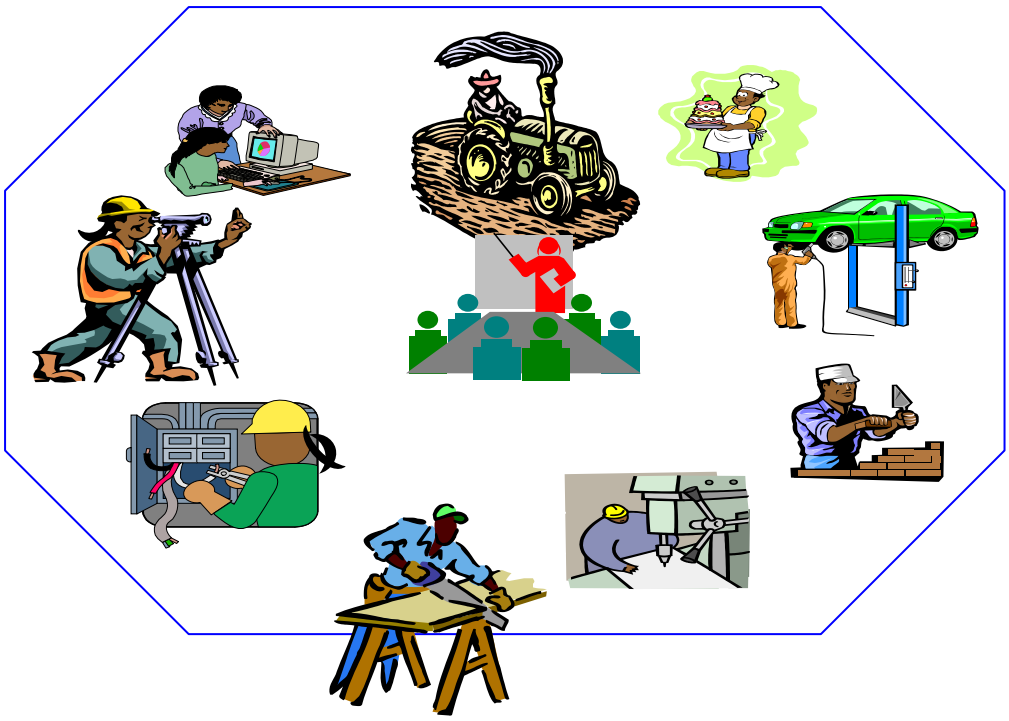
INSTRUMENTATION AND CONTROL SERVICING Level-III

Based on May, 2011 Version OS and Dec, 2020 Version 1 Curriculum



Module Title: Configuring Instrumentation and Control Devices

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December 2020

Bishoftu, Ethiopia

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Visual and Technical Checking of Instrumentation and Control SystemError! Bookmark not defined.

LG #23 LO #1- Plan and prepare for configuration

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Observing OH& S policies and procedures
- Planning and preparing configuration
- Identifying instrumentation and control devices of configured
- Conditioning instrumentation and control standards
- Checking instrumentation and control devices for configuration
- Obtaining materials necessary to complete the work
- Obtaining and checking tools, equipment and testing devices

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Observe OH& S policies and procedures
- Plan and preparing configuration
- Identify instrumentation and control devices of configured
- Condition instrumentation and control standards
- Check instrumentation and control devices for configuration
- Obtain materials necessary to complete the work
- Obtain and checking tools, equipment and testing devices

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.

4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,

If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1 Observing OH& S policies and procedures

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine every aspect of the system to determine which areas are critical to operator or machine safety. If you are not familiar with PLC system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C., publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include: ICS 1, General Standards for Industrial Control and Systems ICS 3, Industrial Systems ICS 6, Enclosures for Industrial Control Systems
- NEC — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- Local and State Agencies — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

Health and Safety Policy

Your Company Name is committed to the goal of providing and maintaining a healthy and safe working environment, with a view to continuous improvement.

This goal is only achievable by adherence to established objectives striving to exceed all obligations under applicable legislation, and by fostering an enthusiastic commitment to health, safety and the environment within Your Company Name personnel, contractors and visitors.

In particular:

- Management, working in cooperation with the Joint Health and Safety Committee, will strive to take all reasonable steps to reduce workplace hazards to as low as reasonably achievable.
- Supervisors and managers are held accountable for the health and safety of all employees under their supervision. This includes responsibility for applicable training and instruction, appropriate follow up on reported health and safety concerns, and implementation of recommended corrective action. This accountability is integrated into the performance appraisal system.
- Supervisors, workers and visitors are expected to perform their duties and responsibilities in a safe and healthful manner, and are accountable for the Health and Safety of themselves and others.
- Your Company Name is committed to providing all necessary training and instruction to ensure that appropriate work practices are followed on the job, and to promote their use off the job.
- If necessary, Your Company Name will take disciplinary action where individuals fail to work in a healthy and safe manner, or do not comply with applicable legislation or corporate policies and procedures.

Health, safety, the environment and loss control in the workplace are everyone's responsibility. Your Company Name expects that everyone will join in our efforts to provide a healthy and safe working environment on a continuous day to day basis. Only through the dedication and efforts of all individuals can Your

Company Name succeeds in providing a healthy safe working environment.

Occupational Health and Safety in Workplaces

Duties of Workers

One of your most important responsibilities is to protect your Health and Safety as well as that of your co-workers. This booklet will discuss some of your duties under the occupational Health and Safety legislation and help you to make your workplace safer and healthier.

The law requires

Workplaces under the jurisdiction are governed by your provincial legislation.

The legislation places duties on owners, employers, workers, suppliers, the self-employed and contractors, to establish and maintain safe and healthy working conditions. The legislation is

administered by your provincial legislation. Your officials are responsible for monitoring compliance.

Duties of Your Employer

Your employer is responsible for providing you with safe and healthy working conditions. This includes a duty to protect you from violence, discrimination and harassment. You must cooperate with your employer in making your workplace safe and healthy.

You're Responsibilities

- You must also comply with the legislation. You have responsibilities to:
- protect your own Health and Safety and that of your co-workers;
- not initiate or participate in the harassment of another worker; and
- Co-operate with your supervisor and anyone else with duties under the legislation.

You're Rights

The legislation gives your three rights:

- The right to know the hazards at work and how to control them;
- The right to participate in occupational health and safety; and
- The right to refuse work which you believe to be unusually dangerous.

You may not be punished for using these rights. An employer can be required to legally justify any action taken against a worker who is active in Health and Safety.

You're Right to Know

The Act requires your employer to provide you with all the information you need to control the hazards you face at work. For example, chemicals at the workplace must be listed. You are entitled to review this list. Your employer must train you to safely handle the chemicals you will work with. If you are inexperienced, you must receive an orientation which includes;

- What to do in a fire or other emergency;
- First aid facilities;
- Prohibited or restricted areas;
- Workplace hazards; and
- Any other information you should know.

You must also be supervised closely by a competent supervisor.

You're Right to Participate

You have the right to become involved in occupational Health and Safety.

The legislation encourages employers and workers to work together to maintain a healthy and safe workplace. Employers at workplaces with (ten or more – consult your provincial act) workers must set up an occupational health committee of employer and worker representatives.

Committees have duties to:

- Regularly inspect the workplace;
- Conduct accident investigations;
- Deal with the health and safety concerns of employees;
- Investigate refusals to work;
- Meet at least (four times a year – consult your provincial act); and return minutes of each meeting to the division.

Committee members are entitled to five days (consult your provincial legislation) of unpaid educational leave each year to take occupational Health and Safety courses.

They may attend courses provided by the Division without loss of pay or benefits.

Certain types of workplaces with less than (ten – consult your provincial act) employees must have a worker Health and Safety representative. The representative must be selected by the workers at the workplace. He or she has many of the responsibilities of an occupational health committee.

You're Right to Refuse

You have the right to refuse to do work which you believe is unusually dangerous.

The unusual danger may be to you or to anyone else. An unusual danger could include such things as:

- A danger which is not normal for your occupation or the job;
- A danger under which you would not normally carry out your job; and/or

- A situation, for which you are not properly trained, equipped or experienced.

To exercise this right, use the following guidelines.

Once you believe that the work you have been asked to do is unusually dangerous, you should inform your supervisor. Make sure that the supervisor understands that you are refusing to do the disputed job for health and safety reasons. Work with the supervisor to attempt to resolve the problem.

If the problem cannot be resolved by the supervisor to your satisfaction, and no worker health and safety representative or occupational health committee exists at the workplace, your supervisor should phone the Division and ask for advice. You also have the right to contact the Division at any time.

The supervisor has the right to assign you to other work (at no loss in pay or benefits) until the matter is resolved.

Do not leave the site without the permission of your employer.

If a committee exists at the workplace, contact your local representative and ask for help. Your supervisor should contact the co-chairpersons and ask them to investigate. They will try to resolve the matter. If they cannot resolve the matter to your satisfaction, they will convene for an emergency committee meeting. The committee will investigate and prepare a report on the refusal. You have the right to continue to refuse until:

- Measures have been taken to satisfy you that the job is now safe to perform; or
- Your occupational health committee has investigated and ruled against your refusal.

If the committee rules against your refusal, you have the right to appeal the ruling to an occupational health officer. The officer will investigate and prepare a report on the disputed work. If you disagree with the decision of the officer, you may appeal to the director of the Division.

An employer cannot assign another worker to do the disputed job unless the replacement worker is advised in writing:

- Of the refusal and the reasons for it;

- Of the reasons why the employer believes that there placement worker can do the disputed job safely;
- That the replacement worker also has the right to refuse; and
- Of the steps to follow when exercising this right.

Safe Work Procedure

A Safe Work Procedure is a written step-by-step description of how a particular task is to be performed that is used during performance of the work by the person performing the work (or by two people doing the work – one reading and one doing). Examples of procedures include: equipment start-up or shut-down procedures; normal operating procedures; written operating instructions; abnormal operating procedures, emergency procedures, special test procedures, maintenance procedures, construction installation procedures, calibration procedures, hydrostatic test procedures, and inspection procedures.

Safe Work Practice

Safe Work Practices are written descriptions of how work is generally carried out and allow flexibility in how the work is accomplished. Due to the diversity of circumstances and situations within JACOS, the information contained in Safe Work Practices cannot be considered complete or applicable in every situation.

Supervisors and employees must refer to federal and provincial health and safety legislation, and industry practices to ensure that the work is accomplished safely.

Development

Procedures should be developed for high-hazard work or where historical information, legislation, a Hazard Assessment dictates.

Practices should be developed for commonly used equipment or process that does not necessarily follow a step by step order.

Employees, Supervisors, and Management will be involved in the development and/or review of these Safe Work Procedures and Practices.

All Safe Work Procedures and Practices will be developed using the standard JACOS Safe Work

Procedure and Practice format and are based on a job hazard assessment.

Review

Employees, Supervisors, and technical experts will periodically review Safe Work Procedures and Practices to ensure that they are complete, accurate and applicable on a minimum 3 year bases or when warranted.

Availability

Safe Work Procedures and Practices applicable to the work being performed will be available to all employees at the work site.

Action Guidelines

IHI Aerospace has established the following action guidelines to put its basic policies into practice, based on its five fundamental safety rules.

- Specify OH & S targets to achieve this policy; establish and implement action schedules.
- Strive to reduce risks and to identify factors that lead to hazards by applying OH & S risk assessment activities to all business activities.
- Establish and adhere to voluntary guidelines to ensure compliance with OH & S regulations and customer agreements.
- Improve health and safety awareness through health and safety training and in-house information activities.
- Periodically review the OH & S management system to ensure constant improvements.
- Pay particular attention to the following points, based on the specific characteristics of IHI Aerospace's operations.
    - Prevent accidents and disasters involving the handling of explosives and pressurized gas.
    - Prevent falls or accidents caused by hazardous operations.
    - Prevent accidents and disasters involving the handling of hazardous substances and chemicals.

- Provide inexperienced employees with safety training and comprehensive instruction in work procedures.
- Institute improvements to create a safe, comfortable workplace.
- Eliminate accidents in commutes to and from the workplace.

2.2 Ethiopian environmental proclamations and regulations

Environmental pollution control (Proclamation no. 300/2002) Proclamation No. 300/2002 on Environmental Pollution Control primarily aims to ensure the right of citizens to a healthy environment and to impose obligations to protect the environment of the country. The law addresses the management of hazardous waste, municipal waste, the establishment of environmental quality standards for air, water and soil; and monitoring of pollution. The proclamation also addresses noise as one source of environmental pollution and it seeks for standards and limits for noise providing for the maximum allowable noise level taking into account the settlement patterns. In general, the Proclamation provides a basis from which the relevant environmental standards applicable to Ethiopia can be developed, while sanctioning violation of these standards as criminally punishable offences

Furthermore, it empowers the Federal Environmental Protection Authority or the Regional Environmental Authority to assign environmental inspectors with the duties and responsibilities of controlling environmental pollution. In order to ensure implementation of environmental standards and related requirements, inspectors belonging to the EPA or the relevant regional environmental agency are empowered by the Proclamation to enter, without prior notice or court order, any land or premises at any time, at their discretion. Such wide powers are derived from Ethiopia's serious concern and commitment to protecting the environment from pollution.

Solid waste management proclamation (Proclamation no. 513/2007)

This proclamation came into force on February 2007 with an objective of implementing effective solid waste management in the country. The Proclamation recognized the existing solid waste management problems in the country and emphasizes the need to prevent environmental pollution that may result from the disposal of solid waste. Environmental Protection Authority (replaced by Ministry of environment, forest and climate change (MEFCC) and now by EFCCC)

is responsible for initiating and overseeing the implementation of overall policies, strategies and guidelines on solid waste management. Capacity building is also an area of intervention by the federal and regional environmental entities to foster sound management of waste in the country.

Regional environmental agencies and urban administrations are also responsible for drawing out their plans as regards the implementation of the Proclamation and monitoring efficacy. In this proclamation the following provisions pertinent to the treatment and disposal of hazardous waste management has been provided: As regards to inter-regional movement of solid wastes:

- Regional states may require any transit of solid waste through their region to be packed and transported in conformity with the directives and standards issued by the concerned environmental agency.
- Each urban administration shall in conformity with the relevant environmental standards, ensure that solid waste disposal sites are constructed and properly used and managed. As regards to the transportation of solid waste:
- Without prejudice to the mandate of the appropriate agency to register, undertake annual registration and technical inspection of the motor vehicles as well as to issue a driving license, the conformity of any vehicle or equipment with the specifications set by concerned environmental agency shall be ascertained by the relevant urban administration prior to its use for solid waste management,
- Each urban administration shall ,without prejudice to the weight and size of the vehicles determine under the relevant laws, set standards to determine the skills of drivers and appropriateness of the equipment and equipment operators and to prevent overload of the solid wastes As regards to the construction of waste disposal sites
- Urban administrations shall ensure that a solid waste disposal site that was under construction or was constructed prior to the coming into force of this proclamation is subjected to environmental auditing as per the relevant laws.
- Urban administration shall ensure that any new solid waste disposal site being constructed or an existing solid waste disposal site undergoing any modification has had an environmental impact assessment according to the relevant law. As regards to the auditing of solid waste disposal sites

- Each urban administration is responsible for ensuring that an environmental audit is carried out on every existing solid waste disposal sites.

The owner of any solid waste disposal site shall make the necessary modification if the environmental audit made under sub-article (1) of this article shows that it's continued operation poses a risk to public health or the environment.

- The authority may prescribe environmental criteria to determine the alternative use of a solid waste disposal site that has ceased operation or is abandoned. As regards to civil liabilities
- The owner of any solid waste disposal site shall, regardless of fault, be liable for any damage caused to the environment, human health or property in the course of its operation and after its closure
- Without prejudice to sub-article (1) of the article ,exemption from liability shall be granted only when certified that it is the victim himself or a third party for whom the owner of the solid waste disposal site is not responsible that has caused the damage
- Any claim for damage under sub-article (1) of this article shall be barred by a period of limitation unless thought within two years from the date on which the occurrence of the damage is known

The major intents of the proclamation, as described in the preamble and objective, are maximizing the economic and social benefits of waste as well as promoting decentralized waste management services which also include a more strong involvement of the community and public at all level in the delivery of waste management services. The proclamation considers waste as a resource, and accords due attention to the issue of waste recycling.

Proclamation no.1090/2018 a proclamation to provide for hazardous waste management and disposal control

This is one of the recently introduced environmental legislations that specifically deal with hazardous wastes, the proclamation in its preamble elucidated hazardous waste as one of the most crucial environmental problems in Ethiopia. It stated the importance of prevention and control of these type wastes and emphasized the need for creation of a system to control the

generation, storage treatment, recycling and reuse as well as transportation and disposal of hazardous wastes to prevent harm to human and animal health as well as the environmental.

The proclamation defined "hazard" as the inherent characteristics of a substance, agent, or situation having the potential to cause adverse effects or damage to human or animal health, the environment, biodiversity and property and has determined the categories and characteristics of hazardous waste in annex I and annex II respectively. The objectives of this proclamation are stated as;

- Create a system for the environmentally sound management and disposal of hazardous Waste
- Prevent the damage to the human or animal health, the environment, biodiversity and property due to the mismanagement of hazardous waste.

Further its scope of application is also stated as:

- Waste that belong to any category contained in Annex One of this Proclamation, and waste possesses any of the characteristic contained in Annex Two; as well as on those wastes that might be categorized as hazardous waste by the directive to be issued by the Ministry;
- Person, who generates, reuses, recycles, stores, transports, or disposes hazardous waste at large in nation. The proclamation within its 24 articles has dealt with all character and management of hazardous wastes.

Proclamation no 1075/2018 industrial chemical registration and administration proclamation One of the most important recent environmental legislations particularly focusing on solving environmental problems associated with chemical industry. The proclamation in its preamble elaborated that Ethiopia, being in the process of economic transformation from agricultural to industrial led economy steadily increases the demand of imported or domestically produced chemicals.

In light of this it is found important to put in place a system to prevent and control of adverse effects to the human and animals health as well as environment safety that may arise from

mismanagement of the chemicals in the process of production, importation, exportation, transportation, storage, and use of industrial chemicals.

It provided a definition of “Industrial chemical” as any chemical that is used for industrial, educational and training, research and transfer purposes, with the exclusion of pharmaceutical and medical, food and food additives, agricultural, chemical weapons and radioactive chemicals.

