid, center conductor insulation, and center conductor are flush at the end of the cable.



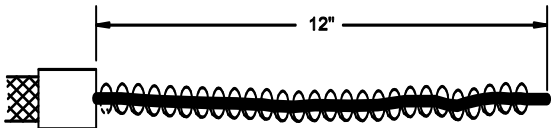
Step E Slide the plastic overbraid back over the sensor cable at least 24” and tape in place tightly.



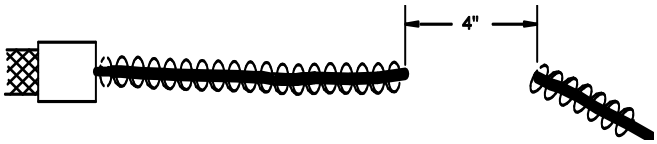
Step F Cut 5" off the exposed end of the sensing cable.

Step G Cut off 15"-18" of the outer jacket and tightly tape the edge of the outer jacket to the metal overbraid. (applies to TFH and jumper cables only.)

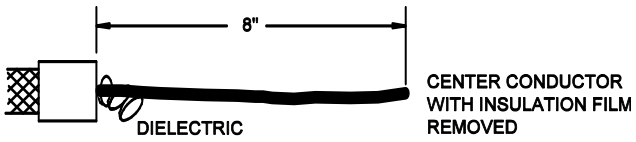
Step H Slide 12" of the metal overbraid back towards the taped jacket. Tape the metal overbraid in place.



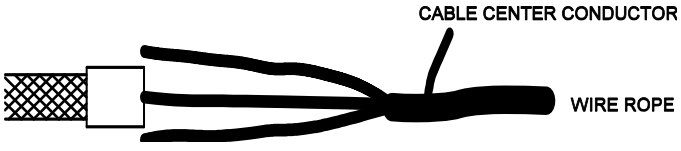
Step I Cut 4" off the end of the center conductor and conductor insulation.



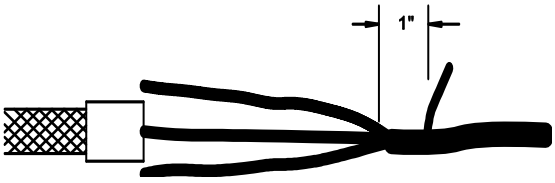
Step J Carefully remove 6"-8" of the dielectric spacer material and conductor insulation from the center conductor. Do not cut the center conductor strands when removing the thin film of insulation. Securely tape the end of the dielectric spacer to the center conductor.



Step K Insert 1" of the cable's center conductor into the throat of the wire rope.

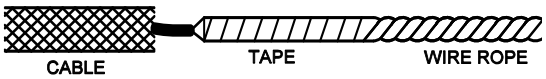


Step L Carefully braid 1" of the 3 and 4-strand sections of the wire rope.

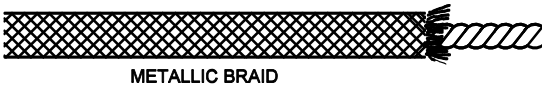


Step M Insert the center conductor of the cable into the next section of the Y throat of the wire rope. Continue to wrap and insert until approximately 5"-7" of the cable center conductor is woven into the wire rope. Tape the end of the wire rope with electrical tape. Cut off excess wire rope at the end of the splice if necessary.

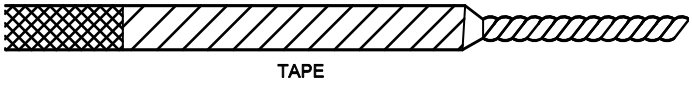
Step N Spirally tape the entire spliced wire rope/center conductor area tightly from front to end.



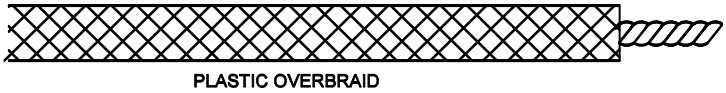
Step O Carefully slide the metallic braid over the woven splice area making sure the braid extends over the splice as much as possible, and is tight.



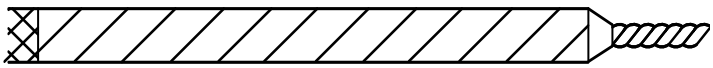
Step P Tightly tape the metallic overbraid in place, from the left end. Extend the tape just past the woven splice area. (Include 2”-3" of the white jacket if applicable.)



Step Q Carefully slide the plastic overbraid over the cable splice. Extended the plastic overbraid over the splice area as far as possible.



Step R Tightly tape the plastic overbraid in place, spirally, from the front end. Extend the tape just past the spliced area. The finished splice should be tapered in appearance.

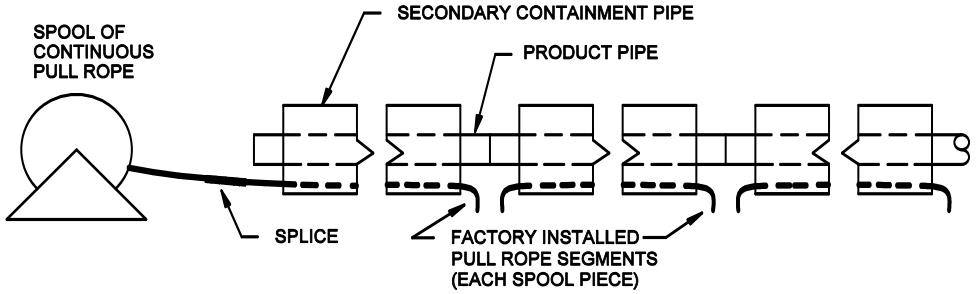


4.4 Installation of the Continuous Pull Rope

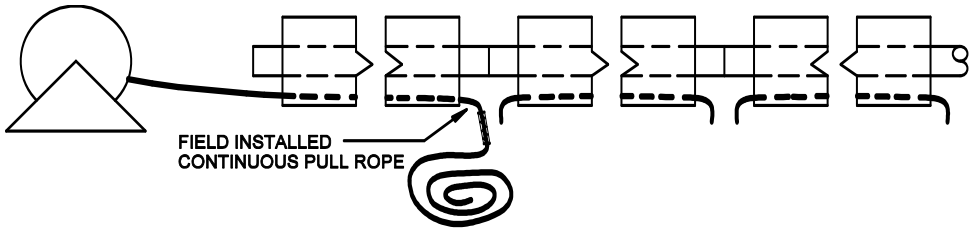
1. PermAlert recommends the installation of a continuous pull rope, free of splices between properly located and accessible pull points.
2. All sections of factory-prefabricated piping should be supplied with a factory-installed pull rope. The factory-installed ropes shall be used to pull the continuous pull rope into the air space before the secondary containment field joint closures are completed. Make sure that the factory installed pull rope moves freely in each section of conduit when laying the pipe in the trench.

3. Pulling the continuous pull rope into the air space of the secondary containment requires careful planning on the installer's part. Care must be taken during the installation of the pipe system to proceed in a manner that will maintain accessibility to the factory installed pull rope.
4. The installation of the continuous pull rope and the pipe system must proceed simultaneously. Working ahead on closing the pipe system joints may prevent the successful installation of the pull rope, necessitating the reopening of a joint(s). **Avoid allowing water, mud or other debris from entering the air space.** This can prevent successful cable pulling and a functional alarm system.
5. **Caution all workers involved in the pipe installation that the factory installed pull rope should never be "temporarily" removed in the expectation that it can be replaced later.** Losing the end of the pull rope and allowing it to fall back inside the secondary containment must be avoided. Special care must be taken at risers where the weight of the rope, in the vertical section of the pipe, tends to pull the rope into the secondary containment.

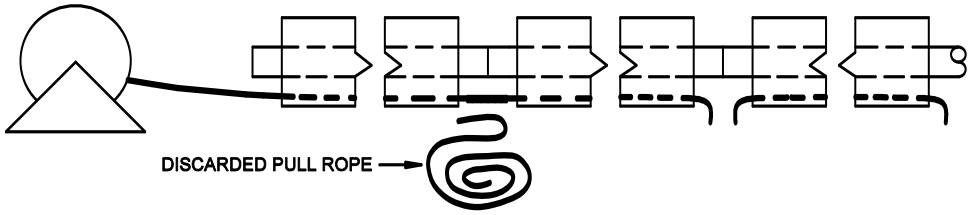
Step A Splice the continuous pull rope to the factory installed pull rope. Follow splicing procedures contained in the "Cable Splices" section.



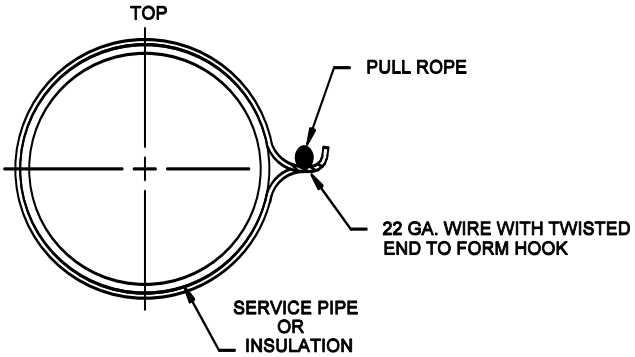
Step B Go to the first uncompleted secondary containment field joint and pull the continuous pull rope into the first section of piping until the splice exits the field joint.



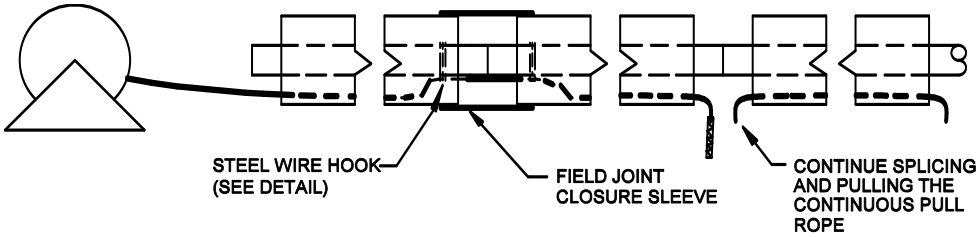
Step C Break the splice on the factory installed pull rope and discard the pull rope. Splice the continuous pull rope to the next section of factory pull rope, and pull the continuous pull rope into the next pipe



Step D Return to the first field joint. If the product pipes are insulated, apply insulation material. To prevent the continuous pull rope from being damaged during joining of the secondary containment, it must be held off the bottom of the containment. Attach the pull rope temporarily to the carrier pipe (insulation) by looping a piece of 22 gauge steel wire around the carrier pipe (insulation) and twisting the ends together to form a hook around the pull rope.



Step E The secondary containment field joint can now be made. After closing the field joint of the secondary containment, restrain the continuous pull rope at the spool end, and pull on the rope at the open field joint in order to pull the rope off the wire hook.



Step F Pull the continuous pull rope from the previously sealed joint to the next open field joint.

Step G Repeat the sequence of splicing, pulling and closing the field joints of the secondary containment until the continuous pull rope has been pulled through the entire piping run. Each time after completing 3 or 4 field closures, move the continuous pull rope back and forth in the containment to insure that the pull rope moves freely.

4.5 Installing the Sensor and Jumper Cables

1. After all other work is completed and the area is free and clear of all activities that can cause damage, the sensor cable should be installed. **Care must be taken during installation of sensor cable to avoid contact with potential contaminants such as water puddles or oil.**
2. PermAlert recommends installing the sensor cable before backfilling of underground secondary contained pipe systems.
3. **Keep the cable dry and clean.** Tent the spool area and do not install the sensor cable during a rainstorm.
4. Slowly play out the cable by hand rotating the spool. Never attempt pulling loose coils of cable off the end of the spool. When loose coils are pulled taut, kinks may form which could prevent bringing the system on-line.
5. **Always be careful to prevent the cable from falling into the secondary containment.** Be particularly careful at risers, where the weight of the cable in the vertical section of pipe tends to pull back the cable.
6. The bottom of a secondary containment that penetrates into a vault or building should be fitted with a minimum 1" threaded pipe coupling or similar fitting. This fitting will be located where the sensor cable enters (exits) the secondary contained piping system.
7. Check for dry air spaces of secondary containment at termination points of the piping system. Drain plugs in the pipe system should be provided for this purpose. If water is found, dry the system completely before attempting installation of the sensor cable.

8. Place the spool of sensor cable at the high end of the run. At this time, do not route the pull rope or cable through the junction box and conduit.
9. Splice the sensor cable to the continuous pull rope using the method described in Section 4.3, "Cable Splices".
10. At least 2 workers are required to pull sensor cable. Work should proceed continuously from pull point to pull point. At the lowest elevation between 2 pull points, one person should slowly pull on the pull rope. At the higher elevation pull point, the second person should carefully play out the cable while pushing it into the interstitial air space. This push/pull action significantly reduces the pulling force required to install the cable. If a problem does arise, the workmen must be able to quickly signal each other. Walkie-talkies are recommended so that communication can occur to prevent cable damage.
11. **The pulling force should never exceed 50 lb.** If a snag is encountered, carefully work the cable back and forth in an attempt to clear the cable. If the snag cannot be cleared, contact PermAlert's Field Service Department for assistance.
12. Where electrical conduit and junction boxes are required, use watertight NEMA 4X boxes and mount per the instructions contained in this guide. Temporarily pull enough sensor cable out of the secondary containment and into the junction box (approximately 2') to allow installation of cable connectors (see Figure 9). **Make sure the bushings and cord grips are slipped on the jumper cable before installing the cable connectors.** Attach the cable connectors, test them, and push the assemblies into the electrical conduits. Thread and tighten the cord grips making a watertight seal against the jumper cable. The conduit termination points must be sealed. **Do not leave conduit termination points open, or moisture may enter and wet the sensor cable.**
13. **If TFH cable is installed, the ends of the cable must be immediately sealed with the shrink tube caps supplied by PermAlert to prevent water from entering the cable.** Make sure the polyester overbraid is not under the shrink cap to insure a good seal. **If water is allowed to enter the ends of TFH cable it must be replaced**

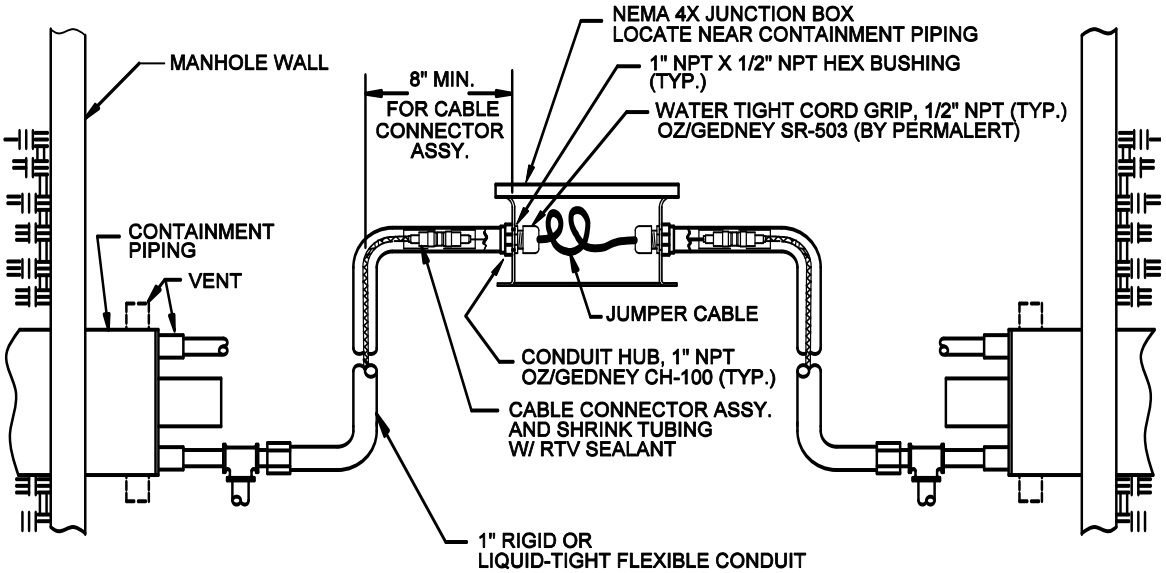


Figure 9
Cable Connections with Electrical Conduit and Junction Boxes

14. In contained pipe systems where branch runs and main runs are monitored, jumper cable can be used to return to the main from the branch. For these installations, PermAlert can furnish a cable routing drawing showing locations requiring the installation of sensor cable and jumper. Depending on the design of the secondary contained system and the free unobstructed air space available, both cables (sensor and jumper) may be installed in the secondary containment air space. This will

require simultaneously pulling both cables, and most likely will reduce the length of cables that can be pulled at one time. When 2 cables are installed in the same air space, both cables must be pulled out of the secondary containment through the threaded coupling and finally connected together with a cable connector in either: (1) a watertight capped pipe chamber connected to the threaded coupling, as shown in Figure 10 or (2) a NEMA 4X junction box. This type of termination should also be accessible to allow for future maintenance. As an alternative to pulling both cables into the air space of the secondary containment, jumper cable can be routed in electrical conduit. If connectors must be used, it is recommended that they be installed in accessible watertight NEMA 4X junction boxes located at grade.

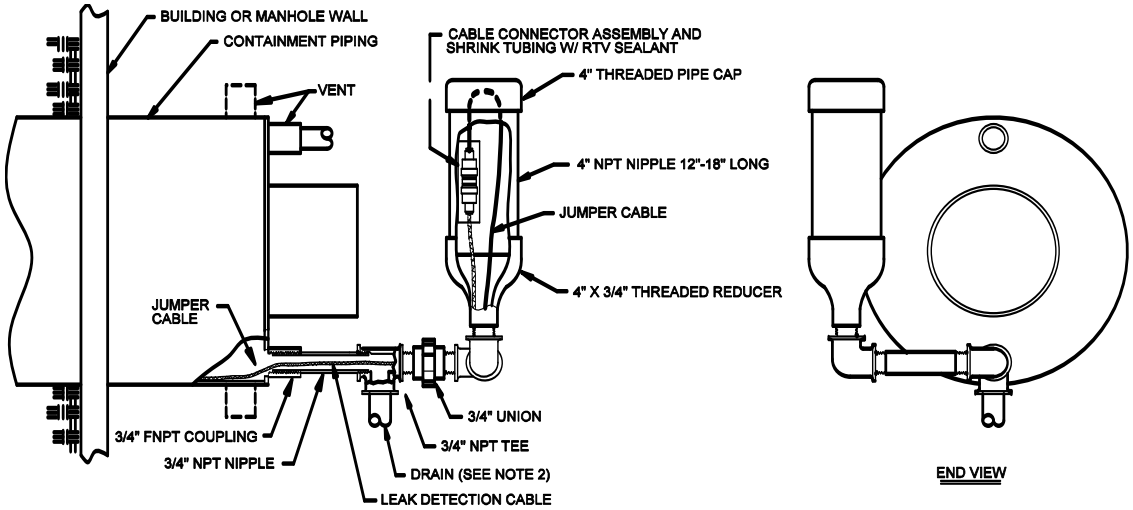


Figure 10
Branch Line Routing of Jumper Cable

15. At least 50' of jumper cable must be installed from the PAL-AT alarm unit before connection to sensor cable. Refer to Table 1 (see Section 3) for jumper that should be installed at the very end of a sensing string in an enclosure (see Figure 11). A cable connector must be attached to terminate the end of the jumper cable. Install the red plastic cap supplied with the PAL-AT, over the connector to keep it clean. The termination of the sensing string should be accessible for future maintenance.

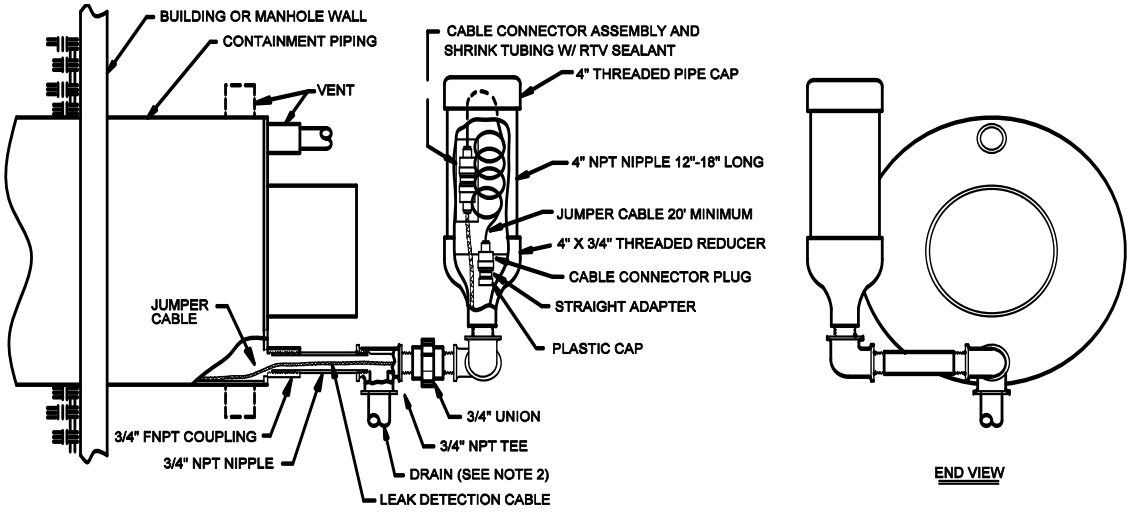


Figure 11
Termination of Sensing String

4.6 Cathodic Protection

When a metallic secondary containment is protected with cathodic protection, it is sometimes necessary to install Cathodic Blocking Packages manufactured by PermAlert. Cathodic Blocking Packages are only required when PWS water probes are installed. The package creates a discontinuity of the cathodic

protection D.C. current path. They should be installed to electrically isolate a water probe from the remainder of the sensing string.

