PALO VERDE
NUCLEAR GENERATING STATION

HVAC Training

Classroom Lesson

HVAC Training	**Date: 2/2/2011 10:28:35 AM**
LP Number: NMH30L050001	**Rev Author: RON NEWELL**
Title: Calibrate Chiller water flow transmitters and rate meters	**Technical Review:** Williams, Donnell L(Z08141) Digitally signed by Williams, Donnell L(Z08141) DN: cn=Williams, Donnell L(Z08141) Reason: I have reviewed this document Date: 2011.02.15 16:11:08 -07'00'
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INITIATING DOCUMENTS

HVAC Technician Training Requirements

REQUIRED TOPICS

None

CONTENT REFERENCES

Electrical Safe Work Practices 01DP-OIS13

01DP-0IS13 ELEC. SAFE WORK PRACTICES

VTD-O045-00002 OMEGA PX771 Differential Pressure Transmitter

VTD-O045-00003 OMEGA DPF64 Digital Rate Indicator

VTD-C150-00113 Carrier Product Integrated Control

LESSON PLAN REVISION DATA

Feb 02, 2011	Ron Newell	Record created

Tasks and Topics Covered

The following tasks are covered in Calibrate Chiller water flow transmitters and ratemeters :

Task or Topic Number*	**Task Statement**

Lesson: Calibrate Chiller water flow transmitters and ratemeters

CHL81	Calibrate flow indicators
CHL84	Calibrate flow switches

Total task or topics: 2

TERMINAL OBJECTIVE:

1 Given the applicable work instructions, reference documents, and M&TE the trainee will, calibrate chiller flow transmitters and ratemeters Mastery will be demonstrated by class participation, and successfully completion of laboratory practical evaluations.

1.1 Discuss transmitter component description

1.2 Discuss transmitter theory of operation

1.3 Discuss transmitter mounting.

1.4 Discuss transmitter housing rotation.

1.5 Discuss transmitter wiring.

1.6 Discuss loop powered indicator option

1.7 Discuss ratemeter description

1.8 Discuss ratemeter specifications.

1.9 Discuss ratemeter wiring

1.10 Discuss ratemeter definitions

1.11 Discuss ratemeter programming

1.12 Discuss calibration setup

1.13 Discuss calibration adjustments

1.14 Calibrate chiller flow transmitter and ratemeter in a loop configuration.

TO: 1 **Given the applicable work instructions, reference documents, and M&TE the trainee will, calibrate chiller flow transmitters and ratemeters Mastery will be demonstrated by class participation, and successfully completion of laboratory practical evaluations.**

EO: 1.1 Discuss transmitter component description

EO01 Discuss transmitter component description

CONTENT

The Series PX771A Differential Pressure (DP) Transmitter measures the pressure differential existing across an orifice plate or similar type device and converts it into a proportional 4-20 mA or a 1-5 Vdc signal that can be applied to the input of a device such as a flow computer, controller, recorder, etc. This transmitter is typically used with gas, water and chemical processes to provide accurate measurements under extreme environmental conditions.

The DP transmitter is offered in ranges from 0-100 inH_2O to 0-300 psi. A listing of ranges for the Series PX771A is given in Table 1A-A.

The transmitter can be installed on a DP pressure manifold or it may be specified with a universal mounting bracket. The bracket permits the unit to be clamped to a two-inch pipe or secured to a support structure.

The transmitter electronics enclosure is constructed of cast aluminum. The diaphragm, flanges, flange bolts and the manifold are offered in two materials; stainless steel, and Hasteloy C.

METHODS & ACTIVITIES

Start Powerpoint presentation slides 1-3

Students use hand out

We use orifice plates

We use 4-20ma input to the ratemeter

WC uses 0-100 in, except for unit one which has a 0-150 in. Rosemount transmitter.

NC uses 25 psig transmitter

EO: 1.2 Discuss transmitter theory of operation

EO02 Discuss transmitter theory of operation

CONTENT

METHODS & ACTIVITIES

Powerpoint slide 3

The main assemblies of the DP transmitter are the electronics housing, sensor module and process flanges. The electronics housing encloses the amplifier board and the field wiring terminals. The sensor module contains the pressure sensor, two sealed fluid systems, an overpressure diaphragm, and two isolation diaphragms. The flanges provide the HI and LO port connections and also function as the outer wall of the pressure input chambers.

The electronic pressure sensor located at the upper part of the sensor module is mounted on a micro diaphragm that serves as a divider between the two fluid systems. One fluid system corresponds to the HI pressure input, and the other to the LO pressure input. The isolation diaphragm of each system isolates the fluid system from the input pressure.