Its scope of application extends to any person who is engaged in the transaction of industrial chemicals while its objectives are

- Establishing a national system for registration and administration of industrial chemicals; and
- Preventing and controlling the adverse effects arising from the mismanagement of chemicals to the human and animals health as well as environment safety that may occur in the transaction of industrial chemicals The legislation has five parts covering eighteen articles in which the acquisition, transportation utilization, monitoring and disposal mechanisms are well articulated.

Addis Ababa city waste management, collection & disposal regulation

This is an elaborate piece of legislation (Regulation No 13/2004) which has 9 parts and 37 articles. Among the key concerns of this regulation are environmental pollution and public health related issues as well as the economic importance of waste. The general spirit of the regulation is the promotion of a more decentralized, participatory and private sector driven waste management service delivery in the City. The regulation also provides, among others, for the establishment of governmental organizations dedicated for waste management related affairs both at the City, Sub-City and Kebele levels.

As expected, the regulation stipulates general provisions that assume detail guidelines and directives to be developed at a later stage to enable the proper implementation of the regulation. The regulation gives a clear definition for the term “hazardous waste”. Article 13 which refers to the management and disposal of hazardous wastes, for example, stipulates that a directive shall be issued on this issue. The regulation also stresses the need to have special

authorization from the City's Environmental Protection Authority, although specific tools that will be used in enforcing these provisions are not indicated.

Notwithstanding the key roles residential and business establishments in the City play in achieving the objectives stated in the regulations, it is more explicit about the responsibility of the generators than on the commitment of the government. Likewise, Article 27 that refers to "Safety and Health of Online Workers" stipulates that taking care of the safety and health of online workers is the responsibility of the employer, although it does not provide for specific instruments to be employed to ensure its proper adherence. It is also worthwhile to note that Article 29, which is about incentives, explicitly promotes the use of appropriate technology for recycling and reduction of waste, but it is silent about the need to provide incentives to those that adopt and/or promote OHS practices.

Public health proclamation (200/2000) The Public Health Proclamation (200/2000) comprehensively addresses aspects of public health including among others, water quality control, waste handling and disposal, availability of toilet facilities, and the health permit and registration of different operations. The Proclamation prohibits the disposal of untreated solid or liquid hazardous wastes into water bodies or the environment that can affect human health.

The labour law proclamations 1156/2019 The former labour Proclamation No.377/2003 is repealed and substituted by a new Proclamation 1156/2019. The new labor legislation consists of much of the provisions of the previous labor law with some improvements and additions made to it. The new legislation have made important improvements on protecting child labor by increasing the minimum age for young workers to be 15 years old (versus the previous 14 years) and have introduced a new sub-article (14h) prohibiting Sexual Harassment or Sexual Assault at workplace to prevent GBV.

Proclamation 1156/2019 is also the prevailing law protecting public and workers safety. The proclamation covers health and safety at work, harmonious industrial relation and minimum workplace standard and addresses workplace vulnerability. Article 92-93 of the proclamation defines obligation of employers and employees in work place including assignment of safety officers and committee. The Labour Proclamation provides a responsibility to employers to protect occupational safety, health and create better working environment for their workers.

Article 92 states that “An employer shall take the necessary measure to safeguard adequately the health and safety of the workers…” The proclamations have details about the safety and health of workers. For instance, it forces employers to

- Take appropriate steps to ensure that workers are properly instructed and notified concerning the hazards of their respective occupations and the precautions necessary to avoid accident and injury to health;
- Ensure that directives are given and also assign safety officer; establish an occupational, safety and health committee of which the committee's establishment, shall be determined by a directive issued by the Minister;
- Provide workers with protective equipment, clothing and other materials and instruct them of its use; etc.

This new Labour Law protects Children against Child Labour abuse. The new Proclamation No. 1156/2019, Article 89 prohibited employment of less than 15 years. This proclamation states “It is prohibited to employ persons under 15 years of age”. It is also prohibited to employ young workers which on account of its nature or due to the condition in which it is carried out, endangers the life or health of the young workers performing it. "Young worker" means a person who has attained the age of 15 but is not over the age of 18 years (Article 89 Sub-Article 1).

In addition to enacting its labor codes, Ethiopia is also a signatory to the international UN conventions and has ratified the major international human rights instruments. Ethiopia has also ratified the following ILO conventions:

- Forced Labour Convention No.29 /1930;
- Freedom of Association and Protection of the Right to Organize Convention, No.87/1948;
- Employment Service Convention, No.88/1948;
- Right to Organize and Collective Bargaining Convention, No.98/1949;
- Abolition of Forced Labour Convention, No.105/1957;
- Minimum Age Convention No. 138 /1973; Occupational Safety and Health Convention, No.156/1981;

- Termination of employment Convention, No.158/1982;
- The Rights of the Child Convention (1989); and
- The Worst Forms of Child Labour Convention No.182/1999.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Directions: Choose the best answer

1. What is your right? (have 5 point)
2. The unusual danger may be to you or to anyone else. An unusual danger could include such things as: (have 5 point)
3. What are duties of committees? (Have 5 point)
4. What are your responsibilities? (Have 5 point)

Note: **Satisfactory rating – 10 and above** **Unsatisfactory - below 10 points**

Score = _____

Rating: _____

Name: _____ Date: _____

Guidelines: The following application guidelines apply, for open loop and closed loop systems:

- For open loop control, always use an electro-pneumatic valve positioner. If the loop system is relatively slow, such as, liquid level, blending, select an electro-pneumatic valve positioner.
- For closed loop control, if the system is relatively fast, such as liquid pressure, and small volume of gas, use an electro-pneumatic transducer (and not use a valve positioner).

Electro-pneumatic Transducers with diaphragm/bellows-actuated control valves	Electro-pneumatic transducers types
	

Information sheet 2- Planning and preparing configuration

Information sheet 3- Identifying instrumentation and control devices of configured

Information sheet 4 Conditioning instrumentation and control standards

Signal Conditioning Challenges Facing The Process Engineer Many types of sensor are available for monitoring processes of all types, including temperature, level, flow, pressure, position, light, and so on; the list of applications using signal conditioning is endless.

Figure 4.1 signal condition

Any industry, heavy or light, from farming to power generation, will make use of signal conditioning units and each industry will present its own set of requirements and problems.

Some applications will require the comparison of signals and an output based upon the result, for example, the difference between input and output oil flow to a burner will be the amount consumed. This is normally done with the use of complex controllers or PLCs, however, advances in the functionality of signal splitters and multi-channel conditioners now mean some of this work can be done by the conditioning block itself.

Although basic signal conditioning has been in use for many years, it can still present a challenge to the process engineer with several things to be considered in any system that needs to transmit analogue signals representing engineering values from a measurement point to a monitoring or control point. There can be many issues that will affect how a signal is conditioned from the mismatch of inputs to outputs, to the environment in which the system is located: The output signal type and level from process sensors can cause problems in being matched to the input requirements for controllers or PLCs. It may be a sensor with a (0 to 10) mA output will need to be connected to a controller with a (0 to10) V input, or even a different mA range. Matching the signals is the primary requirement of any signal conditioner.

Isolation of equipment inputs/outputs on the same control loop may be required, if ground loops that can cause signal errors are to be avoided.

Ranging and scaling signals where sensor outputs are not in the same engineering unit or engineering unit multiple, and potential re-ranging if process conditions change, are potential pitfalls. If the working parameters for a process change, for example a scaled level sensor needing to be re located or changed, can the conditioning block is easily re configured to the new input settings.

A flow sensor representing (0 to 100) l/min may need to be connected to a data logger needing an input representing (0 to 50) l/min and both are using a (4 to 20) mA signal, how will the conditioning unit cope with the miss match.

Signal integrity is important too as a loss of signal or, what can be worse, an incorrect reading may cause a control system to fail or run outside of limits. Integrity can be affected by many factors from inside and outside the control system. The physical ambient conditions, length of cable run, electrical interference, can all cause. A robust system is therefore essential in maintaining signal fidelity.

Isolation between sensors that may become live in a fault condition can be a safety concern in some applications, so a conditioner with a suitable rating can be a major factor in choosing the correct unit for some engineers.

With so many factors to assess, sometimes more than one conditioner may be required, so a single unit that can fulfill all of the requirements can be very useful. The downside to this is that such a sensor can be complex and expensive.

With the ever-growing number of sensor types and manufacturers producing them, it is important that process engineers choose equipment can be easily interfaced. Controllers, PLCs, building management systems, and displays will all need to be integrated to work with each other in many different combinations. This is why most sensors, or the transducer the sensor may connect to, will look to convert its particular engineering value into something that can be interfaced with the vast majority of control systems on the market, which, to be practical,

normally accept only a limited number of inputs. The industry “standards” for analogue signal transmission are within the ranges of (0 to 20) mA DC or +/- (0 to10) VDC.

Flexibility in modern signal conditioning technology is helping the process engineer to reduce the number of units required by making them multi-purpose and by making them easy and quick to commission. Many of the problems presented to the process engineer can be solved by the correct choice of signal conditioning unit.

Status Instruments’ rail mounted SEM1700 range of single and dual channel conditioning and splitter products from Status Instruments has been designed with a view to overcoming many of the common problems associated with signal conditioning. With a worldwide power supply operating from 24 VDC all the way up to mains voltage, 3k75 V isolation between inputs and outputs, and a wide range of input and output configuration, gives the user flexibility in the field.

The dual channel unit can be used in two modes: simple - where only the basic features of a signal conditioner/splitter need to be considered, and advanced. In advanced mode the functionality offers: user non line, signal damping, system diagnostic tool and other options, including recording, are available. Set up is achieved using FOC software and a standard USB lead.

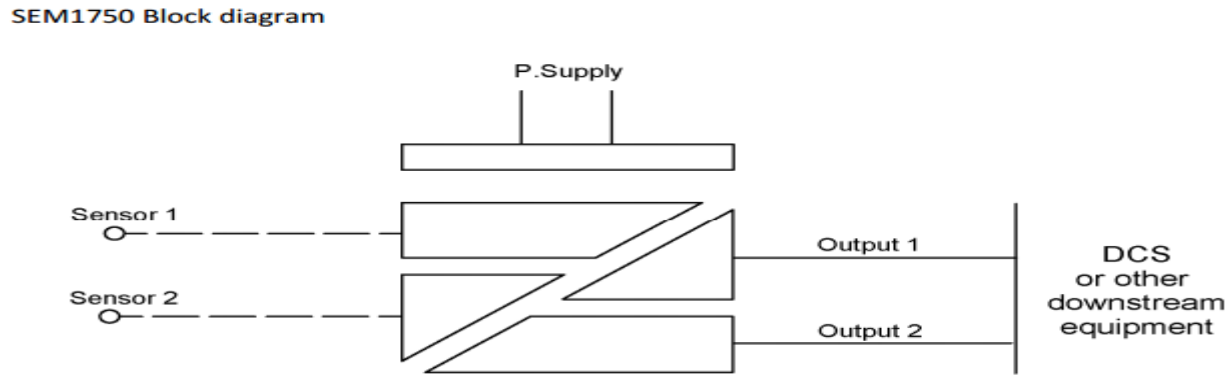
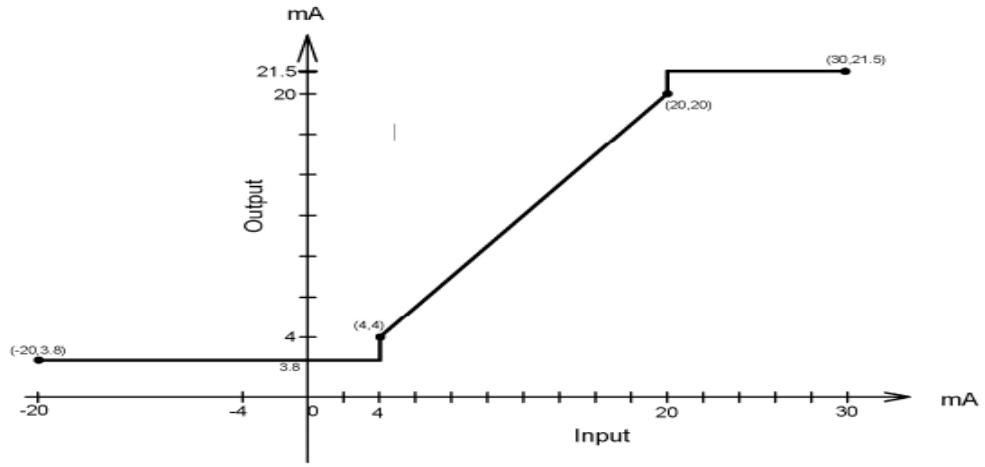


Figure 4.2 SEM1750 Block Diagram

Using the SEM1750 to control the in range and out of range input signal to give a known condition on the output, this is a simple relationship,



Graph 4.1 shows in range and out of range

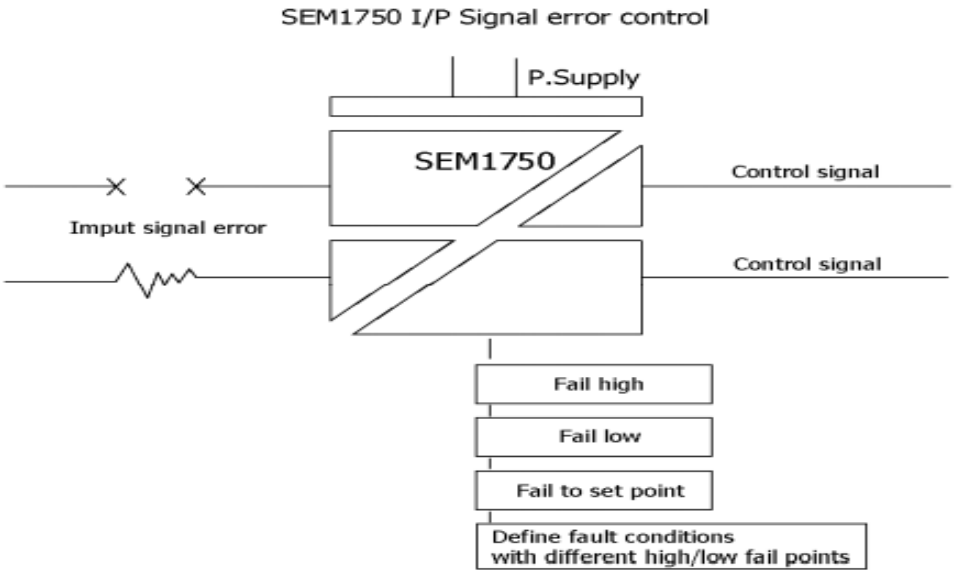


Figure 4.3 SEM1750 sigal error control

More advanced profiles can be entered using the Speed Link software

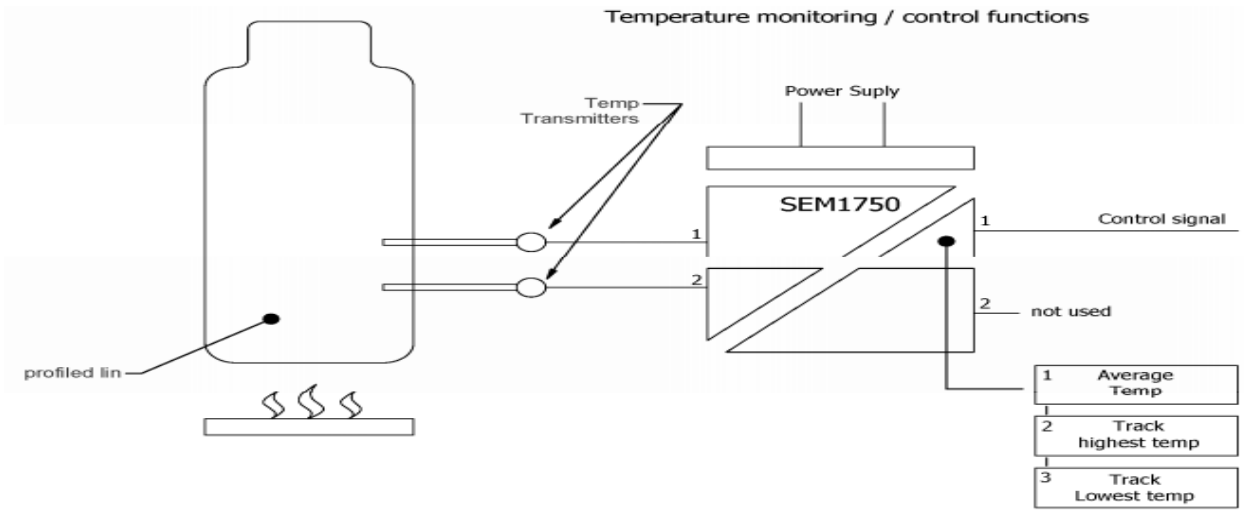


Figure 4.4 Using the SEM1750 to compare two temperature signals.

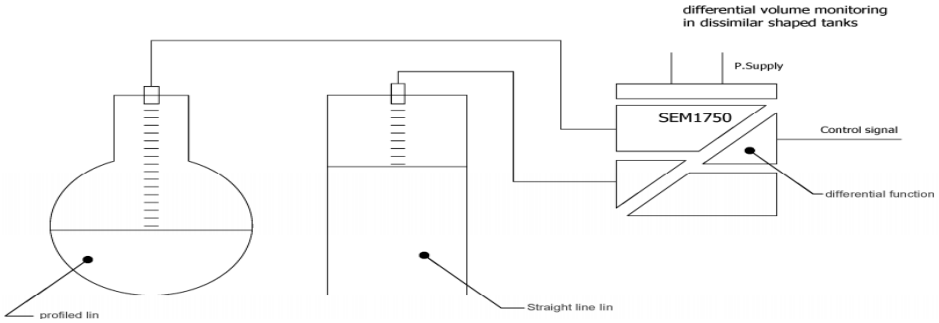


Figure 4.5 Using the SEM1750 to monitor the level in two dissimilar shaped tanks for direct comparison, A-B, A+B, or other comparisons.

