OPERATING INSTRUCTION MANUAL

MODEL P/R60
DIFFERENTIAL 6-WIRE pH & ORP PROBES

N116-140 REV. 0

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1. GENERAL INFORMATION

This manual covers all AquaMetrix P60, and R60 Series differential measurement pH and ORP probes.

The PRR60 series probes feature the AquaMetrix differential design for long lifetime, user serviceability and more accurate readings. In typical installations these probes will last for years whereas the more common combination probe lasts only months. The “P” prefix refers to the pH probe while the “R” prefix refers to the ORP version.

The P/R60 probe is a 6-wire device. It incorporates an encapsulated transmitter that outputs a voltage in accordance with the Nernst equation. The probes can be connected to the AquaMetrix Shark controller, Shark TX transmitter or most of the GLI/Hach controllers (e.g. P33, P53, P63, SC200).

NOTE: Do not discard the protective cap(s) that came with the sensor. If the sensor is removed from the process for an extended period of time, thoroughly clean the sensor, put a piece of cotton ball with few drops of water into the protective cap and replace it on the sensor. This keeps the junction from drying out which causes slow response when put back into operation or causes permanent damage to the sensor. **Sensors should not be left in dry lines or empty tanks for extended periods.**

Do not store the sensors in a dry or humid location. When storing, check the protective cap(s) regularly to make sure the cotton ball remains moist. Improper storage of sensors voids the warranty.

2. Specifications

	pH (P60C-X)	ORP (R60C-X)
Measurement Range	0 to 14.00	0 to 1000 mV or -500 to +500 mV
Wetted Materials	CPVC, Kynar/ceramic, titanium, Viton	CPVC, Kynar/ceramic, titanium, Viton, Platinum
Span	0 to 14 pH	-2000 to +2000 mV
Sensitivity	0.001 pH	0.1 mV
Stability	0.03 pH / day (non-cumulative)	2 mV / day (non-cumulative)
Mounting	1.5” NPT	1.5” NPT
Flow Rate	10 ft/sec (3 m/sec). Flow should be as low as possible in water with low conductivity water or suspended solids	
Maximum Load	450 Ω	
Temperature Limits	-5 to 95°C (23 to 203°F)	
Pressure Limits	100 psig @ 65 °C, 40 psig @ 95°C	
Power Supply Limit	24±4 VDC	
Probe Cable	15 ft. (4.6 m)	
Transmission Distance	3000 ft (900 m)	
Temperature Element	300 Ω NTC thermistor or 1000 Ω RTD (ORP is not temperature compensated)	

3. INSTALLATION

3.1. General Instructions

Specific instructions for each type of probe are given in the following pages. Common to all probes are the following instructions:

1. If the distance between the probe and the instrument is such that a direct connection is not possible, the probe cable should be routed to a junction box with a terminal strip (AquaMetrix Part No. JB1). The box should be well sealed and away from corrosion danger. Be sure that you have sufficient slack cable to allow for probe removal for calibration and servicing.
2. Route the interconnect cable from the junction box to the instrument, preferably in metal conduit. Do not run the power cable or control cables in the same conduit with the probe interconnect cable.
3. Remove the protective plastic caps from the end of the probe before placing in service.
4. For best results probes should always be mounted vertically with electrodes down. If this is not possible, the probe must be at least 15° above horizontal.

3.2. Connecting the P/R 60 to a Shark

Improper wiring of the probe cable to the controller/transmitter will destroy the probe. Please follow these guidelines:

1. Always power down the controller/transmitter BEFORE connecting the probe cable.
2. First connect the probe wires to the male and THEN insert the male connector into the female connector inside the Shark. Do NOT insert the unwired male connector into the female connector first and then connect the probe wires to the male connector.
3. For the Shark TX/P Transmitter: Make sure the transmitter is disconnected from the power source before wiring the probe to the terminal strip on the back side of the transmitter.
4. Check the wiring. Use the diagrams below to insure that you've made the correct connections. If connecting to a Shark controller, make sure that the male connector is inserted into the female connector properly and that it is not offset.
5. Remember: Unplug it, wire it, check it and power it.

