Basic instrumentation handbook pdf

OSTI.GOV Technical Report: The MeE Basics Handbook: Devices and Controls, Volume 1 Handbook on the Basics of Instrumentation and Control was designed to assist contractors working at nuclear facilities in providing operators, service personnel and technical staff with the necessary basic training to provide a basic understanding of instrumentation and management systems. The handbook includes information on temperature, pressure, flow and level detection systems; The system of specifying the position; Process management systems and the principles of radiation detection. This information will give staff an idea of the main operations of different types of devices and meE nuclear systems management systems. Publish Date: Mon June 01 00:00:00 EDT 1992 Study org.: USDOE, Washington, D.C. (United States) Sponsorship Org.: USDOE; USDOE, Washington, D.C. 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United States. doi:10.2172/7295868. . @article osti_7295868, title - DOE Basics Handbook: Tools and Control, Volume 1, author - AbstractNot - Handbook on Devices and Management Basics was developed to assist contractors working at nuclear facilities in providing operators, service personnel and technical staff with the necessary basic training to provide a basic understanding of instrument installations and control systems. The handbook includes information on temperature, pressure, flow and level detection systems; The system of specifying the position; Process management systems and the principles of radiation detection. This information will give staff an idea of the main operations of different types of devices and meE nuclear systems management systems. Mon June 01 00:00 EDT 1992, Month Mon June 01 00:00 EDT 1992, month 01 June 00:00 EDT 1992 Similar entries in collections OSTI.GOV: SHOWING 1-10 OF 10 REFERENCESDigital Electronics, McGraw-HillIndustrial Pressure, Level, and Density Measurement, ISA, Research TriangleLinearization of a Thermocouple, 1. BASICS - What is a toolkit? Basic terminology - Process - His Control - Field Tools - His Principles - Valves - His Working 2. What is a toolkit? Measurement and control devices. Instrument-building equipment is an engineering specialization focused on the design and configuration of process systems. Tools are devices that are used to measure the attributes of process systems. 3. Basic terminology and process: a series of continuous or regularly repetitive steps or actions aimed at achieving a predetermined result, as in metal heat processing, or the production of acid. Transdooker (sensor): An element that converts one form of Energy into another form. Primary transdustrial: a transduser that converts the process parameter into a form read by a secondary transducer. For example: Hole plate - Secondary transdutser: transducer or transmitter that reacts to a measured variable and converts it into a standardized transmission signal, which is a function of measurement only. For example: DP 4 transmitter. Signal: A signal is an event or phenomenon that transmits data from one point to another. Loop: The Loop is a combination of one or more interconnected tools arranged to measure the variable process. It should consist of the entire chain from the Primary element to the correction element. Controller: A device that works automatically using an established algorithm to regulate the variable process (PV) according to the set point (SV). The controller's input receives information about the state of the variable process, and then provides an appropriate output signal (MV-manipulate variable) to the final control (e.g. valves, etc.). 5. Blocking: This refers to a set of plant conditions (e.g. The tank level, furnace temperature, furnace or valve position, fluid flow, etc.) to be met before operation (launch, stop, opening, closing, etc.) of any tool or equipment. ANALYSER: Monitoring emissions of polluting gases as a result of industrial processes. A gas analyzer is a gas comparator that provides a high linearity of signal conversion function. The controller multiplies the signal from the load of the cell (load belt, kg/m) with the help of a high-speed lifter (belt speed, m/s) to get the speed of delivery. The controller then either changes the speed of the belt or load the belt to get speed of delivery. 