When a differential pressure is applied across the HI and LO ports, both isolation diaphragms will compress or retract in response to the change of differential. The movement of these diaphragms causes similar pressure changes in each of the sealed fluid systems that are detected by the sensor.

If the differential pressure applied to the HI-LO ports accidentally exceeds the upper limits of the transmitter, an overpressure diaphragm mechanism takes control of the situation. The action of this mechanism prevents the overpressure from reaching the sensor, thereby minimizing the risk of damage.

Implanted on the sensor's micro-machined surface are four strain gauge resistors connected in a bridge configuration. This circuit, which is powered by a constant current supply on the amplifier board, produces a millivolt output that is equal to the difference between the two pressure inputs.

CONTENT

METHODS & ACTIVITIES

The output of the sensor circuit is wired to a high-gain, linear amplifier that converts the millivolt signals to a 4-20 mA current output. The transmitter output wired to a typical external loop circuit. This circuit uses a 250-ohm load resistor and a 24 V dc power source. The 4-20 mA amplifier current flowing through the load resistor produces a 1-5 V input signal for the external device.

The amplifier circuit includes a fine-gain and fine-offset potentiometer for performing minor calibration adjustments. Transmitters also include internal coarse zero and coarse span switches for more extensive range conversion.

EO: 1.3 Discuss transmitter mounting.

EO03 Discuss transmitter mounting

CONTENT

The transmitter may be mounted in any position. However, when it leaves the factory it is calibrated for operation in the upright position with the electronics enclosure at the top and the DP connections at the bottom. If it is installed in a different position, the transmitter may require a slight zero adjustment.

METHODS & ACTIVITIES

Powerpoint slide 5

Student handout page 1A-7

Discuss our mounting configuration

Discuss the process of flipping the hi and lo side manifold blocks.

EO: 1.4 Discuss transmitter housing rotation.

EO04 Discuss transmitter housing rotation

CONTENT

Once mounted, the Transmitter Housing can be rotated up to 180° in either direction, i.e., clockwise or counterclockwise. The Transmitter Housing must not be rotated from its shipped position any more than 180° clockwise or counterclockwise. ***CAUTION: Transmitter will be damaged if the Transmitter Housing is rotated more than 180° from its shipped position.***

To rotate the Transmitter Housing, the set screw that locks the Pressure Transducer to the Transmitter Housing must be removed with a 3mm Hex Wrench. Once the Transmitter Housing has been turned to the desired position, be sure to replace and tighten the set screw.

METHODS & ACTIVITIES

Powerpoint slide 7

Student 1A-8 and 1A-9

Show to class the transmitter set screw.

EO: 1.5 Discuss transmitter wiring.

IEO05 Discuss Transmitter wiring.

CONTENT

METHODS & ACTIVITIES

Description

2.4 WIRING OF 4-20mA SIGNAL/POWER LOOP

PowerPoint slides Page 2-3 of transmitter student hand out.

The 4-20mA signal/power loop can be powered in two ways. First the loop can be loop powered by the receiving device (controller, recorder, etc.), or the loop powered by an external supply. In both instances, the 4-20mA current flows through a 250Ω load resistor and develops a corresponding 1-5V input for the receiving device.

Signal Shielding: Use twisted wire, shielded cable covered by insulating material for the signal/power wiring. When properly grounded, this cable will minimize pickup of electromagnetic, and radio frequency interference.

We do not use shielding cable.

Show the PIC panel print and explain the wiring configuration that shorts the circuit out when not in use.

The shield lead of the cable is typically grounded at the input of the receiving device (computer controller, recorder, etc.) . Never connect the other end of this shield to the transmitter enclosure or attempt to ground the shield at more than one point along the wire path. Multiple grounds will cause signal errors at the input of the receiving device.

Although it is recommended to connect the cable's shield to the power common return of the receiving device, the actual connection point may differ depending on the design and application of the device. In some instances, better noise immunity can be had by connecting the cable shield to the chassis or a designated shield terminal on the device. Check the instruction manual of the receiving device for the recommended connection points.

EO: 1.6 Discuss loop powered indicator option

EO06 Discuss loop powered indicator option

CONTENT

The loop powered indicator (LPI) option is used to provide local indication in engineering units of the measured represented by a 4-20 mA current loop. The LPI may be installed in a Series PX725A, PX726A or PX771A Transmitter with the Display Cover Assembly or in a stand-alone housing. The LPI is powered by the 4-20 mA current loop using less than 500 uA @ 3 V for the electronic circuitry.

