PALO VERDE
NUCLEAR GENERATING STATION

HVAC Training

Classroom Lesson

HVAC Training	**Date: 2/3/2011 3:59:21 PM**
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Title: Calibrate Chiller Controls & Indicators	**Technical Review:** Williams, Donnell L(Z08141) Digitally signed by Williams, Donnell L(Z08141) DN: cn=Williams, Donnell L(Z08141) Reason: I am approving this document Date: 2011.02.17 08:46:02 -07'00'
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INITIATING DOCUMENTS

15DP-OTR69 Training and Qualification Administration

Training Program Description for HVAC Maintenance

ACAD 02-001 The Objectives and Criteria for Accreditation of Training in the Nuclear Power Industry

REQUIRED TOPICS

CRDR 160240 & 13JC-EC-206 Compressor oil pressure trip set point.

CONTENT REFERENCES

CRDR 113265, Following the performance of 73ST-9EC01 STWO 00899693 The unit 1 essential chiller "A" tripped on high refrigerant temperature (TCS 01-1691)

CRDR 54074 (2-9-0093), Documents incorrect fuses installed in the control circuit for 2MECAE01 (TCS 01-1692)

CRDR 115605 Confusion exists within the electrical maintenance organization as to determining the % of repeat accuracy for agastat time delay relays, per table 1of 32MT-9ZZ82.

EIM 49-10, Operation and maintenance manual power system timer, model FT-2

EPA Section 608 Clean Air Act and 40 CFR, Part 82, Protection of Stratospheric Ozone; Refrigerant Recycling

Palo Verde Standards and Expectations

VTD-A109-001 Agastat qualified time delay relay

VTD-A109-002 Agastat electromechanical relays, switches, rotary drives.

VTD- C150-00004 CARRIER INSTRUMENT LIST FOR THE ESSENTIAL CHILLER [PUB.# PV-20]

VTD- C150-00015 CARRIER OPERATION AND MAINTENANCE INSTRUCTIONS FOR THE HOT GAS BYPASS.

VTD- C150-00016 CARRIER OPERATING AND MAINTENANCE INSTRUCTIONS FOR THE AUTOMATIC THERMAL PURGE RECOVERY SYSTEM.

VTD- U075-00014 UNITED ELECTRIC 400 SERIES SWITCHES FOR NEMA4 GENERAL PURPOSE SERVICE.

VTD- U075-00021 UNITED ELECTRIC 300 SERIES NON-INDICATING TEMPERATURE CONTROL INSTALLATION AND MAINTENANCE INSTRUCTIONS [PUB.#IM-320-

VTD- U075-00011 UNITED ELECTRIC 400 SERIES PRESSURE CONTROLS INSTALLATION AND MAINTENANCE INSTRUCTIONS [PUB.# IMI'400-03].

VTD- U075-00019 UNITED ELECTRIC DIFFERENTIAL PRESSURE CONTROLS TYPES J21K, 27K, J27C & INSTALLATION AND MAINTENANCE INSTRUCTIONS['PUB.# IMJ21KI

VTD- U075-00010 UNITED ELECTRIC PRESSURE CONTROL S6 SERIES PRESSURE CONTROLS INSTALLATION AND MAINTENANCE INSTRUCTIONS[.PUB.# IM6-01].

VTD- A501-00019 ASHCROFT SPECIAL SERVICE GAUGES

VTD- R290-00027 ROBERT SHAW SOLID STATE MOTOR PROTECTORS APPLICATION AND OPERATION MANUAL.

VTD- R290-OO028 ROBERT SHAW UNI-LINE 3433 SERIES SOLID-STATE MOTOR PROTECTION SYSTEMS PRODUCT PROFILE [PUB. # 12].

VTD- A501-00031 ASHCROFT DURA GAUGE MODEL 1320/1377.

VTD A501-0009 ASHCROFT PRESSURE GAUGE INSTALLATION INSTRUCTIONS [PUB. # 250-1997-B].

VTD-I204-0016 ITT BARTON MODELS 288A & 290A/B DIFFERENTIAL PRESSURE INDICATING SWITCHES [PUB. # 91BI]

Electrical Safe Work Practices 01DP-OIS13

OE13462 – A safety-related control room HVAC chiller trip due to a short in hot gas bypass valve actuator.

32MT-9ZZ82 Time Delay Relay Test

82DP-0PP01, Out of Tolerance Program Controls

LESSON PLAN REVISION DATA

Feb 03, 2011	Ron Newell	Removed flow transmitter and ratemeter from this lesson.

Tasks and Topics Covered

The following tasks are covered in Calibrate Chiller Controls & Indicators :

Task or Topic Number*	Task Statement
Lesson:	Calibrate Chiller Controls & Indicators
CHL60	Calibrate pressure switches
CHL66	Calibrate differential pressure switches
CHL63	Calibrate pressure indicators
CHL69	Calibrate differential pressure indicators
CHL72	Calibrate temperature indicators
CHL48	Adjust hot gas bypass valve cam assembly
CHL81	Calibrate flow indicators
CHL84	Calibrate flow switches
CHL75	Calibrate temperature activated switches
CHL123	Check calibration of chiller control panel modules
CHL46	Install hot gas bypass valve
CHL45	Remove hot gas bypass valve
CHL100	Calibrate agastat relays

Total task or topics: 13

TERMINAL OBJECTIVE:

1 Given the applicable work instructions, reference documents, and M&TE the trainee will, calibrate various chiller controls and indicators. Mastery will be demonstrated by class participation, and successfully completion of two laboratory practical evaluations and completing a written examination with a minimum score of 80%.