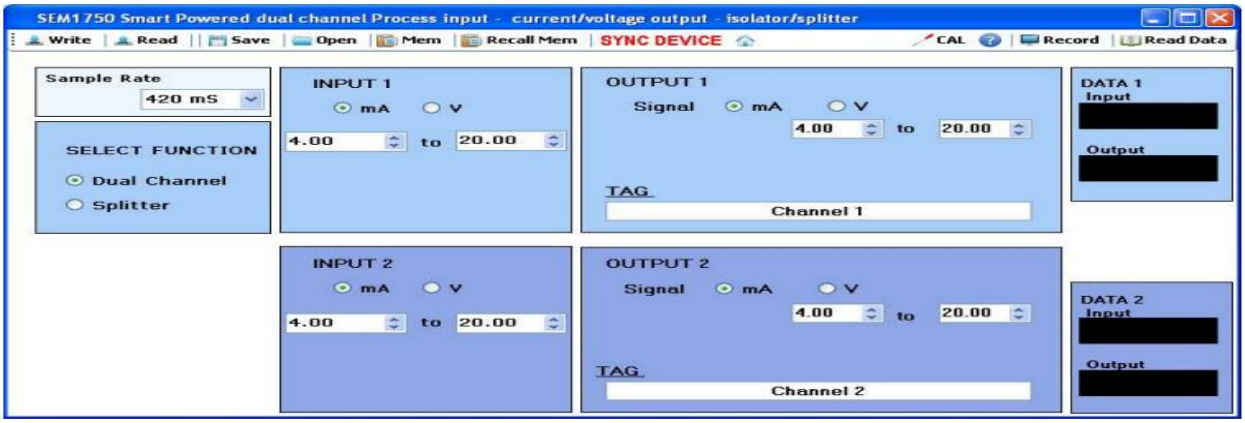


Figure 4.6 SEM1750 simple configuration screen

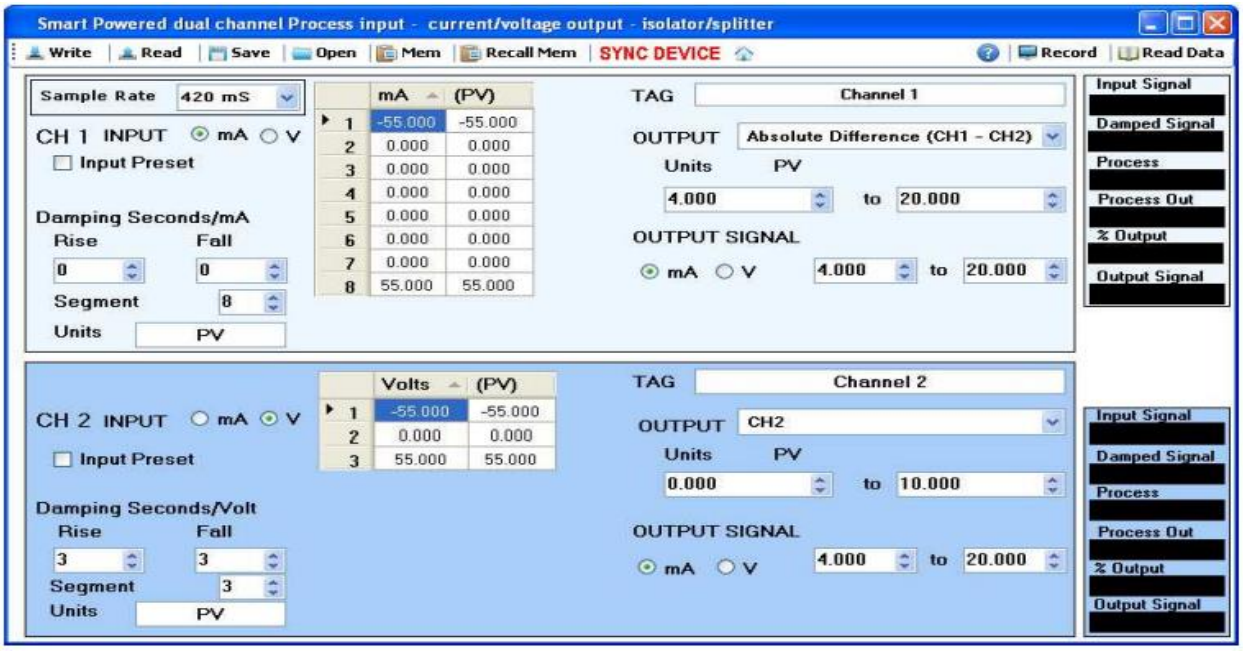


Figure 4.7 SEM1750 advanced configuration screen

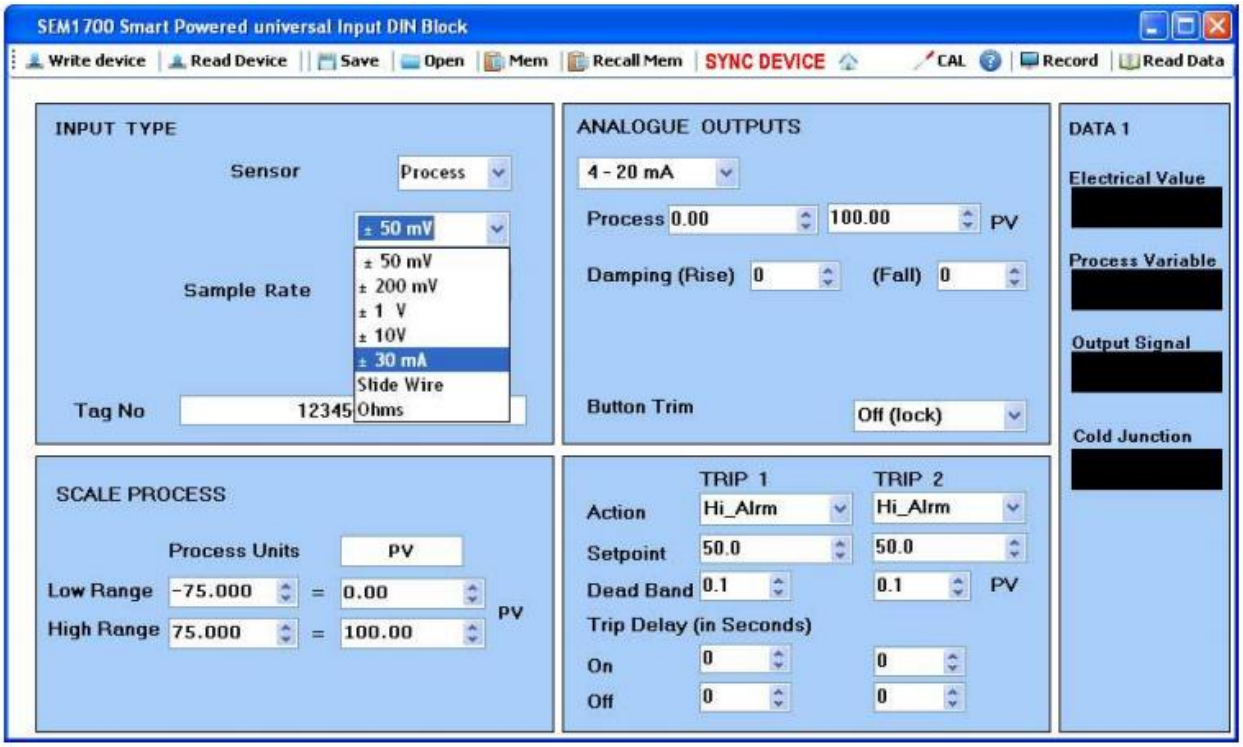


Figure 4.8 SEM1700 configuration screen

Now let's look at processors which change the characteristic of the signal. These are often referred to as SIGNAL CONDITIONERS. One example is the square root extractor. For

example DP flow meters produce an output which is directly proportional to the square of the flow. A processor might be used along with the DP cell to extract the square root so that the resulting signal is directly proportional to flow.

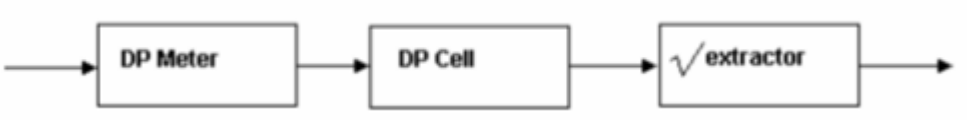


Figure 4.9

Other conditioners bring in the time element. For example the flow meter produces a signal representing the flow rate. If the signal is integrated with time, the output is quantity. Such a unit is called an INTEGRATOR and there are mechanical, pneumatic and electric methods.

Some meters produce a quantity. For example a movement transducer produces distance. If the signal is differentiated with respect to time, we get the rate or velocity. Such units are called DIFFERENTIATORS.

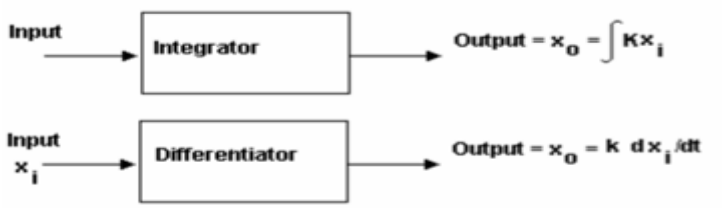


Figure 4.10

FILTERS

Another form of signal conditioning is the SIGNAL FILTER. This is used with electric signals to remove unwanted parts of the signal. For example a signal may contain AC and DC signals. A simple capacitor would filter out the DC signal. The signal may contain AC signals of different frequencies. A more sophisticated filter would remove unwanted frequencies.

MULTIPLEX SYSTEMS

A modern industrial information transmission system requires that many channels be sent from one place to another using either a single frequency of transmission or a single pair of wires such as a telephone line. A system that does this is called multiplexing.

Modems are units that receive and transmit the information to each other. They require a marker signal to let each other know when to receive or transmit. The modem acknowledges a request to receive and this is called handshaking. When acknowledgement is received by the transmitting modem, it sends the data to the receiving modem.

The channels are sampled very rapidly one after another for a fixed period of time. This is called Time Division Multiplexing (TDM). Each sample is tacked in a queue (a buffer) and sent one after another. The process is continually repeated. The receiving end reverses the operation. The incoming data is placed in a buffer, extracted in sequence and diverted to the correct output.

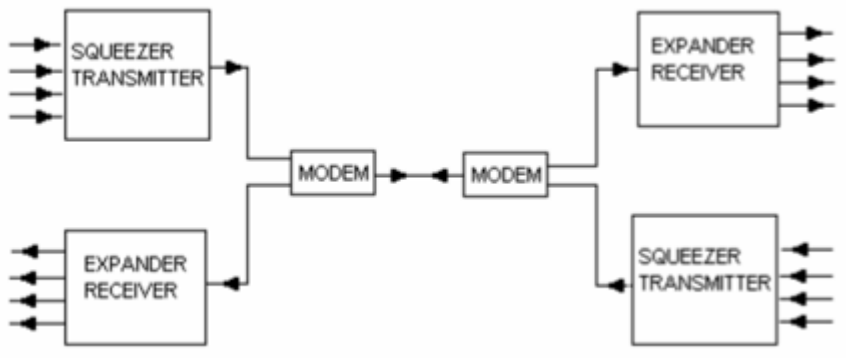


Figure 4.11

If the information is digital, it sends the information for each channel as a package of digits one channel at a time.

BUFFERS and STORES

Very often a signal value needs to be stored. This is usually done by converting them into a digital number and storing them in a memory chip. If a system is receiving or sending serial data but the incoming data is arriving quicker than it can be processed, then the incoming signals are put into a temporary store called a buffer where they wait to be processed.

Self-Check 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer (each 2 point)

1. If the signal is integrated with time, the output is quantity. Such a unit is called _____
2. _____ used with electric signals to remove unwanted parts of the signal.
3. _____ are units that receive and transmit the information to each other.
4. The incoming data is placed in a_____, extracted in sequence and diverted to the correct output.

Answer the following question!

Note: Satisfactory rating 5 points **Unsatisfactory below 5 points**

You can refer at the end of this reference for the copy of the correct answers.

Name: _____ Date: _____

Short Answer Question

Score = _____
Rating: _____

Information sheet 5. Checking instrumentation and control devices for configuration

Recent high profile incidents and accidents have highlighted the need to ensure more than ever that installed layers of protection on hazardous installations meet required reliability and safety integrity requirements.

As operators improve their basis of safety as part of their process safety management obligations, there is an ever increasing need to develop assured methodologies that can link the hazard analysis with the confident development of credible layers of protection and in particular, embracing safety instrumented systems.

The overall operation, maintenance, repair, modification and retrofit phases of any safety instrumented system (SIS) poses significant challenges for process plant operators, particularly for those in the heavily regulated and highly hazardous processing sectors such as the offshore oil and gas sector.

Within the process industries today there are known to be a wide range of techniques and methods adopted by asset owners in their approach to SIS inspection and proof testing and the desire to comply with industry good practice standards such as IEC 61508 and IEC 61511. Regulatory authorities are increasingly showing an interest during their planned site visits in the SIS inspection and proof testing regimes being operated by duty holders.

For asset owners, operating, maintaining and modifying a SIS which is designed and engineered in accordance with minimum industry good practice requirements such as IEC61508/61511 poses both significant challenges and operational and process limitations. One of the fundamental requirements these standards place upon operations and maintenance (O&M) activities is to maintain the performance of the ‘designed-in’ functional safety and integrity of the SIS throughout its installed life.

In particular, there to be an operations and maintenance planning process and schedule for each SIS, Appropriate maintenance ensures each safety instrumented function within the SIS continues to provide the required functionality with respect to its defined safety integrity level. Furthermore, there must also be consistent operational management to ensure that the SIS as a whole provides the required operational risk reduction.

Historically, the ways in which SIS have been managed within the O&M lifecycle phases have varied significantly. Ultimate responsibility for SIS operations and maintenance and compliance to expected industry good practice falls to the asset owner. In many cases, however, the expertise of the supply chain may be called up to help manage and deliver SIS operations and maintenance strategy. In many cases, this may include the original OEM, integrator and maintenance contractor organizations.

Whatever resources and methodologies are deployed within the operation, the use of an inspection and proof test protocol is required to identify and expose any foreseeable unrevealed fail-to-danger fault conditions. If failures are detected during the inspection and proof testing routines, then adequate measures must be in place to manage any additional risk during the recommended repair time and records of any faults will need to be retained for analysis and potential rectification.

Similarly, management of change to the SIS during the operational and maintenance lifecycle phases is required to ensure that modifications are undertaken in a systematic way to prevent errors and potential failures being introduced in the operational SIS. A preventative and corrective operations and maintenance process aligned to the IEC safety standards provides demonstrable compliance and the ability to retain and demonstrate functional safety performance throughout the O&M lifecycle phases of the SIS.

The benefits of compliance with IEC safety standards include:

- The provision of independent assurance that the organization's preventative and corrective O&M strategy is in alignment with accepted industry good practice
- Demonstrating due diligence for the operations and maintenance of installed SIS
- Professionalism
- Establishing an efficient, systematic and repeatable safety management system (procedures, techniques, tools, etc.) to maintain functional safety performance
- Traceability and supporting documentary evidence covering the required O&M preventative, corrective, operational, inspection, change management and proof testing of the SIS

Self-Check 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the benefits of compliance with IEC safety standards 6%

   a. _____
   _____
   _____

   b. _____
   _____
   _____

   c. _____
   _____
   _____

   d. _____
   _____

   e. _____
   _____

Answer the following question!

Note: Satisfactory rating 3 points **Unsatisfactory below 3 points**

You can refer at the end of this reference for the copy of the correct answers.

Name: _____ Date: _____

Short Answer Question

Score = _____
Rating: _____

Information sheet 6. Obtaining materials necessary to complete the work

The configuration process is based on electronic data sheets (EDS-Files) provided by the device manufacturers, and contain relevant communication parameters, both commonly described as:

- Device Net is a digital, multi-drop network, used in Ethernet I/P layer, serving as a communication network between industrial controllers offering a single point of connection for configuration by supporting both I/O and explicit messaging.
- Control Net offers good real-time capabilities, also used in Ethernet I/P layer, providing high speed deterministic transmission for time-critical I/O data and messaging data.

The first step in operating a smart differential pressure transmitter is to set-up properly. This involves correct electrical wiring and positioning.

ELECTRIC WIRING

Reach the wiring block by removing the Electrical cover this cover can be locked closed by the cover locking screw (figure 6.1). To release the cover, rotate the locking screw clockwise

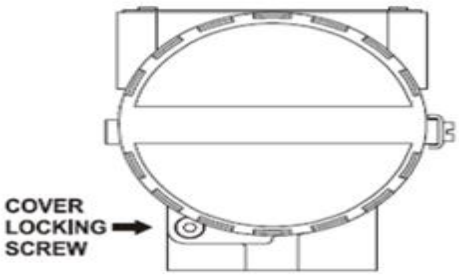


Figure 6.1 housing rotating Set Screw

Test and communication terminal allow, respectively, to measure the current in the 4-20mA loop, without opening it, and to communicate with transmitter. To measure it, connect a multimeter in the mA scale in the**"-"and "+"** terminals, use a HART configurator in **"COMM"** and **"-"terminals**.

The wiring block has screws on which fork or ring-type terminals can be fastened. See figure 6.2

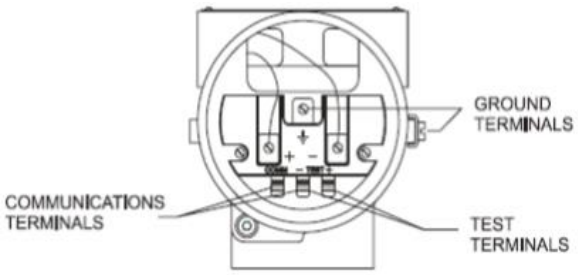


Figure 6.2 wiring block

For convenience there are two ground terminals: one inside the cover and one external located close the conduit entries.

Use of twisted pair (22 AWG or greater then) cables is recommended.

Avoid routing signal wiring close to power cables or switching equipment.

Unused outlet connection should be plugged and sealed accordingly.

The LD301 is protected against reverse polarity.

The Figure 6.3 –conduit installation diagram shows the correct installation of the conduit, in order to avoid penetration of water, or other substance, which may cause malfunctioning of equipment.