The LPI option is a circuit board assembly with a micro-controller, a liquid-crystal display (LCD) and active electronic circuitry contained on a single board, i.e., the "Meter/Display Board." The Meter/Display Board plugs into the "Meter Motherboard" that provides the electrical connections from the transmitter interface and allows the display to be rotated in 90-degree increments.

1.1.1 Features

I. Powered by a 4-20 mA current loop using less than 500 uA @ 3V
II. Dual Board Set - Meter Motherboard allows the Meter/Display Board to be rotated in 90-degree increments.
III. 4½ Digit Display allows display of numeric values as large as 19999.
IV. Eight selectable unit labels: mA, %, psi, IN H2O, bar, kg/cm2, °C, and °F.
V. One selectable "no-label" position.
VI. Reverse polarity protection.
VII. Over current protection

METHODS & ACTIVITIES

Powerpoint slide 8

Reference Appendix B of Omega student handout.

Demonstrate scrolling thru the units on lab mock-up.

EO: 1.7 Discuss ratemeter description

IEO07 Discuss ratemeter description

CONTENT

Description

- Featuring 6 digits of bright, 7-segment Led displays
- Integrating totalizer/ratemeter
- Accepts analog signal inputs
- Programmed to accept 0-20mA, 4-20mA, 0-5v, 0-10v, or 1-5v.
- Optional Square Law input is available
- Programmable high and low scalings settings from front panel

METHODS & ACTIVITIES

Powerpoint slides12-13

Page 2-3 of OMEGA ratemeter student hand out.

EO: 1.8 Discuss rate meter specifications.

EO08 Discuss ratemeter specifications

CONTENT

- Display: 6 digit .55” high and LED
- Input power 120 volt
- Output power plus 24VDC
- Memory: EEPROM stores data for ten years if power is lost.
- Reset: Front Panel: resets displayed values and control outputs.
- Remote: 4-30 VDC positive edge, resets totalizer and control outputs.
- Control Outputs:
  1. Standard-Open collector sinks 250 mA from 30VDC when active.
  2. Optional- 2 each form C SPDT 10AMP
- Inputs:
  Standard-linear 0-20mA, 4-20mA, 0-5V, 0-10V or 1-5V
  Optional-Square root Law 4-20mA, 0-5V, 0-10V or 1-5V
- Calibration: The unit does all of the calibrations internally. There are no potentiometers to adjust and the unit never needs to be removed from the case.
- Set points: The two control set points can be set at any number from 0 to 59999.
- Rate Display: Updates 5 times per second, Accurate to 4.5 digits.
- Totalizer: Integrates from the rate reading and accumulates up to 6 digits of total count. The time base hours, minutes or seconds is field programmable from the front panel.

METHODS & ACTIVITIES

Student handout page 2

EO: 1.9 Discuss ratemeter wiring

EO09 Discuss ratemeter wiring

CONTENT

I. Typical Wiring Hookups

- 2-Wire 4-20mA Transmitter

METHODS & ACTIVITIES

Page 5 student handout

Show ratemeter wiring using the our PIC panel drawing.

EO: 1.10 Discuss ratemeter definitions

EO10 Discuss ratemeter definitions

CONTENT

- Input
- 4-20
- Linear
- 59rt
- Relays
- Hys A
- LoC
- LC ALL
- Setup
- SEE Lo
- SEE Hi
- Lo Cut
- nor
- Pre A

METHODS & ACTIVITIES

Page 7 of Student handout.

Review each difinitions.

EO: 1.11 Discuss ratemeter programming

EO11 Discuss ratemeter programming

CONTENT	METHODS & ACTIVITIES
VIII. Step 1 – Setting Input	Page 10 of student handout.
• Press prgm – displays input	This section of the menu is used to set p the type of signal the unit will be receiving.
• Press Enter – select 4-20 mA	Press the PRGM key to step through choices. Press the RST/Enter key to enter the displayed choice.
• Press Enter – select 59rt	This section will appear on units with the square root extraction option. Press the PRGM key to toggle between the choices and press the RST/ENTER key to enter the desired choice.
II Step 2 – Setting Relays • Press PRGM twice – displays input and relays	This section of the menu sets up the open collector outputs and/or relays.
• Press Enter – HYS A	The number of units below the preset that the output will remain on. Our set-point is 200
• Press Enter – view units or change	This will be our cut-out value.
• Press Enter – HYS B	The number of units below the preset B that the output will remain on.
• Press Enter – view units for HYS B	Enter zero as the value, we use only HYS A.

METHODS & ACTIVITIES

CONTENT

III Step 3 – Setting Locks

- Press Enter 3 times

This section of the menu is used to set up the lockout type and code.