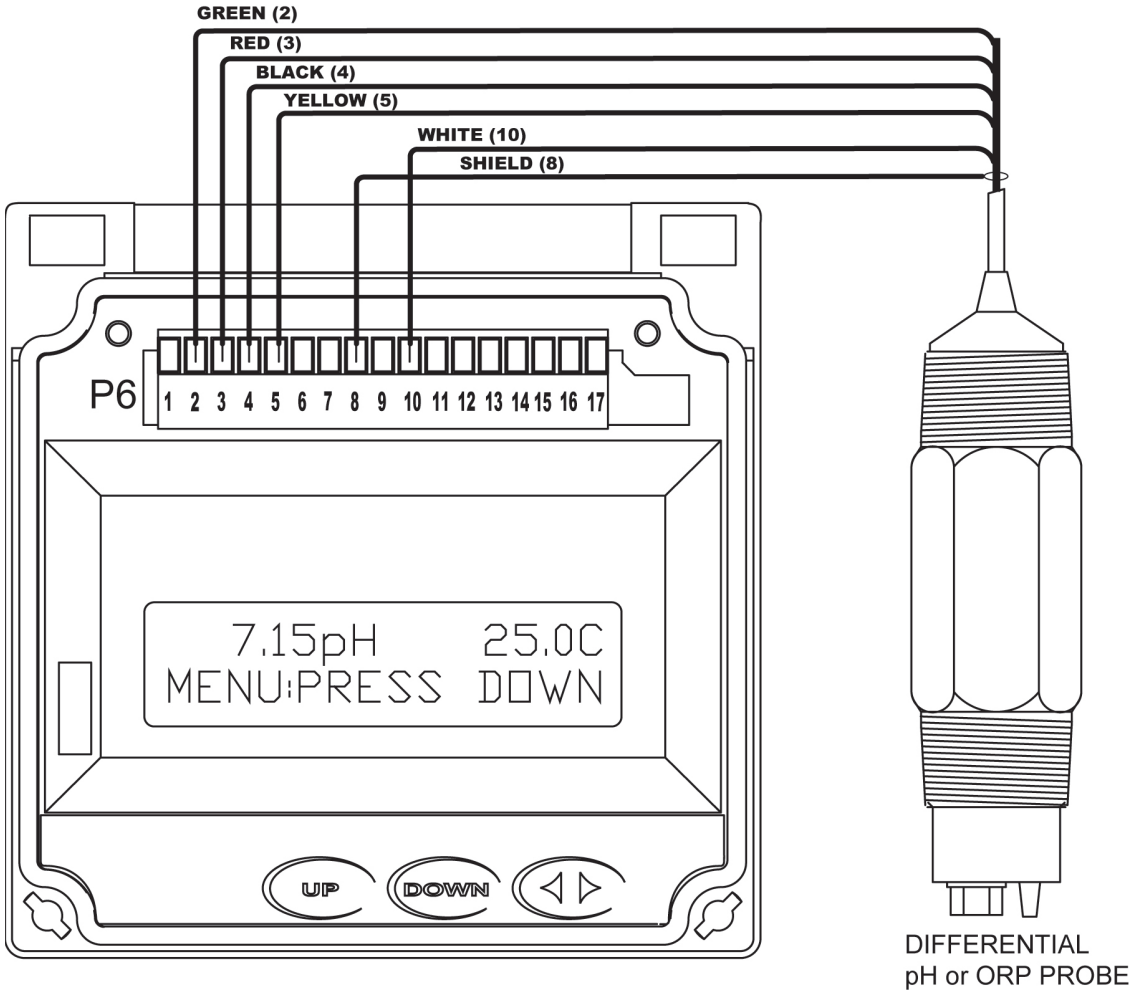

Figure 1 - Wiring a P/R 60 to a Shark controller

3.3. Connecting the P/R 60 to a Shark TX/P

1. Always power down the transmitter BEFORE connecting the probe cable.
2. Make sure the transmitter is disconnected from the power source before wiring the probe to the terminal strip on the backside of the transmitter.
3. Check the wiring. Use the diagrams below to insure that you've made the correct connections.

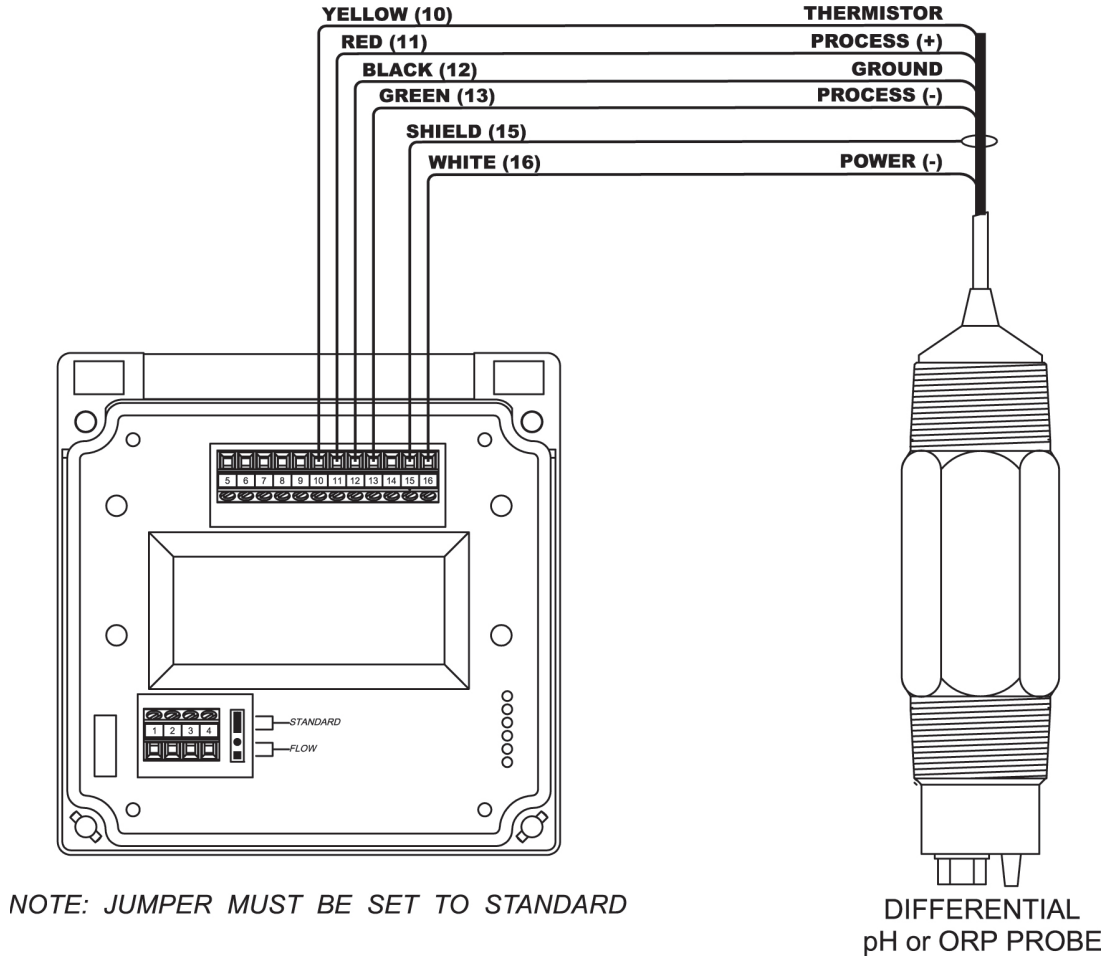

Figure 2 - Wiring a P/R 60 probe to a Shark TX/P transmitter

3.4. Submersion Mounting Series 8 Differential Probes

1. Refer to Figure 6.
2. A submersion mounting kit, STC60L, is available from Water Analytics which includes 4 ft. of 1" pipe, 1-1/2" x 1" reducer, a strain relief fitting and wire mounting bracket. Proceed as follows, either with the kit or with your own hardware.
3. Apply a thread sealant to the thread on the cable end of the probe and screw a 1-1/2" x 1" NPT reducer onto the probe. Route the sensor cable through an appropriate length of 1" pipe and using thread sealant, screw the pipe into the reducer. The cable end of the probe should not be exposed to the process. A cable strain relief fitting should be used on the upper end of the pipe. In the kits a wire bracket is provided to aid in supporting the assembly.