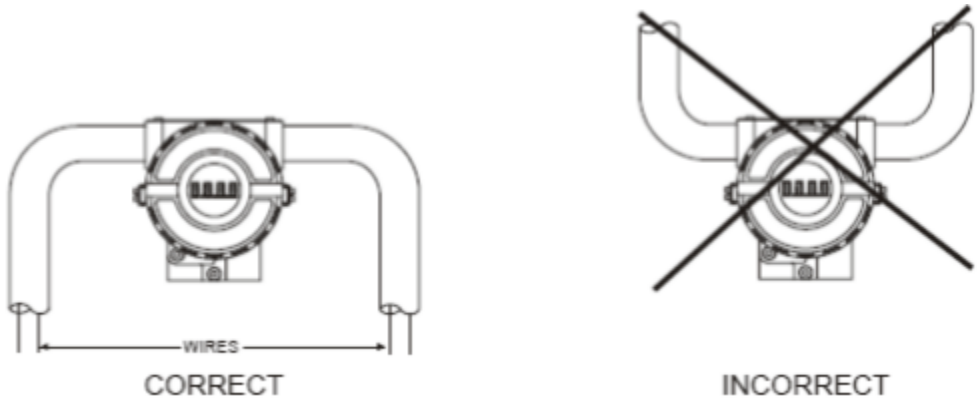


Figure 6.3 conduit installation diagram

NOTE
The transmitters are calibrated in the vertical position and a different mounting position displaces the zero point. Consequently, the indicator will indicate a different value from the applied pressure. In these conditions, it is recommended to do the zero pressure trim. The zero trim is to compensate the final assembly position and its performance, when the transmitter is in its final position. When the zero trim is executed, make sure the equalization valve is open and the wet leg levels are correct. For the absolute pressure transmitter, the assembly effects correction should be done using the Lower trim, due to the fact that the absolute zero is the reference for these transmitters, so there is no need for a zero value for the Lower trim.

Hhen the sensor is in the horizontal position, the weight of the fluid pushes the diaphragm down, making it necessary a lower pressure trim, see Figure 6.5

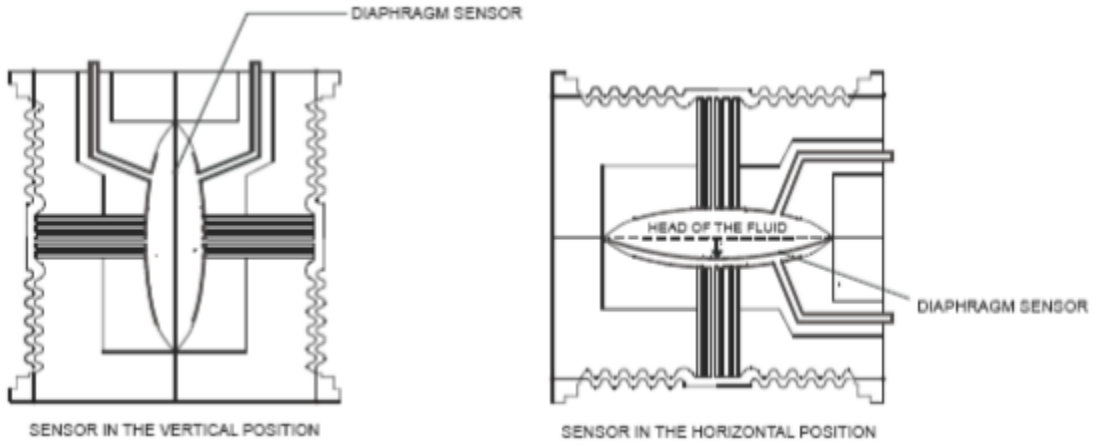


Figure 6.4 sensor positions

Connection of **LD301** working as transmitter should be done as in Figure 6.5.

Connection of **LD301** working as a controller should be as indicated as in Figure 6.6

Connection of **LD301** in multi-drop configuration should be done as in Figure 6.7. Note that a maximum of 15 transmitters can be connected on the same line and that they should be connected in parallel.

Take care to power supply as well, when many transmitters are connected on the same line.

The current through the 250 ohm resistor will be high causing a high voltage drop. Therefore make sure that the power supply voltage is sufficient.

The Hand-Held terminal can be connected to the communication terminals of the transmitter or at any point of the signal line by using the alligator clips. It is also recommended to ground the shield of shielded cables at only one end. The unground end must be carefully isolated.

Note: Make sure that the transmitter is operating within the operating area as shown on the load curve (Figure 6.8). communication requires a minimum load of 250 ohm.

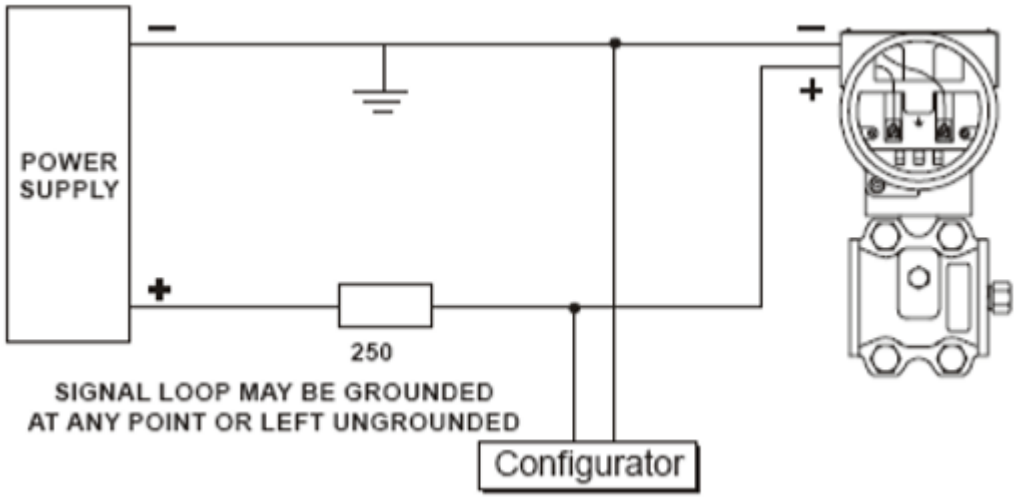


Figure 6.5 wiring diagram for the LD301 working as a transmitter

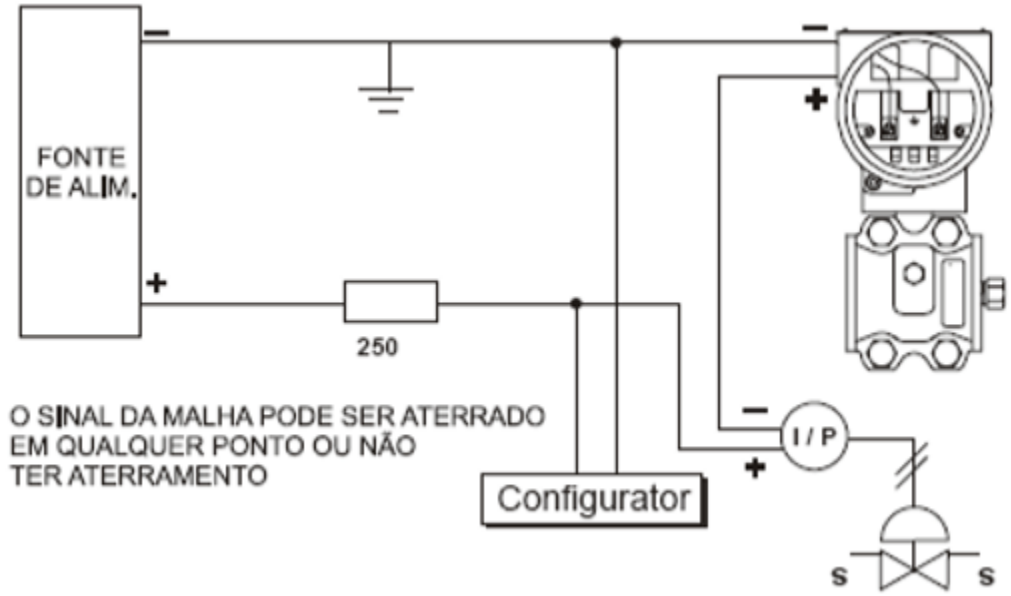


Figure 6.6 wiring diagram for the LD301 working as a controller (optional)

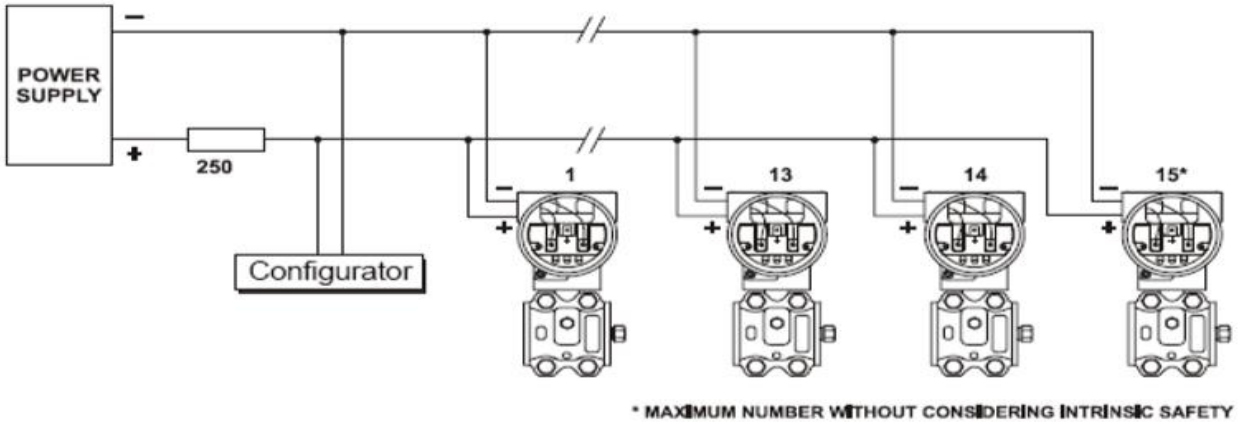


Figure 6.7 wiring diagram for the **LD301** in multidrop configuration

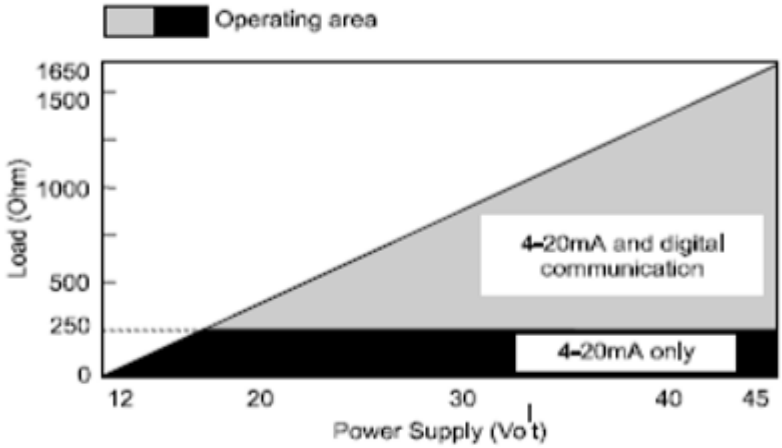


Figure 6.8 load curve

When using the instrument as a transmitter or a controller, the connection diagram is pretty much the same. Their responses to the input though are different.

Self-Check 6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. _____is a digital, multi-drop network, used in Ethernet I/P layer, serving as a communication network between industrial controllers offering a single point of connection for configuration by supporting both I/O and explicit messaging.
2. _____offers good real-time capabilities, also used in Ethernet I/P layer, providing high speed deterministic transmission for time-critical I/O data and messaging data.

Answer the following question!

Note: Satisfactory rating 3 points **Unsatisfactory below 3 points**

You can refer at the end of this reference for the copy of the correct answers.

Name: _____ Date: _____

Short Answer Question

Score = _____
Rating: _____

Signal sources & generators

GS610 - Source measure unit The GS610 is a high accuracy, high speed programmable voltage and current source that incorporate both generation and measurement functions as well as USB storage and an Ethernet interface. As the GS610 can operate as a current source or a current sink, a wide range of electrical characteristics can be evaluated.

- Wide range sink and source operation (3.2 A, 110 V, 60 W)
- Precise pulse generation (down to 100 µs width with 1 µs resolution)
- Battery simulator version available

GS820 - Multi channel source measure unit The GS820 is a highly accurate multi-channel voltage/current source measure unit that incorporates voltage generation/current generation as well as USB storage and an Ethernet interface. Since the two source channels and two measuring channels can be operated arbitrarily, almost all electrical characteristics can be evaluated.

- Dual sink and source operation: 7 V and 3.2 A or 18 V and 1.2 A
- Precise pulse generation (down to 100 µsec width with 0.1 µsec res.)
- 50 V version available, 50 V and 0.6 A or 20 V and 1.2 A

FG400 – Arbitrary/function generators The FG400 provides basic and 25 types of application specific waveforms as standard and generates signals quickly and easily. Acquire signals using a Yokogawa Oscilloscope or Scope Corded and use the 16 bit arbitrary waveform capabilities to reproduce them or add them to other signals.

- 1 or 2 independent or synchronised channels
- 0.01 µHz to 30 MHz
- Precise phase and frequency control between channels
- 20 V peak to peak and 42 V isolation between outputs

  Refer others tools and equipment form your UC of **calibration instrumentation** and controlling device and also Level I from UC **use hand tools and testing equipment**

Self-Check 7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. As the GS610 can operate as a current source or a current sink, a wide range of electrical characteristics can be evaluated by: 3%
   a. _____
   b. _____
   c. _____
2. the two source channels and two measuring channels can be operated arbitrarily, almost all electrical characteristics can be evaluated by: 3%

a. _____
b. _____
c. _____

Answer the following question!

Note: Satisfactory rating 3 points **Unsatisfactory below 3 points**

You can refer at the end of this reference for the copy of the correct answers.

Name: _____ Date: _____

Short Answer Question

Score = _____
Rating: _____

Operation sheet one

1 Configure a smart field device using a HART communicator.

Learning Activity:

1.1 Set-up connection to configure a smart differential pressure transmitter

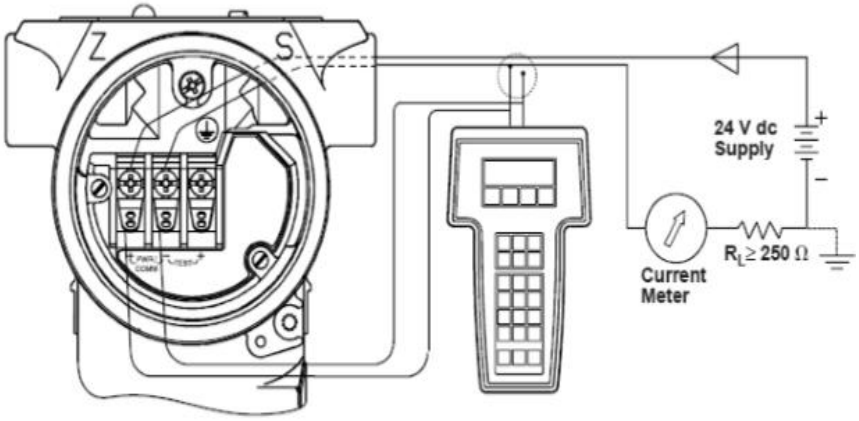
1.2 Configure a smart DP transmitter for pressure, level and flow measurement

Equipment / Resources:

- DC Power supply
- Multimeter
- HART communicator

At the end of this learning activity, you should be able to configure a pressure transmitter using a HART communicator.

1. Connect the HART communicator to a smart-field transmitter as shown in the diagram below.



Typical connection diagram of a pressure transmitter and a HART communicator

2. Apply power to the unit. Refer to Operation Sheet 3.3.1 for the Basic Operation of HART 275 communicator. You may use other configuration tool for this activity as long as it uses the HART protocol. You may also need to refer to the manufacturer's instruction manual.

PRESSURE/LEVEL (HYDROSTATIC LEVEL) TRANSMITTER APPLICATION

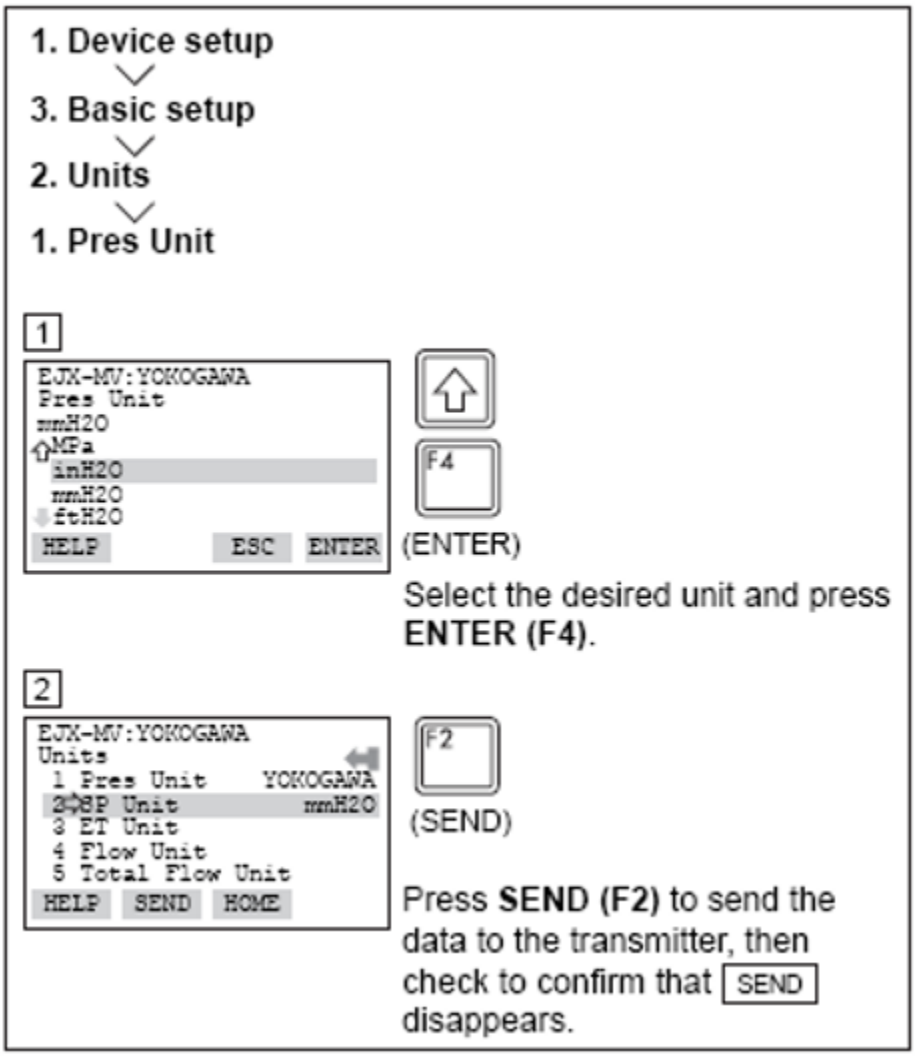
3. Configure the unit for pressure transmitter application. Note: The security features of the transmitter may prevent configuration changes. Check user's manual for proper setting (jumper) of the transmitter.