PermAlert Cathodic Blocking Package includes a nonmetallic NEMA 4X junction box and one set of cable connector assemblies. To install it, mount the junction box and route jumper cable making cable connections as shown in Figure 12.

A maximum of 3 Cathodic Blocking Packages are allowed to meet specific UL and FM requirements. Refer to PAL-AT control drawing, Figure 4 in this manual.

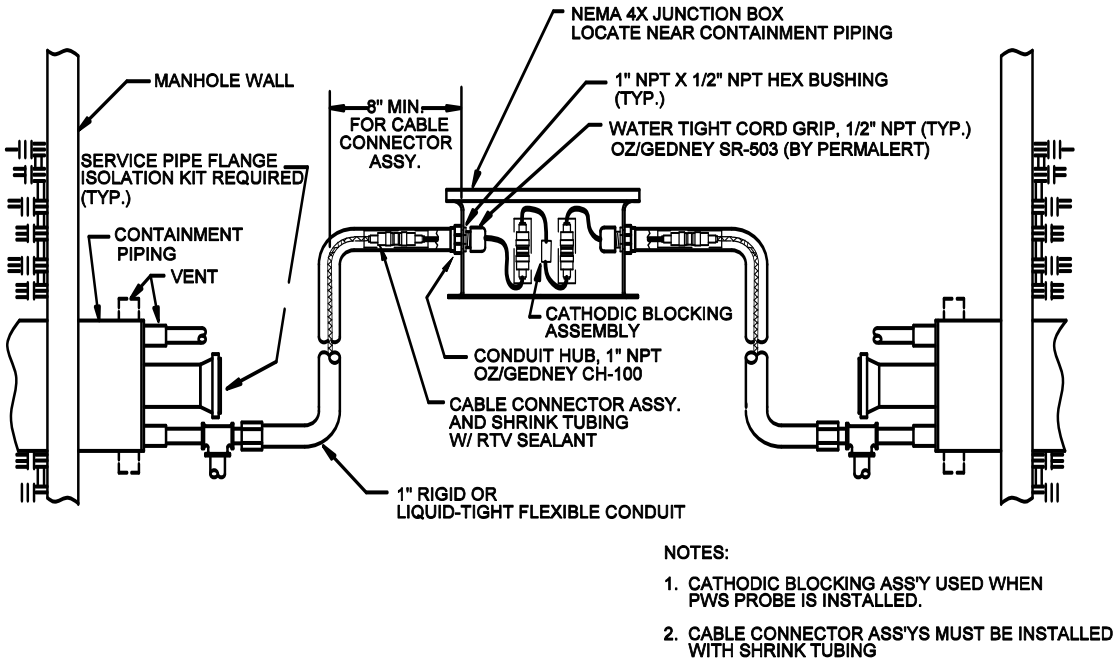


Figure 12
Cathodic Blocking Installation

4.7 Air Testing

1. Air testing of the secondary containment must be performed before backfilling.
2. All sensor cable termination chambers (see Figures 10 and 11) must be completely installed before applying the air test. Also, cap any open vents or drains. Care should be taken to prevent the pull rope or sensor cable from being blown back into the secondary containment.
3. Assemble required piping for air test and follow test procedure provided by the secondary containment piping manufacturer's installation guide.

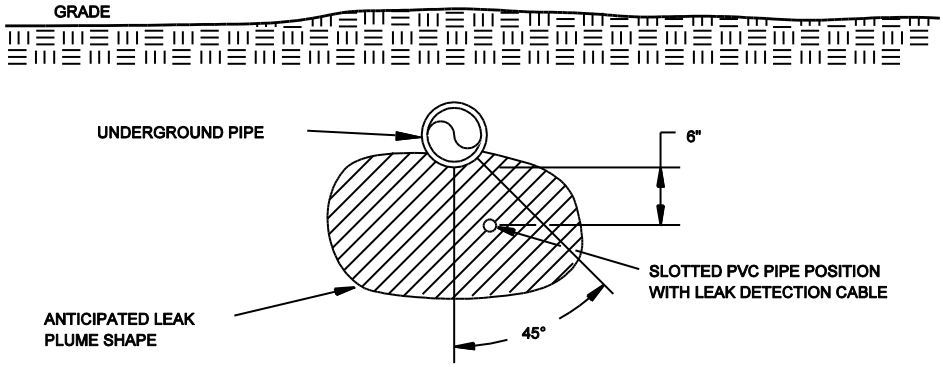
   CAUTION: THE COMPRESSED AIR SUPPLY MUST BE FREE OF WATER AND OIL.
4. After the air test has been completed, remove test piping and cap test ports on the secondary containment.

5 Installation of Direct Buried Sensor Cable

5.1 General

The following instructions and precautions are very important for the successful installation and operation of the PAL-AT system with direct buried sensor cable. These instructions do not cover every possible application but are intended as guidelines for the majority of applications. Remember, the sensor cable is a sensitive electrical cable that should not be crushed, stretched, kinked, cut or damaged. If you have any questions regarding the installation of the direct buried cables, contact PermAlert. Failure to follow these instructions may result in damage to the cables or its jacket and prevent or limit operation of the PAL-AT system.

1. TFH cable is constructed of materials that detect hydrocarbon liquids, but ignore the presence of water. Therefore, this unique sensor cable can be installed in wet soil environments while monitoring for the leakage of hydrocarbon liquids. This feature permits direct burial of TFH, in “screened” or slotted PVC pipe, for the monitoring of underground single wall piping and tanks. The maximum burial depth of TFH cables is 20'. This limitation is due to the fact that the jacket repels water to a maximum pressure of 8.7 psig. If the cable jacket is damaged, water may enter the cable and prevent or limit the operation of the PAL-AT system.
2. The location of the slotted pipe and hydrocarbon detection cable is determined by several variables. These variables include soil type, backfill material, product in the pipeline, water table, pipeline pressure and leak rate. Another consideration is if the installation is new or a retrofit of an existing pipeline.
3. The sensor cables must be located where the hydrocarbon liquids will collect and allow detection. For some applications the use of a closed synthetic liner, installed in the pipe trench, may be considered to facilitate the collection of hydrocarbon liquid for detection and reduce soil contamination. Normally one cable located in a slotted pipe adjacent to an underground pipe will provide satisfactory results. The slotted pipe may be located under the service pipe for a new installation. If the system is installed with an existing pipeline, the slotted pipe can be installed a few inches to the side of the pipeline to minimize the excavation cost.



4. If a synthetic liner is not installed under the slotted pipe, a compacted clay/silt base layer should be used under the pipe to minimize the vertical migration of a leak. The slotted pipe should be covered with backfill material of sand or soil.
5. It is recommended to have 12” inches of backfill installed and compacted with hand tampers above the slotted pipe before mechanical compactors are used, to prevent crushing the pipe.
6. During the storage and installation of the TFH cable, the ends of the cable must be protected to keep water from entering. The cable is shipped with shrink tube caps on the ends. Additional caps are supplied with TFH connectors to be installed on the cable temporarily until the connectors are

installed. The caps should be installed over the jacket, but under the outer plastic overbraid of the cable. The cable ends should not be immersed in water at any time, even with the shrink caps installed. After the connectors are installed, if there is any possibility of water contacting the connectors, they should be sealed with RTV and shrink tubing immediately. If the connector needs to be reopened later for calibration, slit open the outer shrink tubing. Replace it with a new shrink tube immediately after calibration.

7. The sensor cable must be protected from damage when it is in the trench before backfilling. The cable must be protected when pipes are being welded or other work is occurring nearby. The cable should not be stepped on.

8. All connectors of sensor cable must be located in junction boxes at or above grade. A vertical riser of PVC conduit or other material suitable for the project must be installed to provide protection to the cable through the backfill and into the junction box (see Figure 13). Follow the instructions for installing cable connectors using shrink tubing and RTV sealant to insure a watertight assembly.

   CAUTION: It is extremely important to prevent damage to the cable jacket. A damaged cable must be replaced.

5.2 Installing the Sensor Cable

1. After all other work is completed and the area is free and clear of all activities that can cause damage, the sensor cable should be installed. **Care must be taken during installation of sensor cable to avoid contact with potential contaminants such as oil, hydrocarbon liquid, soap or other material that may contain surfactants. Contamination by any of these liquids will destroy the water repellency of the cable and it will need to be replaced.**

2. When the construction schedule allows, the PAL-AT alarm unit should be permanently mounted and connected with electrical power before installing jumper or sensor cable. This will allow the system's setup and calibration procedures to proceed efficiently. For additional information on calibration points, refer to the "PAL-AT Operating Manual".

3. Slowly play out the cable by hand rotating the spool. Never pull loose coils of cable off the end of the spool. When loose coils are pulled taut, kinks form in the cable that could prevent bringing the system on-line. Protect open ends of the cable from damage, contaminants and moisture.

4. Starting from the unit, connect a minimum of 50' of jumper cable before connecting the sensor cable. Route the sensor cable as shown on the contract drawings. Refer to Table 1 (see Section 3) for amount of jumper cable to be connected to the end of the sensing string.

5. Make sure all cable ends are sealed with shrink tubing after installation.

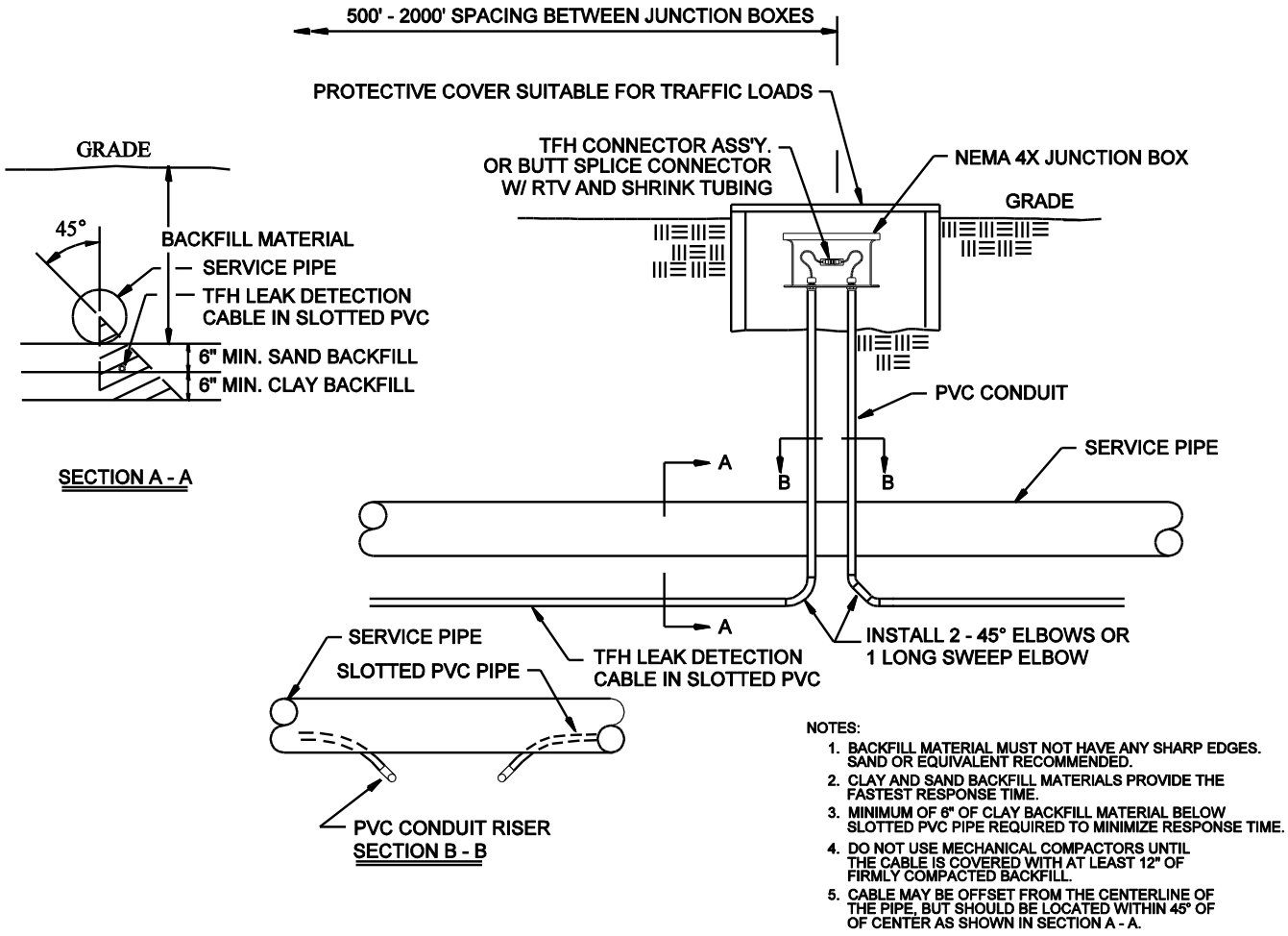


Figure 13
Direct Buried TFH Hydrocarbon Sensor Cables

5 Direct Buried Sensor Cable

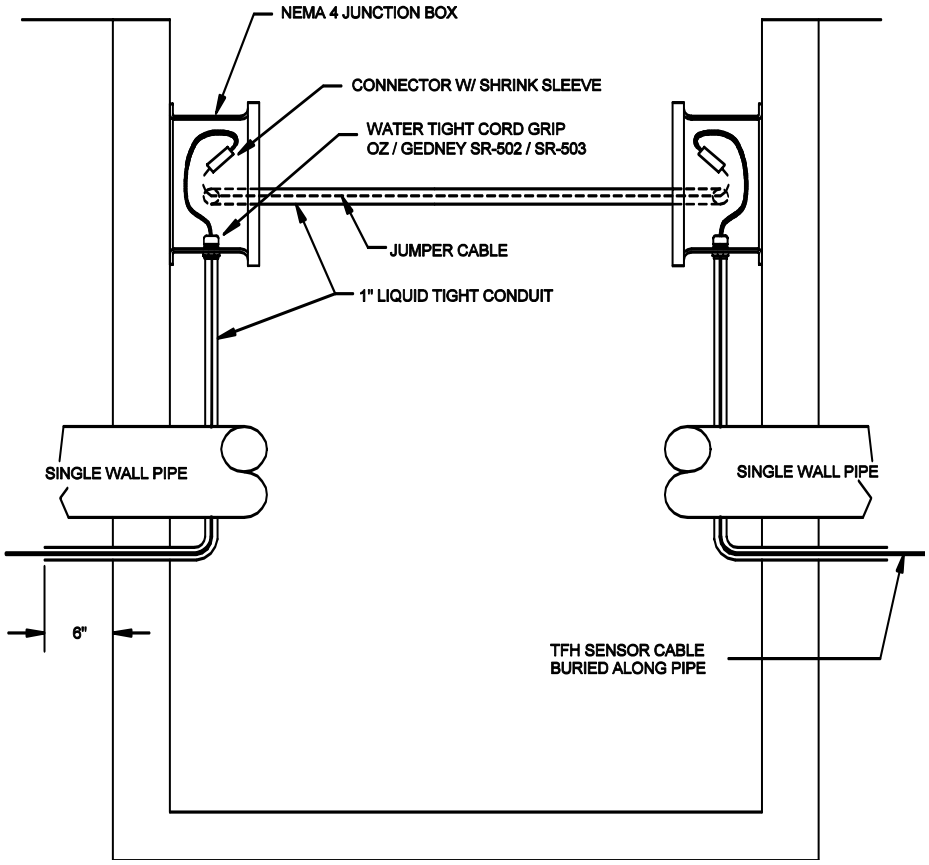


Figure 14
Hydrant Valve Pit / Manhole Penetration
Direct Buried Cable

5.3 Above Ground Storage Tanks

Above ground storage tanks can be monitored for leaks by installing TFH sensor cable in slotted PVC pipe under the bottom of the tank or around the perimeter. Figures 15 and 16 show two such applications. For specific applications contact PermAlert for assistance.