   NOTE: An optional protective shroud, Part No. PROTECTOR-3 should be used on the electrode end of the probe to protect the electrodes from accidental contact with the tank bottom, sides or objects in the process.

3.5. Submersion Mounting Series 6 Differential Probes

1. Refer to Figure 4.
2. A submersion mounting kit, STC60-6 is available from Water Analytics which includes 4 ft. of 1" pipe, 1-1/2" x 1" reducer and a strain relief fitting. Proceed as follows, either with the kit or with your own hardware:
3. Install the optional protective shroud, Part No. PROTECTOR-6 on the probe by threading the probe cable through it. The shroud will contact the shoulder on the probe.
4. Install the compression fitting components on the probe in the order shown in the drawing below so that the pipe thread is towards the cable end of the probe. If you are concerned that the shroud may get pushed up and expose the electrodes you can lock it down by the positioning of the fittings.
5. Snug up the nut of the compression fitting to locate it in the desired position. Hand tighten as much as possible, then turn 1/2 turn with a wrench.
6. Apply a thread sealant to the pipe thread portion of the compression fitting and screw a 1-1/4" x 1" NPT reducer to it.
7. Route the sensor cable through an appropriate length of 1" pipe and using thread sealant, screw the pipe into the reducer on the probe. The cable end of the probe should not be exposed to the process.

3.6. Flow-through tee mounting Series 8 Differential Probes

1. Refer to Figure 6.
2. Apply pipe sealant to the electrode end of the probe and screw it into the AquaMetrix union tee w/ adaptor (Part No. AM-MH538N9A) or any standard 1-1/2" NPT tee.

3.7. Flow-through tee mounting Series 6 Differential Probes

1. Refer to Figure 4.
2. Take the compression fitting apart. Apply pipe sealant to the 1-1/4" NPT thread and screw this part into a 1-1/4" tee. A larger tee with an appropriate reducer may be used.
3. Put the compression fitting components on the probe in the order shown in the drawing. They should be in such a position that the electrodes will be in the pipe stream but not touching the opposite side of the tee.
4. Remove the protective cap from the probe and place the probe in the tee. Now tighten the nut by hand as much as possible, then turn 1/2 turn with a wrench.

3.8. Sanitary Probe P60S, R60S, P60C5-S, R60C5-S

1. The P60S is designed with a stainless steel flange to mate with a Tri-Clover ferrule TL14AM7-2-1/2.
2. The P/R60CS can be replaced by the P60C5-S, which is a P60C5 with a 1" sanitary flange.

3.9. Insertion mounting Series 4 Differential Probes

1. Apply pipe sealant to the electrode end of the probe and screw it into the any standard 1-1/2" Male NPT.

3.10. Hot/Wet tap insertion mounting Series 7 Differential Probes

1. Refer to Figure 5.
2. A ball valve assembly, P60-HTC, is available from AquaMetrix, which includes the ball valve and safety shroud.
3. Mount the ball valve assembly in a desirable location. The assembly comes with a field selectable, 1-1/4 NPTF or socket adaptor. Make sure valve is in the close position before mounting.
4. Remove the union body by turning the union nut counter clockwise. Take the compression fitting apart as shown on the drawing. Insert the back end of the series 7 probe through the union body until safety notch on the probe aligns with the safety stop on the union body.
5. Place the union body, with the probe attached, back into the ball vale assembly and tighten union nut. Open ball valve & slide the probe into the process.
6. Put the compression fitting components on the probe in the order shown in the drawing and tighten the nut by hand as much as possible, then turn 1/2 turn with a wrench to keep probe in place.
7. Insert protective shroud as shown.

4. SERVICE AND MAINTENANCE

4.1. Probe Cleaning

1. The probe should be kept reasonably clean to avoid measurement errors. Frequency of cleaning can only be determined by experience. To clean proceed as follows:
2. Rinse with clean warm water.
3. Soak the end of the probe in warm water and dish detergent for 3 or 4 minutes.
4. Brush the end of the probe, particularly the three electrodes with a soft bristle brush such as a toothbrush. Take care not to scratch the glass electrode.
5. If the probe is still not clean, it may have to be cleaned with acid. *CAUTION: Do not acid clean probes used in processes containing cyanide solutions.* Some experimentation may be required to determine the most suitable acid for your process. Use the most dilute acid, which is effective. Normally 10 parts of water to one part muriatic acid is sufficient. *Do not use hydrofluoric acid.*
6. Soak the probe for not more than 5 minutes in the chosen acid; then rinse thoroughly with clean warm water and soak in water for 3-5 minutes.

Calibrate the system in accordance with the instrument instruction manual.

4.2. Replacement of Salt Bridge for Series 4, 6, 7 & S Differential Probes

1. If the system cannot be calibrated after cleaning the probe, it may be necessary to replace the standard cell solution. A kit is available from Water Analytics for this purpose (Part No. C35-17K). Proceed as follows: Refer to Figure 7.
2. Hold the probe vertically with the sensor face up. Insert long nose pliers in the blind holes in the salt bridge and turn counter-clockwise taking care not to damage the glass electrode. Discard the used salt bridge.
3. Up-end the probe and pour out the contents of the standard electrode chamber. Flush the chamber with a small amount of pH 7 buffer or clean water.
4. Refill the chamber with 7pH buffer solution up to the tip of the electrode inside the chamber. DO NOT OVERFILL. It is important to leave space for the salt bridge thread and a small amount of air.