When changing the unit, from the Online Menu, go to Device

Setup (1) Press Basic

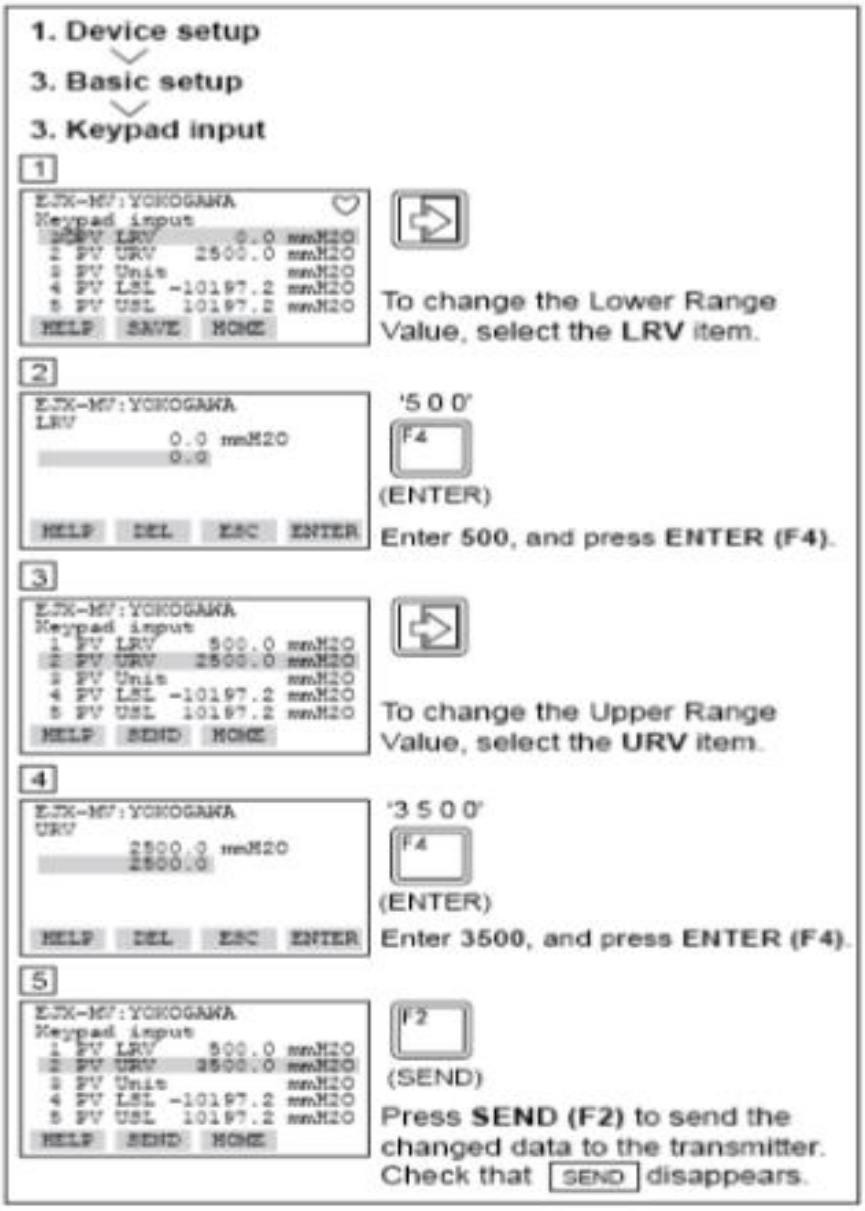
Setup (3) followed by pressing **Units (2).** Follow the on line instructions.

Example: to change the unit from mmH2O to inH2O:



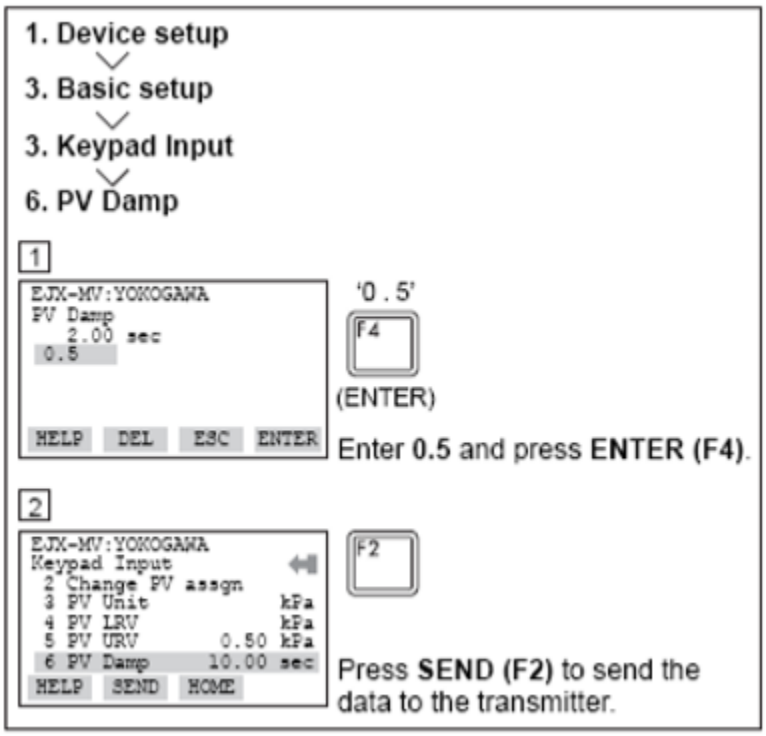
4. Change the pressure range. Go to Online Menu and select Device Setup(1). Press Basic Setup (3) followed by pressing Keypad input. Select LRV(1) to configure the lower range value. Enter the value for as your minimum pressure. Select URV(2) to configure the upper range value. Enter the value as you maximum pressure. Press Send(F2) to send the changed data to the transmitter.

Example: to change range from 0 to 2500 mmH2O to 500 to 33500 mmH2O. Call the Keypad input display.



5. Set the damping time constant of the transmitter. Any number from 0.00 to 100.00 for the damping time constant. This may also vary from various manufacturers' design of transmitter.

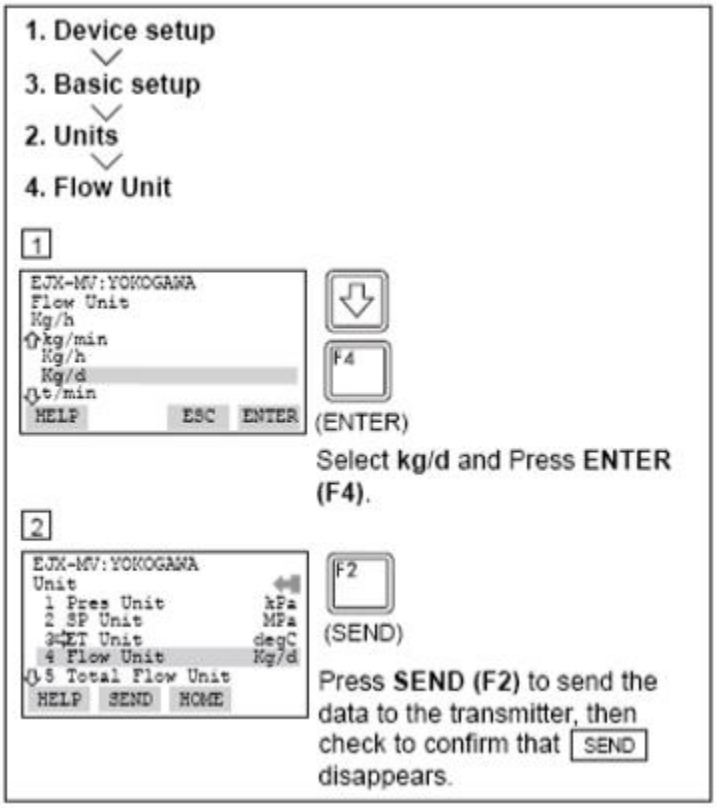
Example: to change from 2.0 seconds to 0.5 second, call the PV Damp display



FLOW TRANSMITTER APPLICATION

6. Configure the unit for flow transmitter application. Note: The security features of the transmitter may prevent configuration changes. Check user's manual for proper setting (jumper) of the transmitter. Go to Online Menu and select DEVICE SETUP(1). Press BASIC SETUP (3) followed by pressing PV RANGE VALUES. Select LRV(1) to configure the lower range value. Select URV(2) to configure the upper range value. Follow the succeeding online instructions.

Example: to change the unit for the flow display from kg/h to kg/d, from the Online Menu:



7. Configure the transmitter for flow transmitter application. From the Detailed Setup (4), go to Signal Condition (2), then Flow Setup (1). Press LRV(1) to change the minimum flow range. Enter the value of you Lower Range Value. Press URV(2) to change the maximum flow range. Enter the value of you Upper Range Value. (Note: You can also change the unit of flow by pressing Flow Unit (3) and the damping time constant by pressing Flow Damp (4). Follow the on-line instructions.

Operation sheet two

1 Configure a smart field device using a HART communicator.

Learning Activity:

1.1 Set-up connection to configure a smart temperature transmitter

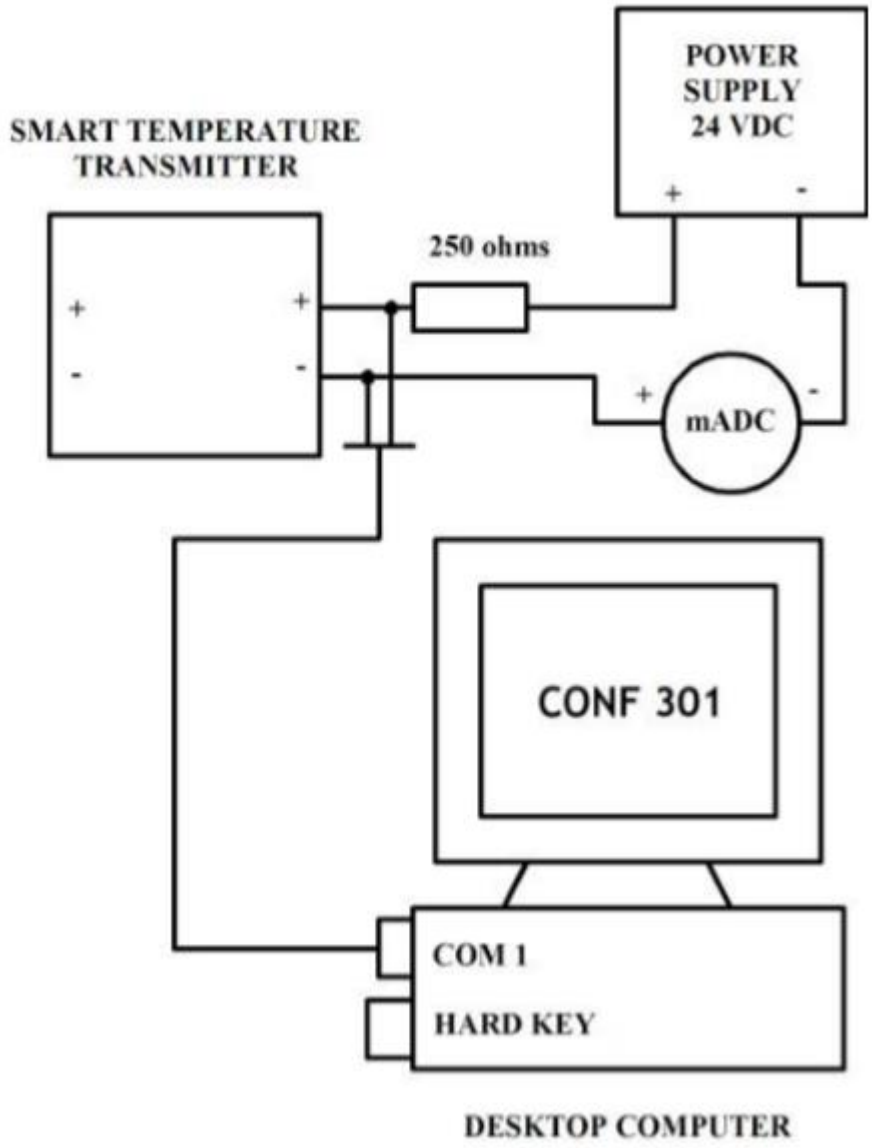
1.2 Configure a smart temperature transmitter using thermocouple and RTD for temperature measurement

Equipment / Resources:

- DC Power supply
- Multimeter
- HART configuration tool (computer w/ software) w/ interface cable
- 250Ω resistor
- Smart temperature transmitter

At the end of this learning activity, you should be able to configure a temperature transmitter using a HART communicator or a HART configuration tool such as a computer with the proper software installed.

1. Connect the HART communicator to a smart-field transmitter as shown in the diagram below.



Typical connection diagram of a temperature transmitter and a HART configuration tool (computer and software)

2. Apply power to the unit. Turn on PC and open the appropriate software such as CONF401 software used by SMAR for TT401 (TT301 – old version) smart temperature transmitter. If set automatically, the configuration tool will search for the transmitter; otherwise, you have to search manually. There are two choices – offline or online. You may choose offline, to configure and save the program in the computer; and download later to a transmitter. Click **online**, right-click, click **polling window**, then click poll. A short way would be to double click **online**.
3. First, configure the input to the transmitter. Go to **Sensor** tab, click **type** and select **RTD** for RTD sensor or click **TC** for thermocouple sensor from the pull down menu. Next, click

Sensor and select appropriate type of sensor, e.g. Pt100 IEC for RTD or J NBS for thermocouple. Set the Connection **– 2-wire, 3-wire** or **4-wire** for the appropriate RTD connection. For thermocouple, select Enabled to activate cold junction compensation, otherwise click **Disabled**. Then press **Send** to send the program to transmitter.

4. To configure the range and unit of the transmitter, go to the **Range** tab. In the **Unit family**, select **Temperature**. In the **Unit**, select the appropriate unit of measurement, e.g. degrees Celsius. In the **URV** dialog box, enter the upper range value and in the **LRV** dialog box, enter the lower range value. You may also set the damping time constant in the **Damping** dialog box. Press saves to send the program to the transmitter.
5. You may explore other functions of the software such as configuring it for other applications such as differential pressure application or flow measurement.

Operation sheet three

1 Configure electronic controller using various PID control algorithms.

Learning Activity:

1.1 Set-up connection to configure a smart electronic controller.

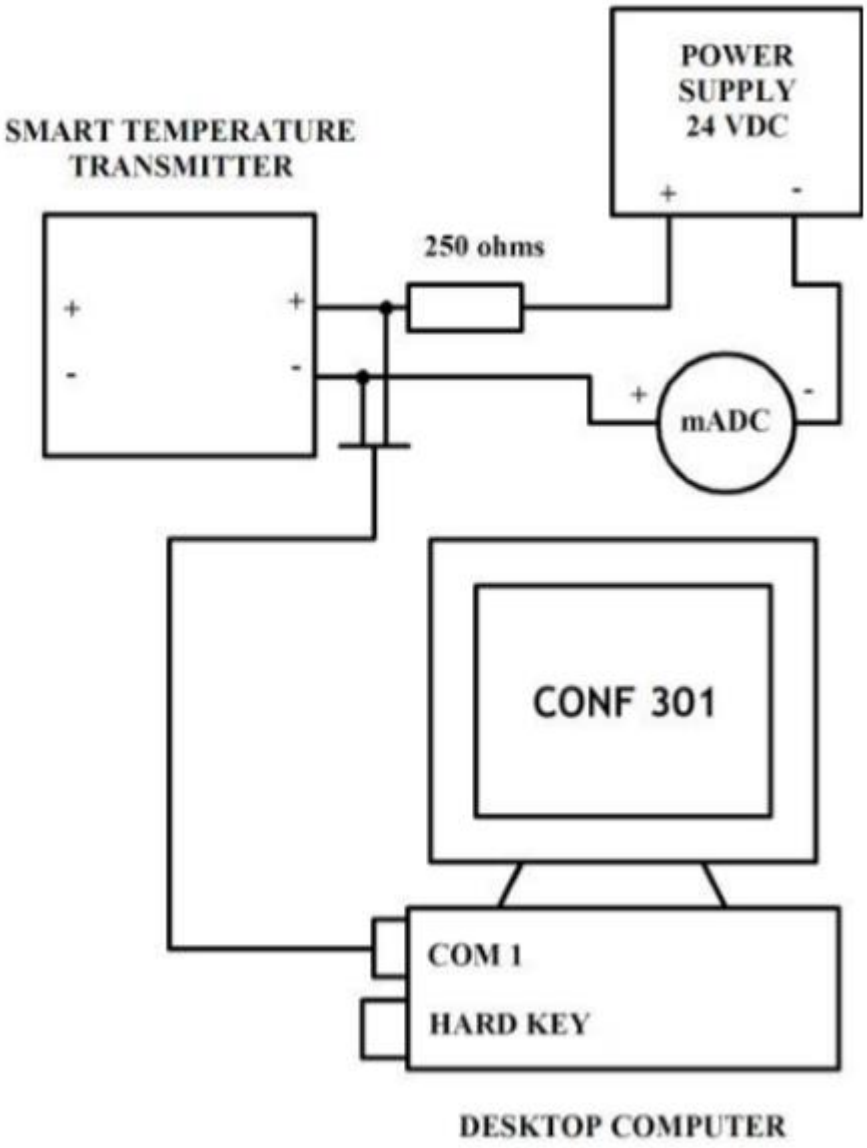
1.2 Configure electronic controller using P, PI, PD and PID control mode.

Equipment / Resources:

- DC Power supply
- Multimeter
- HART configuration tool (computer w/ software) w/ interface cable
- 250Ω resistor
- Smart electronic controller (differential pressure or temperature)

At the end of this learning activity, you should be able to configure a smart electronic controller using a HART communicator or a HART configuration tool such as a computer with the proper software installed.

1. Connect the HART communicator to a smart-field transmitter as shown in the diagram below.



Typical connection diagram of a temperature transmitter and a HART configuration tool (computer and software)

2. Apply power to the unit. Turn on PC and open the appropriate software such as CONF401 software used by SMAR for TT401 (TT301 – old version) smart temperature transmitter. If set automatically, the configuration tool will search for the transmitter; otherwise, you have to search manually. There are two choices – offline or online. You may choose offline, to configure and save the program in the computer; and download later to a transmitter. Click **online**, right-click, click **polling window**, then click poll. A short way would be to double click **online**.
3. First, ensure the PID module in on, so that the device will function as a controller and not as a transmitter. Click **PID Settings** tab and in the **PID** select **On**.