6. DOSER: Conveyors are used as components in automated distribution and stock. The conveyor belt consists of two or more pulleys, with a continuous loop of material - a conveyor belt that revolves around them. One or both pulleys are powered by moving the strap and the material on the belt forward. Eating a pulley is called a pulley drive while a frail pulley is called idleness. BELKWEIGER: Material flowing through the belt can be weighed along the way with a belt. The Belveiger or weighing belt is part of the industrial control equipment used to estimate the mass or flow rate of material traveling through the conveyor belt. 7. Process and its control - Process parameters: - Pressure - Level - Temperature - Flow 8. Pressure Measurement - PRESSURE Force applied or distributed on the surface. Pressure (P) force (F), distributed by area (A), is defined as: P q F / Standard pressure unit Pascal Other pressure units psi kg/cm2 bar atmosphere torr 1 Pa 1 N/m2 9. Pressure measurement : - Diaphragm - Whitebeard - Manometer - Pressure measurements can be divided into three different categories: - absolute pressure - sensor pressure and - differential pressure 10. GAUGE PRESSURE - Sensor pressure is pressure relative to local atmospheric or ambient pressure. Measurements use a sensor to record the difference in pressure between the system and atmospheric pressure. This is called sensor pressure and can be indicated by the following equation: Pg'Pa'Po, where the pressure of the Pgz Po sensor and atmospheric pressure - If the pressure of the system is lower than atmospheric, it is called vacuum pressure. When the pressure is measured by a sensor, the amount obtained usually eliminates atmospheric pressure of the environment and is therefore called excessive pressure, Poverpressure and Pgauge 11. ABSOLUTE PRESSURE If atmospheric pressure is included, then as a result the pressure is called absolute pressure Pabsolute and Patmospheric and Pgauge Absolute pressure is measured in relation to absolute zero pressure - pressure that will occur in an absolute vacuum. P'Pg-Po Pyap absolute pressure, Pgumulator pressure, atmospheric pressure. DIFFERENTIAL PRESSURE differential pressure is the difference in pressure between two points. 12. ATMOSPHERIC PRESSURE Atmospheric pressure is pressure in the ambient air on the Earth's surface or close to it. Atmospheric pressure varies depending on temperature and altitude. Atmospheric pressure is the pressure exerted on the surface of the body by a column of air in the atmosphere. 1 atmosphere on Earth - 760 millimeters of mercury column (760 torr) and 101,325 pascals. STANDARD ATMOSPHERIC PRESSURE : Standard atmospheric pressure (300) is used as a reference for gas density and volume. Teh Atmospheric pressure is determined at sea level at 273o K (0o C) and is 1.01325 bar or 101325 Pa (absolute). Temperatures of 293o K (20o C) are also in use. 13. Types of Pressure Measurement Devices Manometer Bourdan Gauge 14. Continued.. Strain Gage Capacity Types Peizo Electric LVDT 15. Level Measurement - Some of the most commonly used methods of measuring liquid level: Measuring the measurement level using the pressure transmitter P and 17. Open Tank Closed Tank 18. RF Condensate conductive type 19. Hydrostatic head 20. RADAR Type Ultrasonic Type 21. Measuring flow: - Flow is measured by measuring speed through a known area.with this indirect method, the flow is measured by the flow rate. . A x V Where A is a transverse sectional sectional area of the V tube is a unit of low fluid speed is m3/hr or litres/hr 22. Flow Measurements - Types: - Head Type Flowmeters - Mechanical Flowmeters - Electronic Flowmeters - Mass-Teckometers 23. Different types of head Type Flowmeters - Orifice Plate - Venturi - Flow nozzle - Pitot pipe - Elbow 24. Orifice - Maintenance: Clean Liquids, Gas Steam, (no sludge or corrosive) - Scale: Square Root - Precision: 1% Full Scale - Constant Pressure Loss: High Cost: Low Base Equation :V'k (h/D)0.5 25. Venturi : Pure Liquid, Gaza Steam Slams and Dirty Liquids - Scale: Square Root - Precision: 1% Full Scale - Range: 3:1 - Constant Pressure Loss: Low Cost: High 26. Variable meters area 27. Mechanical flowometers 28. Electronic streaming meters 29. Whirlwind flows 30. Ultrasonic flowometers 31. Temperature Measurement: - Webster defines temperature as the degree of composure or cold measured in a certain scale. Different temperature units are linked, as C No 5/9 (F - 32) F - 9/5 (C) - 32 K 273 - C R 460 and F 32. Temperature Measurement - Temperature Measurement Types: - RTD - Thermocup - Termistor - Thermopyl - Pyrometer 33. 