5. Screw the new salt bridge into the cavity until finger tight. Now turn 1/4 turn with long nose pliers. The front face of the salt bridge should be flush with the probe face.

4.3. Replacement of Salt Bridge for Series 8 Differential Probes

1. If the system can't be calibrated after cleaning the probe, it may be necessary to replace the standard cell solution and/or the salt bridge. A salt bridge kit is available from Water Analytics for this purpose (Part No. AM60-9765K for the -8 probe and C35-17K for the -5, -6 and -7 probes). Proceed as follows: Refer to Figure 7. This figure shows the salt bridge assembly for a -6 or -7 probe. The -8 probe assembly differs only in the shape of the salt bridge. Use a hex driver to remove and install the salt bridge.
2. Hold the probe vertically electrodes up. Remove the used salt bridge. For the -8 probe the salt bridge is a hexagonal-shaped capsule that can be removed using a 9/16" socket wrench. For the -5, -6 and -7 probes the salt bridge is a round capsule that is flush with the probe front. Use needle nose pliers to unscrew the piece.
3. Discard the used salt bridge.
4. Dispose of the used solution inside the bridge chamber and flush with pH 7 solution or distilled water.
5. Refill the chamber with 7pH buffer solution, up to the tip of the electrode, inside the chamber. DO NOT OVERFILL. It is important to leave space for the salt bridge thread and a small amount of air.
6. Screw the new salt bridge into the cavity until finger tight. Now perform a 1/4 turn with a 9/16" socket wrench. The salt bridge edges should be flush with the front of the probe face.

4.4. Storage

1. Do not discard the protective cap(s) that came with the sensor. If the sensor is removed from the process for an extended period of time, thoroughly clean the sensor, put a piece of cotton ball with few drops of water into the protective cap and replace it on the sensor. This keeps the junction from drying out which causes slow response when put back into operation or causes permanent damage to the sensor. **Sensors should not be left in dry lines or empty tanks for extended periods.**
2. Do not store the sensors in a dry or humid location. When storing, check the protective cap(s) regularly to make sure the cotton ball remains moist. Improper storage of sensors voids the warranty.

5. TROUBLESHOOTING AND SERVICE

5.1. Checking Probes P60 and R60

The probe can be checked by a few simple measurements. The directions below allow a voltmeter to be used for diagnostics. The Shark or Shark TX may also be used (Diagnostics > Probe Input)

5.1.1. pH Probes

1. Two or three pH buffer solutions—pH 7 and either pH 7 or pH 10—and a voltmeter are required.
2. Clean the probe as described in Section 4.1. If the system cannot be calibrated, replace the salt bridge and pH 7 buffer solution as described in 4.2. If the system still can't be calibrated check the probe as follows.
3. Disconnect red, green, yellow and black wires at the junction box. If you are not using a junction box, disconnect at the instrument after shutting off the power.
4. Place the probe in pH 7 buffer. Allow enough time for the temperature of the probe and buffer to stabilize at room temperature.
5. Measure the resistance between the yellow and black wires to check the probe's temperature compensator. The resistance should be between 250 and 350 Ω at 25°C. If the resistance is within specifications the probe's thermistor is functioning correctly.
6. Reconnect the yellow and black wires and restore power to the instrument.
7. Measure the voltage between the red and green wires. If it is not within –50 to +50 mV the probe is defective. If the voltage is within this range proceed to the next step.
8. Rinse the probe and place it in pH 4 or pH 10 buffer. Allow it to stabilize then check the voltage again between the red and green wires. Measure the voltage and the change in voltage from the pH 7 output. If the change in voltage is between 100 and 230 millivolts (negative in 10 pH buffer, positive in 4 pH buffer) the probe is within specifications. Table 1 summarizes these acceptance criteria.

Table 1 - Acceptable Voltage Output for pH Probes

Buffer	Acceptable Output
pH 4	pH 7 + (170 to 230 mV)
pH 7	-50 to +50 mV
pH 10	pH 7 – (170 to 230 mV)

For measurements with the Shark controller or Shark TX transmitter use the Diagnostics menu.

5.1.2. ORP Probes R60

1. For ORP probes two calibration solutions, 200 and 600 mV, are required. ORP solutions may be ±20% of nominal value. The actual value is noted on the bottle.
2. Clean the probe as described in Section. 4.1. If the system cannot be calibrated, replace the salt bridge and 7pH buffer solution as described in 4.2. If the system still can't be calibrated check the probe as follows:

3. Disconnect red, green, yellow and black wires at the junction box. If you are not using a junction box, disconnect at the instrument after shutting off the power.
4. Place the probe in 200 mV solution. Allow enough time for the temperature of the probe and solution to stabilize at room temperature.
5. Measure the resistance between the yellow and black wires to check the probe's temperature compensator. The resistance should be between 250 and 350 Ω at 25°C. If the resistance is within specifications the probes thermistor is functioning correctly.
6. Reconnect the yellow and black wires and restore power to the instrument.
7. Measure the voltage between the red and green wires. The reading should be between 160 and 240 mV; otherwise, the probe is defective. If the voltage is OK proceed to the next step.
8. Rinse the probe and place it in 600 mV solution. Allow it to stabilize then check the voltage again between the red and green wires. If the voltage is between 560 and 640 mV, the probe is within specifications.

5.2. Troubleshooting

A pH or ORP probe is a simple instrument. As a potentiometric device it outputs a voltage in response to a change in pH or ORP.

A pH probe that is not functioning properly will output a voltage that is out of range of the specifications listed in Table 1.

The ORP sensor is unique in that the voltage is the ORP reading. There is no span between readings of two calibration solutions. However mA readings should be within the ranges stated in Section 5.1.