4. Configure the input to the controller. Go to **Sensor** tab, click type and select **RTD** for **RTD** sensor or click **TC** for thermocouple sensor from the pull down menu. Next, click **Sensor** and select appropriate type of sensor, e.g. Pt100 IEC for RTD or J NBS for thermocouple. Set the Connection **– 2-wire, 3-wire** or **4-wire** for the appropriate RTD connection. For thermocouple, select **Enabled** to activate cold junction compensation, otherwise click **Disabled**. Then press **Send** to send the program to transmitter.
5. To configure the range and unit of the transmitter, go to the Range tab. In the **Unit family**, select **Temperature**. In the **Unit**, select the appropriate unit of measurement, e.g. degrees Celsius. In the **URV** dialog box, enter the upper range value and in the **LRV** dialog box, enter the lower range value. You may also set the damping time constant in the **Damping** dialog box. Press saves to send the program to the transmitter.
6. Go back to **PID Settings**. Select the appropriate **Action**, either **Direct or Reverse**. You may also select the **Mode.** Click **Manual,** for manual operation. Click **Auto** for automatic mode operation. In the **SP** dialog box, enter the set point value.
7. To configure the controller for the tuning parameters, click **Limits and Tuning**. Here the Limits and Tuning window will open. In the appropriate dialog box, enter the values for the gain **(Kp),** integral time (**Tr),** in minutes per repeat and derivative time **(Td),** seconds. Click **Save** and **Done**.
8. To test you work, apply procedure for testing configured smart electronic transmitter.

LG #24 LO #2-Configure instrumentation and control devices

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Using appropriate personal protective equipment
- Checking Normal functioning systems and components
- Diagnosing fault/s or problem/s in the device
- Configuring instrumentation and control devices
- Responding to unplanned events or conditions

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Use appropriate personal protective equipment
- Check Normal functioning systems and components
- Diagnose fault/s or problem/s in the device
- Configure instrumentation and control devices
- Respond to unplanned events or conditions

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets”
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 Using appropriate personal protective equipment

- Ensuring PPE is:
  - ✓ selected with regards to the nature of the work and any hazard associated with the work
  - ✓ suitable with regards to size and fit and reason ably comfortable for the worker associated with the work
  - ✓ maintained, repaired or replaced so that it continues to minimise risk the worker as well as including that it is hygienic, in good working order and used or worn by the worker
- providing workers with information, training or instruction and instruction in the:
  - ✓ proper use and wearing of PPE
  - ✓ storage and maintenance of PPE
- Workers are not to be charged or imposed a levy for the provision of PPE

General Requirements

- The use of PPE is supported by training or instruction, supervision of use, regular maintenance and replacement procedures as outlined through this document.
- Special protective clothing or equipment shall be free of charge to the employee and a available also to the students.
- Employees and students shall receive appropriate instruction in the use of PPE and clothing.
- Faculty and Divisional Heads shall provide supervision to ensure, as far as practicable, the appropriate equipment and clothing is being used in the manner required.
- Employees shall use protective clothing and equipment for the purpose provided and in the manner required
- PPE should be replaced when not fit for purpose or as recommended by the manufacturer. Staff and students should refer to their supervisor for replacement of PPE.

Selection

Selecting the most appropriate PPE for the task is the first step to ensuring the user is protected against the hazard. The decision making process for selecting PPE can be supported by sources of information including:

- Designers, manufacturers or suppliers of PPE can give advice on the specifications and appropriate use of their products.
- hazardous chemical safety data sheets

- risk assessments
- Safe work procedures (safe work methods statements/job safety analysis).

It is important to correctly select the required PPE as not all PPE will meet the same performance requirements and provide the same protection. For example, no one type of glove provides adequate protection against all chemicals. A respirator designed to be effective against a certain concentration in air of a contaminant may not be effective for higher concentrations. When selecting the appropriate PPE consideration should be given to elements such as:

- Durability
- Permeability
- Abrasion
- Resistance
- Burn resistance
- Insulation
- Cut resistance
- Ability to be cleaned
- Size
- Comfort.

Circumstances in which PPE may be required to be worn include:

- **Head protection** (hard hats, helmets, sun hats) shall be provided where there is a risk of injury to the head, such as a person struck on the head by a falling object, a person may strike his/her head against a fixed object, there may be inadvertent head contact with electrical hazards.
- **Eye protection** (goggles, safety glasses) shall be provided where a risk of eye injury exists. Typical hazards might include flying particles, dust, splashing substances, harmful gases, vapours, aerosols, and high intensity radiation from welding operations.
- **Hearing protection** (ear plugs, ear muffs) shall be provided where a risk of noise induced hearing loss exists. The need for hearing protection may be assessed through noise monitoring or surveys.

- **Respiratory protection** (respirators, face masks, cartridge filters) shall be provided where there is a risk of airborne contaminates. This will minimise the risk to of exposure to an atmosphere that is or may be injurious to health.
- **Hand protection** (gloves, gauntlets) shall be provided where there is an identified hazard associated with a potential for hand injury. A list of hazards shall be compiled for each workplace and suitable hand protection obtained to minimise risk.
- **Protective footwear** (safety boots, gumboots, enclosed shoes) shall be provided where the nature of the work exposes the employee to a medium to high risk of injury to feet, eg occupations such as workshop/maintenance and gardening staff.
- **Body protection** (high-visibility garments, thermal wear, overalls, aprons, safety harnesses) shall be provided to minimise risk of injury occurring to the body. Examples may include those who are required to work outdoors and are exposed to the sun's rays for continuous periods in a day. Direct exposure of the skin to UV radiation from outdoor work shall be minimised by providing hats, long sleeves/trousers and an adequate supply of sunscreen.
- **Outer wear** (high visibility safety vests, reflective vests, fluoro jackets) shall be provided to highlight the worker in the area often used where there is a risk of injury associated with working on or near roadways or near moving traffic or moving plant.

Use

Any protective equipment provided for use should be appropriate for the wearer and that is controls the risk. Protective equipment should be in a clean and hygienic condition for the wearer. This equipment should not be shared between wearers unless the equipment is deemed to be clean.

Any protective equipment used should be stored and located in an appropriate place so that it remains clean and not exposed to the elements. Any storage areas for protective equipment should be clearly identified.

Self-check 1	**Written Test**

Directions: For the following questions, give short answer

1. What we consideration When selecting the appropriate PPE? (have 5 point)

   _____, _____, _____, _____,

   _____, _____, _____, _____,

   _____

2. List the decision making process for selecting PPE can be supported by sources of information are? (Have 5 point)

   i. _____

   _____

   ii. _____

   iii. _____

   iv. _____

Note: **Satisfactory rating – 5 and above points, Unsatisfactory - below 5 points**

You can refer at the end of this UC for the copy of the correct answers.

Score = _____
Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 2 Checking Normal functioning systems and components

:

1 Plan and prepare for configuration. Learning Activity:

1.1 Interpret instrumentation and control standard.

1.2 Read/interpret P&ID diagram.

Piping and Instrumentation Diagram (P&ID)

A Piping and Instrumentation Diagram - P&ID, is a schematic illustration of functional relationship of piping, instrumentation and system equipment components

P&ID shows all of piping including the physical sequence of branches, reducers, valves, equipment, instrumentation and control interlocks.

The P&ID are used to operate the process system.

A P&ID should include:

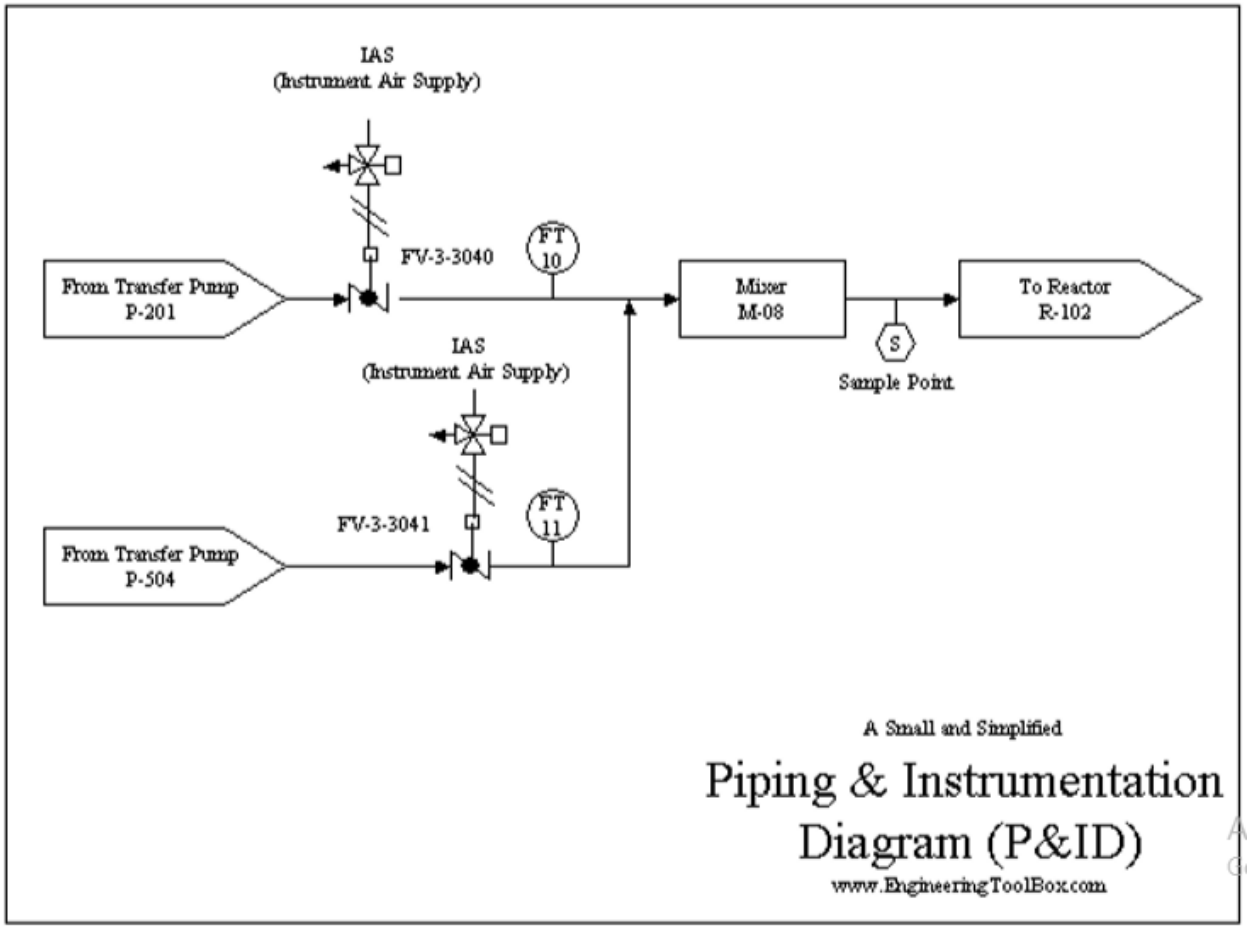
- Instrumentation and designations
- Mechanical equipment with names and numbers
- All valves and their identifications
- Process piping, sizes and identification
- Miscellaneous - vents, drains, special fittings, sampling lines, reducers, increasers and swagers
- Permanent start-up and flush lines
- Flow directions
- Interconnections references
- Control inputs and outputs, interlocks
- Interfaces for class changes
- Seismic category
- Quality level
- Annunciation inputs
- Computer control system input
- Vendor and contractor interfaces
- Identification of components and subsystems delivered by others
- Intended physical sequence of the equipment

A P&ID should not include:

- Instrument root valves
- Control relays

- Manual switches
- Equipment rating or capacity
- Primary instrument tubing and valves
- Pressure temperature and flow data
- Elbow, tees and similar standard fittings
- Extensive explanatory note

This figure depicts a very small and simplified P&ID:



Learning outcomes:

1 Plan and prepare for configuration.

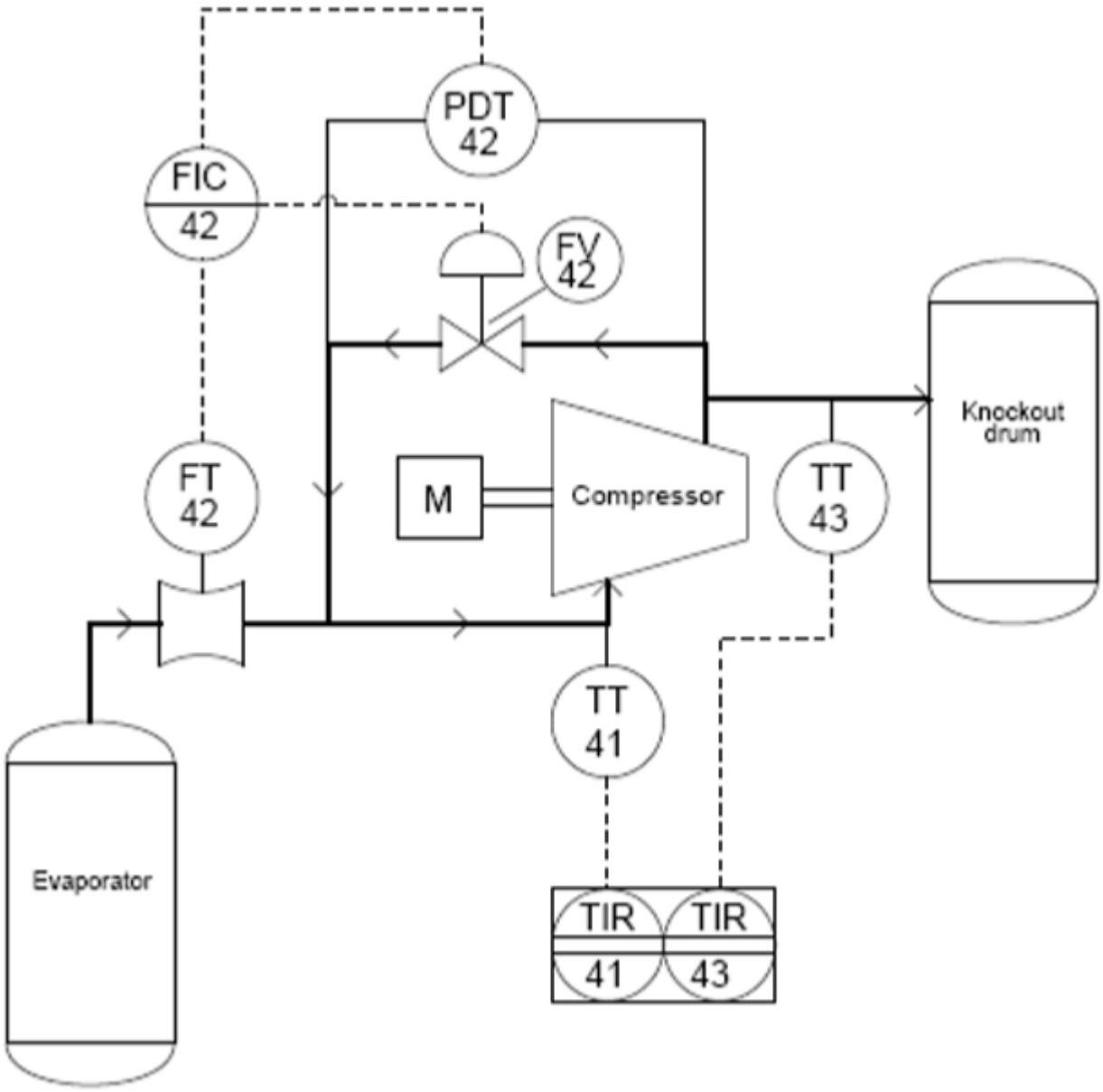
Learning Activity:

1.1 Interpret instrumentation and control standard.

1.2 Read/interpret P&ID diagram.

INSTRUCTIONS:

Analyze the diagram shown below. Answer the questions that follow.



Sample P&ID of a compressor control system

1. Describe the process flow of the compressor control system shown above.
2. Describe the instruments that are involved in the process.
3. Can you specify the instruments that are shown?

Learning outcomes:
1 Plan and prepare for configuration.
Learning Activity:
1.1 Interpret instrumentation and control standard.

1.2 Read/interpret process flow diagram (PFD).

Process Flow Diagram (PFD)

The Process Flow Diagram - PFD, a schematic illustration of the system. A Process Flow Diagram - PFD - (or System Flow Diagram - SFD) shows the relationships between the major components in the system. PFD also tabulate process design values for the components in different operating modes, typical minimum, normal and maximum. A PFD does not show minor components, piping systems, piping ratings and designations.

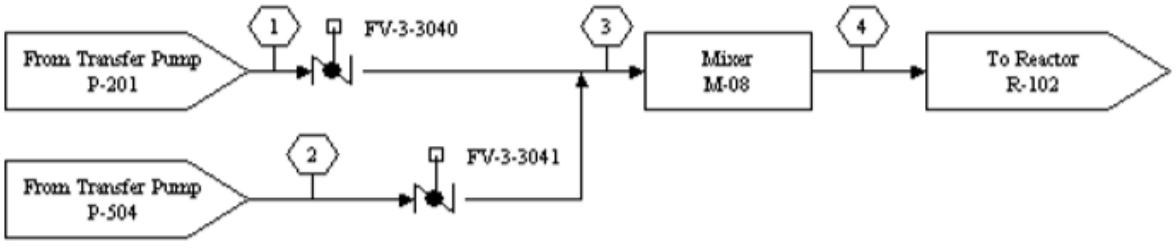
A PFD should include:

- Process Piping
- Major equipment symbols, names and identification numbers
- Control, valves and valves that affect operation of the system
- Interconnection with other systems
- Major bypass and recirculation lines
- System ratings and operational values as minimum, normal and maximum flow, temperature and pressure
- Composition of fluids

System Flow Diagrams should not include:

- Pipe class
- Pipe line numbers
- Minor bypass lines
- Isolation and shutoff valves
- Maintenance vents and drains
- Relief and safety valve
- Code class information
- Seismic class information

This figure depict a small and simplified PFD:



Mode	Parameter	Points			
		1	2	3	4
Normal	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Maximum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Minimum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				

A Small and Simplified

Process Flow Diagram

www.EngineeringToolBox.com

Self-Check 2	**Written Test**

Directions: For the following questions, say TRUE if the statement is correct and FALSE if it is incorrect (wrong).