- Press enter – LC All

Locks program and presets

- Press enter – Code

When code is displayed, press any key o view existing lock code. To change the code press he key under each digit to be changed. Press RST/ENTER to enter displayed valve.

IV Step 4 – Setting Setup

- Press PRGM 4 times - Setup

This section of the menu is used to set up important operating variables.

- Press enter – redec.

RDEC = rate decimal location.

We are unable to change this value or units.

- Press enter – set lo

SET LO = Rate value for lowest input. We set this at zero. Key in the desired low value and press enter to enter displayed value.

- Press enter – set hi

SET HI = Rate valve for the highest input. This will be 1837 for WC flow unit one (C) Chiller and 1500 for all other WC flow inputs. Due to unit one having a 0-150 transmitter. The set point for NC is 3223. Key in the desired hi value and press enter.

- Press enter – Lo Cut

Lowest rate value to be recognized. Enter a value of zero and press enter.

CONTENT	METHODS & ACTIVITIES
• Press enter – nor	Normalizing or averaging factor we set ours at 10.0. you can change this value back to zero during calibration but remember to reset to 10.0. Key the desired value and press enter.
• Press enter.	To leave programming mode.
V Step 5 – Setting the Presets	
• Press – Pre A menu button	PRE A = Preset A The set point at which output A will trigger. HVAC technician may refer this to the Cut-in. WC set-point 1000 NC set-point 1800
• Press – Pre B menu button	PRE B = Preset B the set point at which output B will trigger. We set at 0.
VI Step 6 – Setting the lock status	We currently due not untilizes the lock status

EO: 1.12 Discuss calibration setup

EO12 Discuss Calibration setup

CONTENT

Equipment Recommended

A. Test source capable of generating fixed pressure values equivalent to 0%, and 100% values of transmitter's range.
B. Pressure monitor device to read test source
C. Electrical supply source capable of producing 24V-DC power to the transmitter.
D. Digital Multimeter with a 5-1/2 digit scale
E. Current sampling Resistor

Lab Vs. On-site Setup

Although it is more convenient and recommended to perform this procedure using a laboratory setup, calibration can also be performed on site providing that the connecting line or flange is equipped with a calibration tap and appropriate shutoff and bypass valves. This added equipment allows you to feed in an external test pressure source or use the process pressure as a reference signal. In the latter setup, the valves are closed to seal a fixed pressure in the connecting line. Only fine calibration using the external adjustments should be attempted in wet, dusty, or hazardous environments.

METHODS & ACTIVITIES

Page 3-1 student hand out

Discuss out M&TE requirements.

Discuss shop versus on site calibration setup.

CONTENT

METHODS & ACTIVITIES

Isolating the instrument

1. Major concerns when isolating & restoring instrument
   A. Damaging the assembly
   B. Keeping wet legs wet and dry legs dry
   C. Air bubbles
   D. Valve mispositioning – as-left configuration
   E. Valve / instrument identification
   F. Safety – venting high pressure

Discuss the requirements of manipulations of valves.

(Conduct of maintenance)

(Component manipulation log)

Discuss using (water bottles) to keep wet legs wet and the benefits.

Flow instruments

2. Sequence for removal from service
   A. Shut the high pressure isolation valve
   B. Open the equalizer
   C. Shut the low pressure isolation valve
   D. Shut the equalizer line in connection lines to the dragon valve manifold.

Flow instruments

3. Sequence for return to service
   A. Verify both isolation valves are shut and equalizer valve is open.
   B. Open the low pressure isolation valve
   C. Shut the equalizer
   D. Open the high pressure isolation valve
   E. Loosen cap on the top of the valve assembly and vent entrapped air.

CONTENT

SOER 85-02 Documents valve mispositioning events involving human error.

A. Mispositioned valves have resulted in degradation of safety systems and reduced plant availability.
B. Mispositioned Auxiliary Feedwater valves contributed to the Three Mile Island event.
C. Mispositioning of valves occurs most frequently during maintenance, calibration or modification activities.
D. This included instrument isolation valves

METHODS & ACTIVITIES

What could you do to prevent this from happening?

Palo Verde Standards and Expectations booklet.