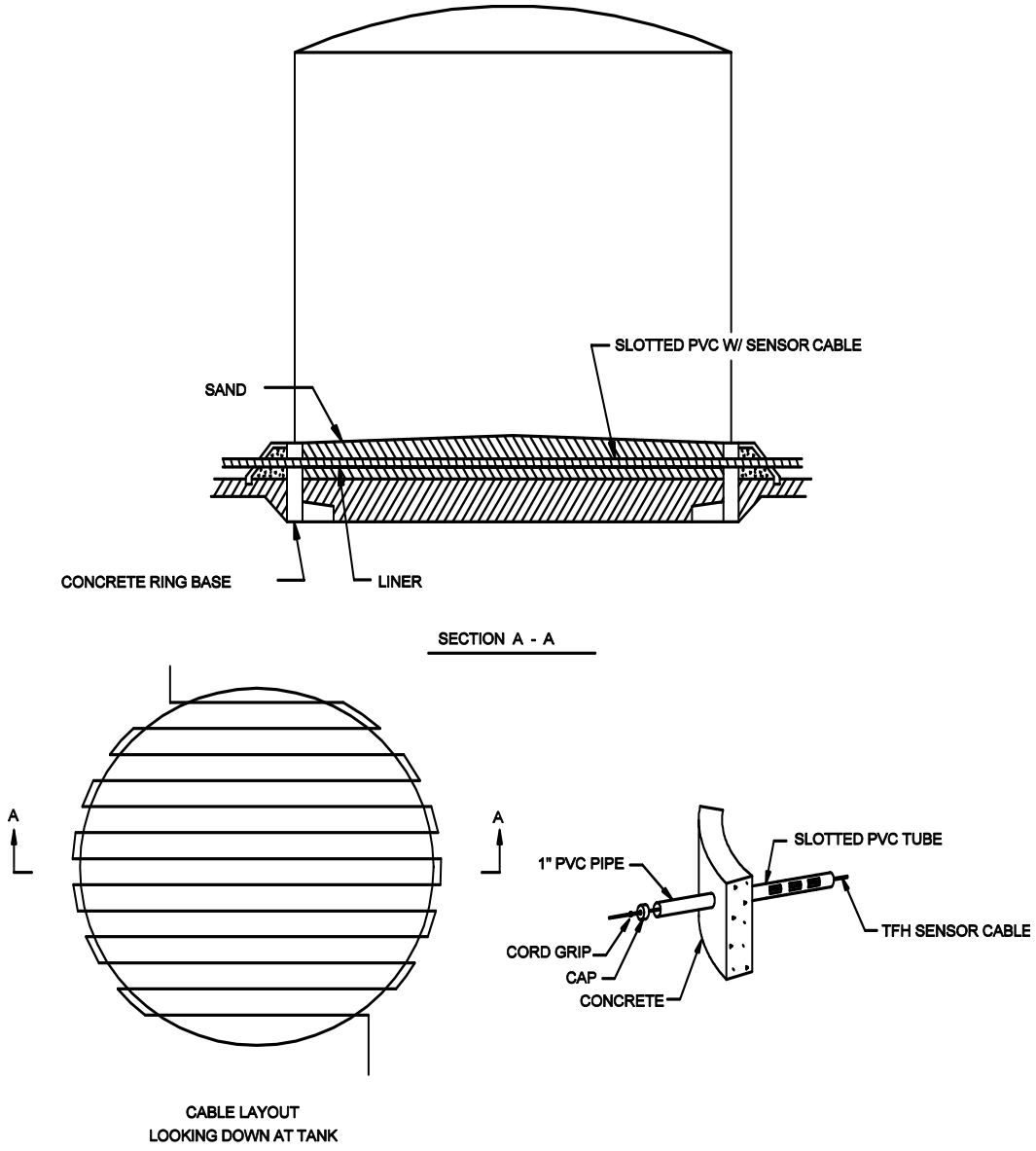


Figure 15
Double Bottom Above Ground Storage Tank

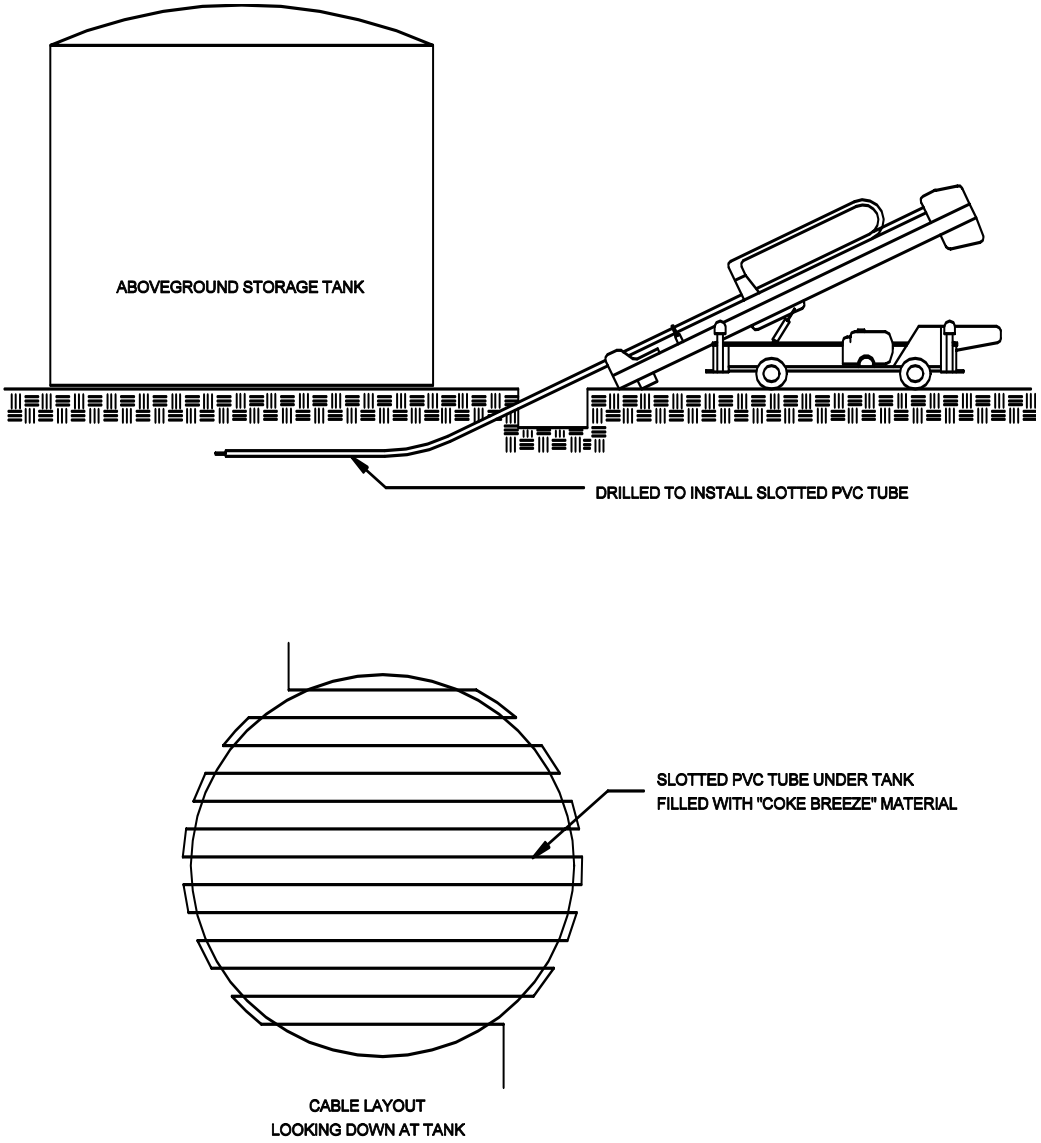


Figure 16
Above Ground Storage Tank Horizontal Drilling

6 Cable Installation for Raised Floor Areas

6.1 General

The PAL-AT sensor cables can be installed in ceilings or on subfloors below raised flooring to detect water, hydrocarbons, or chemical liquids. AGT-Gold responds quickly to thin films of liquid. AGW-Gold allows a small accumulation before detecting a leak and dries quickly after removal of the liquid.

The AGT-Gold sensor cable has a polypropylene yarn dielectric that is designed to readily absorb water to detect leaks on flat floor applications. It also absorbs moisture from the air if the air is saturated or near saturation. PermAlert recommends a maximum of 80% relative humidity, keeping in mind that the relative humidity will increase if the temperature of the air or a surface in the airflow decreases. In subfloor applications, care must be taken to make sure the cable is not located directly in the airflow where localized higher humidity or saturated air is present.

If the humidity level cannot be controlled and intermittent high humidity conditions exist, then the best option is to use the quick-drying AGW-Gold cable in place of the wicking AGT-Gold cable.

6.2 Install the Sensor Cable

1. After all other work is completed and the area is free and clear of all activities that can cause damage, the sensor cable should be installed. Care must be taken during installation of the sensor cable to avoid contact with potential contaminants, such as water puddles or oil.
2. When the construction schedule allows, the PAL-AT alarm unit should be permanently mounted and connected with electrical power before installing jumper or sensor cable. This will allow the system's setup and calibration procedures to proceed efficiently. For additional information on calibration points, refer to the "PAL-AT Operating Manual".
3. Slowly play out the cable by hand rotating the spool. Never pull loose coils of cable off the end of the spool. When loose coils are pulled taut, kinks form in the cable that could prevent bringing the system on-line. **Keep the cable dry and clean.**
4. Starting from the unit, connect a minimum of 50' of jumper cable before connecting the sensor cable. Route the sensor cable as shown on the contract drawings. Most designs require the sensor cable to be installed in a serpentine pattern of 4' centers. Normally, this method gives satisfactory protection and does not require the cable to be repositioned when equipment is moved at a later date. Typically, centers of 6’ through 12’ can be used if the facility has low risk (see Figure 17).
5. If the serpentine pattern cannot be adapted to the installation, an alternative is to isolate the potential leakage areas. Typically, this means running the sensor cable around the perimeter of the room and placing a run of cable under or near any water lines or drains in the room's interior. The sensor cable should be routed around air conditioning units and chillers so that an overflow from a plugged condensate tray must pass the sensor cable before it can reach power or data cables.
6. The sensor cable should not be routed directly in the airflow from an air-handling unit, especially if a humidifier is being used. In this case the unit may send out drops of water, which can collect in the cable and give an alarm for a minor puddle.

   This is more critical with AGT-Gold cable. The wicking nature of the cable will absorb the fine spray from the humidifier and cause an alarm. Typically, the cables should be 3' to 5' from the perimeter of the air units.
7. Refer to Table 1 (see Section 3) for amount of jumper cable to be connected to the end of the sensing string.
8. Cables are attached to the subfloors and ceilings with fasteners (cable mounts). Normally, cable mounts are spaced on 8' intervals along the sensor and jumper cable length. Additional cable mounts should be located adjacent to all changes in direction of the sensor cable.
9. Cable mounts (CMA) ordered from PermAlert are adhesive backed. When installations require mounting to unsealed concrete surfaces, it is recommended that adhesive construction mastic be used. Care must be taken to ensure that the mastic does not touch the sensor cable. This material

can be purchased from most supply houses. Inspect subfloor (or ceiling) surfaces to be sure it is clean and dry before beginning installation. Cable tags (CTA) are typically installed on 50' intervals for location purposes.

10. In high traffic areas, cable shields should be used to protect the cable from damage.
11. Service loops (slack cable) should be positioned at connector locations.

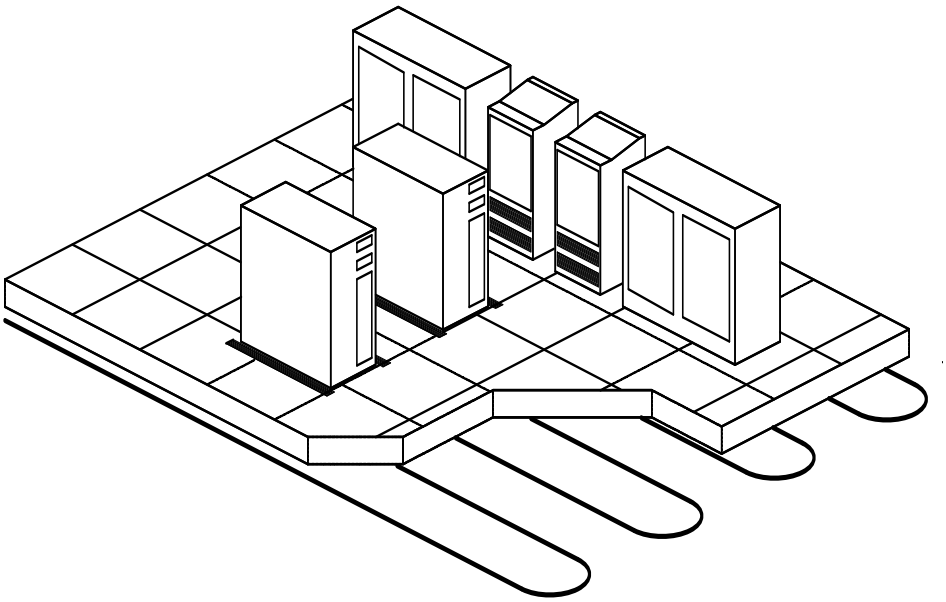


Figure 17
Computer Room Floor

6.3 Locator Chart

A graphic display map drawn to scale shall be prepared by the contractor (installer) after completion of installation from "as built" drawings. The map shall indicate, in relation to the raised floor grid, the location of the cable, connectors, and landmarks (such as equipment, walls, and drains). Cable distance readings shall be marked off in 100' (or other suitable) increments, beginning at the monitoring unit, to facilitate physically locating a leak detected by the system. The locator chart should be placed in a plastic frame suitable for permanent mounting adjacent to the monitoring unit.

7 Cable Connectors

7.1 General

This section outlines: (1) the installation procedures for several types of connectors; (2) the application of shrink tubing; and (3) the electrical testing of connectors and cable.

An instructional video for Cable Connector Installation is available from PermAlert.

7.2 Cable Connector Installation

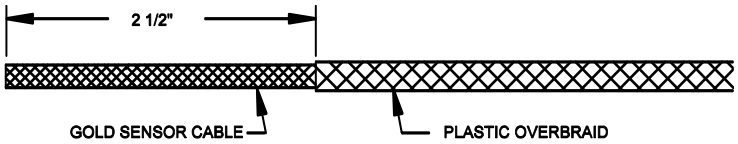
1. Cable connectors must be installed at changes of cable types, pull points, junction boxes, calibration points, and at the termination of the sensing string.
2. All the PAL-AT cables are coaxial construction consisting of an insulated center conductor and a braid shield. Jumper and TFH (hydrocarbon only) sensor cable have a polymer jacket over the shield. All sensor cables also have a polymer overbraid surrounding the cable.
3. **Crimp style connectors are required for all sensor cables and are strongly recommended for all jumper cables**.
4. **TFH sensor cable ends must be kept dry until the connectors are installed and encapsulated in shrink tubing. Connectors that will become calibration points during the commissioning of the system should not be installed before needed for commissioning if they can't be kept dry. Install the shrink tube caps that are included with the connectors on the end of the cables temporarily.**

7.2.1 CAGOLD and CATFHG Connectors for Sensor Cable Types AGW-Gold, AGT-Gold and TFH

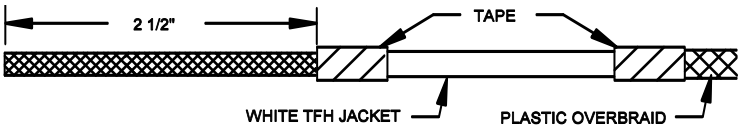
Crimp type cable connectors must be installed on AGW-Gold and AGT-Gold sensor cables and they are recommended for TFH cable. The CAGOLD connector assembly for AGW-Gold and AGT-Gold consists of 2 crimp-style UHF plugs, one UHF straight adapter and piece of shrink tubing. The CATFHG assembly for TFH includes the same connectors and 3 pieces of shrink tubing. Steps A thru I describe procedures that must be followed to install a connector.

Step A Measure and cut the required length of cable.

Step B Carefully cut and remove 2½" of the plastic overbraid. It may be helpful to slide the remaining overbraid back several inches and use electrical tape to hold it in place out of the way.



TFH cable has a white outer jacket under the overbraid. Remove 2 ½" of the white jacket.

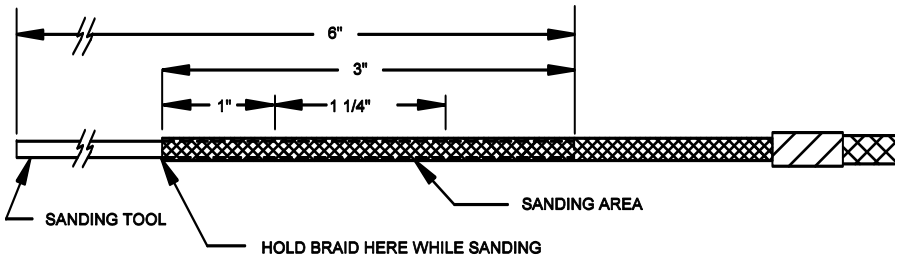


Step C Skip this step for TFH cable. A 6" long sanding tool (included with the purchase of a crimp tool) is inserted into the cable. The tool is a 6" length of stainless steel tubing.

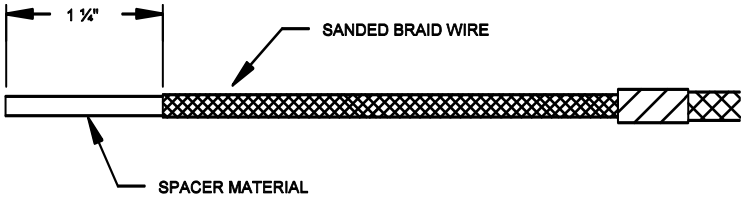
For AGW-Gold, insert the center conductor and 2 plastic spiral spacers into the end of the tubing. Then, as you slowly rotate the tube counterclockwise, gently push the tubing 3" into the cable underneath the braid wire.

For AGT-Gold, slide the braid wire back 2" and remove 1 7/8" of the yarn spacer. Then insert the sanding tool 3" over the center conductor and slide the braid wire back over the tubing.

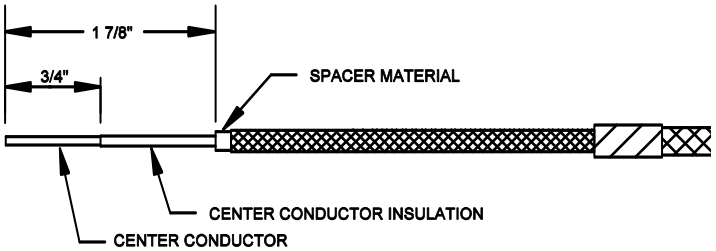
Hold the end of the braid in place against the sanding tool while you sand the 1¼" area as shown below. Rotate the cable slightly and repeat the sanding process until the entire circumference of the 1 ¼" section has been sanded. The gold-colored plastic coating on the braid strands does not have to be removed completely. However, the outer surface of the braid strands should have bare copper exposed around the entire circumference of the cable.



Step D Carefully cut and remove approximately 1¼" of braid (this should remove all the unsanded braid wire).

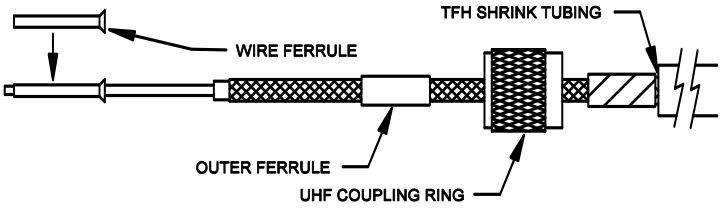


Step E For AGW-Gold and TFH cables only, slide the braid back an additional ¾" then remove 1 7/8" of spacer material (plastic spiral on AGW-Gold and white core on TFH). For all cables, remove ¾" of the thin film insulation from the center conductor.

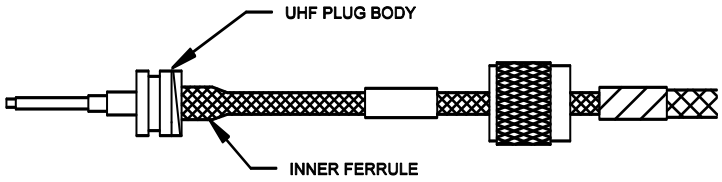


Step F For TFH only, slide one 4" piece of heavy wall shrink tubing over the end of the cable, and position it over the overbraid. For all cables, slide the UHF plug coupling ring onto the cable. Then slide the outer crimp ferrule onto the cable.

The center conductor can either be soldered or crimped to the connector. If the conductor will be crimped, a ¾" long, #16 AWG wire ferrule should be installed. If the wire ferrule is slightly crushed, the conductor will not slide in easily. If this happens, push the ferrule onto a standard 3d finish nail to correct the problem. Slide the ferrule over the conductor until it stops at the center conductor insulation. Make sure all the strands go through the ferrule and extend out of the end.

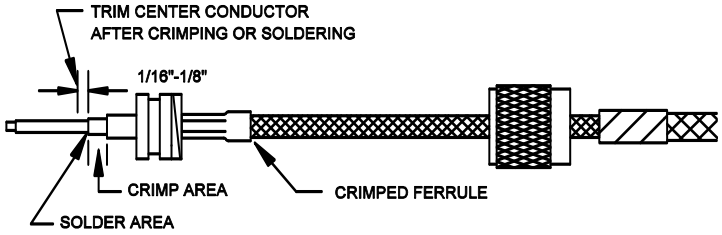


Step G Slide the UHF plug body over the cable center conductor. Be sure all the strands of the center conductor or the wire ferrule slide completely through the center contact of the plug. At the same time, slide the braid over the inner ferrule to the UHF plug body.



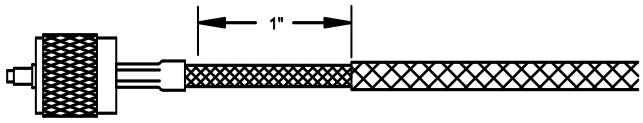
Step H Slide the outer ferrule over the braid and up against the UHF plug body. **Caution: Once the crimp tool (PermAlert Part No. 8068301) starts to close, it must be closed completely before it will open again.** Position the crimp tool (0.255" die) carefully around the outer ferrule and crimp it.

If the center conductor is to be crimped, crimp the end of the center contact as shown using a 0.100" die. Leave a 1/16" to 1/8" gap from the end of the plug and trim the excess center conductor and ferrule.



Otherwise solder the center conductor to the UHF plug center contact with rosin core solder. **Do not use acid core solder.** Hold the soldering iron on the center conductor at the end of the center contact to avoid getting solder on the larger diameter section of the contact. Heat the contact and wire sufficiently and then solder the wire securely to the center contact.

Step I Slide the plastic overbraid as close to the UHF plug body as possible to remove any slack. Trim it so there is approximately a 1” gap between the end of the overbraid and the end of the ferrule.



Test all connections as described in the "Cable and Connector Testing Procedures" section. Each end of the cable in the stage shown above will be fastened together by using one UHF straight adapter. All cable connectors should be encapsulated with RTV sealant and shrink tubing.

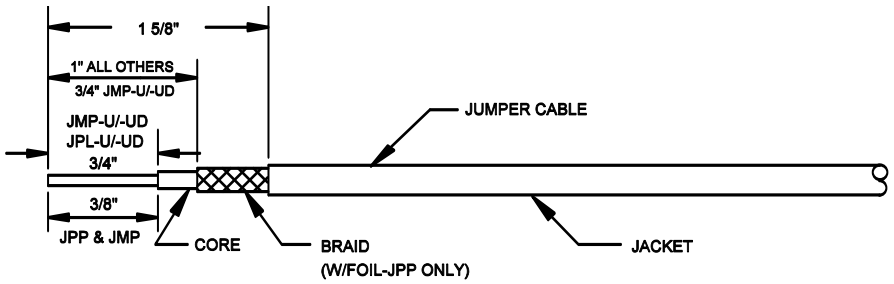
7.2.2 CAGOLD / CAJPL Connector for Jumper Cable Types JMP-U/-UD, JPL-U/-UD, JPP and JMP

Crimp type cable connectors are recommended for JMP-U, JMP-UD, JPL-U, JPL-UD, JPP, and JMP jumper cables. The CAJPL connector assembly for JMP-U/-UD and JPL-U/-UD consists of two-crimp style UHF plugs and one UHF straight adapter. It also includes 2 pieces of shrink tubing and spiral cable wrap for JMP-U/-UD. The CAGOLD assembly, described in the previous section, is recommended for JPP and JMP jumper cables. Steps A thru H describe procedures that must be followed to install a connector.