If the change in pH probe output when going from pH 7 to pH 4 or 10, or the absolute reading of the ORP probe does not fall within the ranges listed in Section **Error! Reference source not found.**, then the cause of the problem may be one of the following:

1. The process electrode (glass bulb) is coated with scaling or biofouling.
2. The process electrode is inoperable (likely broken).
3. The reference solution has been contaminated with the process to the point that it is no longer pH 7.
4. The salt bridge has fouled to the point that reference solution cannot pass through that is needed to complete the potentiometric circuit.
5. The printed circuit board (PCB) has shorted out by ingress or the op-amp on the board has failed.

The manifestations of these different sources are as follows:

1. A coated electrode (1) will create a narrower span or reduced ORP readings. If the coating is from scaling then soaking the probe in a weak acid (e.g. vinegar or 0.1 M HCl) will remove the scale. If the coating is from fouling then soaking the probe in bleach will clear it.
2. Either problems 2 or 5 If the pH or ORP reading does not change when changing from one calibration solution to another then either the cause is a failed PCB (5) or broken electrode (2).
3. A contaminate reference solution (3) will result in both a lower span and higher offset for pH probes or an erroneous ORP reading.
4. A fouled salt bridge (4) will result in a slower response but not necessarily a narrower span or inaccurate ORP readings. AquaMetrix sells replacement salt bridges at very modest pricing.

5.3. Customer Service

If a problem has not been resolved with the above procedures, a telephone consultation with your AquaMetrix representative, or directly with Water Analytics will provide the answer.

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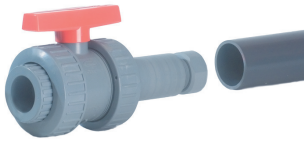
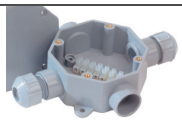
If you are returning a probe for inspection, enclose description of the problem. Pack the probe adequately to avoid damage to the glass electrode and ensure that it will not be exposed to temperatures below –5°C. Water Analytics cannot be responsible for shipping damage nor for damage due to frozen electrodes. For safety reasons, Water Analytics cannot accept probes which have not been thoroughly cleaned to remove all process material.

5.4. Parts and Accessories

Description	Part #
Submersion Mounting Kit for Series –8 Probes	STC60L
Submersion Mounting Kit for Series –6 Probes	STC60-6
Protective shroud for Series –8 Probes	PROTECTOR-3
Protective shroud for Series –6 Probes	PROTECTOR-6
Hot/Wet tap Ball Valve Assembly for Series –7	P60-HTC
Union Mounting Tee w/ Adaptor for Series –8	AM-MH538N9A
500 mL pH 7 Buffer Solution	A35-14
4L pH 7 Buffer Solution	A35-118
500 mL pH 4 Buffer Solution	A35-13
4L pH 4 Buffer Solution	A35-117
500 mL pH 10 Buffer Solution	A35-24
4L pH 10 Buffer Solution	A35-119
500 mL 200mV Buffer Solution	A35-40
4L 200mV Buffer Solution	A35-115
500 mL 600mV Buffer Solution	A35-41
4L 600mV Buffer Solution	A35-116
Salt bridge kit for Series –4, –6, –7 & –S (Package of 3 salt bridges and cell solutions)	C35-17(K)
Salt bridge kit for Series –8 (Package of 3 salt bridges and cell solutions)	AM60-9765(K)
Junction box with terminal strip	JB-1
50 ft. 5-wire Interconnect cable dressed both ends	C42-5P-050

Probe and Accessory Photographs

P/R-60-C-8		P/R-60-C-5	
P/R-60-C-5		P/R-60-C-7	
AM-6010 AM-6040		P/R-60-C-4	
P/R-60-C-S		P/R-60-C-5-S	
Protectors -8: PROT 3 -5: PROT 5		Jet Cleaners -8: AM-JT8 -5: AM-JT5	
Salt bridge Kit		-8, -5: AM60-9765K -6: C35-17K Each kit holds 3 salt bridges and 1 vial of pH 7 Buffer solution	
Hot Tap Assembly P60-HTC		Submersion Hardware STC 60L (for -8, -5 probes)	
Union Tee AM-MH538N9A (for -8 probes)		Junction box JB-1	
pH Calibration Solutions 4: A35-17 7: A35-14 10: A35-24		ORP Calibration Solutions 200 mV: A35-40 600 mV: A35-41	