1.1 Calibrate pressure activated switches

1.2 Calibrate pressure indicators.

1.3 Calibrate Chiller temperature indicators.

1.4 Calibrate temperature activated switches.

1.5 Adjust the hot gas bypass valve.

1.6 Calibrate ITT Barton flow indicators and switches.

1.7 Check the calibration of control modules.

1.8 Perform agastat relay test per 32MT-9ZZ82

In this lesson the HVAC Trainee will learn how to perform the calibrations of the controls and indicators on the Normal and Essential chillers.

TO: 1 **Given the applicable work instructions, reference documents, and M&TE the trainee will, calibrate various chiller controls and indicators. Mastery will be demonstrated by class participation, and successfully completion of two laboratory practical evaluations and completing a written examination with a minimum score of 80%.**

EO: 1.1 Calibrate pressure activated switches

Introduction

In this objective the trainee will learn how to calibrate the pressure activated switches used on the chillers.

Main Idea

Assess and address workplace hazards.

Verify system is de-pressurized.

Live-dead-live check.

PPE for working on energized equipment.

1) Pressure controls are activated when a bellows, diaphragm or piston sensor responds to a pressure change. This response actuates a switch or switches, converting the pressure signal into an electrical signal. Opening or closing contacts.
   a) Diaphragm - Senses the process pressure on one side, and atmospheric pressure on the other side. The resultant motion is mechanically scaled to provide actuation of control switches.
   b) Bellows - Sensing element more sensitive than the diaphragm or bourdon tube. Process pressure is sensed inside the bellows, the bellows expands or contracts corresponding to the temperature. The process pressure can be either the refrigerant pressure or sensing bulb pressure.
   c) Piston - Similar to the diaphragm. Senses the process pressure on one side, and atmospheric pressure on the other side. The piston sensor can be used in higher pressure/special applications to provide actuation of control switches.

2) The first pressure operated switch we will look at is the **condenser refrigerant high pressure switch**.
   The function of this switch is to shut down (trip) the chiller if the condenser refrigerant pressure exceeds the set maximum point.
   This is a United Electric J6 control.
   a) It is mounted inside the control panel and is directly connected to condenser pressure.

b) J6 pressure controls are activated when a bellows or piston sensor responds to a pressure change. This response actuates a single snap-action switch, converting the pressure signal into an electrical signal.

c) Control set point may be varied by turning the internal adjustment screw according to the procedure outlined below:

i) Remove cover and gasket.

ii) The three switch terminals are clearly labeled common, normally open and normally closed.

iii) Connect an ohm meter to the switch to be tested.

iv) Disconnect the instrument lines at instrument and temporarily plug or cap.

v) Connect a pressure source.

vi) Apply pressure to obtain as found data.

vii) To make an adjustment to the setpoint turn the right hand adjusting screw.

viii) Turning this screw clockwise will increase the setpoint.

3) The next pressure activated switches we will look at is for the purge unit. The **purge operating pressure differential** and the **purge safety pressure differential** switches, both are United Electric, model J21KD.

a) The J21K Differential Pressure Switch utilizes opposing metal bellows to detect pressure differences between two pressure sources.

i) The bellows are connected to a mechanical linkage. When the pressure at the high port exceeds the pressure at the low port by a pre-determined amount, the mechanism operates a snap-action electrical switch.

ii) Apply test pressure to the high side, vent the low side.

b) Set point adjustment is achieved by varying the gap between the mechanical actuator and the plunger on the electrical switch.

i) To raise the differential pressure setting, turn the hex head screw out (to the left).

ii) To lower the differential pressure setting, turn the hex head screw in (to the right).

If any "as found" readings for either the purge operating pressure differential switch or the purge safety pressure differential switch are found out of tolerance, generate the appropriate administrative document to evaluate the impact on the out of tolerance.

4) The next pressure operated switch we will look at is the **compressor oil pressure differential switch**.

a) This is also a United Electric switch, model J27KB, it is mounted inside the control panel and is connected to the pressure.

i) This unit has two (2) electrical switches with independent adjustments.

ii) Apply test pressure to the high side, vent the low side.

iii) To raise the differential pressure setting, turn both of the hex head screws out (CCW).

iv) Switches may be set to operate together or apart up to 50% of the adjustable range.

v) The repeatability of this switch must be verified. Cycle switch through (pressure decreasing) the calibration 3 times.

The switch must be able to reset so that the trip set point and reset do not overlap. The dead band should not be so large as to interfere with normal system pressure (24 PSID). References: CRDR 160240 & 13-JC-EC-206

If any "as-found" readings are found to be out of tolerance. Generate the appropriate administrative document to evaluate the plant impact, and to document the failure on failure data trending information system.

(RCTS # 041747 N.O.D. IR 94-13, CRDR 94-0287)

Explanation

Use the power point presentation and pressure switches.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to calibrate pressure activated switches.

An optional exercise is to have one of trainee's perform the calibration as you explain the process.

Use Self check/Peer check.

EO: 1.2 Calibrate pressure indicators.

Introduction

In this objective the trainee will learn how to calibrate pressure indicators.

Main Idea

Assess and address workplace hazards.
Verify system is de-pressurized.

The terms listed below are optional information. It can be found in the Ashcroft handout.

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and down-scale, before and after lightly rapping the gauge to remove friction. A pressure standard with accuracy at least 4 times greater than the accuracy of the gauge being tested is recommended.

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leak tight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – Two checking techniques exist – direct and reverse reading. ASME B40.1 recommends the direct approach wherein **known** pressures are applied and readings are taken from the gauge under test. When the gauge under test has a relatively coarsely graduated dial, it is tempting to use the reverse method wherein the applied pressure is adjusted to precisely align its pointer with a dial graduation and then readings are taken from the pressure standard. The reverse reading technique is often misleading and should not be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1 on page 6) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap.