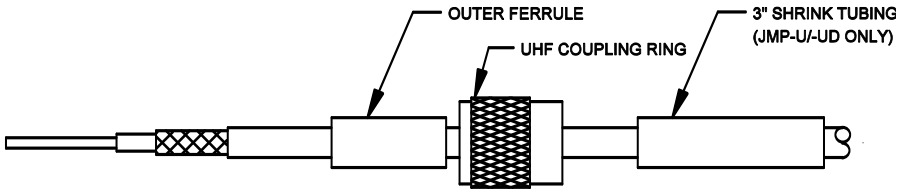
Step A Measure and cut the required length of cable.

Step B Carefully cut and remove 1 5/8" of the outer jacket, 1" of the braid (3/4" for JMP-U/-UD) and ¾" of the plastic dielectric core (3/8" for JPP and JMP). JMP-U and JPL-U have a sticky water-blocking material on the braid. To make handling it easier, keep your fingers and tools damp.

JPP has a foil wrapped between the braid and the core. Slide the braid back to the jacket and remove 1½" of the foil. This will prevent a short inside the connector. The foil is slightly bonded to the core. It may be necessary to carefully slice the foil with a sharp knife to make it easier to peel off. **Be very careful not to slice the core underneath the foil.**

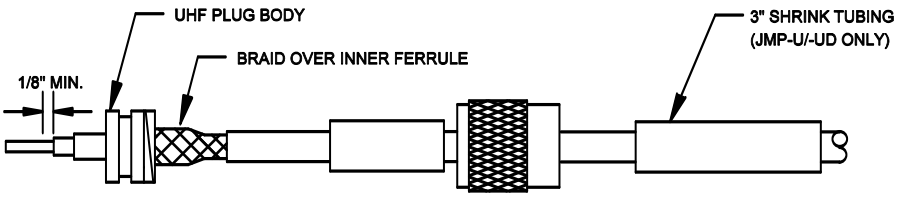


Step C For JMP-U/-UD only, slide the 3" piece of shrink tubing onto the cable. For all cables, slide the UHF coupling ring on the cable. Then slide the outer ferrule onto the cable.



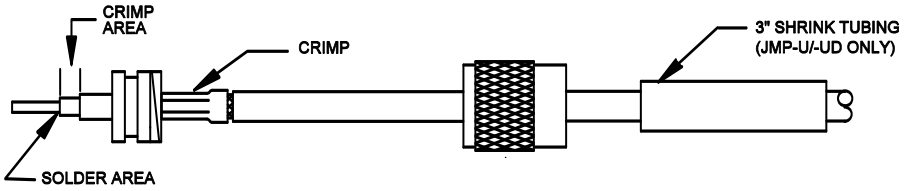
Step D Slide the UHF plug body over the cable center conductor. Be sure all the strands of the center conductor slide completely through the center contact of the plug. At the same time, the plastic core should fit inside the inner ferrule of the plug body and the braid should go over the outside of the inner ferrule. When the cable is inserted properly, at least 1/8" of the center conductor will extend past the end of the UHF plug body and the plastic core will be tight against the plug body inside the inner ferrule.

Note: Before installing JMP-U/-UD, flair the braid wire I.D. slightly with a small 1/8" slotted screwdriver so the braid will slide over the inner ferrule. Be careful to not unbraid the wire. **The wire must be braided, i.e. 2 strands thick over the inner ferrule, to be the correct thickness for a good crimp**.



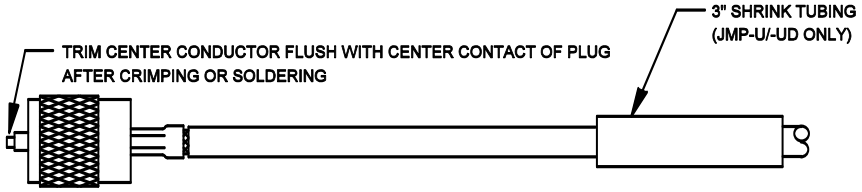
Step E Slide the outer ferrule over the braid and up to the UHF plug body. **The center conductor should extend at least 1/8" past the end of the connector**. **Caution: Once the crimp tool (PermAlert Part No. 8068300) starts to close, it must be closed completely before it can be opened again**. Position the crimp tool (0.427" die for JPL-U/-UD or JMP-U/-UD, 0.255" die for JPP or JMP) carefully around the outer ferrule and crimp it.

The center conductor of JPL-U/-UD cable can be crimped or soldered in the connector. **The center conductor of JMP-U/-UD, JPP, or JMP cable must be soldered.**

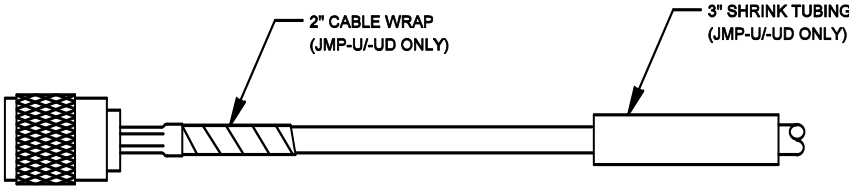


If the center conductor is to be crimped, crimp the end of center contact as shown using a 0.100" die. Otherwise solder the center conductor to the UHF plug center contact with rosin core solder. **Do not use acid core solder.** Hold the soldering iron on the center conductor at the end of the center contact to avoid getting solder on the larger diameter section of the contact. Heat the contact and wire sufficiently and then solder the wire securely to the center contact.

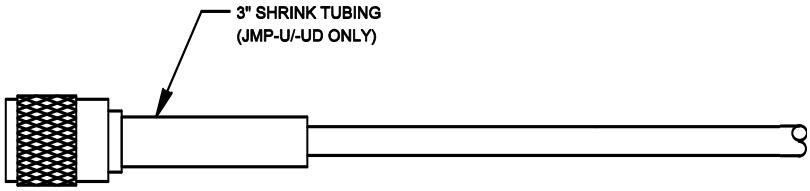
Step F Trim any center conductor that extends out of the center contact of the plug. Thread the UHF coupling ring onto the UHF plug body.



Step G **JMP-U/-UD only:** Place a 2" piece of plastic cable wrap around the cable jacket and slide it under the uncrimped end of the outer ferrule as far as possible.



Step H **JMP-U/-UD only:** Slide the 3" piece of shrink tubing over the crimped outer ferrule until it completely covers the ferrule. Make sure the shrink tubing doesn't slide onto the plug body. Heat the shrink tubing with a heat gun until it has fully shrunk and adhesive oozes out the end. Let the assembly cool before handling.



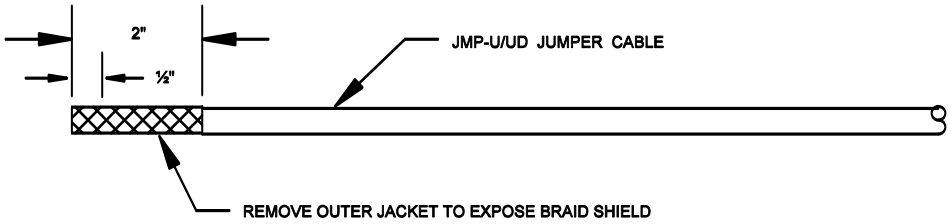
Test all connections as described in the "Cable and Connector Testing Procedures" section. Each end of the cable in the stage shown above will be fastened together by using one UHF straight adapter. All cable connectors should be encapsulated with RTV sealant and shrink tubing.

7.2.3 CASTD Connector for Jumper Cable Types JMP-U and JMP-UD - Alternate

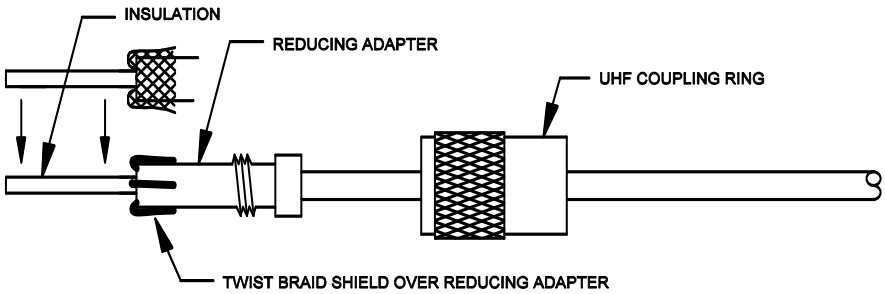
Each CASTD connector assembly consists of 2 reducing adapters, 2 UHF plugs and 1UHF straight adapter. Steps A thru F describe procedures that must be followed to install this non-crimp connector.

Step A Measure and cut the required length of cable.

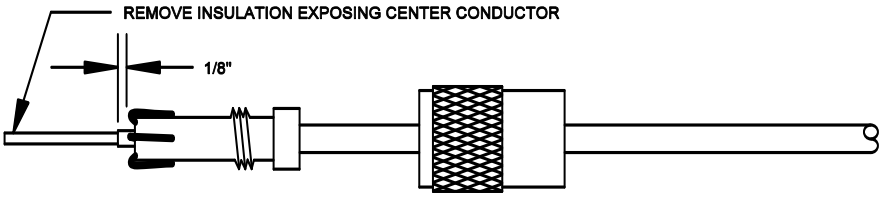
Step B Carefully cut and remove approximately 2" of the jacket to expose the braid shield. Then remove ½" of the braid. The JMP-U braid has a sticky material on it. To make handling it easier, keep your fingers and tools damp. Jumper cable that will be connected to TFH cable must also have a 4" long piece of shrink tubing installed. The shrink tubing will be used to provide a watertight seal after final connector assembly (see Section 7.3, "Shrink Tubing" in this manual).



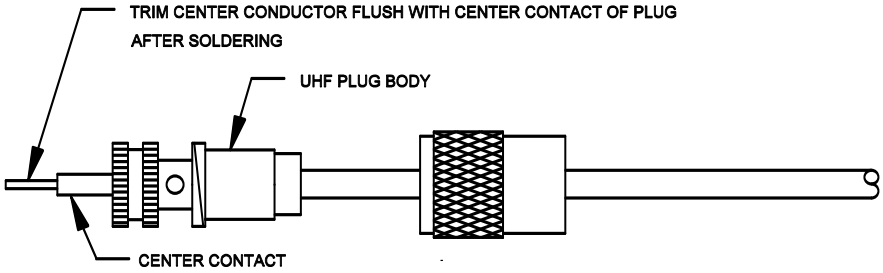
Step C Slide the UHF coupling ring onto the cable. Then slide the reducing adapter onto the end of the cable. Unbraid the braid wire to the reducing adapter and twist it into 4 equal “pigtails”. Fold the pigtails over the reducing adapter. Slide the reducing adapter toward the end of the cable so the pigtails are bent over the end of the adapter. Trim off any braiding that extends over the threaded section of the adapter.



Step D Trim off the insulation, surrounding and in contact with the center conductor, so that it extends 1/8" past the end of the adapter and braid.

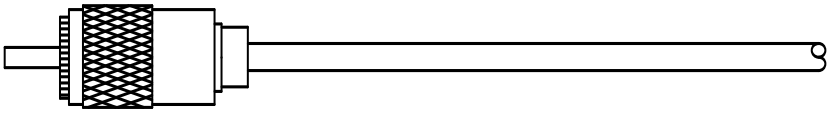


Step E Slide the UHF plug body over the cable center conductor and screw it onto the reducing adapter while holding the adapter and cable stationary. Be sure the strands of the center conductor slide completely through the center contact of the plug. **Use 2 pairs of pliers and tighten the reducing adapter to the UHF plug body, being careful not to overtighten.** Hold the connector and gently pull and twist on the cable to make sure the braid is clamped securely before soldering. Redo if there is any movement of the braid wire. Solder the center conductor to the connector's center contact with rosin-core solder. **Do not use acid core solder**. Make sure there is no solder on the outer surface of the center contact. Trim any excess center conductor that extends out of the center contact of the plug.



Step F Assemble the UHF coupling ring over the UHF plug body. If the cable has an overbraid, remove the temporary tape, slide the overbraid to the connector, and retape it.

Each end of the cable in the stage shown above will be fastened together by threading one UHF straight adapter into the male plug assembly. Test all connections using the "Cable Testing Procedures" in Section 7.4 of this manual.

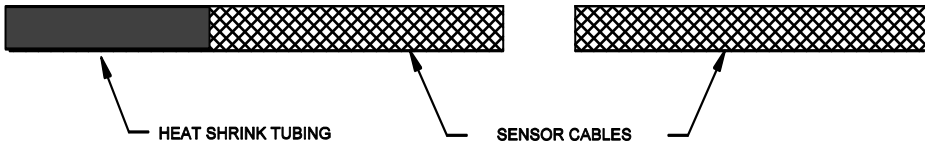


7.2.4 Butt Splice Connector for TFH Cable

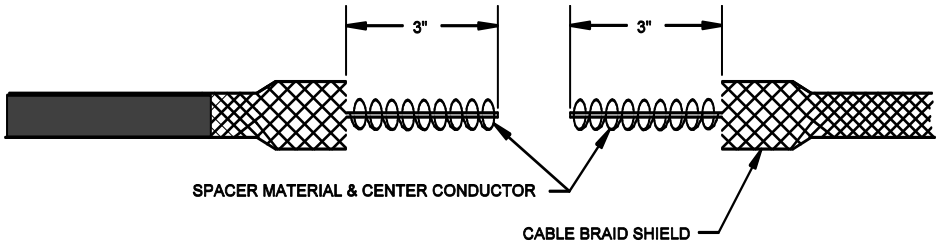
Butt splice cable connectors can be used with TFH cable when the cable is not "pullable" and the connector is not a calibration point. In some applications, it is used to prevent water from traveling into the connector and creating a short. **The cable MUST NOT be pulled after connectors are installed.** Each connector assembly consists of: 1 butt splice, 1 piece of 3:1 heat shrink tubing and 1 tie wrap. Steps A thru J describe the procedures that must be followed to install a connector.

Step A Measure and cut the required length of cable.

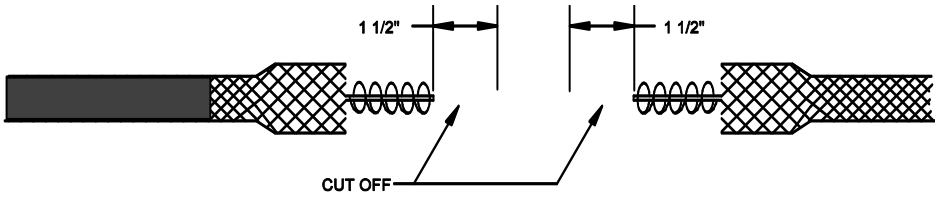
Step B Slide the heat shrink tubing onto the sensor cable. Keep the heat shrink tubing at least 6" from the end of the sensor cable. Slide the overbraid and jacket back several inches.



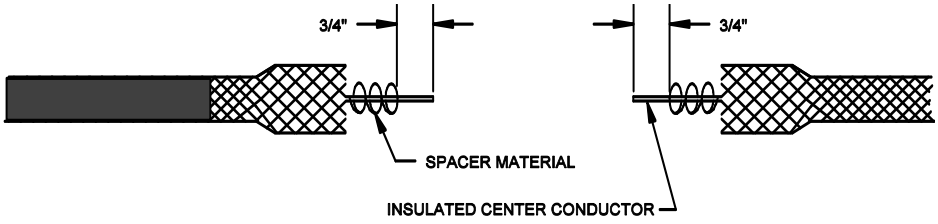
Step C Pull the cable braid back approximately 3" from the end of each sensor cable. This will cause the braid to flair out slightly and expose the spacer material and the center conductor.



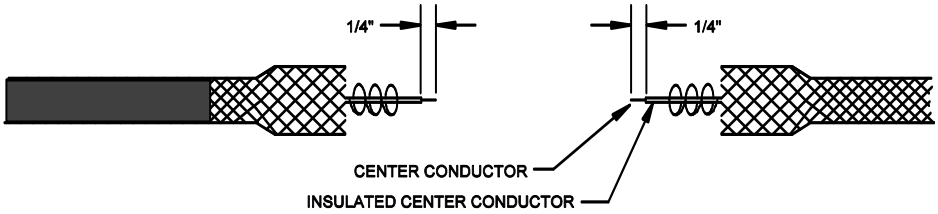
Step D Cut approximately 1½" of the exposed spacer material and center conductor.



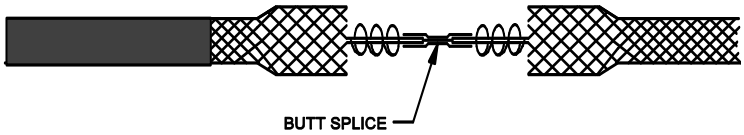
Step E Cut an additional ¾" of the exposed spacer material. **(DO NOT nick the insulation on the center conductor when the spacer material is removed.)**

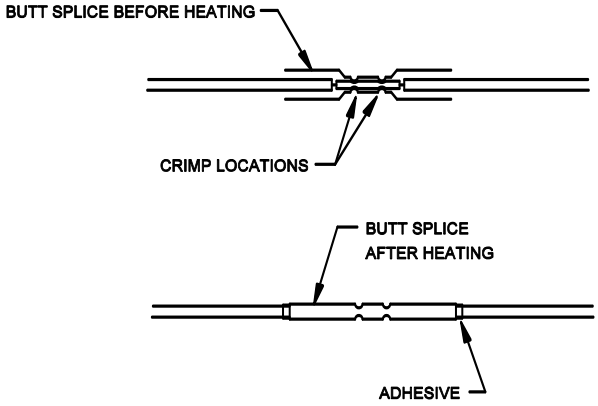


Step F Remove approximately ¼" of insulation from the center conductor.

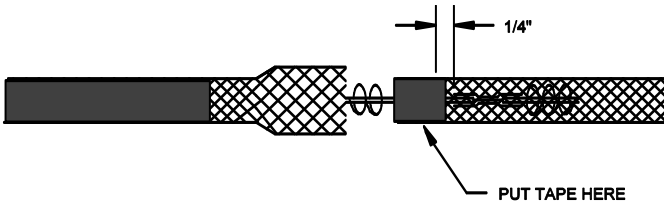


Step G Slide the 2 center conductors into the butt splice. Make sure the conductor is fully inserted into the splice. The insulation on the center conductors must be undamaged to the crimp portion of the butt splice. Crimp the 2 center conductors in the splice. Heat the butt splice's shrink tubing until adhesive starts to flow from the end of the tubing. (Note: Make sure that the piece of 3:1 heat shrink tubing is not heated at this time.)

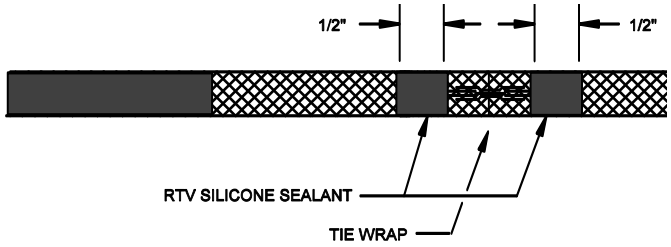




Step H Slide the braid from one side over the butt splice. The end of the braid MUST BE at least ¼" past the end of the butt splice. Use a small amount of electrical tape to tape the end of the braid to the spacer material and center conductor. (Make sure the tape IS NOT over the butt splice.)

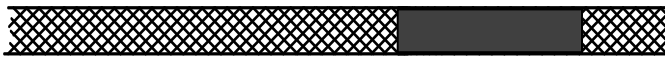


Step I Slide the braid from the other side over the butt splice. Fasten the tie wrap securely over the middle of the butt splice and cut off the excess tie wrap. Put a bead of RTV Silicone Sealant (part # 8047640) approximately ½" from both ends of the butt splice.



Step J Slide the outer jacket to the RTV and smooth out the wrinkles. Center the heat shrink tubing over the butt splice. Shrink the tubing in place.

Test all connections using the "Cable and Connector Testing Procedures".

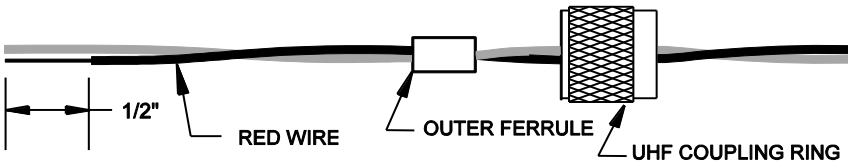


7.2.5 CAGOLD Connector for ATP Cable

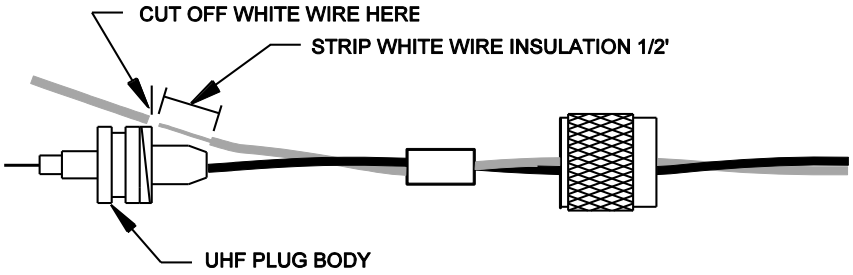
The CAGOLD cable connector should be installed on ATP cable to connect ATP to the jumper cable at the start of a run. It also can be used at a calibration point instead of the permanent crimp connector to have a reconnectable connector. Steps A thru G describe the procedures that must be followed to install a connector.