1. Write some of piping installation equipment? 4%.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
   g. _____

Note: **Satisfactory rating – 2 and above points, Unsatisfactory - below 2 points**

Answer Sheet

Score=_____

Rating:_____

Name:_____ Date:_____

Information Sheet 3 Diagnosing fault/s or problem/s in the device

Test Operator performing recurring testing operations on a variety of electrical, mechanical, and optical hardware.

- Works from prints, schematics, engineering changes, wiring diagrams, procedures, sketches, and similar documentation of electrical, electronic, mechanical, electro-mechanical, hydraulic, pneumatic and other functional subsystems.
- Uses automated and manual test equipment to test, evaluate, and verify the performance of subsystems for conformance with technical and operational requirements and performance standards. Validates and performs system tests thru direction from established Functional Test Procedures (FTPs), station software, and Manufacturing Process Plans (MPPs).
- Sets up and operates requisite checkout equipment, specially designed functional test panels, consoles, and other recording devices.
- Performs troubleshooting/analysis of subsystem failures or malfunctions to determine cause and submit rework recommendation. Rectifies by performing minor repairs, such as replacing malfunctioning units, parts, or wiring and completes checkout, or requests cognizant Manufacturing, Engineering, or Quality division for requisite corrective action, rework or repair processing. Performs retest of reworked or modified subsystems. Accepts or rejects unit under test by generating required documentation within applicable production control and Quality systems.
- Observes records, analyzes, verifies and interprets sectional and composite instrument and panel readings, makes computations and calculations requisite to the collation of data and assists higher graded personnel in locating and eliminating discontinuities and transient irregularities caused by test station interference.
- Recommends changes in tests and testing procedures to facilitate documentation accuracy, obtaining complete and accurate test information, and audit readiness.
- Performs other assigned functions such as maintaining pertinent logs and records, demonstrating equipment operations and trains other technicians as required.

- Assists test Engineering personnel in conducting in depth failure investigations and maintaining test equipment. Conducts regular audits of Test Station work area to insure audit readiness prior to Test commencement.
- Must have the ability to work 1st, 2nd, 3rd, and “D” shift

The experimental setup includes a manual leakage control valves to generates leakage in the system with different levels at various locations of the system. This manually adjusted fault control subsystem allows for the study of fault detection and diagram with controlled fault situation. The initial experimental setup by Festo is shown in Figure 3.1 with a 8 on/off valves combination providing 8 different leak levels by turning on and off different valves. However, the leakage system has a relative smaller flow rate of less than 20 l/min, which is not able to cover the full range of our research interest.

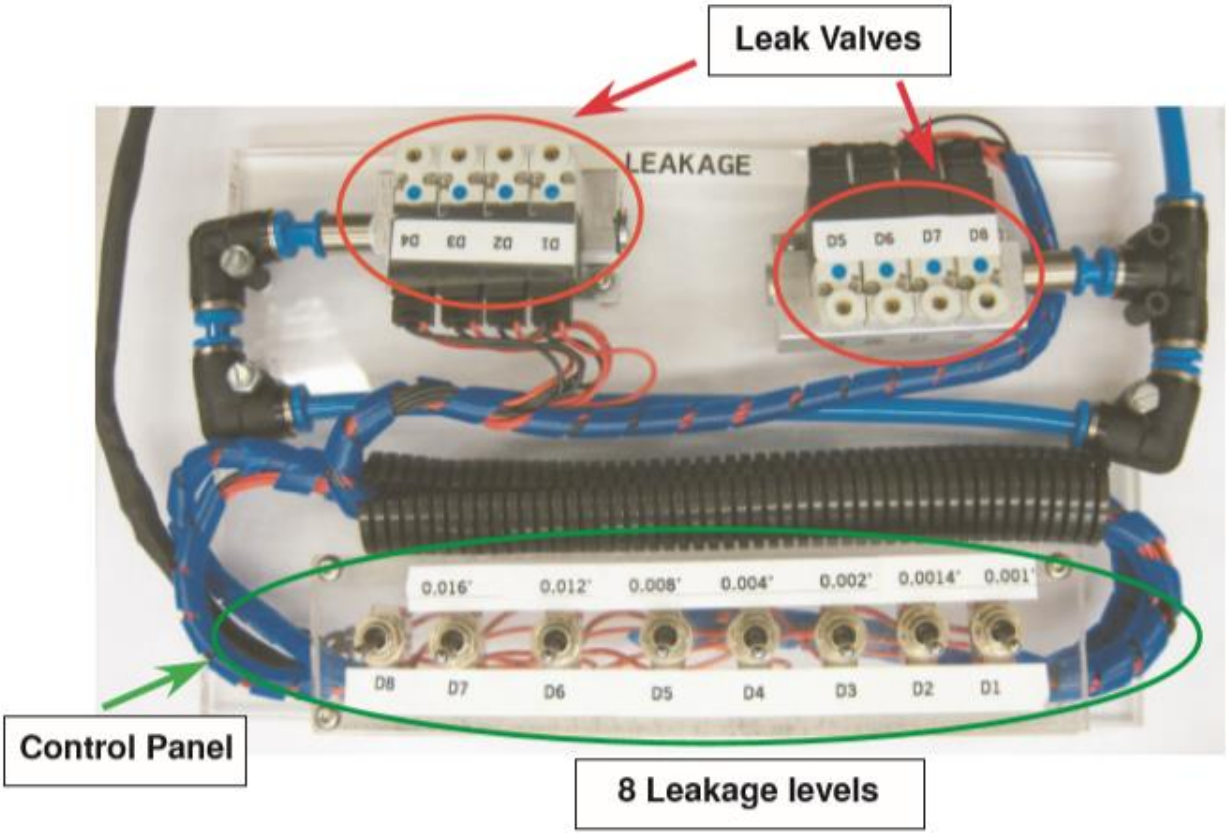


Figure 3.1 Fault (leakage) introduction components

To conquer this disadvantage, we introduce another leakage level control device with higher amount as shown in Figure 3.1 .This is a one way flow control valves (Festo GR3/8B), which is able to offer max. 1000l/min leakage with 20 rotation turns. The GR-3/8B valves is placed on both retract and extend lines connecting to studied cylinder and the supply line of the system. All possible locations where leakage could be introduced in the system are listed in Table 3.2. And Figure 3.3 indicates the 3 possible introduced leakages places at the retracting side of DNC and HMPLV cylinders and the supply line. The maximum turn is set to be 6 is because the limitation of flow meter measuring range

Table 3.1 Leakage locations and levels in the pneumatic system

Actuator	Leakage Potential Location	Leakage Level (number of turns)
All actuators	Supply Line	1 - 6
DNC	Retracting, Extending Line	1 - 6
DRQD	Retracting, Extending Line	1 - 6
DGPL	Retracting, Extending Line	1 - 6
SLT	Retracting, Extending Line	1 - 6
HMPL_H	Retracting, Extending Line	1 - 6
HMPL_HZ	Retracting, Extending Line	1 - 6
HMPL_V	Retracting, Extending Line	1 - 6
HMPL_VS	Retracting, Extending Line	1 - 6
HGD2	Retracting, Extending Line	1 - 6
Regulator	Pilot Line	1 - 6

(200l/min), if higher flow rate value is expected practical case, more investment is needed.

Figure 3.2 Leakage control valve with a silencer

Figure 3.3 Three different leakages introduced at DNC-retracting side, HMPLVretracting side and supply line (in green circle)

The GR-3/8B valve can be turned n turns counterclockwise from its completely closedpositiontosimulatetheleakage. Inthiswaydifferentlevelsofleakagearereliedon The relationship between the number of turns and the nominal flow rate is shown in Figure 3.13 as well as the our test shows the similar property in Figure 3.14. It is noticed that the curve in Figure 3.14 is not linear so the flow rate and pressure do not change linearly with the number of turns. To further understand the variations of pressure and flow rate values under different turns of the valve, relationship of flow rate and pressure is measured and plotted in Figures .

The overall concept of fault detection and diagnosis (FDD) consists in the following three essential tasks:

a. Fault detection: detection of the occurrence of faults in the functional units of the process, which leads to undesired or intolerable behavior of the whole system;
b. Fault isolation: localization (classification) of different faults; and
c. Fault analysis or identification: determination of the type, magnitude end cause of the fault.

The intuitive idea of the model based fault diagnosis technique is to replace the hardware redundancy by a process model which is implemented in the software form on a computer. A process model is a quantitative or a qualitative description of the dynamic and steady-state behavior, which can be obtained using the well-established process modeling technique. This model usually represents the nominal behavior of the system, without any fault.

Deviation from normality was recognized based on the knowledge of how normal components work. In this way, we are able to reconstruct the process behavior on-line, when associated with the concept of hardware redundancy, this is called software redundancy concept. Software redundancy is also called analytical redundancy. Similar to the hardware redundancy schemes, the process model will run in parallel to the process and be driven by the same process inputs in the framework of the software redundancy concept. It is reasonable to expect that the re-constructed process variables delivered by the process model will follow well the corresponding real process variables in the fault-free operating states and show an evident derivation by a

fault in the process. In order to receive this information, a comparison of the measured process variables (output signals) with their estimates delivered by the process model will then be made. The difference between the measured process variables and their estimates is called the residual. Roughly speaking, a residual signal carries the most important message for a successful fault diagnosis: if residual6= 0 then fault, otherwise fault-free (4.1) The procedure of creating the estimates of the process outputs and building the difference between the process outputs and their estimates is called the residual generation. Correspondingly, the process model and the comparison unit build the so-called residual generator, as shown in Figure 4.1. Classical approaches use models to generate residuals with an observer, with a parity space approach, or with the detection filter. The main practical difficulties arise from the model precision and unknown disturbances of the system. This leads to the trade-off between the false alarm and missed detection.. Model-based fault detection methods use residuals which indicate changes between the process and the model. One general assumption is that the residuals are changed significantly so that detection is possible. In other words, the residual size after the appearance of a fault is large enough and long enough to be detected. The most important issue in model-based fault detection is the accuracy of the model describing the behavior of the

Self-Check 3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part II Fill the black space

1. Write three essential fault detection and diagnosis (FDD) tasks?
   a. _____
   _____
   b. _____
   _____
   c. _____
   _____
2. Model-based _____methods use residuals which indicate changes between the process and the model. (2%)

_____,_____

_____,_____

.Answer the following question!

Note: Satisfactory rating 6 and 11 points Unsatisfactory below 6 and 11 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information sheet 4 Configuring instrumentation and control devices

Sensors/transducers/transmitters: - A transducer is a device that converts one form of energy data into another proportionally equivalent form of signal data. A transmitter is a device that conditions and conveys signal data. These terms are often used interchangeably; transducers are more of a general term though. A transducer may form part of a transmitter. A transmitter converts signal from a sensor/transducer into a standard signal.

Relays/Converters/conditioners: - Relays refer to devices which converts signals into another form suitable for a specific application. Examples of relays include I/P converters, square root extractor, differentiator, integrator, summer, etc. Converters are devices for converting standard signals into another type of standard signal. For example, a P/E converter accepts a 3-15 psi pressure input and gives an output voltage of 1-5 VDC.

Signal conditioners are devices which convert signals into many forms suited for other types of application. For instance, signals converted are done so field sensors; transmitters and transducers can interface with indicators, recorders, DCS, PLC and PC based SCADA systems. These devices can also be used to stop erratic measurements caused by ground loops. It can also be used to split one signal, allowing one primary measurement to be sent to two separate systems. Signal conditioners amplify signals to enable more instruments to be added to an overburdened loop. These devices can also step-down dangerous high-voltage signals to safer levels. It can solve DCS start-up problems that result from incompatible signal types.

Controllers/PLCs/DCS: - Intermediate elements are devices that are used to control an instrumentation system. In most cases, intermediate elements are multi-functional, that is, they control and monitor an instrumentation system. A simple process controller is a device used to control the behavior of a process variable, usually, by maintaining its value at one point. It is also referred to as a stand-alone controller.

A programmable logic controller (PLC) is a device for controlling simple and complex automation systems. Originally, PLCs read binary devices such as switches, proximity switches, push buttons, etc. It replaces the function of traditional electrical relays which control binary devices (e.g. lamps, motors, solenoid valves, etc.) but because the technology today is so advanced, PLCs today can also be used to monitor and control simple to complex process control systems. This involves the use of analog devices such as thermocouples, thermistors, RTDs, transmitters, etc.

A distributed control system (DCS) is a combination of instrumentation and control devices which is designed to monitor and control large and complex process control systems. It involves the use of computers and software's for measurement, monitoring and controlling. Although this can also be done by PLCs using SCADA, DCS are designed to handle more complex applications such as a built-in asset management system, inventories, a CMMS and more. A typical DCS can operate one or more plant operations.

Control Valves: - Control valves are the most popular among final control elements. It is used to manipulate (and/or regulate) the flow of material going into the process.

Indicators/meters: - Indicator/meters are devices used for monitoring process variables and process conditions. They are also called readout devices. Most instruments have the display option. Examples are indicating controllers, indicating transmitters and indicating recorders.

Recorders/data loggers: - Recorders and data loggers are examples of monitoring devices which has the ability to store/maintain/record information for future analysis. Information is usually stored in special types of paper, e.g. chart paper, fan-fold charts, thermal papers, etc. Recorders are typically used for trend (continuous) analysis; while data loggers store information at specified time or event. The information stored by data loggers are usually in textual form. Many recorders/data loggers today can perform both functions.

Alarms: - Alarm devices are devices which allow audible or visual devices to get the attention of operators for an abnormal condition or event. Alarm devices usually received signals from a sensor. It is set to activate at one point (or more) which triggers the audible or visual devices, such as flashing lights or horns. Alarms can be found in most instruments (as options) as well, like transmitters, controllers and indicators.

Annunciators: - Annunciator is actually a set of alarms with corresponding lights which lit when triggered. It indicates the condition of a process or equipment. Annunciators may be coupled with a buzzer and other audible alarms for improved call of attention.

Data Acquisition System: - DAS involves the process of sampling real world physical conditions and conversion of the resulting samples into digital numeric values that can be manipulated by a computer. Physical conditions relate to process variable or process conditions, e.g. pressure, temperature, level, flow, alarm conditions, events, etc.