- Rap means lightly tapping the gauge before reading to remove friction as described in ASME B40.1.

Referring to Figure 1 on page 6, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is dropped or over pressured and the bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer.

- Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 on page 6 is not linear.

- The Ashcroft Duragauge is equipped with a rotary movement feature which permits the user to minimize this class of error.
- Other Ashcroft gauge designs (e.g., 1009 Duralife) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves.

- This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly rap-ping the gauge case. If excessive, the movement should be replaced (if replaceable by design). One possible cause of excessive friction is improper adjustment of the hairspring.

- The hairspring should be level and the coils should not touch or distort at any point between zero and full scale. The hairspring torque should also be at a near optimum level – adequate without being excessive.

1) There are several pressure indicators, gauges used on the chillers.
   a) To name a few; the compressor oil pressure differential indicator, the cooler refrigerant pressure indicator, and the condenser refrigerant pressure indicator.
      i) These gauges are a Bourdon tube type gauge.
      ii) The Bourdon tube is a circular stainless steel or bronze hollow tube inside a mechanical pressure gauge that is flattened to make it more flexible.
         (1) The tube moves according to the pressure in it, which changes the reading on the face of the gauge.
2) The **compressor oil pressure differential indicator** is an Ashcroft Differential Pressure gauge, Type 1125. This gauge is a single pointer gauge which indicates the difference between two independent pressure sources on a usual type dial.
   1) The type 1125A, also with a single pointer to indicate a pressure difference on a dial with 0 at top center.
      i) On Type 1125A Gauges the pointer reading is an indication of the amount of pressure the left-hand connection exceeds the right-hand connection or vice versa.
      ii) Always apply pressure to a gauge slowly. Do not open the gauge cock or valve too quickly--this imparts a severe strain on the Bourbon tube, which may rupture it, or result in shortened life.
      iii) Avoid over-pressure.
      When a gauge is over pressured to the extent of causing a pointer position shift of equal value all over the dial. The condition is known as "Set." If this occurs, the system should be discarded and replaced.

iv) Sudden pressure release has the same detrimental effect and should be avoided or compensated for.

v) When installing a gauge use a wrench on the flats of the gauge socket to screw the gauge in place.

vi) When a fitting is being screwed to the gauge, hold a wrench on the socket flats instead of twisting against the gauge socket screws, which are intended to hold the gauge mechanism in the case.

vii) When gauges are mounted on the panel, make sure they are connected free from piping strains. Also see that the mounting surface is flat, or insert washers under the flange of the gauge case to obtain three-point suspension. Replace broken glasses and thus keep dirt out of the working

viii) Never oil gauge movements or linkages except with high grade instrument oil. Regular oil attracts dirt and becomes gummy, thus causing the gauge to act sluggish and in accurate.

3) When calibrating the oil pressure differential indicator.

i) Disconnect instrument lines and temporarily install a plug or cap.

ii) Apply test pressure to high side while venting the low side.

iii) To avoid damaging the gauge, always apply pressure to the high side first.

<u>When reconnecting the gauge to the system, apply the pressure to the high side first!</u>

3) Cooler refrigerant pressure indicator, the **condenser refrigerant pressure indicator**, and the **purge separator pressure indicator.**

1) Pointer adjustment

Calibration that can be corrected by repositioning the pointer relative to the scale is called "rezeroing" the gauge. Some gauges are furnished with easily adjustable pointer reset devices that do not require removal of the pointer from the movement. Pointer reset devices are of the following types:

a) Adjustable pointers include the micrometer adjustable geared type and the friction type with a knurled bushing or with a screw driver slotted bushing.

b) Another method used to reset pointers is by rotating the movement. Here, a cam causes a slight rotation of the movement with a consequent shift in pointer position. This is not a complete recalibration as pointer resetting is only one part of calibration.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to 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 check.

EO: 1.3 Calibrate Chiller temperature indicators.

Introduction

In this objective the trainee will be inspecting and calibrating various bi-metal thermometers used for temperature indication on the chillers.

Main Idea

Assess and address workplace hazards.

1) There is a variety of temperature indicators used on a chiller.
   a) The most commonly used at Palo Verde is the Ashcroft bi-metal thermometer.
2) This include the **thrust bearing temperature indicator**, the **compressor oil reservoir temperature indicator**, the **condenser water outlet temperature indicator**, the **chilled water outlet temperature indicator**, and the **chilled water inlet temperature indicator**.
   a) The oil sump temperature indicator is currently being phased out. If a non-adjustable gauge is found out of tolerance order a replacement gauge.

b) On the Essential chiller, if the "as found" readings for the Chilled Water outlet is out of tolerance, generate the appropriate administrative document to evaluate the impact on the out of tolerance. This gauge is used for determining operability.

3) A bi-metal element is a sensor that consists of two different metals that are bonded together into a strip or a coil. The metals react differently to heat, expanding and contracting at different rates.
   a) When the bi-metal is heated, the element bends away from the metal with the greatest rate of expansion.
   b) When the bi-metal is cooled, the element bends toward the metal with the greatest rate of expansion.
   c) The sensitivity and temperature range of the element increases when it is coiled.
   d) The thermometer uses the expansion and contraction of a metal coil to measure temperature.
4) When calibrating, the indicator is removed and a temporary plug or cap is installed.
   a) The Thermal King is used to provide the test condition. The indicator is placed into the properly sized chuck. Do not drop the chuck into the well.
      Remember to allow sufficient time for instrument readout to stabilize prior to making adjustments.
      Re-set using the standardize feature.
      Wait ten minutes for stabilization.
   b) The Ashcroft bi-metal thermometer 50EI60E0900/200F are used for the inlet and outlet water temperature indication.
      Make calibration adjustments using external adjustment.