Step A Make sure the red and white wires are twisted with an approximate 2"–3" pitch and then cut off excess ATP cable. Slide the UHF coupling ring onto the cable, followed by the outer ferrule.

Step B Remove ½" of the insulation on the red wire.

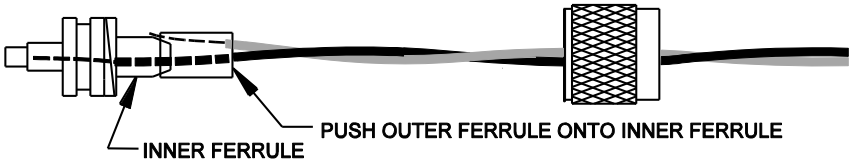


Step C As a measuring guide, slide the plug body onto the red wire until it stops against the wire insulation. The wire should extend out of the center contact. Cut the white wire even with the shoulder of the plug body. Remove the plug body and strip ½" of the insulation from the white wire.

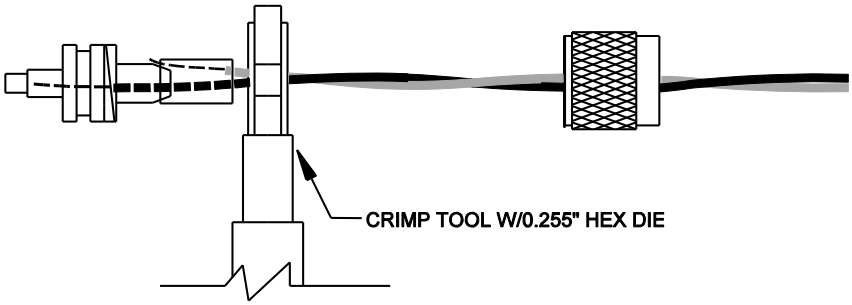


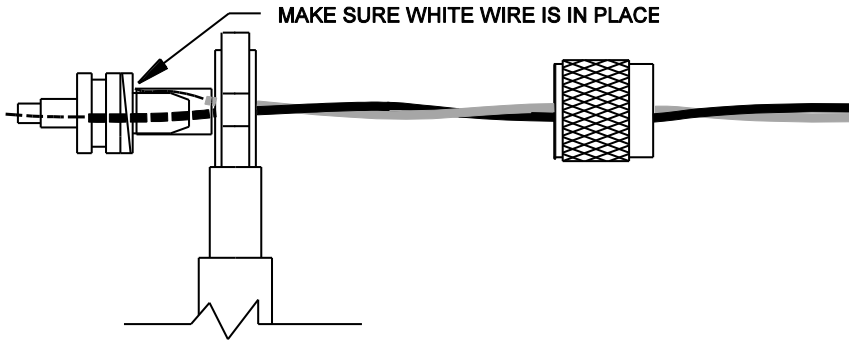
Step D Slide the plug body on the red wire again until the white wire is just past the tapered end of the inner ferrule. Then slide the outer ferrule over the end of the inner ferrule and the white wire until

it is a snug fit.



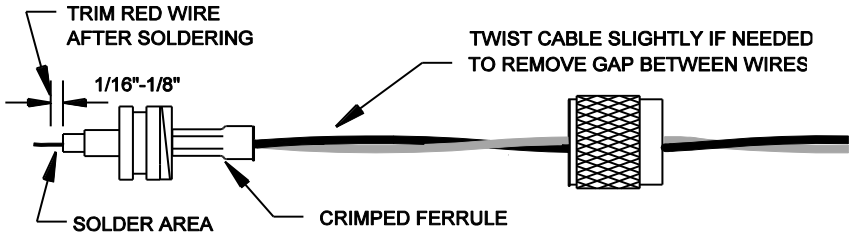
Step E Next, take the crimp tool and clamp the 0.255" die around the twisted wires behind the outer ferrule. Be careful not to pinch the wires. They should slide freely through the die. Then push the plug body toward the crimp tool to force the outer ferrule and white wire to slide over the inner ferrule until they are tight against the plug shoulder as shown in the second view.





Step F Use the 0.255" hex die and crimp the outer ferrule.

Step G Solder the center conductor to the UHF plug center contact with **rosin core solder**. **Do not use acid core solder.** Hold the soldering iron on the center conductor at the end of the center contact to avoid getting solder on the larger diameter section of the contact. Heat the contact and wire sufficiently and then solder the wire securely to the center contact. Trim the excess center wire. Slide the coupling ring to the plug body and thread it onto the body. If there are any gaps between the red and white wires, twist the connector slightly until the gaps are gone.

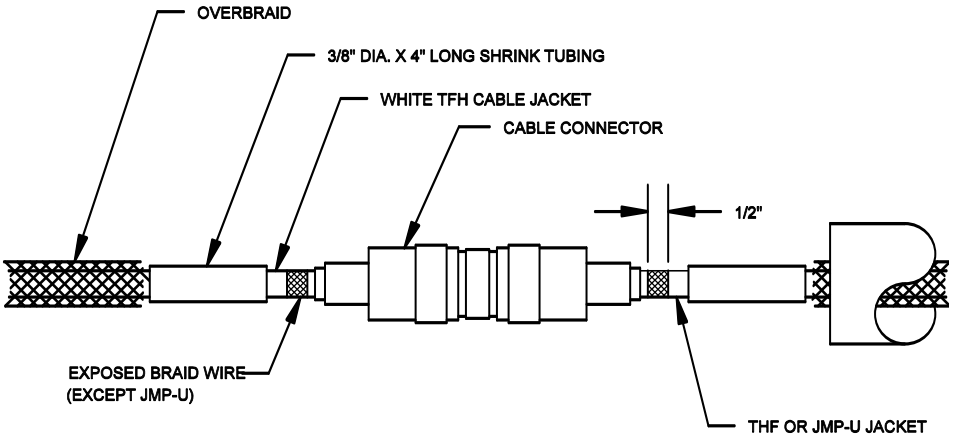


7.3 Shrink Tubing

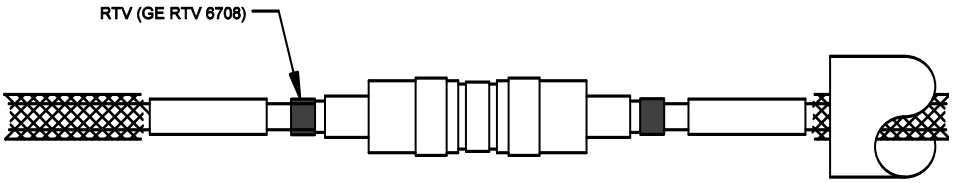
7.3.1 Cable Type TFH

1. **The TFH cable connector assemblies must be encapsulated in watertight shrink tubing.** Test connectors according to the "Cable and Connector Testing Procedures" before heating the shrink tubing. **Connectors that are calibration points must be kept dry until the system has been commissioned. After commissioning, the shrink tubing should be installed. If water is allowed to enter the end of the cable and get under the jacket, the cable must be replaced**.
2. Install the shrink tubing in accordance with the following steps:

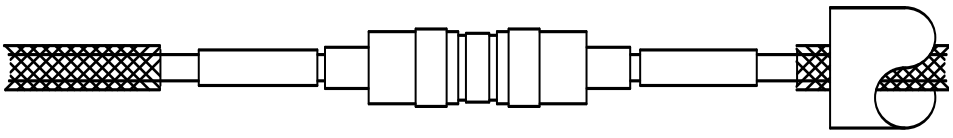
Step A Slide the overbraid and cable jacket back from the reducing adapter, to expose ½" of braid wire. Smooth the excess cable jacket away from the connector, so there is at least 5" of smooth surface adjacent to the connector. If the sensor cable is being connected to a jumper cable, skip steps A and B for jumper cable.



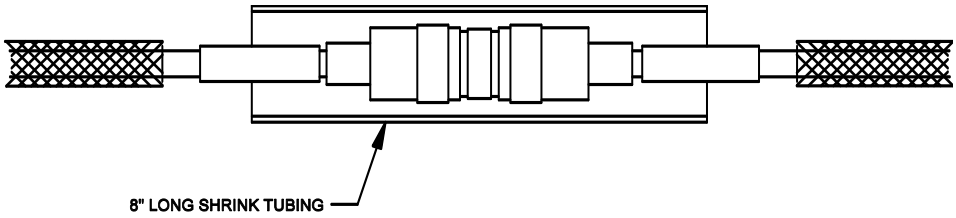
Step B Place a 1/4" bead of RTV sealant around the cable on the exposed braid wire.



Step C Slide the 4" long shrink tubing to the reducing adapter, if the CASTD connector is used. Make sure there are no wrinkles in the cable jacket. Make sure the shrink tubing does not overlap the reducing adapter. Slide the shrink tubing over the outer crimp ferrule to the back of the connector body if the CAGOLD crimp style connector is used. Heat the shrink tubing with a heat gun until it has fully shrunk and adhesive oozes out the end. Do not disturb the assembly until the shrink tubing has cooled (approximately 5-10 minutes).



Step D After both cable ends have been sealed with the 4” shrink tubing, recheck that the connectors are tightened securely. Test the connector according to the "Cable and Connector Testing Procedures". Then slide and center the 8" shrink tubing over the connector and heat it until it is fully shrunk and adhesive oozes out the ends.



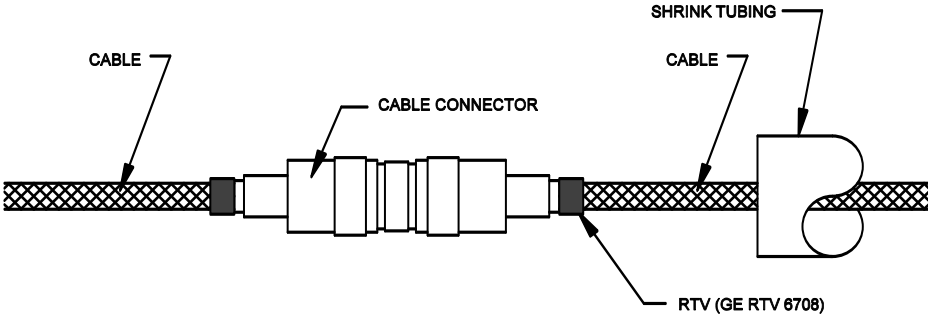
Step E Slide the overbraid to the connector and tape in place with electrical tape.

7.3.2 Cable Types AGT-Gold and AGW-Gold

All cable connectors installed in inaccessible locations or locations subject to frequent leaks or corrosive environments should be encapsulated with shrink tubing. Connectors that will be used for calibration points should not be sealed until the system has been brought online unless they may be exposed to water before start-up.

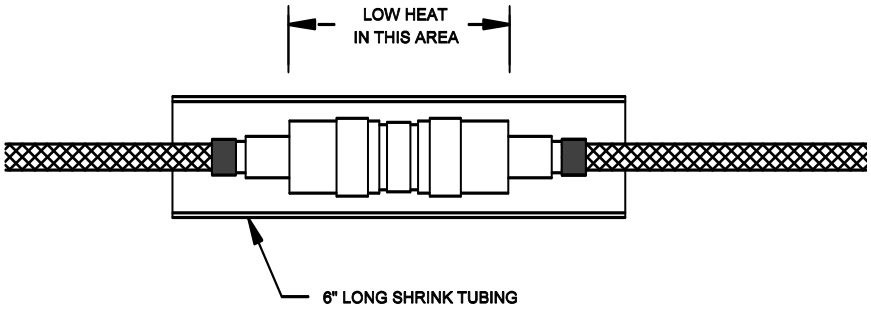
Step A Install connectors and test them following the "Cable and Connector Testing Procedures" in this manual.

Step B Slide a 6" piece of shrink tubing on the cable and tighten the connector assembly securely.



Apply a ¼" bead of **noncorrosive type RTV** completely around the cable next to the end of each of the connectors.

Step C Center the shrink tubing over the connector. Carefully heat the tubing, slightly, over the center of the connector. **Caution: If the shrink tubing is overheated in the center area, it will tear as it tries to shrink to the size of the cable. Next heat the remainder of the tubing. Do not heat the tubing any longer than required to shrink the tubing around the cable.**



7.4 Cable and Connector Testing Procedures

7.4.1 General

The following tests should be performed on each length of cable after both connectors are installed. Figure 18 illustrates the tests. Any overbraid or outer jacket is not shown.

7.4.2 Continuity Test

The continuity test checks for broken cable, open connectors, and poor solder connections.

1. Connect a short jumper wire with alligator clips between the UHF connector's center contact and the body of the connector at one end of the cable, as shown in Figure 18. **Note: Do not clip onto the threaded coupling ring because it is not tightly secured and will give intermittent readings**.
2. Connect the ohmmeter's test leads to the connector's center contact and connector body on the other end of the cable.
3. The ohmmeter reading should be less than 10 ohms/1000' of cable. If it is not, check the jumper wire, test lead connections, and repeat the test. If the problem persists, contact the PermAlert Field Service Department for assistance.

7.4.3 Insulation Test

The insulation test checks for a short between the center conductor and outer braid shield.

1. Remove the jumper wire used in the continuity test, as shown in Figure 18 and connect one ohmmeter test lead to the connector's center contact and the other lead to the connector body.
2. A good cable will give a full-scale reading (at least 10 megohms). Test readings below full scale indicate damaged cable or an improperly installed connector. If you cannot resolve the problem, contact PermAlert's Field Service Department for assistance.

7.4.4 Alternative System Test

1. Connect the entire cable string to the PAL-AT panel.
2. Make sure the panel is turned off and the cable card is installed.
3. Measure the resistance at the far end of the cable string. Connect one test lead to the center contact of the last connector and the other lead to the connector body. It should measure less than 60 ohms + 10 ohms/1000' of cable string.

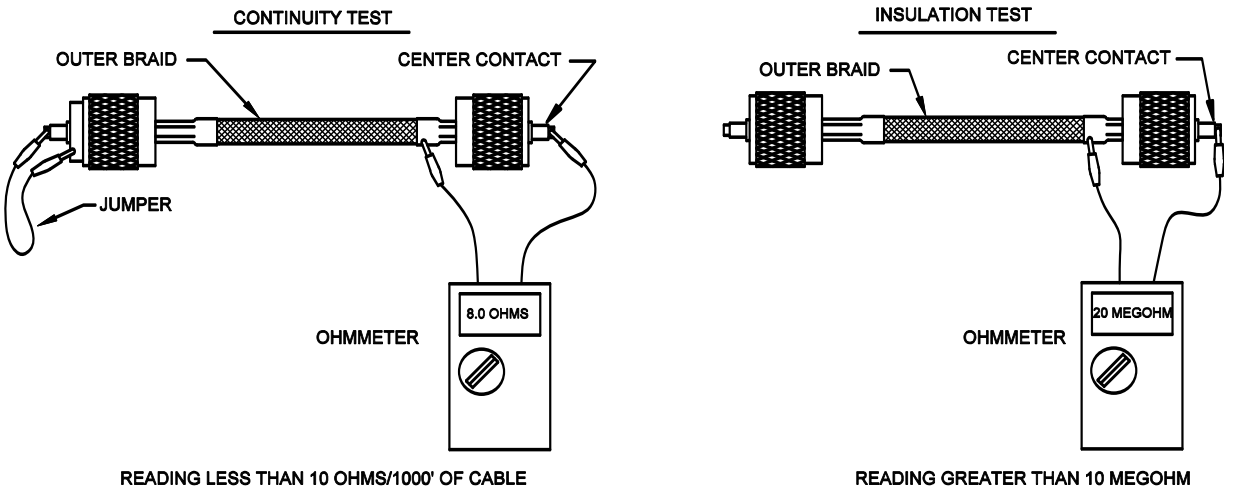


Figure 18
Cable Test Procedures

8 Probes

8.1 UL and FMRC Requirements

The PAL-AT is UL listed and FMRC approved. It provides intrinsically safe output circuits for use in Class 1, Division 1, Group C & D hazardous locations when used with probes listed below and installed in accordance with the instructions in this manual.

The probe configurations are:

1. PHL Solid State Hydrocarbon Sensor for Liquids, with PT10 Probe Integrator.
2. All PermAlert supplied probes and float switches, with PT10 Probe Integrator, which operate as a simple dry contact switch closure.
3. A PermAlert PT10 Probe Integrator connected to a customer supplied switch, if the switch operates as a simple dry contact closure with no external power supplied to the switch. The switch may operate as normally open or normally closed.

8.2 Probe Integrator Selection

All probe integrators have a red or blue band(s) of shrink tubing on the 6" length of probe twin lead cable. A probe integrator with a red band(s) is used with PHLR, PSTV, PFS and PTHL probe or a normally closed switch. A probe integrator with a blue band(s) is used with the PWS probe or a normally open switch.

The number of bands on the probe integrator indicates where it can be used in the sensing string. One band (-S model) indicates the probe integrator must be connected to the system in the first 5,000' of sensing string. Two bands (-L model) indicate that the probe integrator must be connected to the sensing string beyond 5,000'.

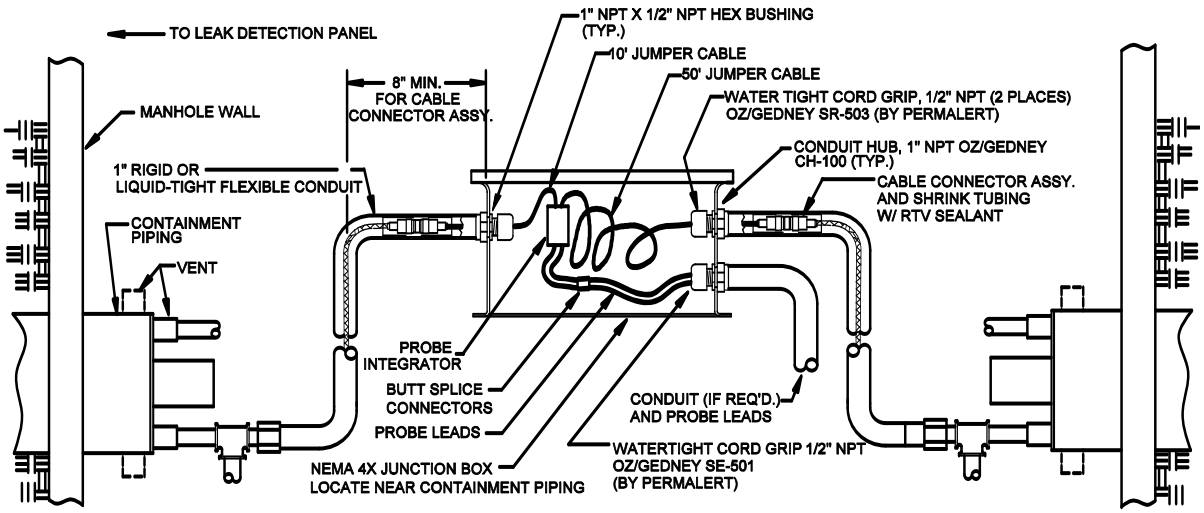
8.3 Probe Installation

1. All PAL-AT probes are furnished with a probe integrator and 60' of JMP-U jumper cable in a NEMA 4X junction box. The probe integrator allows the attachment of probes to the PAL-AT monitoring system. The standard 10" x 8" x 4" junction box can house 1 integrator. A 12" x 10" x 4" NEMA 4X junction box is recommended if 2 probe integrators are located in one box.
2. Mount the probe integrator junction box at a location close to the point being monitored. PermAlert supplies probes with 20' of twin lead cable. Uncoil the twin lead cable. **Do not splice on additional wire to lengthen the leads.** If the probe integrator is located in a manhole or pit, which may collect and hold water, mount the junction box as high as possible.
3. Figures 19 and 20 show the recommended installation procedures. Figures 21 thru 25 show typical probe installations. Install the probe and use electrical conduit and/or watertight cord grips, as necessary, to prevent water entry where the probe twin lead penetrates the monitored area. If the probe leads length is longer than 5' and the probe is installed in the first 800' of a system, plastic conduit should be used instead of metal conduit. The cord grip (part # 8057950) with the oval opening in the bushing is used with the twin lead cable. The cord grip (part # 8057954) with the round hole is for the jumper cable.
4. Once a probe is installed, the twin lead should be routed to the junction box containing the probe integrator. **Trim the excess length of the probe twin lead before splicing it to the probe integrator.** Splice the leads by using the crimp connectors supplied with the probe. Heat the splice with a heat gun to seal the adhesive-lined shrink tubing on the connector. Additional jumper cable is required after a probe that is installed past 3000' on the cable string (see Table 2 in Section 3).
5. Use all 60' of jumper cable furnished with the probe integrator. **If the jumper cable leads are too long, do not shorten,** but loosen the watertight cord grips and coil the excess jumper cable within the probe junction box. One jumper cable length is shorter than the other. Connect the shorter end (10') to the cable segment closest to the alarm/locator unit. The longer length of jumper cable (50') can be routed to the connection point for the continuation of the sensing string. If the probe location is at the end of the sensing string, terminate the longer length of jumper cable with a cable connector and store it within the junction box. If a probe is the end of a sensing string, refer to Table 1 (Section 3) for length of jumper cable needed to connect to the end of the probe.