EO: 1.13 Discuss calibration adjustments

EO13 Discuss calibration adjustments

CONTENT

The external adjustments are for fine offset and fine gain settings. The offset adjustment screw will not affect the gain. That is, adjusting the offset (A1) screw will move both calibration points equally. The gain adjustment will also affect the offset of the instrument. That is, adjusting the gain (A2) screw moves the end point unequally. To minimize the interaction of the gain, it is best to adjust the offset screw for full scale output while full scale pressure is applied and adjust the gain screw for a zero output while minimum pressure is applied.
To access the fine offset (A1) and fine gain (A2) adjustment screws, loosen the screw that secures the I.D. Plate to the top of the transmitter housing and pivot the I.D. Plate. The fine offset and gain screws are labeled A1 and A2 respectively. The calibration label that identifies A1 and A2 is affixed to the top of the transmitter housing and will be exposed when the I.D. Plate has been pivoted.

Removing the end cover accesses the transmitter's coarse calibration adjustments. Once the cover is removed, the adjustments appear as shown in Figure 3-2.

The PX771A Series Transmitter can be configured for either voltage, or current output. To change the setting, simply change the position of the voltage/current jumper (JP1-JP8). Note that the field wiring must also change if converting from voltage to current mode.

METHODS & ACTIVITIES

Powerpoint slide

Show transmitter adjustments.

METHODS & ACTIVITIES

CONTENT

ACCESS TO ADJUSTMENTS

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CONTENT

METHODS & ACTIVITIES

EXTERNAL CHECK PROCEDURE

The general check procedure determines the accuracy of the transmitter at its calibrated operating range. It uses the offset (A1) and the gain (A2) adjustment screws for minor calibration corrections. Proceed as follows:

1 Provide a test setup as shown in Figure 3-1a or 3-1b depending on whether the unit has been configured for current or voltage mode. Make sure that no electrical power is applied to the transmitter while making connections. The Multimeter must be set in “Voltage” mode.
2 Set the DMM to a scale that will cover a 1-5Vdc range.
3 Apply 24Vdc power to the transmitter.
4 Set the pressure test source for a precise 0% range value. The DMM should display 1.00Vdc ± 4mV (4mA dc ± 0.016mA).
5 Similarly, adjust the pressure test source for 100% range value. The DMM should read 5.00Vdc ± 4mV (20mA dc ± 0.016mA).
6 If the readings of steps 4 to 6 are within tolerance, no calibration is required. Testing is complete. However, if any readings were in error, proceed to step 7.
7 Set the test pressure source to 100%. If this reading is out of tolerance, correct it by turning the A1 adjustment screw (clockwise rotation increases the reading).
8 Reset the test pressure source to 0%. If this reading is out of tolerance, correct it by turning the A2 adjustment screw (clockwise rotation decreases the reading).
9 Recheck the 0%, and 100% readings. Repeat steps 7 and 8 as needed. This may need to be done two or three times. If errors are still present at full-scale pressure, recheck the switch settings. If the DIP Switch is in the correct configuration, proceed to step 10. If errors are encountered at 0%, recheck the Rotary Switch settings. If the switch is in the correct position, proceed to step 10.
10 If the above three readings cannot be brought into proper calibration, the transmitter may require service or replacement. See Section 5, Service, for troubleshooting hints.

CONTENT

METHODS & ACTIVITIES

The range changing procedure uses the coarse span (SW1) and zero switches (S1:1-8), along with the fine offset (A1), and gain (A2) adjustment screws. The locations of the switches are shown in Figure 3-2. The equipment setup required to perform range changing is the same as that described in topic 3.1. The coarse zero switches are contained in a single DIP switch package, with the switches labeled from 1 to 8, with either a "1" or a "0" silk-screened on the board. The coarse span switch is a 10 position rotary switch.

TYPES OF RANGE CALIBRATION

When selecting a range, one of three types of calibration schemes will be encountered. Each of these three methods refers to the manner in which a 0 psi input signal is referenced to the 1-5V output of the transmitter. The three methods are defined as follows:

Zero Based Calibration:

0 psi = 1V (4mA) output
Sample Ranges:
0 to 50 psi
0 to 100 psi

Elevated Zero Calibration:

0 psi > 1V (4mA) output [0 psi results in an output greater than 1V (4mA)]
Sample Ranges:
-10 (vacuum) to +20 psi
-30 to 0 inHg

EO: 1.14 Calibrate chiller flow transmitter and rate meter in a loop configuration.

EO14 Calibrate chiller flow transmitter in a loop configuration.

CONTENT

METHODS & ACTIVITIES

II. Demonstration

A. Prior to performing the demonstration have the trainees perform the hazard assessment and afternoon what PPE is required for the task. Using the lab practical evaluation and the work instructions, show the trainee how o perform the calibration. An optional exercise is to have one of trainee's perform the calibration as you explain the process. Based on the experience of the trainee, have one trainee read the instruction and the other performs the task. Self check/Peer.

Reference: Palo Verde Standards and Expectations.

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.