The following list of terms is optional information

TEMPERATURE RANGES

a) Standard Fahrenheit and Celsius ranges have been established to encompass all normal temperature measurement requirements. A bimetal thermometer can be used at an operating temperature anywhere throughout its dial range. Provision should be made for extreme temperature conditions. No bimetal thermometer should be exposed continuously to process temperatures over 800°F (425°C).

THERMOWELLS

a) Thermowells must be used on any application where the stem of the bimetal thermometer may be exposed to pressure, corrosive fluids or high velocity. Additionally, the use of a thermowell permits instrument interchange or calibration check without disturbing or closing down the process.

POINTERS

a) The pointers are balanced to close tolerances and the paint finishes are controlled to assure long-term stability under adverse ultraviolet conditions.

CASES

a) There are three case styles.

i) The CI series has no adjustment but is hermetically sealed.

ii) The EI series has an external adjustment and is hermetically sealed.

iii) The EL series provides the same features as the EI plus the added benefit of liquid filling. The instruments are leak tested to ensure the integrity of the joints.

COILS

a) The bimetallic coils are carefully wound and inspected. Each is heat treated for optimum stability and over temperature capability.

BEARINGS

a) The bearings are made of Teflon or other low friction material.

SHAFTS

a) Shafts are made of specially drawn stainless steel wire with a very smooth finish.

DIALS

a) The dials are based on computer-calculated temperature deflection data.

WINDOWS

a) The standard windows are heavy-duty glass. Plastic and shatterproof glass are optional.

Refer to the Ashcroft handout of Thermometer selection information.

EI Case Style

a) This series has a hermetically sealed case and external adjustment. Connection locations are rear, lower and Everyangle. The hermetic seal prevents entry of moisture into the casing, minimizing the possibility of icing or fogging inside the case.

b) Everyangle Case Connection

   i) This design provides maximum utility. The entire dial face can be rotated 360 degrees, and angled 180 degrees by positioning the harness on the back of the case. The instrument can be installed almost anywhere and can be adjusted so that the dial can be easily read.

Explanation

Refer to product information in Ashcroft Bulletin BM-1 for the indicator assembly and ordering information.

Review the Thermal King instructions handout.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to 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 perform the task. Self check/Peer check.

EO: 1.4 Calibrate temperature activated switches.

Introduction

In this objective the trainee will learn how to calibrate the temperature activated switches used on the chillers.

Main Idea

Assess and address workplace hazards.
Live-dead-live check.
PPE for working on energized equipment.

1) The United Electric F300 and F302 are remote bulb non-indicating temperature controllers.
   a) They are used to control the operation of the **chiller cooler hot gas by pass switch** and the **cooler refrigerant low temperature switch**. (F300) And the **cooler water low temperature switch** (F302)
2) F300 Operation
   a) The switches respond to temperature variations sensed by the remote bulb. This is hydraulically transmitted through the capillary tubing to the bellows or diaphragm whose expansion and contraction serves to actuate the snap-acting switches.
   b) Control set point may be varied by turning the internal adjustment screw. Adjusting the dial will change the differential setting.
   c) To adjust the set point.
      i) Remove the cover and connect an Ohm meter to the switch to be calibrated.
      ii) Remove the sensing bulb from the thermowell. Adjust the Thermo King to the applicable temperature to open and close the switches.
      iii) If an adjustment is required turn the adjustment screw in (clockwise) to raise the setting, or out to lower the setting. Do this until mean process temperature for each switch meets requirements. Replace the cover.
3) Hot gas by pass switch
   a) When checking the **hot gas by pass switch** verify action of the second set of contacts (which close actuator) while performing calibration of primary contacts which open actuator. The actuator operation is verified separately from the switch calibration, (inlet water temperature)
4) Cooler water low temperature (recycle) switch
   a) Checking the **cooler water low temperature (recycle) switch** will require the chiller to be operating. This has a wet well, do not remove the sensing bulb to perform the calibration.
   It is important to communicate with OPS that you will be loading the chiller prior to starting this calibration.
   Since the chiller will be running during this calibration and loading the chiller will increase the current draw of

the chiller. Also note that during high W.C. load conditions an alternate chiller may need to be started to help bring the chill water loop down to the recycle switch set point. There have been times that this calibration was rescheduled because the W.C. loop temperature was too high.

b) Install a jumper wire and a meter across the cooler water low temp switch before starting the machine.
c) Also either install a jumper across the cooler low refrigerant temperature switch or remove the sensing bulb from the thermowell.
    i) This will prevent the chiller from tripping on low refrigerant temperature.
    ii) This test requires that you manually run the chiller and slowly decrease the water temperature.

Caution -Monitor refrigerant pressure and temperature.

Do not allow refrigerant temperature to fall below 32°F.

Manually control chiller using the 32 SM and **slowly** decrease water temperature until the set point is reached.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to 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 perform the task. Self check/Peer check.

EO: 1.5 Adjust the hot gas bypass valve.

Introduction

In this objective the trainee will verify the operation of the hot gas by-pass valve actuator to correctly position the valve in the open and closed position.

Main Idea

Assess and address workplace hazards.

There is voltage potential across the switch.

Operating the valve requires manipulation of the open/close switch.