6. Additional jumper cable may be connected on either side of the probe integrator to facilitate connection of remote sensing string components.
7. Refer to the "Cable Connector Installation" section of this manual and install a connector on each length of jumper cable. Test all connectors using the "Cable and Connector Testing Procedures".
8. Cable connections to jumper cable from the probe integrators will become calibration points and must be accessible during system start-up.
9. The PHL probe cannot be exposed to water for long periods of time. Continued exposure will damage the probe and it will no longer respond to hydrocarbons**.** The probe should be installed in normally dry locations. It will be available for a limited time for those applications which require the smaller, 5/8" diameter.

   The PHLR series probe replaces the PHL and is strongly recommended for all applications, including those where the probe is exposed to water frequently.

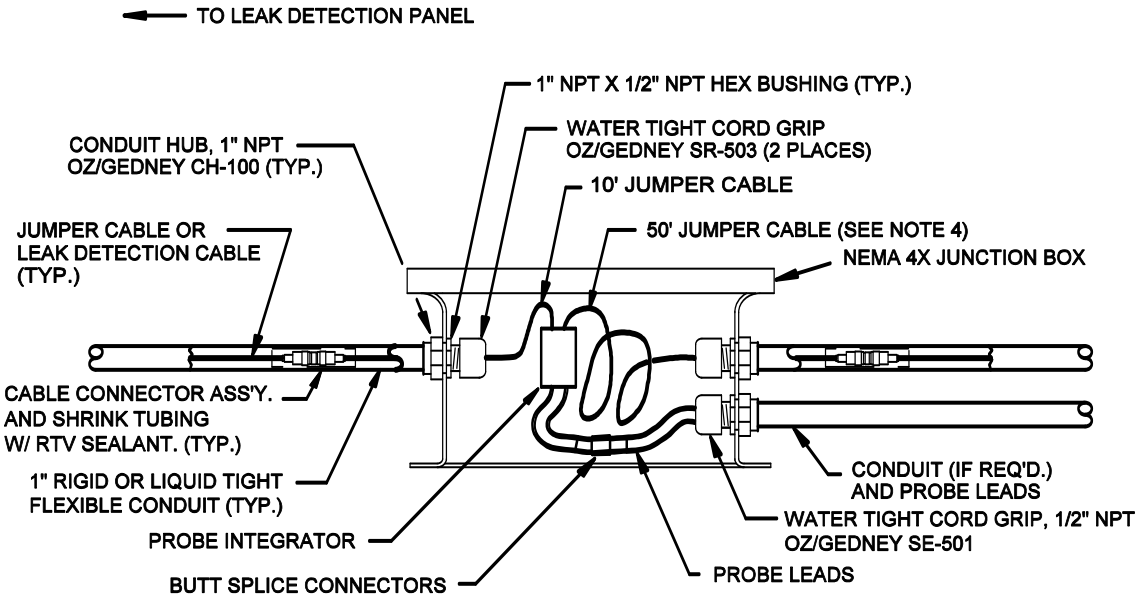
   WARNING: If a hydrocarbon probe is submerged in water, a hydrocarbon spill may float on the surface of the water and not contact the sensor.
10. The maximum number of probes per cable string is 10. A maximum of 3 probes installed past 5000' is allowed.



NOTES:

1. WATERTIGHT CORD GRIPS, CONDUIT HUBS AND CONDUIT ARE RECOMMENDED
2. THE 10' AND 50' JUMPER CABLE CONNECTED TO THE PROBE INTEGRATOR MUST NOT BE SHORTENED. COIL EXCESS WITHIN NEMA 4X JUNCTION BOX.
3. 50' LENGTH OF JUMPER CABLE ATTACHED TO THE PROBE INTEGRATOR MUST BE DOWNSTREAM OF THE PROBE INTEGRATOR AWAY FROM THE PAL-AT PANEL
4. CONDUIT SHOULD BE USED TO PROTECT THE PROBE LEADS IN APPLICATIONS WHERE DAMAGE MAY OCCURE
5. MARK UNPROTECTED PROBE LEADS WITH CABLE TAG, PART NUMBER 8057661.
6. ALLOW SLACK ON SENSOR CABLES TO INSTALL CONNECTORS.

Figure 19
Typical Probe Connection in Monitored Areas



NOTES:

1. ALLOW SLACK IN LEAK DETECTION CABLE TO INSTALL AND SERVICE CONNECTOR
2. PIPE AND CONDUIT FITTINGS SUPPLIED BY INSTALLER.
3. THE 10' AND 50' JUMPER CABLE CONNECTED TO THE PROBE INTEGRATOR MUST NOT BE SHORTENED. COIL EXCESS WITHIN NEMA 4X JUNCTION BOX.
4. 50' LENGTH OF JUMPER CABLE ATTACHED TO THE PROBE INTEGRATOR MUST BE DOWNSTREAM OF THE PROBE INTEGRATOR AWAY FROM THE PAL-AT PANEL
5. CONDUIT SHOULD BE USED TO PROTECT THE PROBE LEADS IN APPLICATIONS WHERE DAMAGE MAY OCCURE
6. MARK UNPROTECTED PROBE LEADS WITH CABLE TAG, PART NUMBER 8057661.

Figure 20
Typical Conduit Connection Detail

8.4 PHLR Hydrocarbon Probe

The PHLR series is a reusable hydrocarbon probe that detects hydrocarbon liquids in sumps, interstitial spaces of pipes and any other areas where hydrocarbon liquids can accumulate to a depth of ¼". The probe is designed to detect fuels (gasoline, diesel fuel, jet fuel, crude oil, etc.) and many hydrocarbon

solvents. The probe is reusable by cleaning or replacing the sensor elements. There are 2 models of the PHLR probe available:

- The standard PHLR is designed for non-pressurized locations such as sumps, manholes, and non-pressurized containments. The PHLR can be installed in any orientation – vertical or horizontal.
- The PHLR-P is designed for pressurized containment applications. This model is ideal for typical sealed, containment piping systems which are maintained under pressure with a nitrogen or air blanket. The PHLR-P should be installed in a vertical orientation. **The PHLR-P has vent holes that must not be submerged in a liquid before the containment is pressurized** (see Figure 22).

An extension to the probe housing can easily be added with standard ¾" Schedule 40 PVC pipe to accommodate installation requirements.

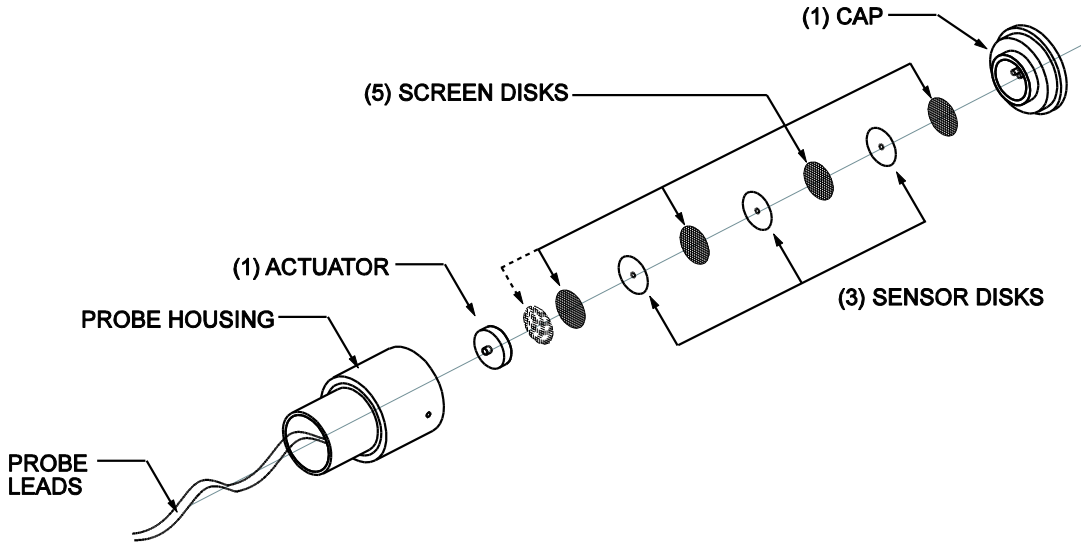


Figure 21
PHLR Sensor Package

8.4.1 Cleaning Sensor Elements Procedure

The replacement sensor package consists of 8 disks: 5 screen disks and 3 sensor disks as shown in Figure 21. The replacement package includes all removable parts: probe cap, sensor elements, and actuator. Replacement sensor elements only can also be purchased.

The following procedure is a general guideline to follow to clean the probe and sensor elements after exposure to hydrocarbon liquids. **Caution: It is the user's responsibility to determine safety precautions and the suitability of exposing personnel to the hydrocarbon liquid on the probes and various cleaning solvents suggested.**

The sensor disks swell after exposure to fuels and solvents. The swelling forces the actuator to move and operate a low-force sealed switch. Volatile hydrocarbon liquids, such as gasoline, will eventually evaporate after a period of time resulting in the sensor disks returning to their original size. This allows the switch to return to the normal position. A faster resetting process is to disassemble the probe to speed the evaporation of the liquid. Other liquids such as diesel fuel and jet fuel, which do not evaporate, must be flushed with a solvent to remove the contamination. Disassemble and clean the probe as follows:

1. Remove excess hydrocarbon contamination from the exterior of the probe.
2. Hold the switch in a vertical position with the cap downward and unscrew the cap. It is suggested to do this over a table so the small parts are not lost if they are dropped. **Be very careful not to lose the sensor disks.** They are very similar to contact lenses in size and texture.

3. Place the actuator, screens, cap, and sensor disks into a small container of solvent. Coleman Camp Fuel, which is naphtha, works well and evaporates very quickly. Other solvents that evaporate quickly and completely are also suitable.
4. Soak the components for a minute or two and then remove them.
5. Let the solvent evaporate until the disks return to the original diameter and fit into the cap easily. If the sensor disks do not slip easily into the circular holder in the cap, repeat the cleaning process. The disks should be about 0.5" diameter when dry.
6. Reassemble the switch. Carefully alternate the 4 screens and 3 sensor disks in the cap as shown in Figure 21. Place the actuator on top of the top screen. The actuator has a small point in the center of one side that must face the probe housing as shown. Hold the probe housing vertically and screw the cap finger-tight into the bottom of the housing.
7. If response time is over 5 minutes for diesel fuel at room temperature, insert the optional 5th screen next to the actuator. Make sure the extra screen does not activate the probe when it is tightened. If so, remove the extra screen. The extra screen accommodates manufacturing tolerances and reduces the amount of swelling of the sensor disks that is required before the probe activates.

8.4.2 Testing the Probe

The assembled probe can be easily tested with an ohmmeter and a small paperclip.

1. Connect the ohmmeter leads to the probe leads.
2. The reading should be very low, typically under 10 ohms.
3. Insert the paper clip into one of the five holes in the center of the cap and press gently (1-2 oz of force) into the switch.
4. The ohmmeter should read an open circuit or 0.L.
5. Remove the paper clip and the reading should return to the original low reading.
6. Disconnect the ohmmeter.

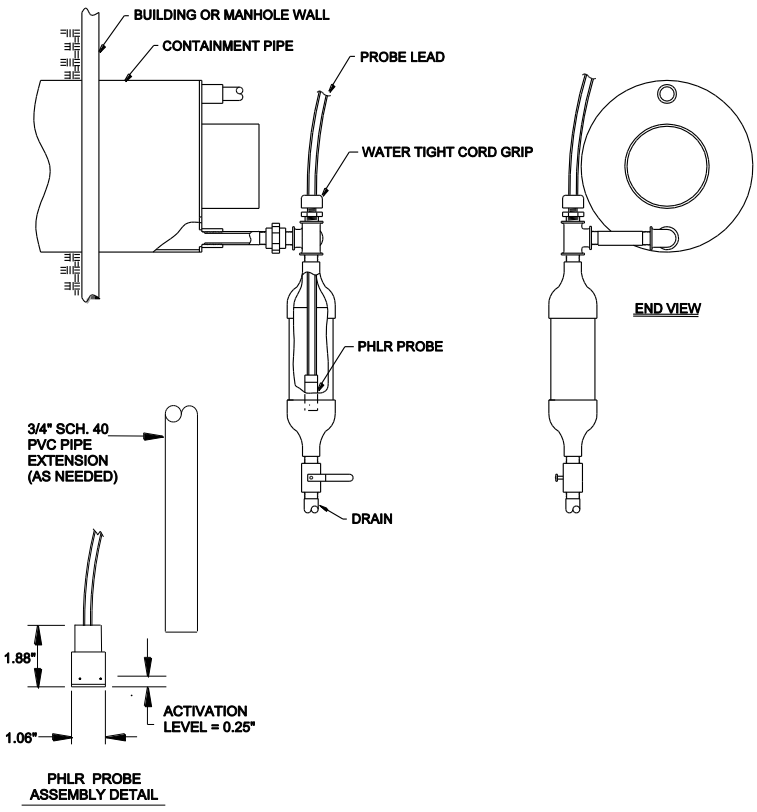
8.4.3 Troubleshooting

If the test results are not as expected, the following checks should help determine the problem.

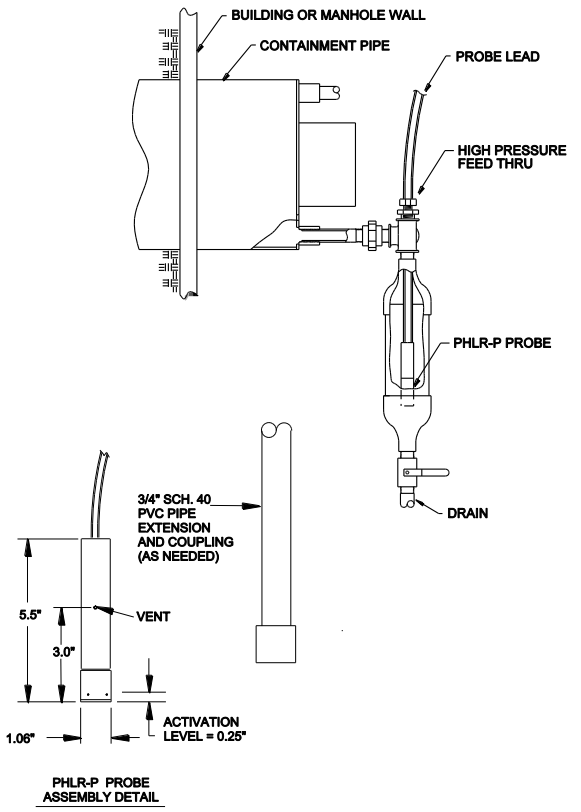
- If the original reading is open, or 0.L, then
    - Check that the sensor disks and screens are installed correctly. They must be flat, not folded over.
    - Verify that the diameter has returned to the original size. Clean again if needed.
    - If the optional 5th screen adjacent to the actuator is installed, it should be removed.
- If the ohmmeter reading is not an open circuit, 0.L, when the paperclip is inserted, then
    - Check that the meter leads or probe wires are not shorted together.
    - Disassemble the probe and make sure the actuator point is oriented properly to press into the center of the switch in the probe housing.

8.5 Typical Installations

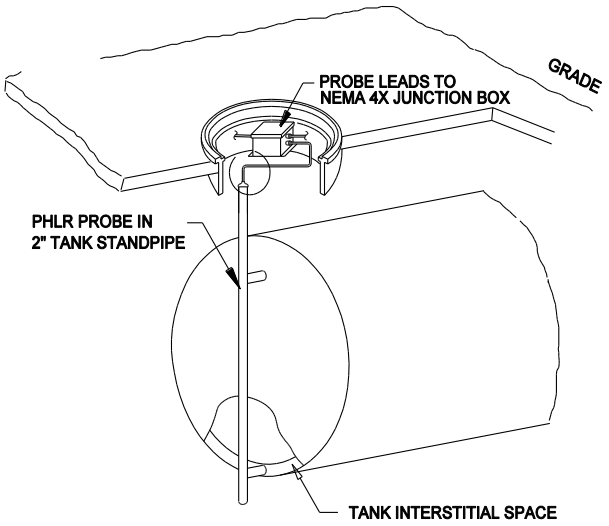
Contained Pipe



Pressurized Contained Pipe



Double-Wall Tanks



Contained Area

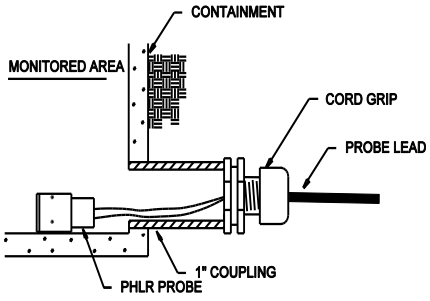
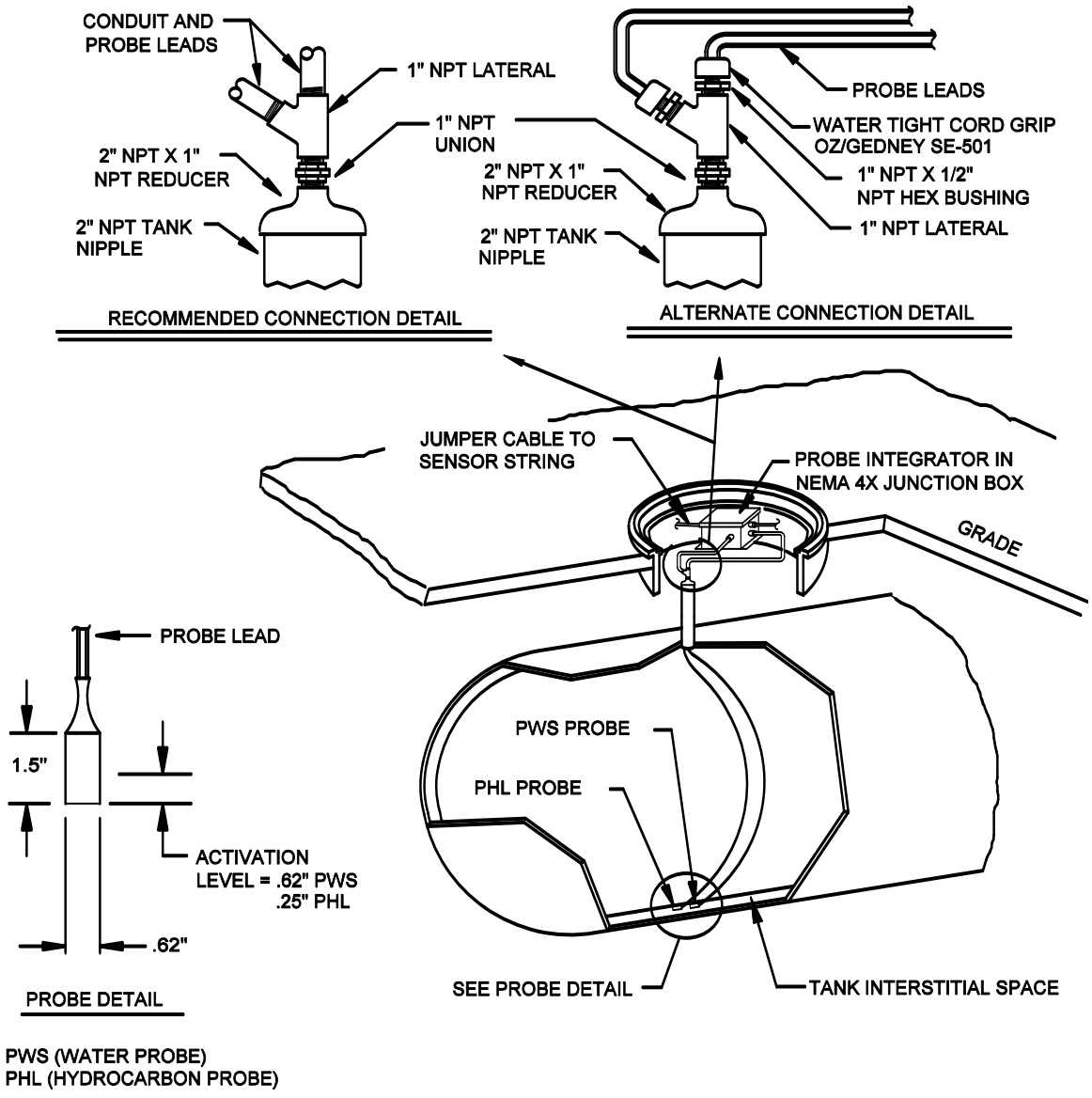