35 Steam Cold Water Hot Water Load Breaking TT TIC I/P Temperature Temperature Control Loops - Temperature Loop Issues: - Fluid Reaction Slowly Change In intake heat - Requires advanced management strategies - Feedforward Control 34. 36 - Example: Termistors - RTD (discussed later) - Termistors - Semiconductors made from specific mixtures of pure nickel oxides, manganese, copper, cobalt and other metals, speculating at a very high temperature. Used with Wheatstone Bridge, which amplifies a slight change of resistance - in a simple chain with a battery and micro-ammeter. Stability - - Linearity - - Exit Tilt - Changing temperature measurement technology in RESISTANCE with response to change TEMPERATURE Poor Moderate Negative 35. 37 RTDs temperature sensors - What is RTD? - RResistance TTemperature DDetector Platinum resistance change with Rosemount temperature in series 78, 88 Rosemount in series 68, 58 Series 65 Two common types of RTD elements: Wire wound sensing element of thin film sensing element Operation depends on the inherent characteristic of metal (Platinum usually): electrical resistance to current temperature changes. If we can measure resistance in metal, we know the temperature! 36. 38 RTDs Temperature Sensors - How Does RTD Work? - Изменения сопротивления повторяются - Изменения сопротивления платиновой проводки могут быть приближены к идеальной кривой - IEC 751 0 50 100 150 200 250 300 350 -400 -200 0 200 400 600 800 Сопротивление (Ohms) Температура (Ohms) Температура (Ohms) Температура (Ohms) Температура (Ohms) Температура (Ohms) Температура (Ohms) Температура (Ohms) o C) o C Ohms 0 100.00 10 103.90 20 107.79 30 111.67 Международное Сопротивление против температурного графика: IEC 751 IEC 751 IEC 751 Константы :- A 0.0039083, B - 5.775 x 10 -7 , Если t>-0'C, K-0, Если t<0, C - 4.183 x 10 -12 Пример: RT - R0 No1 - Bt2 - C (t-100)t3 - 103.90 37. 39 ProcessProcess TemperatureTemperature Hot Crossroads - Two different metals connected to the Hot Crossroads Cold Junction - MV - Wires are connected to a tool (voltmeter) that measures the potential created by the temperature difference between the two ends. DT 40 millivolt!, Tommy Seebeck shouted in a heated debate. The combination of two different metals creates a small voltage output proportional to the temperature! What is Thermocumple? Thermocoupla temperature sensors 38. 40 - How does Thermocouple work? - The measured voltage is proportional to the temperature difference between hot and cold connection! (T2 - T1) ΔT. - MVHeat Hot Crossroads Cold Junction o C Millivolts 0 0.000 10 0.591 20 1.192 30 1.801 Thermoelectric voltage vs. Temperature chart: TYPE E THERMOCOUPLE ΔT -2 0 0 20 40 60 80 -500 0 500 1000 Tension (mV) Temperature (o C) IEC 584 Measurement JunctionJunction TT22 ReferenceReference JunctionJunction TT11 Thermocouples 39 temperature sensors. 41 Type J - Iron / Constantan - White, Red - 0 to 760 Degrees Celsius - Least Expensive Types Thermocouple Type K - Chromel / Alumel Yellow, Red 0 to 1150 Degrees Celsius The Most Linear Type T - Copper / Constantan Blue, Red -180 to 371 Degrees Celsius High Resistance to Corrosion - Moisture - Moisture - Moisture - Moisture . 42 - Best accuracy - Repeatability - RTD signal less susceptible to noise - Better linearity - RTD can be matched by transmitter (interchangeability error eliminated) - CJC error inherent in T/C's; RTD Lead Wire Resistance Errors Can Be Eliminated Why Choose RTD Over Better stability - T/C drift is unsustainable and unpredictable; RTD drift predictably - - Can't be recalibrated Great flexibility - Special extension wires are required - You don't need to be careful with cold connections Temperature Sensors Comparison 41. 43 - Applications for higher temperatures - Above 1100 degrees Fahrenheit - Lower cost element - Cost is the same when considering temperature performance requirements - Faster response time - insignificant compared to response time to T-Well and process - Perceived as more durable - Rosemount's design methods produce extremely durable RTD Why choose a thermocuple on RTD? Temperature Sensors Comparison 42. 44 RANGE OFFER -200 to 500o C RTD 500 to 1100o C Thermocouple Type K zgt;1100o C Special Thermocouple R, S or B Temperature Sensors Temperature Sensors ComparisonComparison 43. 