DEI Module 16

Advanced Diploma of Electrical & Instrumentation (E&I) Engineering for Oil & Gas Facilities

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Installation

• Follow the Manufacturer’s instructions!

• Obvious?
  – Well, why don’t people do this then?

• Codes of Practice state:-
  – “Instructions shall be provided in a form that is suitable for the person installing the equipment”
Chapter 1
Maintenance
Maintenance of Instruments

- A program for preventive and corrective maintenance of instruments should be established and documented.

- Preventive and corrective maintenance should be performed using components and procedural recommendations at least as stringent as those specified by the manufacturer of the instrument.

- The instruments shall undergo calibration prior to use and following any preventive or corrective maintenance or any adjustment that voids the previous calibration.
Maintenance: requires Inspection

• Maintenance:
  – Keeping equipment working correctly before unnecessary failure

• Inspection:
  – Visual Inspection:
    • An inspection that identifies, without the use of access equipment or tools, those defects, eg missing bolts, which will be apparent to the eye.

• Close Inspection:
  • VISUAL INSPECTION and, in addition, identifies those defects, e.g. loose bolts, which will be apparent only by the use of access equipment e.g. steps (where necessary), and tools. CLOSE INSPECTIONS do not normally require the enclosure to be opened, or the equipment to be de-energized.

• Detailed Inspection:
  • CLOSE INSPECTION and, in addition, identifies those defects, eg loose terminations, which will only be apparent by opening-up the enclosure, and/or using, where necessary, tools and test equipment.
Maintenance of Instruments

- Corrective Maintenance
- Preventive Maintenance
- Predictive Maintenance
Troubleshooting

• No right or wrong way!

• Three stages:
  – The Symptoms and the Cause
    • Observation
  – Troubleshooting Techniques
    • Depends on experience
  – Fault Analysis
    • Why did it happen?
    • How do we prevent it happening again?
Troubleshooting Techniques

- Power check
- Visual inspection
  - Good observation
    - What is it doing?
    - What is it NOT doing?
- Using a sense of touch (What????)
  - Smell check (Overheating?)
- Substitution (Component replacement)
  - Signal tracing
Chapter 2

Electrical Measurements
Current Measurement

• Ammeters.

• connected *in series* to the circuit, where the current has to be measured.

• The SI system of units define 1 ampere:
  – the electrical charge of 1 coulomb flowing through the conductor in one second.
Ammeter Connection

Current in Point A =?
Rules to be observed

- Select the DC or AC Function on the meter
- Select the appropriate Range
  - Higher or highest range if expected value is unknown
- Check the Zero Setting
- Connect the Test Leads to the Input of the Ammeter
- Break the Circuit under test at the Point of Measurement
- Connect the Test Leads to the Circuit
- Take the Readings
Voltage Measurement

• The potential difference between two points is 1 volt if 1 joule of work is done in moving 1 coulomb of charge from one point to another.

• It is measured with a voltmeter
  – Electrical pressure

• The voltmeter is always connected in parallel to the measured circuitry (non intrusive therefore more useful)
Voltmeter Connection

Voltage Drop Across $R = ?$
Resistance Measurement

- According to Ohm’s law, the ratio of potential difference across the ends of a conductor and the current flowing in it, is a constant.

- If a current $I$ flows through a conductor of resistance $R$ when the potential difference across its ends is $V$, then $V/I = R$ or $V = IR$.

- Ohmmeter is used to measure the Resistance.
An Ohmmeter

Precision Voltage Source

R_X

Ammeter

Ohmmeter
How measuring resistance differs from measuring current & voltage

- Turn off
  - Isolate from power source

- Disconnect one of the resistance ends, before applying the measurement

- Short the test leads of the ohmmeter to prove zero
  - Adjust meter Zero if necessary

- Apply to circuit under test
Analogue and digital meters
Test Equipment Suitability

- Suitability of measurement: V&I
Other useful equipment

- Meters
  - Fixed measurement
  - Multi-meter

- Oscilloscopes
  - Higher frequency issues
  - Voltage measurement based

- Frequency meters
- L and C meters
Electronic components overview

• Resistors
  – Variable and fixed
  – Temperature dependent
  – Types (safety implication)
    • Carbon film
    • Metal film
    • Wire wound

• Diodes
  – Ordinary
  – Zener

• Transistors: many types!
Chapter 3

Instrument Performance
Make sure it works

- Operational data
Typical Instrument Loop

- Sensor
- Excitation
- Power & Signal Interface
- O/P Stage
- Memory
- D/A
- \( \mu P \)
- A/D
- Sensor
- Sensor
-

Transmitter

- Line resistance
- Voltage Limits
- 4/20mA current
- Conditioned
- Resistor 250\( \Omega \)
- Supply +ve
- 1 – 5V output
- Receiving Instrument
- Measurement 0V
- Supply 0V
- Output Stage
  (acts like variable resistance!)

(Incorporated into instrument)
What aspects must we consider?

Time for a list....
Measurement

• Comparison
  – between a sampled quantity and a predefined standard

• Valid measurement
  • Standard used for comparison purposes must be accurately defined and commonly accepted.
  • Apparatus used and method adopted must be provable.
Instruments

- Determining quantities as variables

- A simple instrument consists of a single unit that gives an output reading or signal according to the unknown variable applied to it.

- In a complex measurement system the instrument may consist of several separate elements.

- The essential elements in an Instrument Loop are:
  - Sensor / detector element
  - Transducer
  - (Current transmission system and Power Supply)
  - Indication
  - Recording (Trend and/or Database)
  - Control algorithms (if necessary)
  - Each of above may require setup/calibration
Chapter 4
Calibration Principles
Calibration

- Calibration:
  - To check, adjust, or determine by comparison with a standard
  - The determination of actual measurement

- How often should we calibrate?
Calibration Curves and Tables

<table>
<thead>
<tr>
<th>Input %</th>
<th>Expected OP</th>
<th>Measured OP</th>
<th>Deviation</th>
<th>% Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>-1%</td>
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<tr>
<td>25</td>
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<td>+1</td>
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<td>+2</td>
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<tr>
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<td>100</td>
<td>103</td>
<td>+3</td>
<td>+3</td>
</tr>
</tbody>
</table>

Instrument Data Sheets: should specify
- Required unit accuracy
- Points of calibration
- Standard of Calibration
Calibration Data Sheets

- The following information is required to be a part of a calibration data sheet:
  - Instrument Identification Number (Tag)
  - Nameplate Data
  - Calibration Range & Tolerance
  - Location
  - Calibration Procedure Number
  - Calibration Dates and Interval
  - Test Standards
  - Comments
  - Equipment used
  - Technician signature and Date of calibration
  - Reviewer signature and date
Calibration Sheets

- Examples given in Appendix A of Manual

- Any Comments or Questions about this?

- Are these workable?
Chapter 5

Fundamentals of Process Measurement
Basic Measurement Performance Terms and Specifications affecting Control

- Range of Operation
- Hysteresis
- Linearity
- Repeatability
- Response

- Covered in the previous Module 15.1 to 15.8
- Also discussed in next Module
Instruments and control valves in the overall control system
Chapter 7

PID Controllers
PID Control

• Control “Action”

• Calculated based on Measurement

• Therefore Measurement MUST be HIGH QUALITY

• This subject is covered in Module 17 so not discussed here
• Thanks for your attention and input to the course.