Figure 22
Typical PHLR and PHLR-P Probe Installations



PWS (WATER PROBE)
PHL (HYDROCARBON PROBE)

NOTES:

1. LENGTH OF PROBE LEAD IS 20 FEET MAX.

Figure 23
Typical PHL and/or PWS Probe Installation

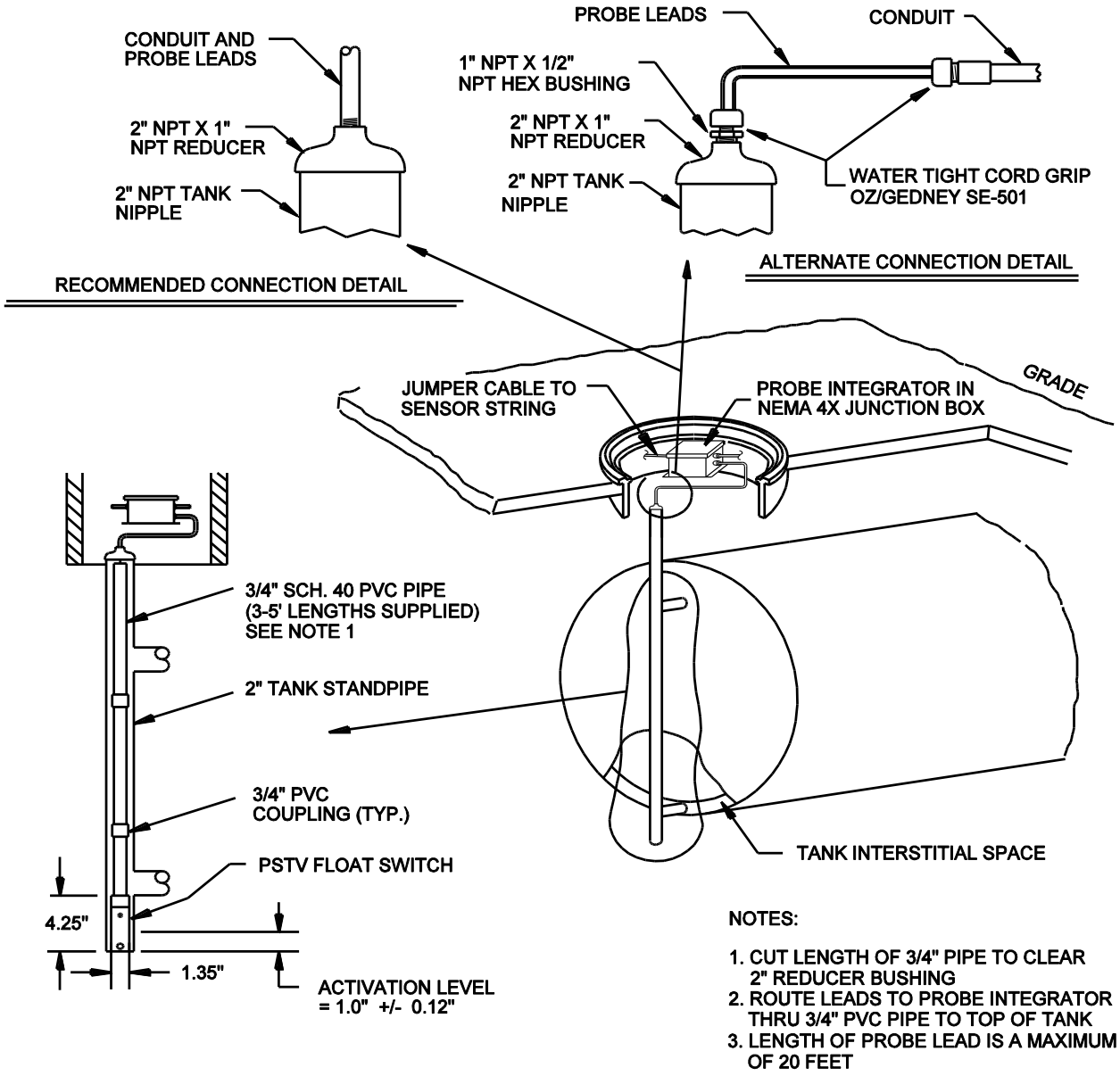
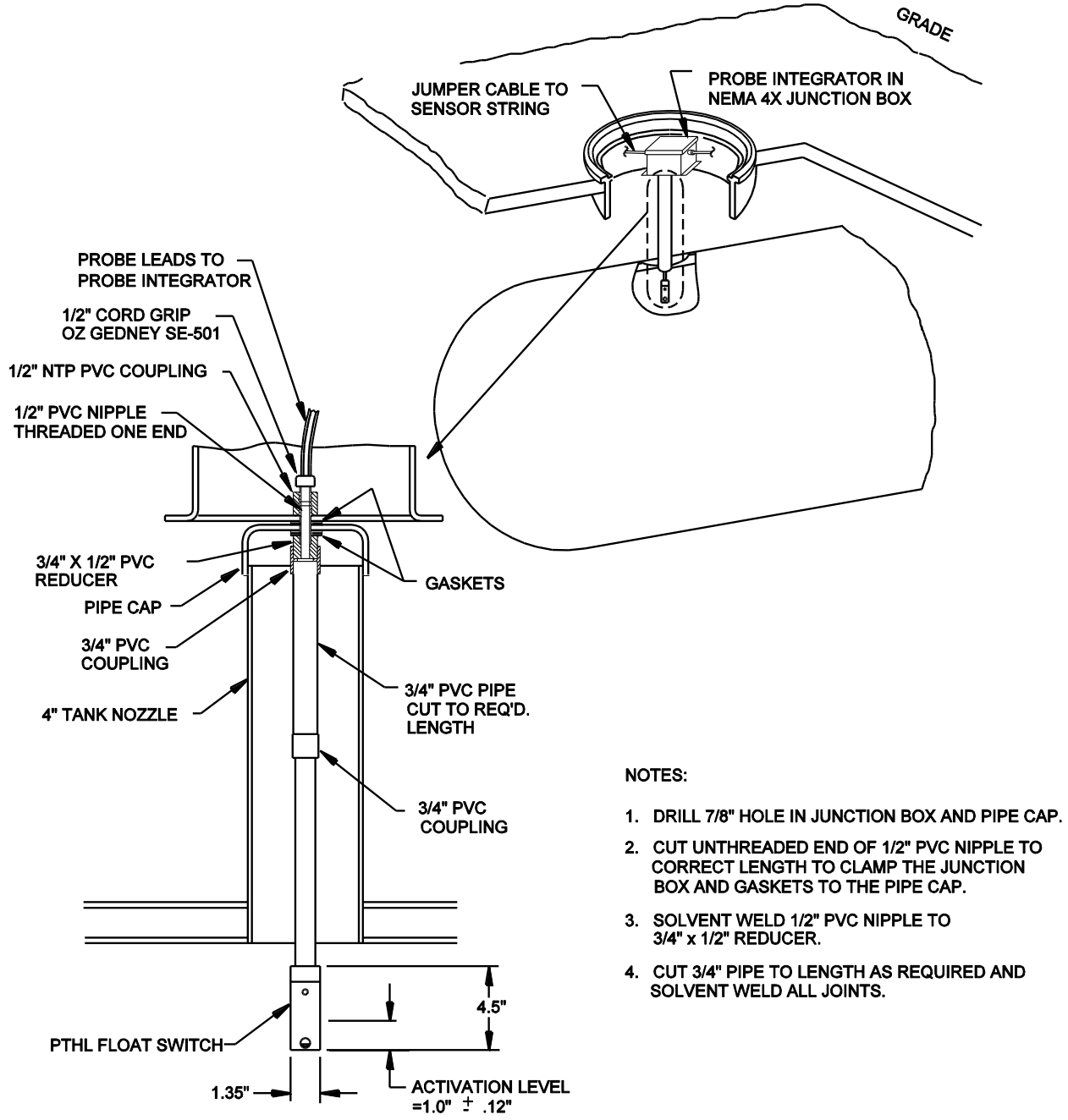


Figure 24
Typical PSTV Tank Float Switch Installation



NOTES:

1. DRILL 7/8" HOLE IN JUNCTION BOX AND PIPE CAP.
2. CUT UNTHREADED END OF 1/2" PVC NIPPLE TO CORRECT LENGTH TO CLAMP THE JUNCTION BOX AND GASKETS TO THE PIPE CAP.
3. SOLVENT WELD 1/2" PVC NIPPLE TO 3/4" x 1/2" REDUCER.
4. CUT 3/4" PIPE TO LENGTH AS REQUIRED AND SOLVENT WELD ALL JOINTS.

Figure 25
Typical PTHL Installation

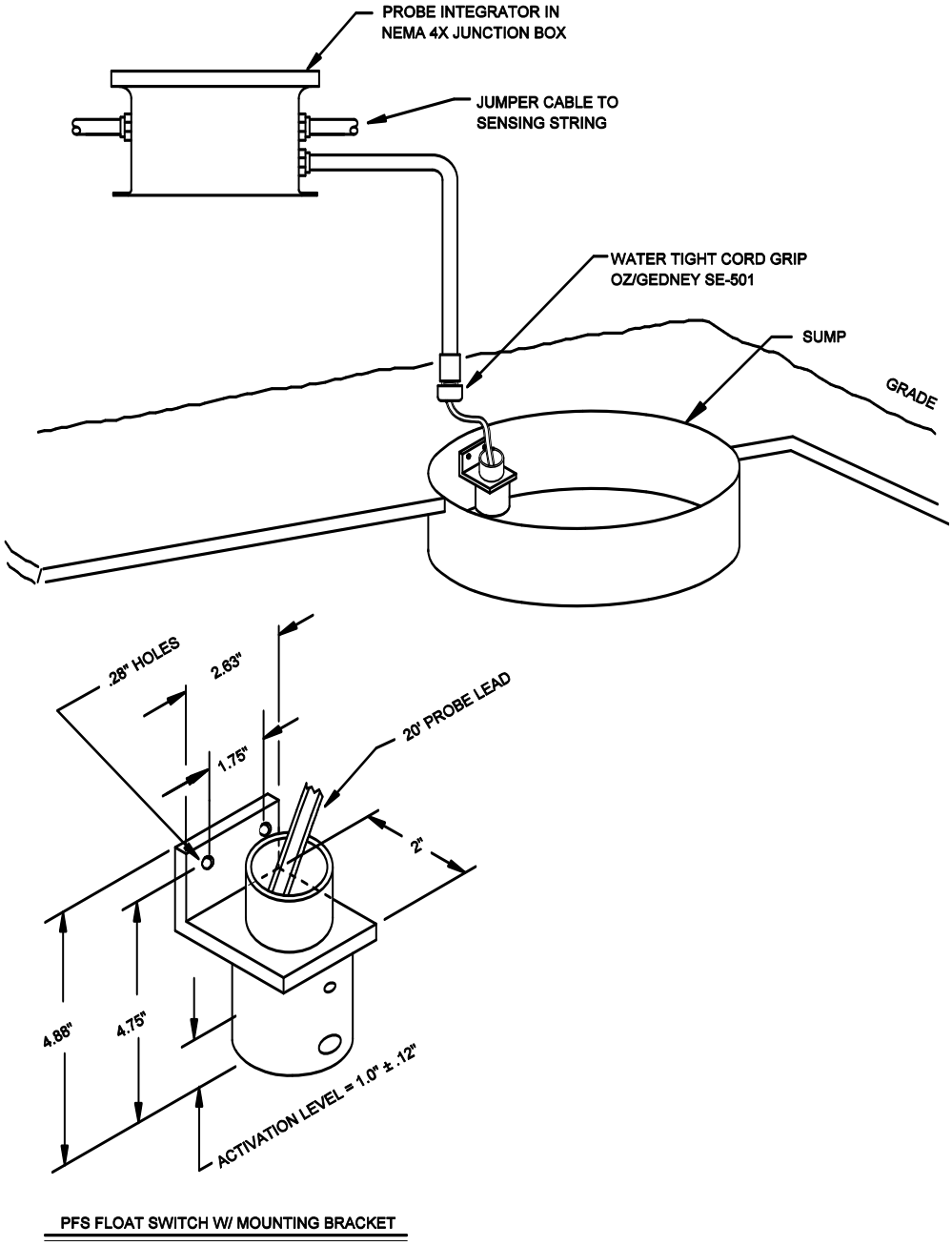


Figure 26
Typical PFS Installation

8.6 Probe Tests

Figure 27 shows a typical probe integrator test setup. There are 4 test procedures based on the type of integrator used. The red lead of an ohmmeter should be connected to the center pin of either of the connectors (point A). The black lead should be connected to the connector housing (point B). The ohmmeter should be set to resistance. Follow the test procedure in Figure 28 to test the probe integrator and probes.

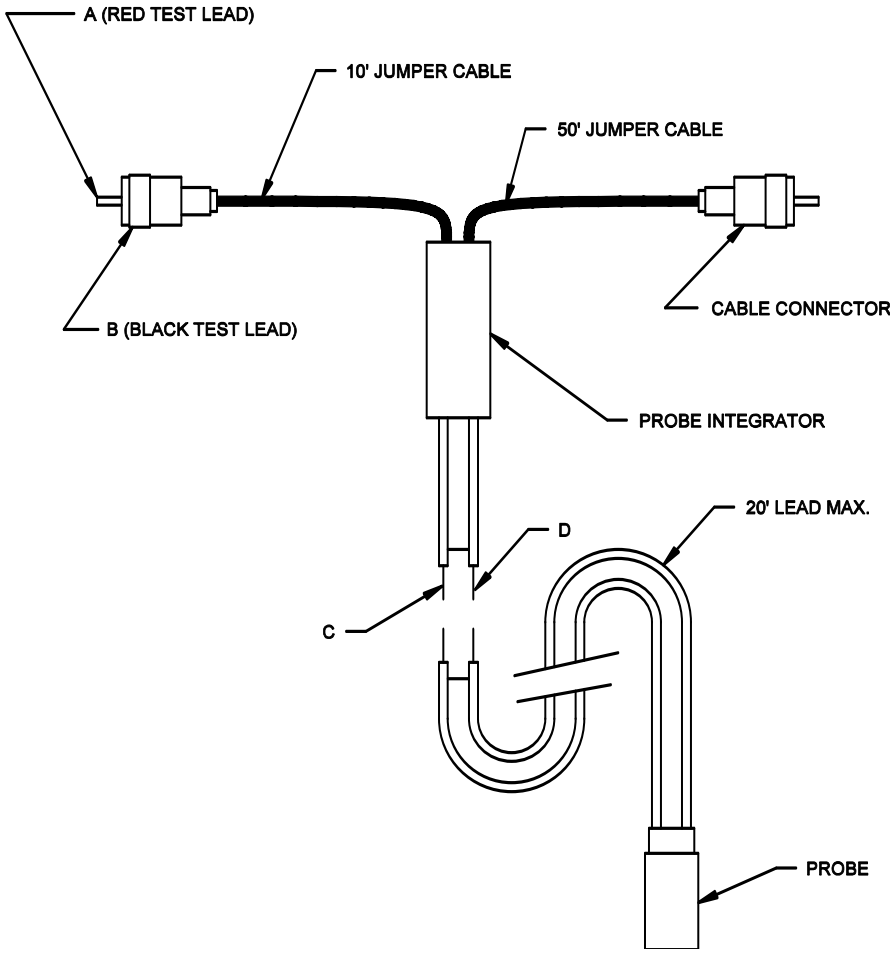


Figure 27
Probe Integrator Test Setup

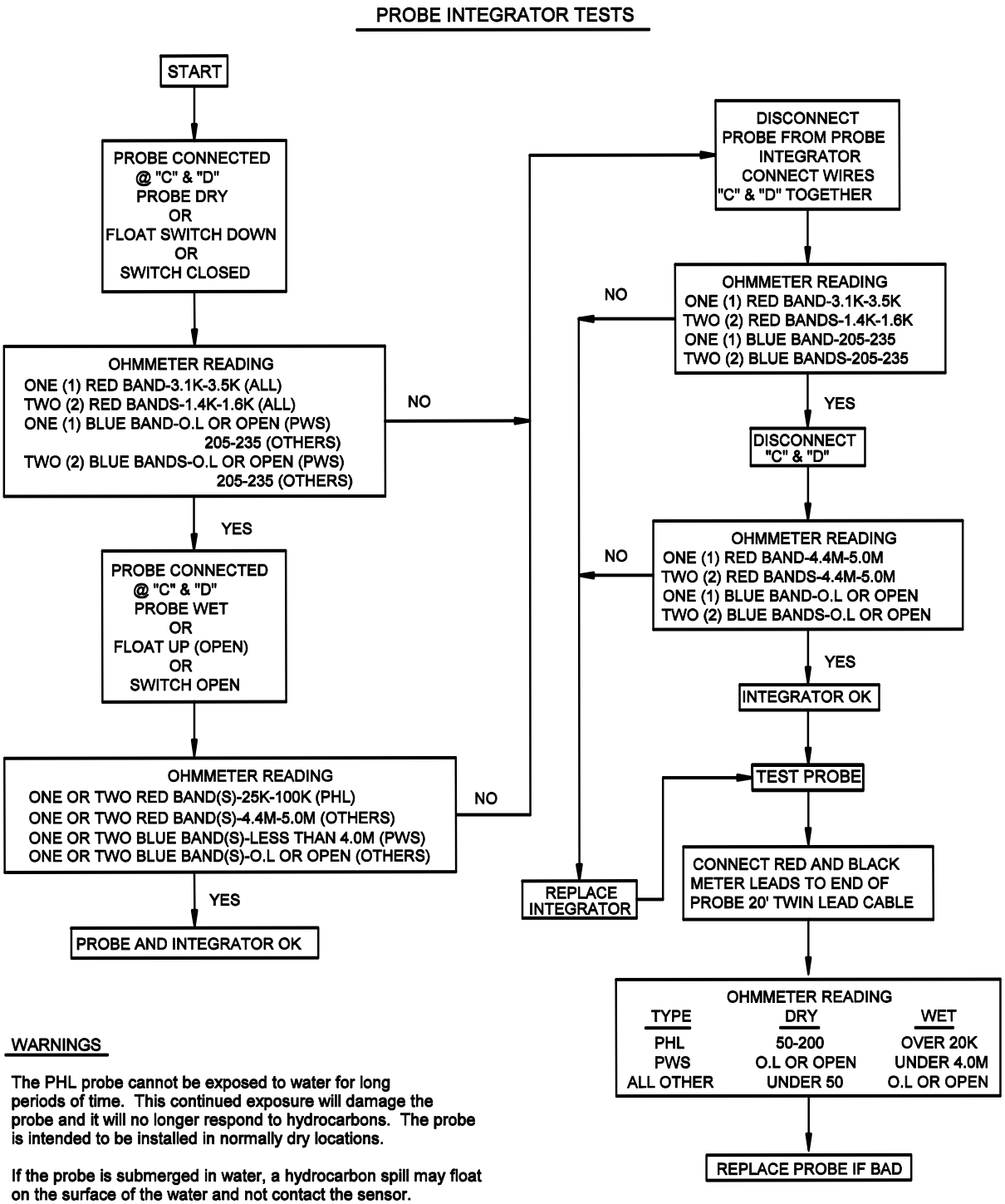


Figure 28
Probe Integrator Test

9 ATP Cable in Polyurethane Foam Insulation

9.1 General

This section outlines installation procedures for ATP twisted pair leak detection cable. The cable has 2 insulated solid copper wires, one red and the other white. It is installed at the factory in polyurethane foam. Extra cable extends 12" past each end of the pipe and is coiled around the pipe to protect it during shipping. **The extra cable must be protected from damage and must be moved away from the pipe before welding the pipe. Repeated bending of the cable can also damage it.**

The cable is typically installed at the 12 o'clock position in the foam insulation for straight runs. It may be in other orientations for fittings and returns from branch runs, so check the drawing layout for specific job information.