45 - What is a thermowell (T-good) ? - The device that protects the sensor from the flow of process, pressure, vibration and corrosion - Allows the removal of the sensor without stopping the process - slows down the response time (5 times) Why there are different types of materials? - To handle different corrosive environments - to handle different temperatures and pressure limits sensor accessories Thermowells 44. Control valves - The control valve manipulates running fluid such as gas, steam, water or chemical compounds to compensate for load disruption and as close as possible to the desired point of the set. The control valve regulates the flow rate of the liquid, as the position of the valve fork or disk changes by force from the drive. Control valves are valves used in industrial plants and elsewhere to monitor operating conditions such as temperature, pressure, flow and fluid level by full or partial opening or closing in response to signals received from controllers that compare a set point to a variable process whose value is provided by sensors that monitor changes in such conditions. The control valves are opened or closed using electrical, hydraulic or pneumatic systems. 45. CONTROL VALVES: They are basically pneumatically operated valves that require about 4 to 5 kg/cm2 of air pressure to operate the valve. I / P PositionER CONTROL VALVE SUPPLY AIR Air signal CURRENT SUPPLY AIR 46. Control of the Type 47 valve. The valve body types are Diff. Valve Body Types: - Valve Butterfly - Globe Valve - Ball Valve - Valve Fork - Needle Valve 48. Positioner and its accessories - Pneumatic controlled valves depend on the positioner to take input from the process controller and convert it into a travel valve. - The pneumatic signal (usually 3-15 psig) is fed into the positioner. The positioner transfers this to the required position of the valve and delivers a valve drive with the necessary air pressure to valve in the correct position. Analog I/P Positioner - This positioner does the same thing as stated above, but uses electric current (usually 4-20 mA) instead of air as an input signal. 49. Automation (ancient Greek: self-dictated), robotics or industrial automation or numerical control is the use of control systems, such as computers, to manage industrial equipment and processes, replacing operators. The most commonly used automation systems are: DCS - Distributed Control System - PLC - Programmable Logic Controller - SCADA - Control and Data Collection System 50. DCS - Distributed Control System (DCS) refers to a control system, usually a production system, process, or any dynamic system in which the controller elements are not central by location (such as the brain), but are distributed throughout the system with each component of the subsystem controlled by one or more controllers. The entire controller system is connected by a network of communication and monitoring. DCS is a very broad term used in various industries to monitor and control distributed equipment. DCS typically uses computers (usually specially designed processors) as controllers and uses both its own relationships and communication protocols. The input and output modules form components of THE DCS. The processor receives information from input modules and sends information to weekend modules. The input modules receive information from input tools in the process (as well as the field) and the output modules transmit instructions to the weekend instruments on the ground. Computer buses or electric buses connect processors and modules through multiplexers/demultiplexes. Buses also connect to distributed controllers with a central controller and finally to the Human-Machine Interface (HMI) interface or control consoles. 51. ARCHITECTURE DCS Operating Station 1 Operator WorkStation 2 Operator Workstation 3 Controller 1 Controller 2 Controller 3 Controller 3 Controller 4 Sensor 1 Actuator 2 Sensor 3 Sensor 3 Sensor 4 Sensor 4 Drive 4 Entry Module Module Module Sensor 2 Input Module Input Modular Modular Output Modular Output Module 52. HIS ENG STATION FCS NIU NIU BCV MFCD RL BUS V PURE ETHERNET FIELD INSTRUMENTS RIO BUS V NET FCS MOPL JB 1 JB 2 FIELD INSTRUMENTS MAR MAR DCS : BASIC CONFIGURATION MAR V NET JB 3 53. BASIC TERMINOLOGIES OF DCS HIS: The Human Interface Station The HIS is mainly used for work and monitoring - it displays the process variables, control parameters and alarms needed for users to quickly understand the state of the plant. NIU: Node Interface Unit is a remote I/O unit that all tools are connected.these units are in turn connected to the FCS via the RIO bus. FCS: Field control This is the main control unit that controls the plant.there can be more than one FCS that then communicate with each other as well as communicate to communicate HIS, where the Operator works from. Vnet: Vnet control systems are real-time BUS links stations such as FCS, HIS, BCV and CGW. ETHERNET: Ethernet is used to communicate HIS,ENG and surveillance systems.it is also used to transfer data files to control computers and to equalize HIS data. RL Bus: This is a BUS control system (communication) that connects field control units, operator stations. CGW: Communication Gateway This device links the Vnet BUS control system to the ETHERNET BUS BCV: Bus Converter Communication beads of one version of THE DCS cannot communicate with the new versions, so BUS CONVERTER is used to convert BUS into suitable mode. At our plant, our existing RL BUS is converted into a newer Vnet system bus from Bus Converter, which is stored in an engineering room next to the central control room. 54. A programmable logic controller (PLC) is a microprocessor-based system that uses programmable memory to store instructions and implement functions such as logic, sequencing, timing, counting, and arithmetic to manage machines and processes. Unlike a personal computer, THE PLC does not contain peripherals such as a display or keyboard that allow the user to interact directly with the PLC. To facilitate the interaction, a separate computer is provided, usually taking the form of a standard PC. With this external computer, the operator can reprogram THE PLC, provide a set of points, and view trends in variable processes that are controlled and managed by PLC. PLC Drive sensor process external computer 55. Microprocessor Communication Module - Analog Memory Entry (AI) Discrete Exit Module (DO) Discrete Input Module (DI) Analog Output Module (AO) Module Analog Sensor Sensor Analog Drive Drive Discrete Drive Operator WorkStation Programmed Logic Controller Architecture PLC 56. Communication Module Microprocessor Input Module External Computer Programmable Logic Controller Architecture PLC Exit Module Drive Process Sensor 57. PLC consists of the following components: Microprocessor - This is brain PLC. It reads input signals, performs a management program, and transmits the results (solutions) of the management program as signals of action to exits. Memory - It keeps a management program that must be performed at the prescribed rate. - Power Supply - This component is used to convert AC voltage into low DC voltage (e.g. from 240V AC to 5V DC). This unit powers the processor and circuitry in the input and output modules. Entry Module - This component receives information from external devices (sensors). It contains circuits that provide electrical insulation and signal conditioning functions. The input module can be analog (AI) or discrete input module (DI). The AI module receives an ever-changing signal, the amplitude of which is proportionally proportional the value of the measured variable process. The DI module receives discrete/digital (ON/OFF) information from discrete sensors, such as the press button (ON, if the button is pressed, OFF, if the button is not pressed). Note that DI is used much more often than AI. Exit Module - This module transmits control actions to external devices (drives). It contains the diagrams needed for a PLC interface with drives (e.g. a digital analog converter and a power amplifier). Like the input module, the output module can be an analog output (AO) or a discrete output module (DO) depending on the type of drive used. Communication Module - This component allows PLC to communicate with external devices through complex multi-china digital communication protocols (such as Ethernet). 58. Programmed Logic Controller (PLC) 59. PLC Programming - Ladder Chart - Most Common - Structure Text Programming (ST) - Functional Block Programming (FB) - List of Instructions (IL) - Serial Feature Schedule (SFC) 60. The SCADA system performs the following tasks - collecting data from field devices that can be sensors, drives and controllers. Transfer of field communication information to the central site (master station) - the implementation of any necessary calculations of analysis and control, all of which occur at the main stations. Displaying processing information on a number of operators' screens. - Transfer all necessary surveillance actions back to field devices. Control and Data Collection (SCADA) (SCADA)