1) The hot gas by-pass valve is controlled by a United F300 temperature activated switch. When the chilled water inlet temperature is 46ºF +/- 2.5 ºF the hot gas by-pass switch will close to open the hot gas by-pass valve.
   a) To verify the operation of the valve manipulate the switch to operate the valve open and closed.
      i) Be careful when performing this manipulation, there is voltage potential across the switch.
2) Valve adjustment is required when the valve is not positioning correctly when actuated open or closed.
   a) To make adjustments, remove the cover, by first removing the position indicator pointer and hold down screws.
   b) Adjustment Instructions:
      i) To adjust the actuator for valve open and valve closed positions, the cams for the motor control limit switches #1 and #2 must be moved as follows:
         (1) Valve open position: (Switch S2)
            (a) Loosen the top cam set screw. If the valve needs to open more, rotate the cam counterclockwise as viewed from above. If less rotation is required, rotate the cam in the clockwise direction. Retighten the set screw.
            (b) Verify the valve is in the correct position.
         (2) Valve closed position: (Switch S1)
            (a) Loosen the top cam set screw. If the valve needs to close more, rotate the cam clockwise as viewed from above. If less rotation is required, rotate the cam in the counterclockwise direction. Retighten the set screw.
         (3) Verify the valve is in the correct position.
            (a) Caution: Whenever an actuator is removed from the valve and then remounted, the limit switches may require readjustment.See adjustment section of applicable VTD.

2) When servicing a valve/actuator assembly, the best practice is to remove the entire assembly from service.

If the valve needs to be replaced follow the instructions in the VTD for the applicable valve assembly.

OE13462 – Documents an event that caused a safety-related control room HVAC chiller to trip due to a short in hot gas bypass valve actuator.

Description of event:

On 3/11/2002, at Braidwood Units 1 & 2, the 0A Control Room HVAC Chiller (Carrier Model 19EA, 230 ton R-114) was found tripped. During the initial determination of what caused the event, the control power fuse was found blown. Trouble-shooting of the components led technicians to identify a short in the Hot Gas Bypass Valve Actuator. The actuator was completely replaced to enhance future reliability of the chiller system.

Component Information:

Manufacturer: Jamesbury

Model Number: EJ-50

Part Number: Carrier P/N 17FA101-1333

Details of the event

The 0A Control Room HVAC Chiller (Carrier Model 19EA, 230 ton R-114) was found tripped. There was no warning of this condition in the Main Control Room. The local control panel lights were off with the exception of the Oil Pump Running light. The oil pump was running.

The Guide Vanes were open (they are expected to go closed on a normal trip or shutdown of the chiller). During the initial determination of what caused the event, the control power fuse was found blown. It was replaced and when the fuse did not immediately blow again a trouble-shooting plan was initiated to determine if the cause was solely a bad fuse or if it was an electrical fault in the system

This troubleshooting plan had EMD manually actuate relays in the cabinet and then reset all the relays with the reset button. Neither of these actions caused the fuse to blow. Next, the chiller compressor motor breaker was placed in the TEST position and closed via a start with the switch in the Control Room. The proper operation of the breaker (in TEST) showed that the chiller control power fuse was not blowing during the control circuit sequencing. Operations started the chiller and it ran for 17 minutes before tripping with the same symptoms as before. Because the trip occurred so soon after startup, it was postulated that the Hot Gas Bypass Valve Control or Guide Vane Control could be at fault. Again, EMD investigated and when the cover was pulled from the Hot Gas Bypass actuator (Jamesbury EJ-50, Carrier P/N 17FA101-1333), evidence of electrical arcing and a damaged wire were seen. This fault occurred because the wire to the capacitor in the Hot Gas Bypass valve actuator was laying next to the back plate of the actuator. The wire insulation was worn away and the conductor in the wire had come in contact with the plate. This caused a short circuit, which caused the fuse to blow. The reason why the wire came in contact with the plate is unknown, however, this equipment has been in operation for approximately twenty years. Additionally, the lead from the capacitor was found bent over at a 90-degree angle at the capacitor. It can not be determined when this was done, but it is not proper bend radius practice and should not have been done. The actuator was completely replaced to enhance future reliability of the chiller system.

Why did it happen? The cause identified in the OE of how the wire came in contact with the cam is unknown. It is speculated that sometime during the last fifteen years, a technician inappropriately bent the wire over in an attempt to ensure the wire fit properly in the actuator cover. This caused the wire to come in contact with the cam and over time the insulation was worn away.

Analysis:

From the Jamesbury installation, Maintenance & Operating Instructions: "Hot Gas Bypass valve actuator is designed to actuate Jamesbury and Salisbury double-seal ball valves up to 3 inches in size." Continuing, "In operation, a reversible, single phase, permanent-split-capacitor motor (two motors on the EJ-50) cycles the drive shaft through a spur gear train reduction unit. Two cams geared directly to the drive shaft actuate limit switches to control the cycle. Each actuator is equipped with thermal overload protection." This equipment failed when a wire from the capacitor came in contact with the cam. Over time, movement of the cam wore through the insulation of the wire and the conductor came in contact with ground. This caused an overload which blew the main control power fuse (10 amp) for the chiller causing the chiller to trip.

Could this type event happen at PV? Have the group determine if this could happen at PV.

Demo

Have a valve on hand to pass around to the trainees.

Optional activity: Demonstrating operation of the valve, perform a hazard assessment and establish the appropriate safety requirements prior to proceeding with the demo.

Ask the trainee to identify the PPE requirements for this task.

What are the requirements in the field?

EO: 1.6 Calibrate ITT Barton flow indicators and switches.

Introduction

In this lesson the trainee will learn how to calibrate the Barton Model 288A Differential Pressure Indicating Switch for the Normal Chiller.

Main Idea

Assess and address workplace hazards.

Verify system is de-pressurized.

Live-dead-live check.

PPE for working on energized equipment.

The **Chilled Water Flow Switch/Indicator** and the **Condenser Water Flow Switch/Indicator** consist of the following.