9.2 System Configuration

A typical PAL-AT Leak Detection and Location System can have one or more cable cards. **A cable card used to monitor ATP cable, must only monitor ATP**. No probes or other types of sensor cables can be connecter to the card. A cable card has at least 50' of jumper cable connected to it. The jumper cable may connect directly to ATP cable or to a transformer, which is connected to ATP, depending on the system design. **Once ATP sensor cable is connected, no jumper cable can follow for that card.** The gain on the cable card should be set to medium. If the cable card is version K or higher, it will have a STD/AUX jumper. The jumper should be set in the AUX position.

9.3 Calibration Points

During the initial setup and calibration of the PAL-AT system, connectors at selected locations (calibration points) must be disconnected. The wire at these locations can be prepared for the crimp connectors, but the connector should not be crimped until the calibration process is completed for each section.

During the PAL-AT setup process, the ATP cable should be setup as type 1, ATP.

9.4 ATP Cable Tests

The following tests should be performed after each pair of crimp connectors is installed and again after the polyurethane foam insulation is poured in each field joint. **The ATP cable must be disconnected from the transformer or jumper cable when conducting these tests or damage to the equipment could result. A 500-volt megger is used to measure the resistance between the wires and the carrier pipe**. If a nonmetallic pipe is used, use an earth ground connection in place of the pipe connection referenced in the following tests.

9.4.1 Insulation Test

1. Perform this test at the unconnected end of the length of ATP just added to the sensor string.
2. Connect one of the megger test leads to the red wire and the other lead to the pipe. The reading should be "open" or greater than 20 megohms.
3. Check the white wire in a similar manner.
4. Connect one of the megger test leads to the red wire and the other lead to the white wire. The reading should be "open" greater than 20 megohms.
5. If any reading is less than 20 megohms, check the last connection for a short and repair the problem. The wire insulation may be damaged or adhesive lined shrink tubing wasn't installed over a splice and the condition must be corrected.

9.4.2 Continuity Test

1. The continuity test checks for broken cable or open connectors.
2. Temporarily connect the red and white wires together next to the transformer with a clip lead or wire nut.
3. Connect the megger leads to the red and white wires at the far end of the ATP cable.
4. The reading should be approximately 8 ohms/1000 feet of cable.
5. If the reading is high, check the last connector installed and correct the problem.

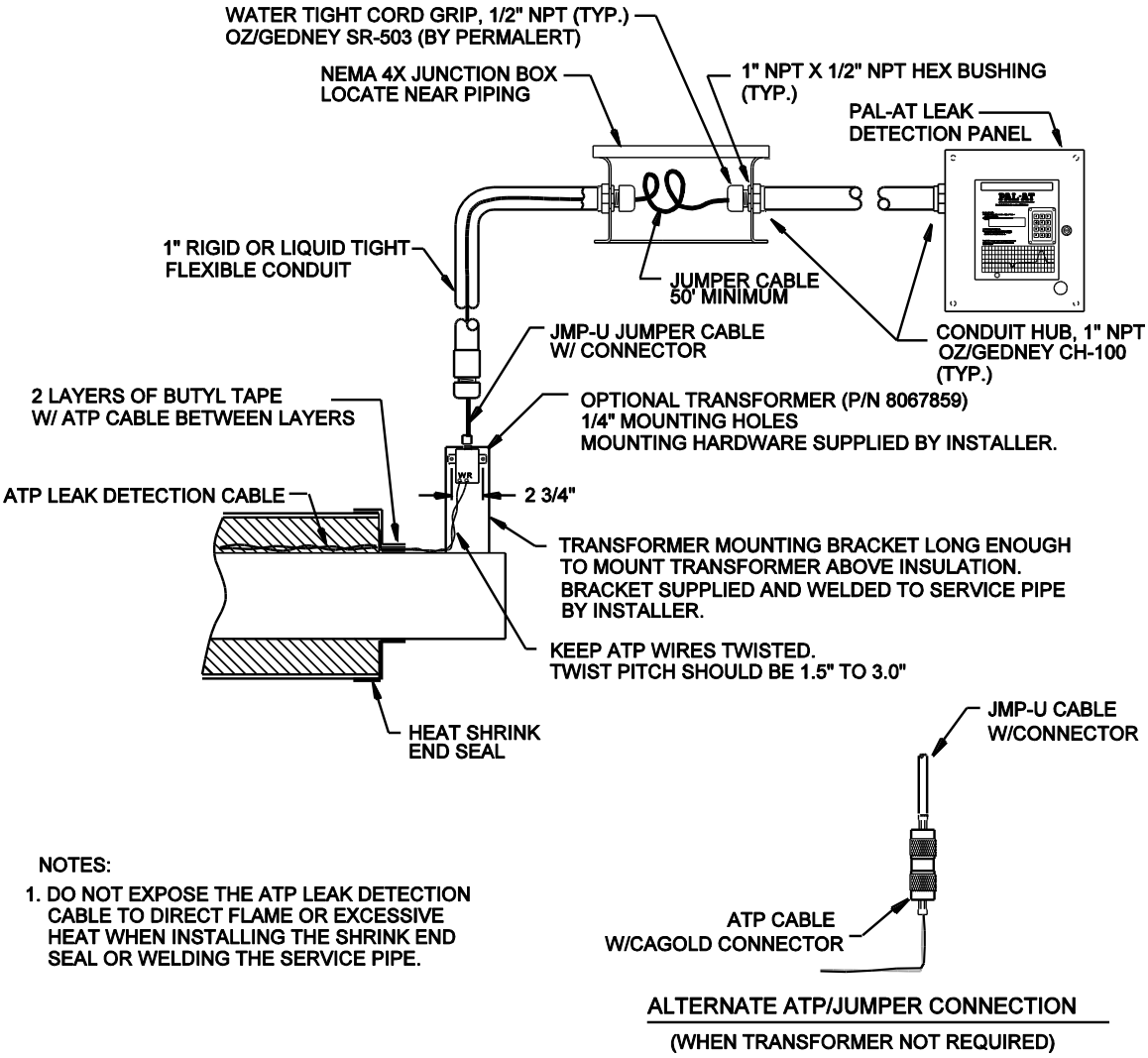


Figure 29
ATP Cable Connection- Start of Run

9.5 Start of Run

The initial length of jumper cable from the PAL-AT panel is connected to the ATP cable at the start of the pipe run. There are two configurations used as shown in Figure 29.

In the first configuration, a transformer, part number 8067859, is mounted on a bracket attached to the pipe and the 2 cables are connected to it. Connect the JMP-U jumper cable from the panel to the UHF

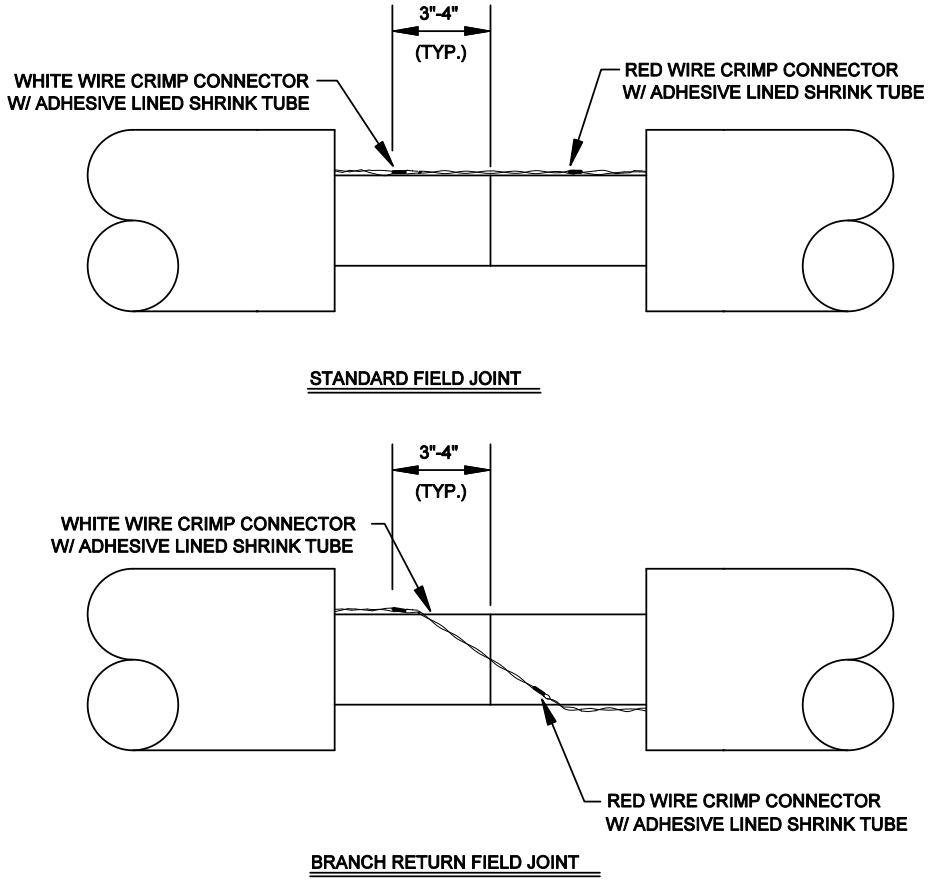
connector on the top of the transformer. Cut off excess ATP cable, strip the red and white ATP wires, and connect them to the transformer terminal screws.

The second method omits the transformer and has the jumper cable connected directly to the ATP cable. The ATP cable requires a CAGOLD connector. See Section 7.2.5 of this manual for connector installation details.

9.6 Connection of ATP Cable

The ATP cable is spliced at field joints with crimp connectors using the following steps (see Figure 30).

1. The red wires should be spliced on one side of the pipe joint and the white wires on the other side, each splice approximately 3"- 4" from the end of the pipe.
2. If the ATP cable from the first pipe is not directly in line with the cable from the second pipe, the cable should be routed in as direct a line as possible between the 2 splice points (refer to Branch Return design in Figure 30).
3. Cut the red wire from one pipe so the end is centered over the first splice location. Cut the other red wire so the wires meet. Minimize excess slack in the wire.
4. Strip 5/16"-3/8" of insulation from the ends of the red wires. The wire size is 1.5 mm^2 (metric size). If the correct stripping tool, Model T60/124, part number 8068309, is not available, use a tool for #14 AWG. Do not use a smaller die or uncalibrated hand tool, such as wire cutters, which may damage the center conductor.
5. **Slide a 1½" long piece of adhesive lined shrink tubing on the wire before crimping the connector**.
6. The crimp tool, Model T60/125, part number 8068308, is ratcheted so the crimp must be completed once it is started. The crimp connector has an indentation (wire stop) in the center. **Two crimps are required, one on each half of the connector. The model T60/125 crimp tool must be used**.
7. Insert one red wire into the connector and place the connector in the T60/125 tool so the die is centered over the half of the connector with the wire. Make sure the wire is fully inserted into the connector until it hits the stop, and then crimp the connector.
8. Repeat step 7 with the other red wire.
9. Try to pull the splice apart with 10-25 lb. force to ensure the wires were correctly seated in the connector.
10. Repeat steps 3-9 for the white wire. The red and white wires must be twisted with a 1 ½" – 3" pitch throughout the splice area before crimping the second connector.
11. Slide the 2 pieces of shrink tubing over the splices and shrink the tubing. There should be no copper wire exposed after the tubing shrinks. If so, the connector should be replaced.
12. There should not be large gaps between the red and white twisted wires. If they are not in contact with each other, twist the wires slightly to minimize any gap.
13. Test each wire for continuity and insulation as described above.



NOTES:

1. DO NOT EXPOSE THE ATP LEAK DETECTION CABLE TO DIRECT FLAME OR EXCESSIVE HEAT WHEN INSTALLING THE SHRINK END SEAL OR WELDING THE SERVICE PIPE.
2. COMPLETE THE SPLICE CONNECTIONS IN ACCORDANCE WITH THE INSTALLATION MANUAL INSTRUCTIONS.
3. TEST THE SPLICE CONNECTIONS IN ACCORDANCE WITH THE INSTALLATION MANUAL INSTRUCTIONS.
4. CRIMP CONNECTORS SUPPLIED BY PERMA-PIPE.
5. KEEP ATP LEAK DETECTION CABLE WIRES TWISTED TWIST PITCH 1.5" TO 3" IN FIELD JOINT AREA.
6. ONLY USE THE CRIMP CONNECTORS AND CRIMP TOOL SUPPLIED BY PERMALERT.

Figure 30
ATP Connection Details

9.7 ATP Cable at Tee Connections

Two lengths of ATP cable are used on branch lines and tees (see Figure 31). One cable is typically at the 12 o'clock position and the other is located at the 6 o'clock position. The ATP cable from the preceding section is connected to the ATP cable at 12 o'clock using the procedure described above. At the end of the branch, the 2 cables are spliced together as shown.

The return length of ATP cable from the end of the branch is spliced at the tee in the 6 o'clock position using the standard procedure. Since the ATP cable of the next section of pipe is located at the 12 o'clock position; the cable to the next section has to wrap around the pipe. This is shown in Figure 30.

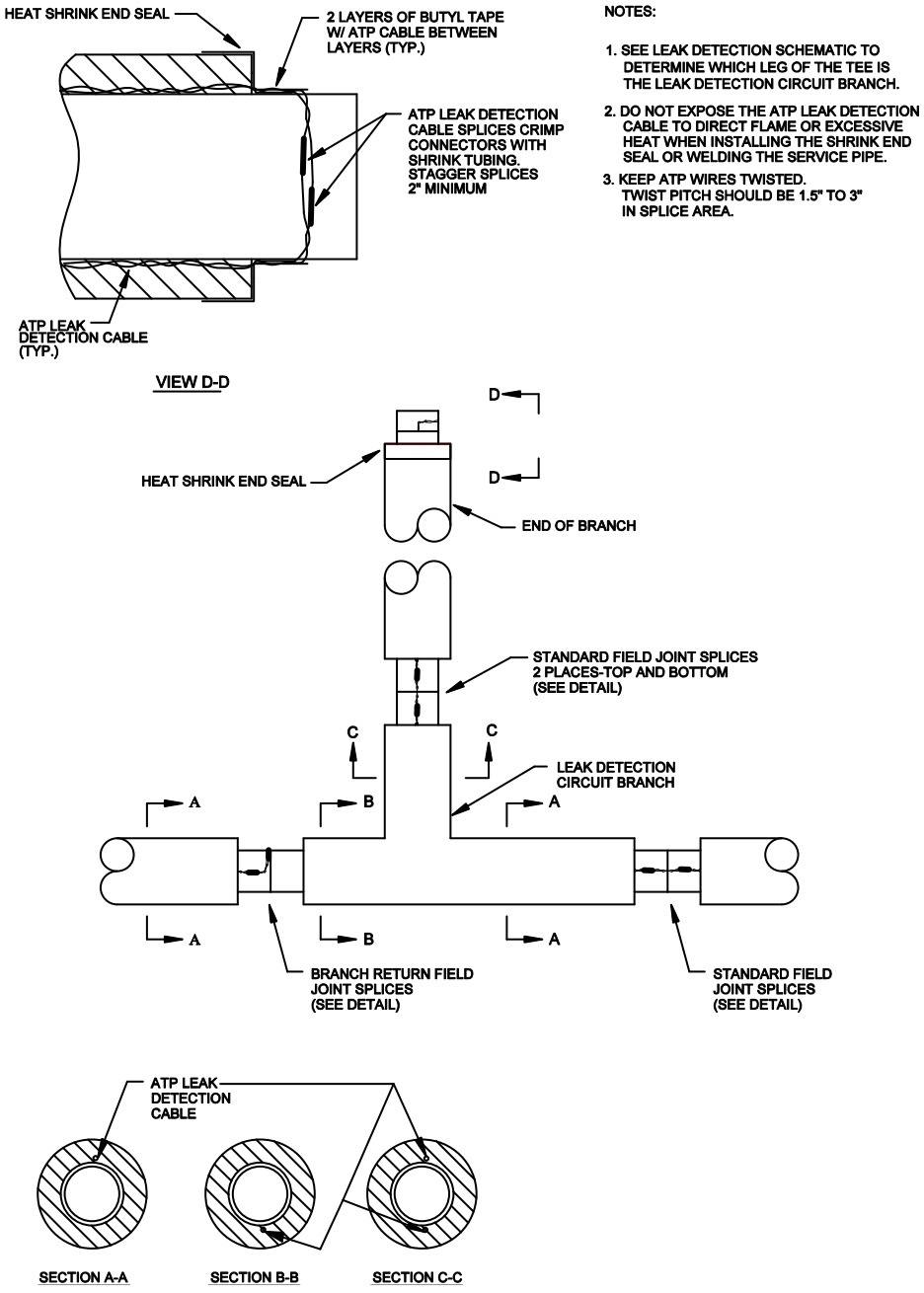


Figure 31
ATP Cable at Tee and End of Branch

9.8 End of Run Termination

Install a NEMA 4X junction box near the end of the pipe. Electrical conduit should be used to protect the wire if the box is more than a few inches from the pipe end seal. The ATP cable from the pipe should be

spliced to 50 ft. of ATP cable that is coiled in the junction box (100 ft is required if the cable length is greater than 3300 ft.). Make sure the ATP cable remains twisted. The splices to the red and white wires should be staggered and encapsulated with shrink tubing as described above.

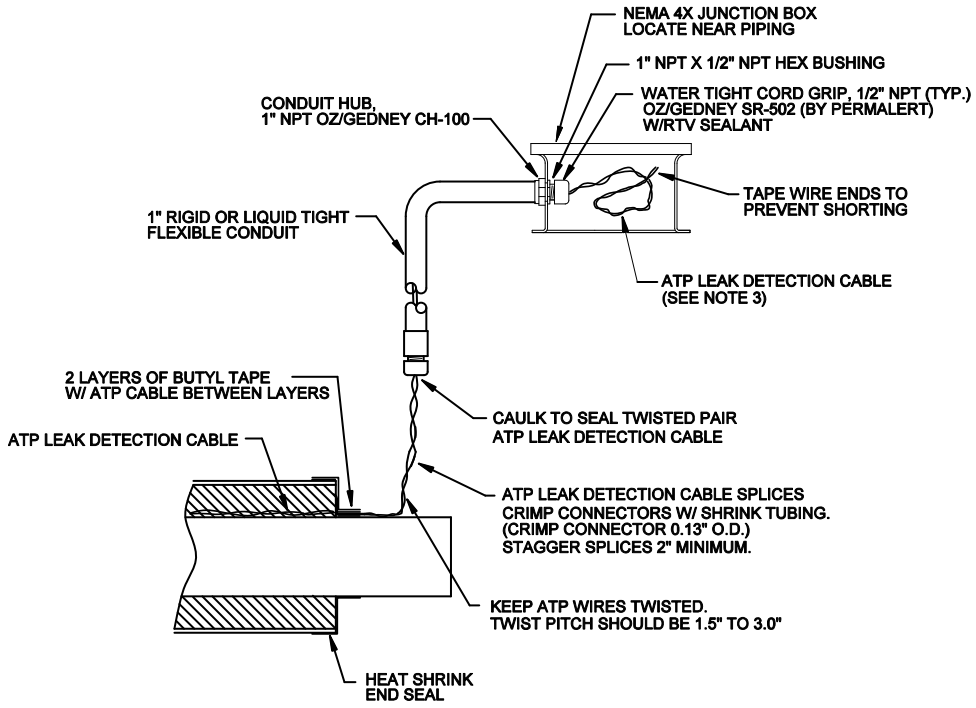


Figure 32

ATP Cable End of Run Detail

WARRANTY

Seller warrants that the PAL-AT Leak Detection System (the "System") will be free from defects in materials and workmanship for a period of one year from the date of shipment by Seller to Buyer. Seller is not responsible for damage to the System occurring in transit or arising from the installation, alteration or repair of the System by persons other than Seller's employees, or from any abnormal or improper use of, negligence with respect to or accident affecting the System. Expendable service parts, such as probes, are not warranted by Seller. Seller's sole obligation and liability, and Buyer's sole remedy, under this warranty shall be the repair or replacement, at Seller's election, by Seller of any defective materials or workmanship covered by this warranty, without the charge to Buyer. Repaired or replacement materials shall be delivered to Buyer f.o.b. Seller's plant or f.o.b. such other location as Seller shall designate. Seller shall not be responsible for any product returned to Seller without Seller's prior express consent. No claim shall be permitted under the warranty contained in this Section unless Buyer notifies Seller in writing within ten (10) days after Buyer first hears of facts giving rise to any such claim and unless notice is given within the one year term of this warranty. In order to be valid, any notice sent to Seller in connection with said claim under this warranty must reasonably specify the defect which is the subject of such claim. Buyer shall be responsible for testing and inspecting the System promptly after receipt and thereafter at such intervals as are reasonably prudent so as to inform Seller of any defects which exist in the System. Notwithstanding the filing of a claim hereunder, this warranty shall expire after one year from the original date of shipment of the System in respect to materials and workmanship which are not then the subject of a proper claim.

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