6. DRAWINGS

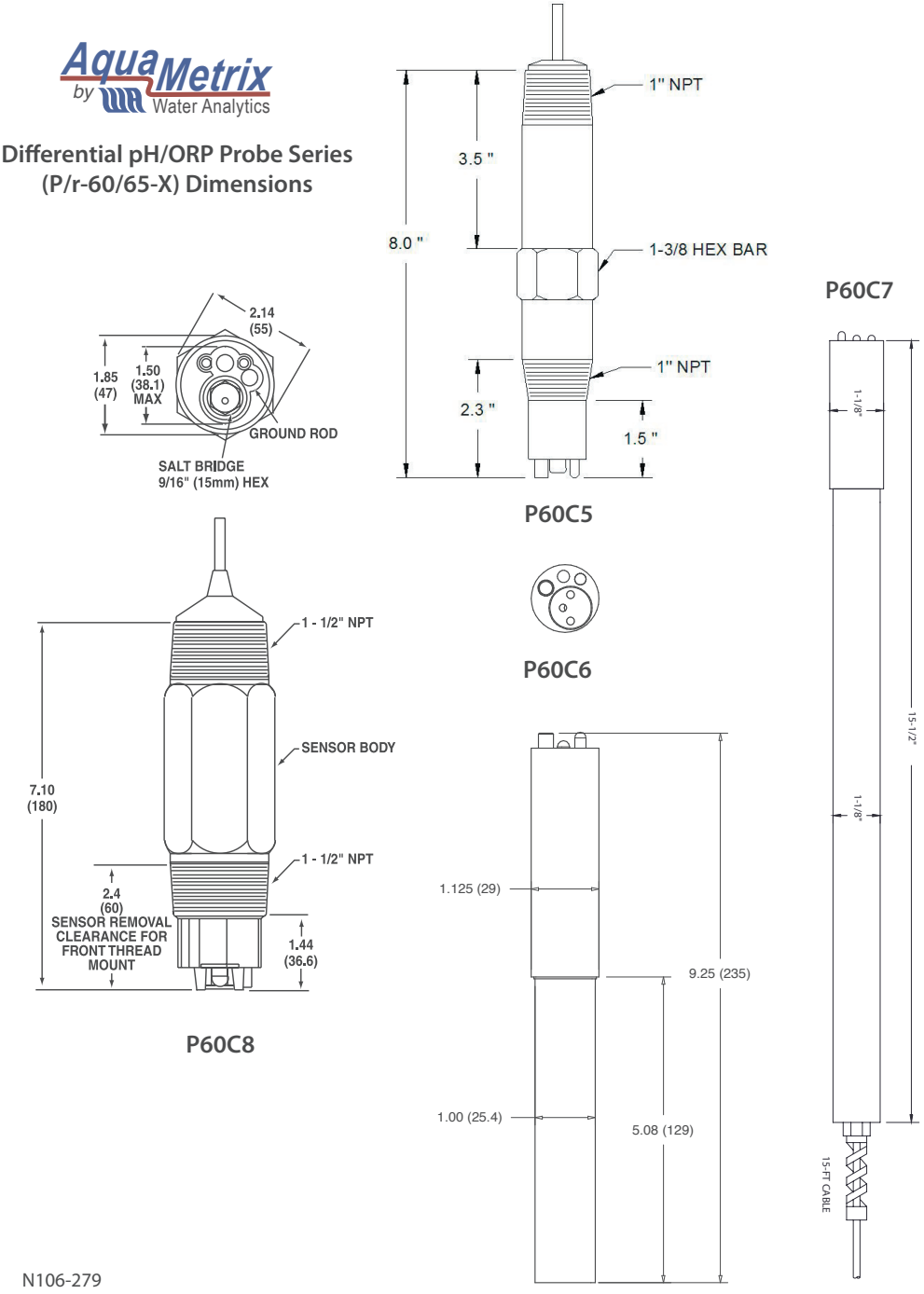


Figure 3 - Differential Probe Dimensions

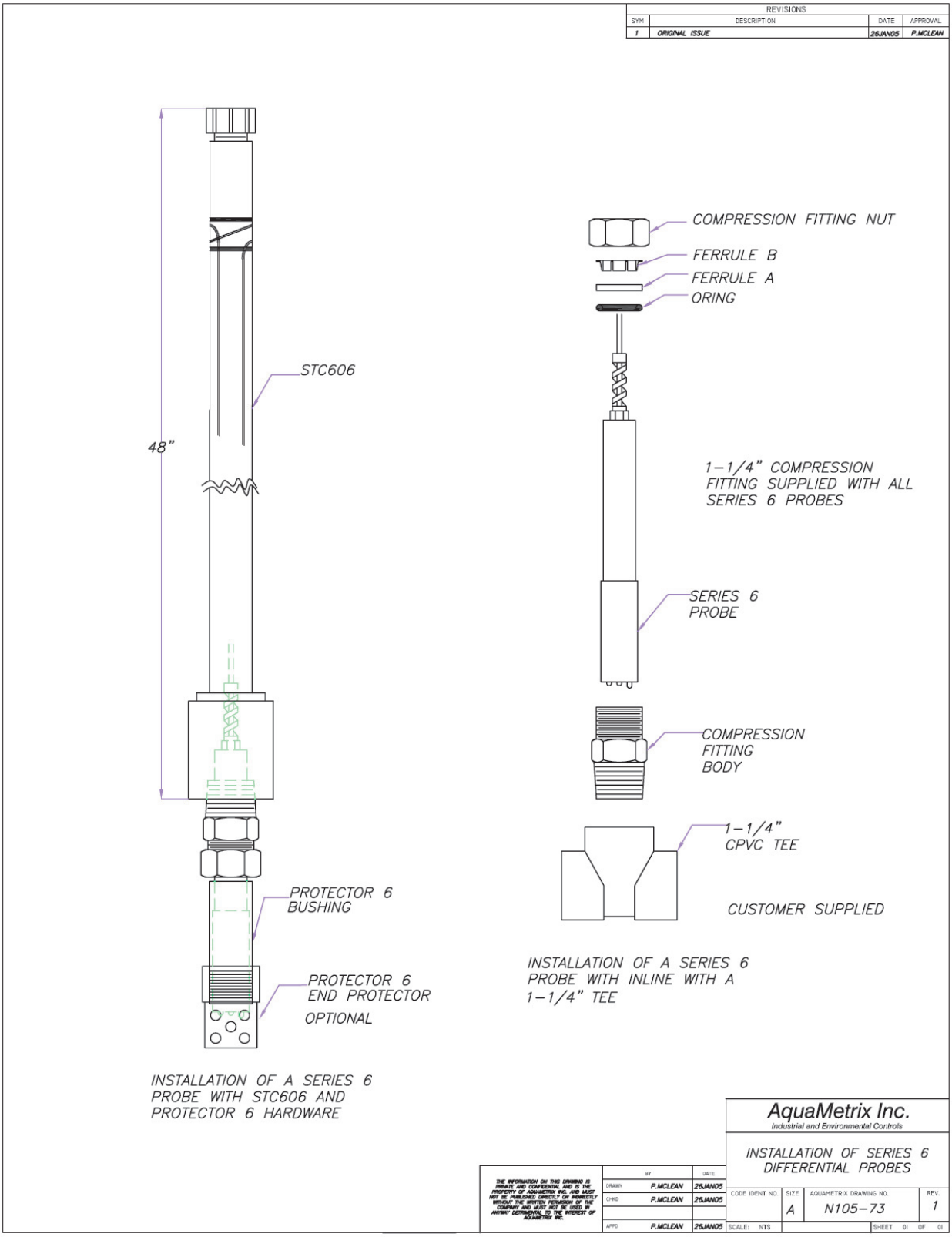


Figure 4 - Installation of Series 6 Differential Probes

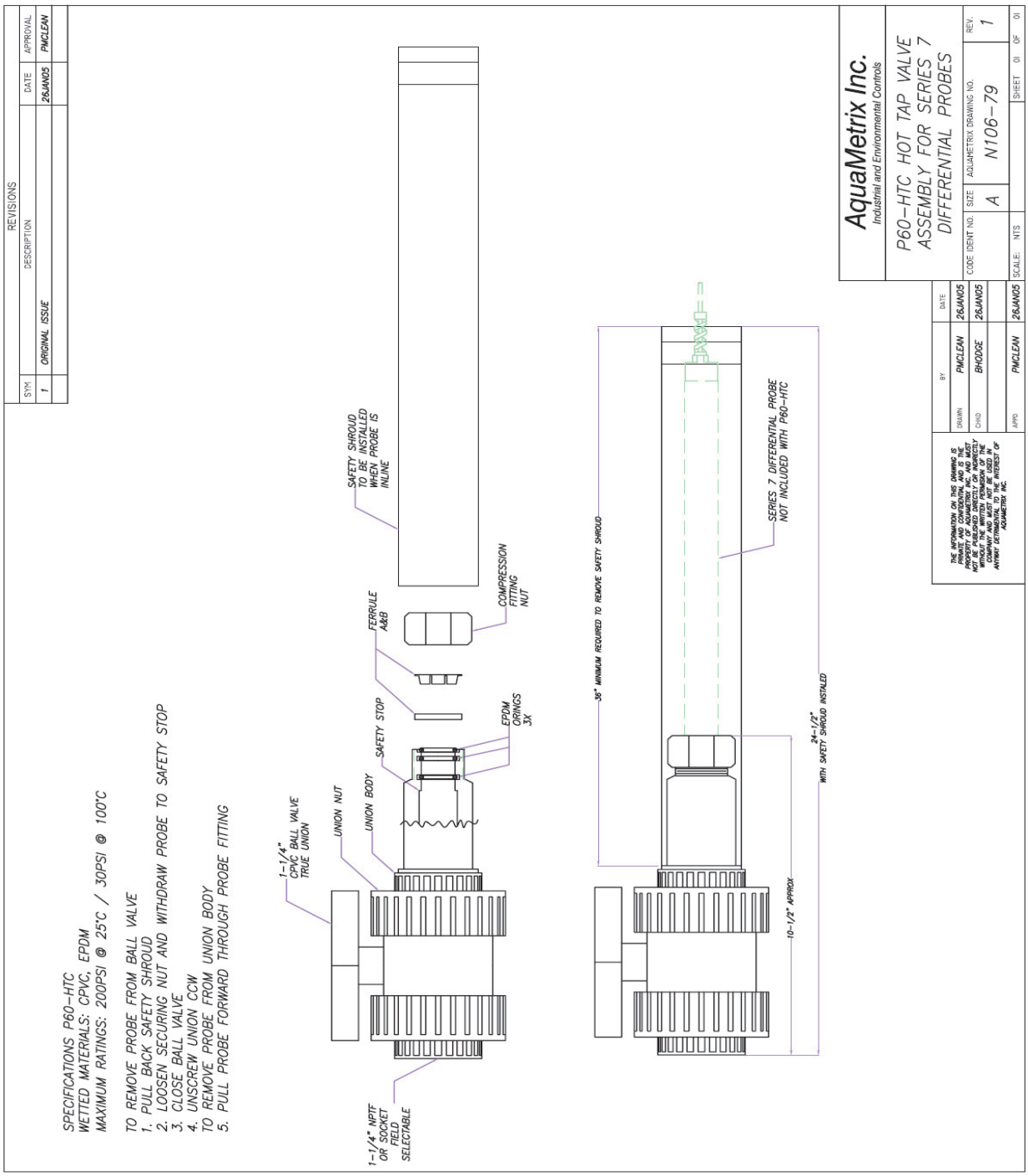