Note: The EW condenser switch has been eliminated.

1) The Barton Model 288A is a Differential Pressure Indicating Switch. The switch is used for flow measurement applications, the instrument is connected (by tubing) to the Chilled Water and the Condenser Water piping.

   The Barton Models 288A Differential Pressure Indicating Switches consist of two component units: the actuating differential pressure unit and the indicating switch (case assembly).

2) The Models 288A Differential Pressure Switches are actuated by the Barton Model 224 Differential Pressure Unit (DPU).

   The DPU has two interconnected, liquid-filled bellows. The bellows are mounted on opposing sides of a center plate and are enclosed by separate chambers.

   The difference in pressure between the two chambers causes the bellows to travel toward the side with the lowest pressure. The bellows motion is transmitted through a rotating shaft to the input mechanism of the switch.

   Terms used during calibration

   i) Set Point: The measured pressure at which the snap-switch actuates and thereby changes the states of the normally opened and normally closed contacts. For example, the set point of the low switch is 24 psid with decreasing pressure.
   ii) Deadband: The difference in the measured pressures between switch-actuation and switch-reset. Deadband is usually expressed as percent of fullscale.

Deadband is not adjustable. For ex-ample, the switch above was found to reset at 26.4 psid with increasing pressure.
The deadband was 2.4 psi, or 4% of the fullscale (0 to 60 psid).

3) Indicating Switch
   a) The mechanical output of the DPU is transmitted to the indicating switch by the DPU torque tube shaft. The rotation of the torque tube shaft is coupled through connecting linkage within the indicating switch case to move the indicating pointer across the scaler plate providing a reading of the measured process variable.
   b) An actuating cam, directly connected to the torque tube shaft, rotates the motion of the shaft. Two cam follower roller/actuator arm assemblies, one for each switch, respond to the rotation of the torque tube shaft by opening and closing the switches as they ride on and off the cam.
   c) The differential pressure at which the switch actuates is adjustable with switch adjustments on the scale plate.
   d) Switch actuation can be connected to operate normally-opened or normally-closed contacts as required by the application.
4) Checking the calibration
   a) Isolating the instrument to remove from the piping.
      i) Major Concerns When Isolating & Restoring Instruments
         (1) Damaging the bellows assembly
         (2) Keeping wet legs wet and dry legs dry
         (3) Air bubbles
         (4) Valve mispositioning - as-left configuration
         (5) Valve / instrument identification
         (6) Safety - venting high pressure
   b) Flow Instruments, sequence for removal from service
      i) Shut the high pressure isolation valve
      ii) Open the equalizer
      iii) Shut the low pressure isolation valve
      iv) Shut the equalizer line in connection air lines to the dragon valve manifold.
   c) With the instrument Out-of-Service
         (1) Install water bottles to high and low side connections, let equalize and then shut equalizer valve.
         (2) Attach calibration pressure source (hand air pump) to HP water bottle housing.
         (3) Apply pressures as described in the work instructions and observe pointer readings for accuracy. Use the M&TE as required by the work instructions (Heise gage).
         (4) Change pressures slowly in discrete steps. A "bleed-pressure" method may cause errors.

(5) If the indicator is not within limits calibrate

d) Pointer calibration

i) The Model 288A/290A/B pointer is calibrated according to the following procedure.

(1) Remove the glass lens, and the face plate. To remove the face plate, apply enough pressure to the instrument to move the arm to the 12 o'clock position.

NOTE To prevent interference with the pointer during calibration, separate the actuator arms from the cam. Use a paper clip, rubber band, or tape to do this. Tap the case lightly to overcome internal friction when obtaining pointer readings,

(2) Align the linkage between the drive arm and movement.

(3) Check pointer for zero indication. If necessary, set the pointer to zero by slipping the pointer on the hub.

(a) Hold the pointer with the fingers and turn the hub with a wrench.

(4) Apply 100 percent pressure. If the pointer exceeds full scale, lengthen the movement range arm.

(5) Release pressure. Set the pointer to zero using the pointer hub for the zero adjustment.

(a) Repeat as necessary to obtain zero and full scale readings.

(6) Apply 0 percent, 25 percent, 50 percent, 75 percent, 100 percent, 75 percent, 50 percent, 25 percent, and 0 percent of full scale differential pressure consecutively to the instrument without overshoot.

(7) Lightly tap the indicator to overcome friction. Pointer should accurately indicate each applied pressure.

(8) Test the instrument repeatability by applying 0 percent, 50 percent, 0 percent, 50 percent of full scale differential pressure. Indicator should accurately indicate each applied pressure.

4) Low flow trip Switch calibration

i) Inspect the switch assembly for the following:

(1) • The roller rotates without wobble or binding.

(2) • The cam does not touch the roller side shields.

(3) • The actuator arm moves freely on its pivot.

(4) • All switch mounting screws are tight.

(5) • Linkages are straight and do not bind at the pivots.

Note: If any of the above problems are encountered the assembly should be replaced.

(6) Connect the multi meter to the switch input terminals.

(7) Apply pressures as described in the work instructions. Record as found set points for opening and closing the switch. If the as found is not within limits perform the following to change set-point:

(a) Loosen the lock screw.

(b) Move the switch plate.

(c) Tighten the screw.

(d) Test the set-point

5) Flow Instruments, sequence for return to service

(1) Verify both isolation valves are shut and equalizer is open, remove water bottles and install caps.

(2) Open the low pressure isolation valve

(3) Shut the equalizer

(4) Open the high pressure isolation valve

(5) Loosen cap on the top of the valve assembly and vent entrapped air.

SOER 85-02 Documents valve mispositioning events involving human error

Mispositioned valves have resulted in degradation of safety systems and reduced plant availability.