Figure 5 - Installation of Series 7 Differential Probes

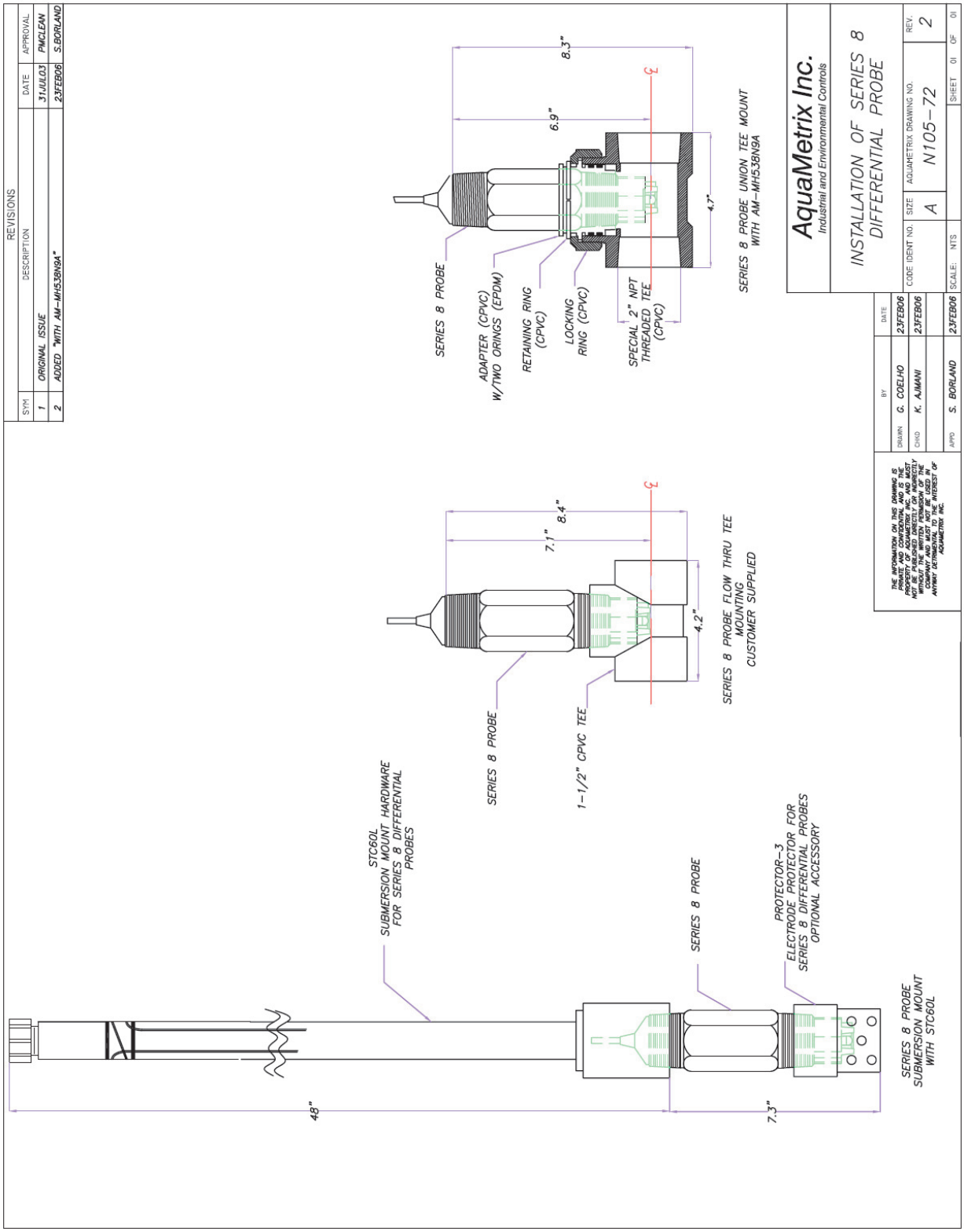


Figure 6 - Installation of Series 8 Differential Probes

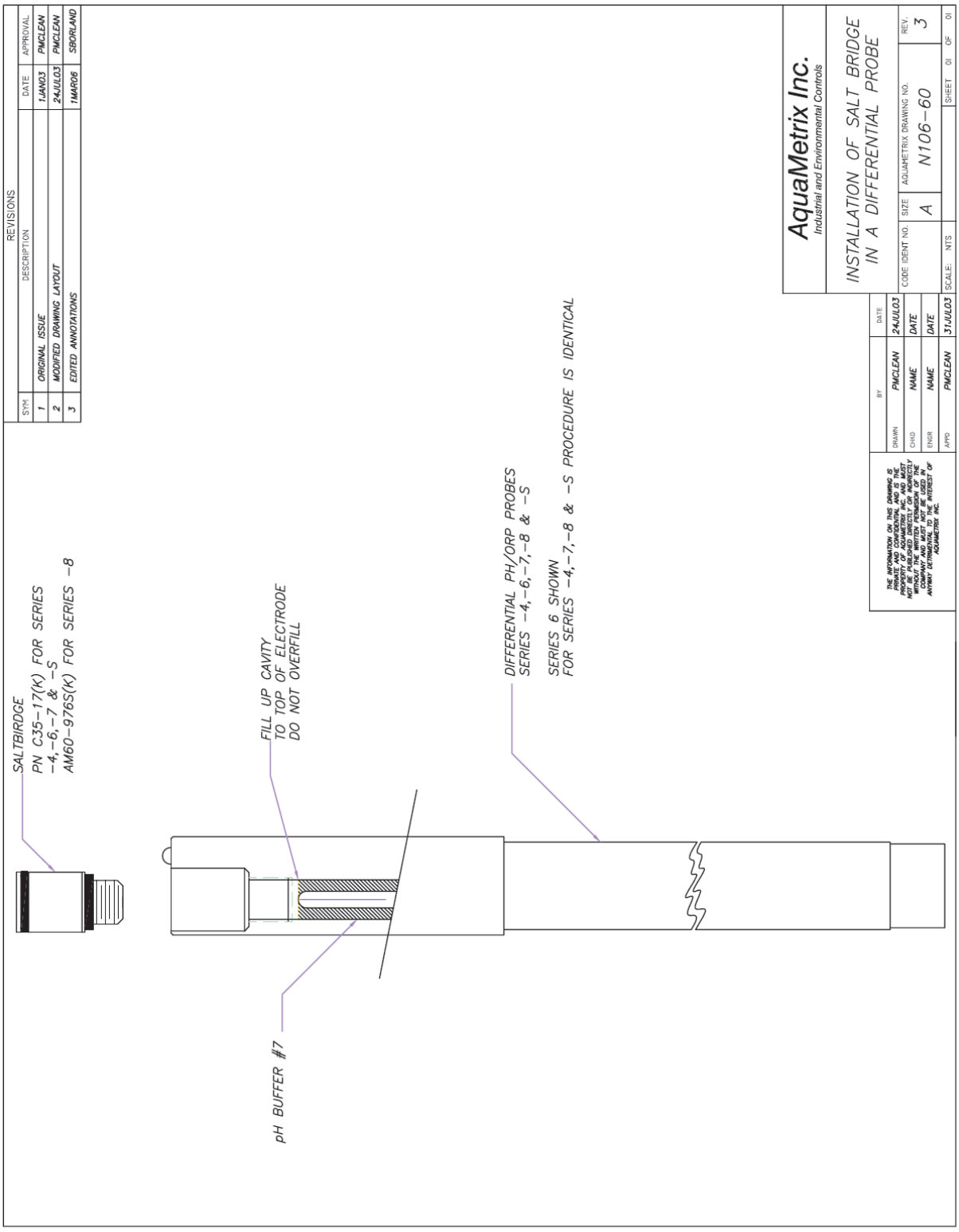


Figure 7 - Installation of a salt bridge in a differential probe. The probe pictured is a series 6 or 7 probe. For a series 8 probe a hex driver is used to remove and install the salt bridge.

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