Mispositioned Auxiliary Feedwater valves contributed to the Three Mile Island event.

Mispositioning of valves occurs most frequently during maintenance, calibration or modification activities.

This includes instrument isolation valves

What could you do to prevent this from happening?

What Prevent Event tools are applicable?

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to 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 perform the task. Self check/Peer check.

EO: 1.7 Check the calibration of control modules.

Introduction

In this lesson the trainee will learn how to check the set point of Robertshaw solid state control modules.

Main Idea

Assess and address workplace hazards.
Live-dead-live check.
PPE and EPE for working on energized equipment.

The calibration verification of the protection modules on Essential chillers is checked on a PM. This is not currently required on the Normal chillers.

The resistance values plotted on the Resistance vs Temperature graph are the resistance value at the sensor and do not include the fuse or wiring.

1) The Robertshaw solid state protection modules MP-1016 and MP-1010 are used for
   a) compressor motor temperature protection
   b) high oil temperature
   c) refrigerant discharge temperature.
2) The electronic module is factory calibrated to specified temperature limits depending on the application. The module is then matched with a compatible sensor.
   Modules are non-adjustable. If the “as found” ohm value is not within tolerance the module must be replaced.
   a) Modules currently used on the chillers are equipped with either and internal or external transformer.
3) To check the set points of the modules perform the following.
   a) **Compressor bearing high oil temperature switch**
      i) Verify the module is de energized using live dead live on the internal and the control circuit contacts.
      ii) Disconnect the control wiring and remove the fuse, F-3.
      iii) Select the appropriate M&TE; connect the DVOM and Decade resistance box. Use the lift/land sheet.
      iv) Connect decade resistance box to terminal 35 and orange wire from module to fuse F-3.
      v) Energize the module transformer using external power or restoring the control panel power.
      vi) Adjust the resistance and verify the Setpoint 235ºF(108.4 ohms)(increasing). Start at approximately 100 ohms and work up until the contacts open.
      vii) De energize the module and restore equipment.
      viii) Verify that fuse F-3 is reinstalled.
   b) **Compressor motor high temperature switch**

i) Verify the module is de energized using live dead live on the internal and the control circuit contacts.
ii) Disconnect the control wiring and remove the fuse, F-1.
iii) Measure the end turn sensor resistance between terminals 31 and 32.
iv) Measure and record ambient temperature.
v) Select the appropriate M&TE; connect the DVOM to the control contacts. Connect the Decade resistance box between terminal 32 and the orange wire from module to fuse F1.
vi) Energize the module transformer using external power or the restoring the control panel power.
vii) Adjust the resistance and verify the Setpoint 235°F(108.4 ohms)(increasing).
i) Install fuse F-1. Remove fuse F-2.
ii) Measure the slot sensor resistance between terminals 32 and 33.
iii) Measure and record the ambient temperature:
iv) Connect decade resistance box to terminal 32 and orange wire from module to fuse F-2.
v) Adjust the resistance and verify the Setpoint 235°F(108.4 ohms)(increasing)
vi) Install fuse F-2.
vii) De energize the module and restore equipment.
viii) Verify that fuses F-1 and F-2 are reinstalled.

c) **Compressor discharge high temperature switch.**

i) Verify the module is de energized using live dead live on the internal and the control circuit contacts.
ii) Disconnect the control wiring and remove the fuse, F-4.
iii) Select the appropriate M&TE; connect the DVOM and Decade resistance box to terminal 86 and the orange wire from module to fuse F-4.
iv) Energize the module transformer using external power or the restoring the control panel power.
iv) Adjust the resistance and verify the Setpoint 215°F(104.0 ohms)(increasing)
ix) De energize the module and restore equipment.
x) Verify that fuse F-4 is reinstalled.

The resistance value of the fuses used in the safety circuits (high bearing temp, high motor temp, and high refrigerant discharge temp) is critical and is required, by Carrier, to be between 1.2 and 3.0 ohms.

Be sure to use dedicated fuses Shop stock is not acceptable.

CRDR 54074 (2-9-0093), Documents incorrect fuses installed in the control circuit for 2MECAE01 (TCS 01-1692)

4) To check the sensor, measure the resistance value. Refer to the applicable temperature resistance chart. A short or ground in the sensor circuit is indicated by resistance approaching zero. A resistance approaching infinity indicates an open connection.
   a) Refer to the chart for resistance values at specific ambient temperatures.

b) Because the motor sensors are embedded in the motor windings they can only be replaced if the stator is rewound with new sensors in place. Refer to sensor specifications.

c) The bearing and discharge sensors are replaceable.

d) The module set points are non-adjustable, if found out of tolerance they are replaced.

CRDR 113265, Following the performance of 73ST-9EC01 STWO 00899693 The unit 1 essential chiller "A" tripped on high refrigerant temperature (TCS 01-1691) Documents that on On 12/22/1999 following the performance of 73ST-9EC01 STWO 00899693 the Unit 1 Essential Chiller "A" tripped on high refrigerant temperature.

The HVAC Maintenance Engineer was in the Control Room at the time and was dispatched to the chiller, preliminary data gathering revealed that the Thermistor (1JECATE0593) had an open circuit.

The thermistor leads are prone to fail due to vibration.

All sensors have been replaced and spares are on-hand as needed.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to 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 perform the task. Self check/Peer check.

EO: 1.8 Perform agastat relay test per 32MT-9ZZ82

Introduction

In this objective the trainee will perform time delay relay testing using the procedure TIME DELAY RELAY TEST, 32MT-9ZZ82.

The student will perform testing of the time delay on energization and de-energization agastat relays. Each student will document this process using the current revision of the procedure.

Successful completion of the Lab will require each student to perform calibrations of a time delay relay within the recommended tolerance using the elementary diagram.

You will be simulating field conditions, this includes using Prevent Event tools, all required PPE, self checking and peer checking.

Main Idea

Assess and address workplace hazards.

Live-dead-live check.

PPE for working on energized equipment.

1) Introduction:
   a) Agastats are used in the chiller control circuit to provide accurate control of the chiller starting sequence.
   b) The Agastat Series 7000 Timing Relay provides accuracy and versatility in performance without the IEEE rating. They are the 1TR, 2TR, 3TR, 4TR relays.
   c) The E7000 series of agastat relays are designed and tested to meet the requirements established by IEEE Standards 323-1974, Standard for Quality Class 1E Equipment for Nuclear Power Generating Stations. This is the 5TR relay.
   d) Some of the features these electromechanical devises offer are:
      i) On-Delay Model 7012 (delay on pick-up)
         (1) Time delay on energization
         (2) De-energizing the unit during the delay period immediately recycles the unit, readying it for another full cycle.
      ii) Off-Delay Model 7022 (delay on drop-out)
         (1) Time delay on de-energization
         (2) Energizing the unit during the delay period immediately recycles the unit, readying it for another full cycle.
         (3) No power is required during the timing period.
      iii) Time calibrated delay adjustment to as long as 60 minutes.
2) Chiller control Agastats
   b) The agastats used in the Essential Chiller Control Panels require periodic testing to verify the repeat accuracy
   c) Identify each relay and explain how to decipher the model number using the catalog number code.
      i) 1TR, Model 7022AH
         (1) Off delay
         (2) 3 to 30 mins
      ii) 2 TR, Model 7012AB
         (1) On delay
         (2) .5 to 5 secs
      iii) 3 TR, Model 7012AB
         (1) On delay
         (2) .5 to 5 secs
      iv) 4 TR, Model 7022AB

(1) Off delay

(2) .5 to 5 secs

v) 5 TR, Model E7022AF

(1) Off delay

(2) 1 to 10 mins

3) Agastats are periodically tested to verify that the timer repeat accuracy is within the manufacturers recommended tolerances.

4) Perform agastat testing the most current revision of the testing procedure. 32MT-9ZZ82, Time Delay Relay Test.

TM-200 Timer

A. The TM-200 timer is a solid state electronic instrument which measures elapsed time between two events.

B. The timer responds to a wide choice of signals which are all accepted at the same terminals.

C. The TM-200 has a voltage mode and a contact mode which is different than the FT-2 timer.

D. The range on the TM-200 timer is selected automatically by the timer itself.

E. With the power cord connected and the contact mode selected (bottom right lamp lit), on either the start or stop terminal there is approximately 18.5 VDC on the Start/Stop terminals supplied by the timer.

F. If you select the voltage mode (upper right lamp lit) on either the start or stop terminal there is no voltage supplied by the timer. The timer only supplies voltage in the contact mode.

1.The two lights, on the right side, in the start box determine what mode you are going to use to start the timing function. The top light should be lit if you are going to use voltage (AC/DC) to start the timing. The bottom light should be lit if you are going to use a contact (open/close) to start the timing.

2. The top left side light in the start box is lit if you are going to energize the circuit to start the timing in the voltage mode.

3. The bottom left side light in the start box is lit if you are going to de-energize the circuit to start the timing in the voltage mode.

4. The top left side light in the start box is lit if you are going to close a contact to start the timing in the contact mode.

5. The bottom left side light in the start box is lit if you are going to open a contact to start the timing in the contact mode.

6. The two lights on the right side in the stop box determine what mode you are going to use to

stop the timing function. The top light should be lit if you are going to use voltage (AC/DC) to stop the timing. The bottom light should be lit if you are going to use a contact (open/close) to stop the timing.

7. The top left side light in the stop box is lit if you are going to energize the circuit to stop the timing in the voltage mode.

8. The bottom left side light in the stop box is lit if you are going to de-energize the circuit to stop the timing in the voltage mode.

9. The top left side light in the stop box is lit if you are going to close a contact to stop the timing in the contact mode.

10. The bottom left side light in the stop box is lit if you are going to open a contact to stop the timing in the contact mode.

Connection of test leads:

1. One test lead goes from the Staco power source 120 vac 9a isolated power supply either terminal to L1 or L2 on the agastat relay.
2. From the same Staco power supply terminal to one of the start terminals on the TM-200 timer.
3. Connect the test lead from the Staco power supply terminal not used yet to L1 or L2 on the agastat timer not used yet.
4. Connect test lead from same Staco power supply terminal to other start terminal on TM-200 timer.
5. From TM-200 timer stop terminal; connect one lead to an agastat relay common contact terminal.
6. From the other TM-200 timer stop terminal connect a test lead to either N.O. or N.C. relay contacts. Same circuit with common terminal.
7. TM-200 timer 120 vac power cord plugs into the Staco power supply black receptacle.
8. Staco power supply cord plugs into any 120v power supply.

Note: When testing a 20 minute timer:

Use calibrated hand held stop watch.

Explanation

Refer to the handouts as you review the material.

Use the Agastat mock-up to demonstrate the operation of the relays.

The most current revision of 32MT-9ZZ82 will be used to perform the calibration.

Various power supplies can be used.

Various timer can be used, review TM200 instructions.

Demo

Prior to performing the demonstration have the trainees perform the hazard assessment and determine what PPE is required for the task. Using the Lab Practical Evaluation and the work instructions, show the trainee how to perform the calibration.

Demonstrate the test sequence using the TM200 timer and a regulated power supply.

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 perform the task. Self check/Peer check.

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.