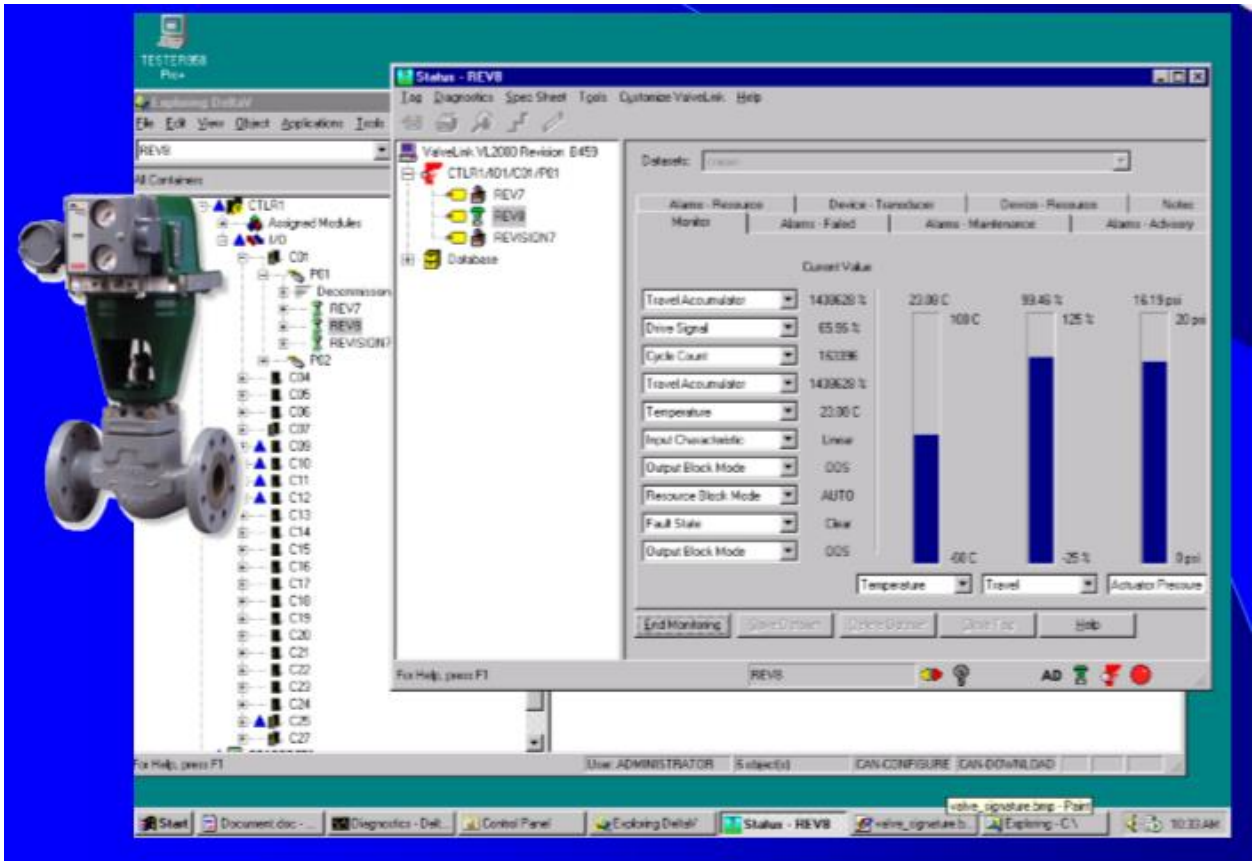


Figure 4.1

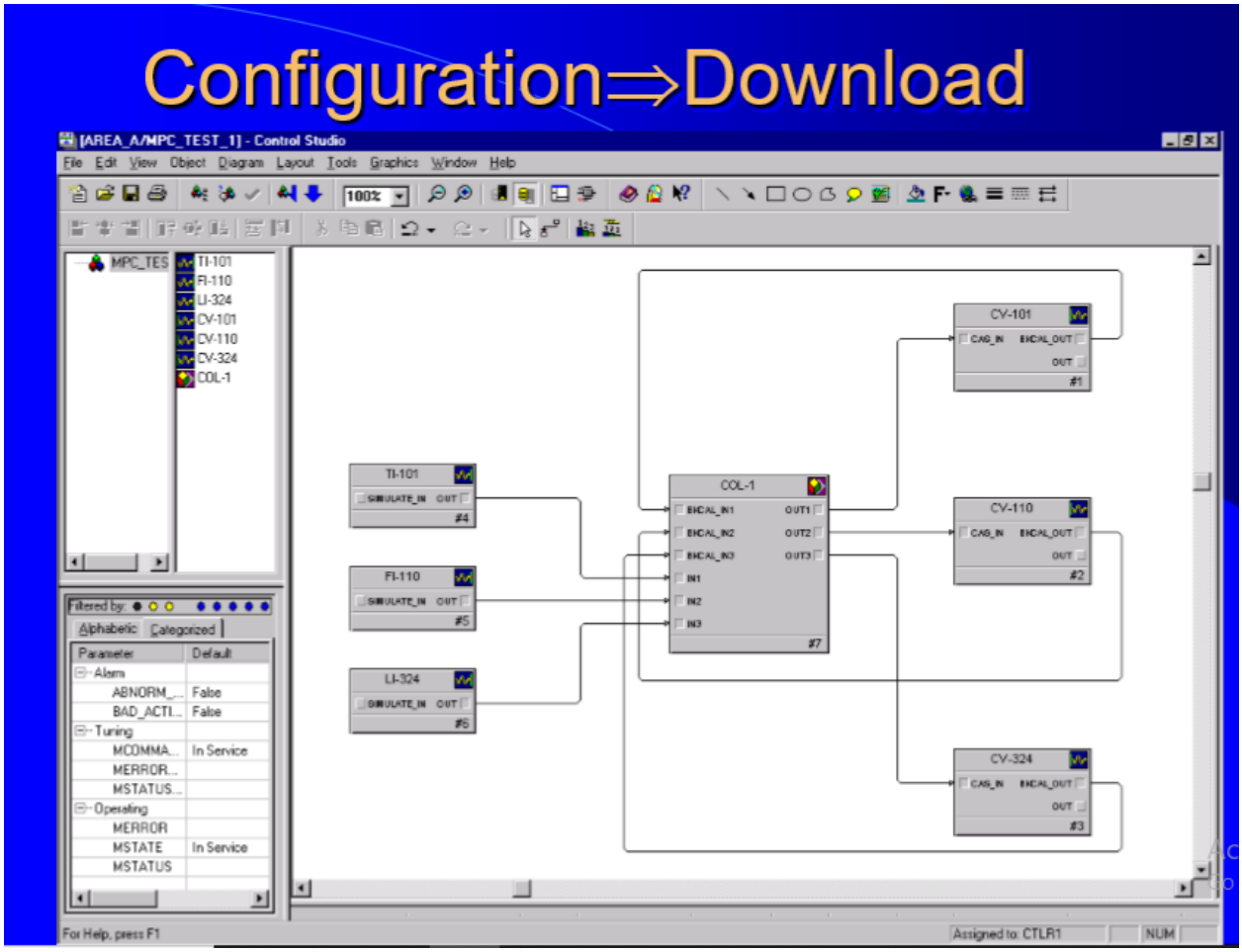

Configuration⇒Download
[AREA_A/MPC_TEST_1] - Control Studio
File Edit View Object Diagram Layout Tools Graphics Window Help
MPC_TES
TI-101
FI-110
LI-324
CV-101
CV-110
CV-324
COL-1
Filtered by:
Alphabetic Categorized
Parameter Default
Alarm
ABNORM_... False
BAD_ACTI... False
Tuning
MCOMMA... In Service
MERROR...
MSTATUS...
Operating
MERROR
MSTATE In Service
MSTATUS
TI-101
SIMULATE_IN OUT
#4
FI-110
SIMULATE_IN OUT
#5
LI-324
SIMULATE_IN OUT
#6
COL-1
BKCAL_IN1 OUT1
BKCAL_IN2 OUT2
BKCAL_IN3 OUT3
IN1
IN2
IN3
#7
CV-101
CAS_IN BKCAL_OUT
OUT
#1
CV-110
CAS_IN BKCAL_OUT
OUT
#2
CV-324
CAS_IN BKCAL_OUT
OUT
#3
For Help, press F1
Assigned to: CTLR1
NUM

Figure 4.2

Self-Check 4	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I Fill the black space

1. _____devices are devices which allow audible or visual devices to get the attention of operators for an abnormal condition or event. (2%
2. _____ refer to devices which converts signals into another form suitable for a specific application. (2%)
3. _____and _____are examples of monitoring devices which has the ability to store/maintain/record information for future analysis. (2%)

. Answer the following question!

Note: Satisfactory rating 4 and above Unsatisfactory below 4 points

points

You can ask you teacher for the copy of the correct answers.

Score = _____
Rating: _____

Answer Sheet

Name: _____ Date: _____

Operation sheet

- Plan and prepare for configuration.

Learning Activity:

- Identify instrumentation and control devices for configuration.
- Specify minimum specification required to configure instrumentation and control devices.

Refer to the diagram below. Analyze the process flow and identify the important elements involve that is part of the instrumentation. Answer the questions that follow.

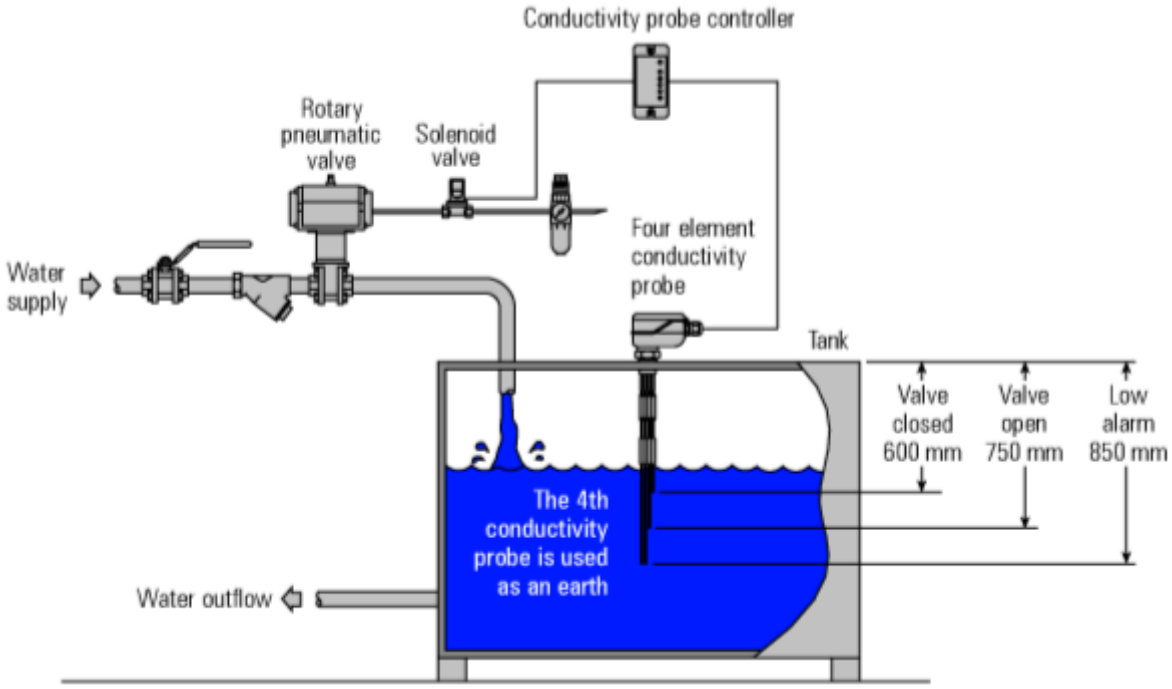


Figure 4.3 Sample level control loop.

1. Describe the process as you understand it.
2. Identify the elements of the level control loop? Describe their function in the above process control application.
3. What are the important specifications required of each device that are involve in the level control loop? Define those specifications.

Job sheet

1 Plan and prepare for configuration.

Learning Activity:

1.1 Understanding a job/work order.

1.2 Become familiar with a job order.

Define a job order or work order?

A job order is a written document which contains orders to perform a job. A work order or job order (sometimes job ticket or work ticket, as it often has some type of ticket attached) is an order received by an organization from a customer or client, or an order created internally within the organization.

A job order contains written instructions to perform a work according to specified requirements, within specified timeframe and cost estimates.

A job order may be a request for products or services.

Sample job orders or work orders

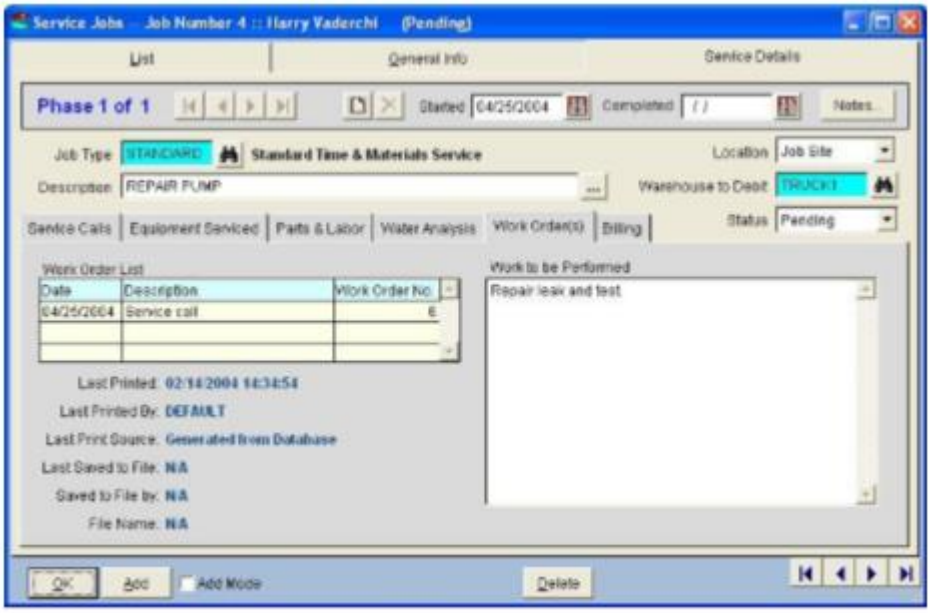


Figure 4.4

The above job order is a computer generated job and can be printed for approval and implementation.

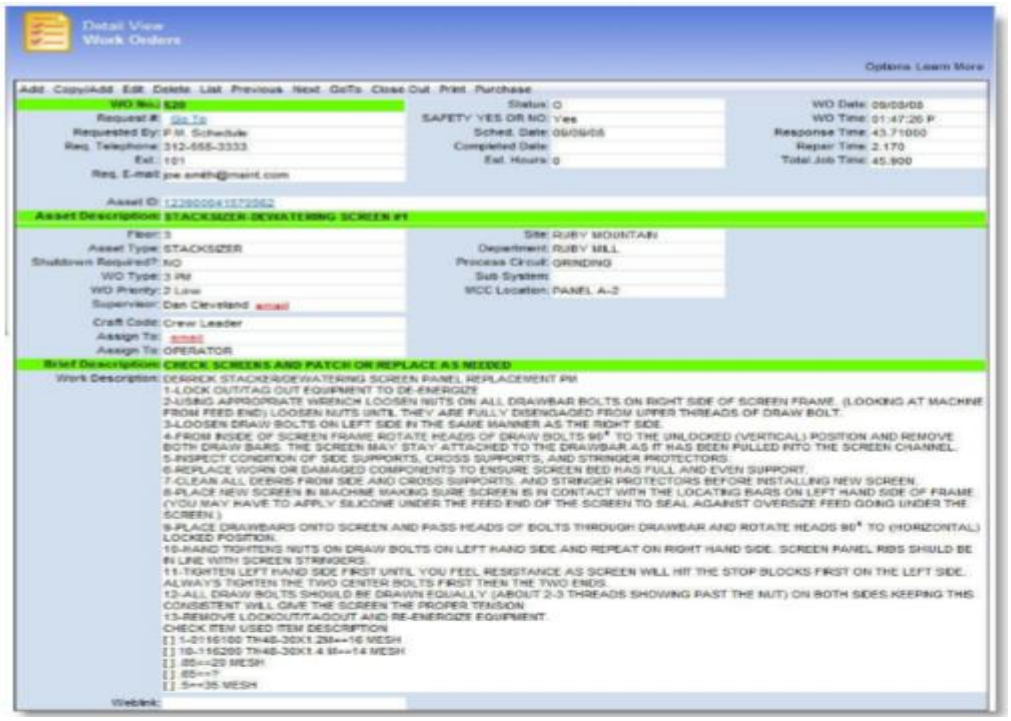


Figure 4.5

The above job order is created via a computer program. It provides important information that would aid the technician to carry out the job well. It tells the technician the location of the job; the type of equipment involve, and even specific location of the equipment to be serviced. It also states the work details that must be performed.

Figure 4.6

The above work order describes a specific job area, which is plumbing works. It already contains what kind plumbing work is to be carried out. A simple tick will do the work order. It already provides information about the cost of labor and materials for plumbing works. This kind

of work order serves a number of purposes. It serves as a proposal, a work order and an invoice as well.

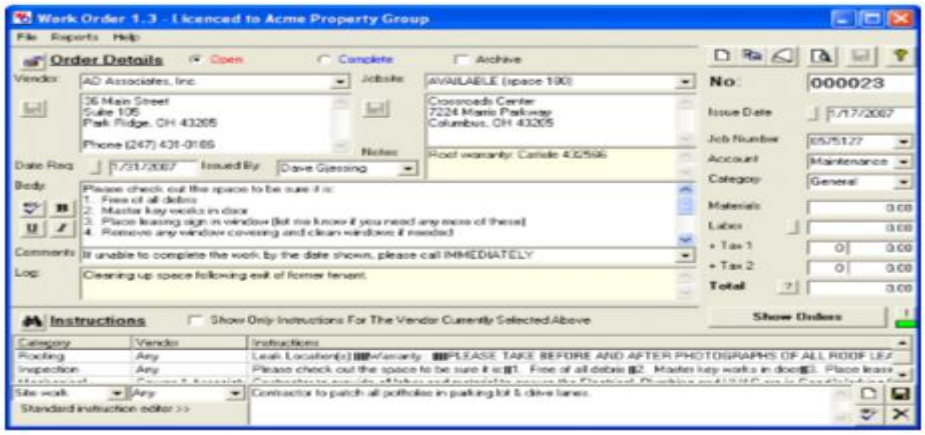


Figure 4.7

This is another example of a work order for maintenance personnel. The work order can be generated via a computer and a specific program. This kind of program can also be incorporated for the maintenance management system of a plant.

In the next example work order from Ground Control, it also provides defined services that will be carried out in the installation of a satellite system. One good thing about this job order is, it also contains an area for customer sign off. A customer signing the work order proves a successful job carried out by the technician. Therefore the service rendered may be billed or declared complete.

Figure 4.8

Information sheet 5 Responding to unplanned events or conditions

Accidents, malfunctions, and unplanned events are accidents or upset events or conditions that are not planned as a part of routine Project activities during any Project phase. Even with the planning and application of mitigation, accidents, malfunctions, and unplanned events could occur during any phase of the Project. These could occur as a result of abnormal operating conditions, wear and tear, human error, equipment failure, and other possible causes. Many accidents, malfunctions, and unplanned events are preventable and can be readily addressed or prevented by good planning, design, equipment selection, hazards analysis and corrective action, emergency response planning, and mitigation. In this section, the potential accidents, malfunctions, and unplanned events that could occur during any phase of the Project and potentially result in significant adverse environmental effects are described, discussed, and assessed. The focus is on credible accidents that have a reasonable probability of occurrence, and for which the resulting residual environmental effects could be major without careful management. It is noted that accidents, malfunctions, and unplanned events are evaluated individually, in isolation of each other, as the probability of a series of accidental events occurring in combination with each other is very minimal. These possible events, on their own, generally have a very low probability of occurrence and thus their environmental effects are of low likelihood. They have an even lower probability or likelihood of occurring together – thus their combination is not considered credible, nor of any measurable likelihood of occurrence. Accidents, malfunctions, and unplanned event scenarios have been conservatively selected that represent higher consequence events that would also address the consequences of less likely or lower consequence scenarios. The accidents, malfunctions, and unplanned events that have been selected based on experience and professional judgment are as follows:

- Worker accident: worker accidents may occur during either construction or operation, and may result in harm, injury, or death to one or more Project workers;
- Fire: consists of a fire in a Project component. The focus is on the consequence, and not the mechanism by which it occurs;
- Hazardous materials spill: spills of fuel, petroleum products, and/or other chemicals used on site or in Project components; and

- Vehicle accident: Project-related vehicle accidents that could occur on the road transportation network.

Worker accident

A worker accident has the potential to interact with communities as it may result in harm, injury, or death to workers. All workers will be properly trained in practices to prevent workplace accidents including Workplace Hazardous Materials Information System (WHMIS), first aid, and other applicable training programs. These procedures are designed to prevent serious injury to staff and the general public as well as to minimize the occurrence of unplanned events and minimize any potential damage to the environment. Interactions between a worker accident and communities will be mitigated by compliance with health and safety legislation, safety by design, and implementation of environmental management measures aimed at protecting human health. Safety risks to workers will be reduced by complying with the requirements of various governing standards including the federal Canada Labour Code, the federal Transportation of Dangerous Goods Act, the Manitoba Workplace Health and Safety Act and all associated regulations. Adherence to public safety codes and regulations will help the Project to be carried out in a safe manner to protect workers and the public. With the application of, and compliance with, these acts, regulations, and standards, including the application of safety and security measures that are known to effectively mitigate the potential environmental effects, the potential environmental effects of a worker accident on communities during construction and operation and maintenance of the Project are assessed as minor.

Fire

A fire at the Project location could interact with the atmospheric environment (smoke emissions), infrastructure and services (stress on services) communities (potential safety risks to workers), land use and property (potential for substantive loss or damage to property of resources), and the aquatic, wildlife and natural vegetation environments (potential contamination with sediment-laden water used in extinguishing the fire). A fire may arise from Project heavy equipment or from natural causes such as a lightning strike. In the unlikely event that a fire occurred, the immediate concern for a fire would be for human health and safety. Local air quality conditions may deteriorate through the duration of the fire. Personnel will take the necessary precautions to prevent fire hazards when at the work site and will keep the site free of all flammable waste. Manitoba Hydro will ensure that personnel are trained in the use of

fire-extinguishing equipment. In the unlikely event of a fire, local emergency response will be able to reduce the severity and extent of damage.

Hazardous materials spill

A hazardous material spill may interact with the atmospheric environment, groundwater resources, aquatic resources, wildlife, vegetation and agricultural land use. Hazardous materials could potentially be released into the air, soils, surface water or groundwater as a result of an accidental spill of solvents, fuels, herbicides etc., during construction or operation and maintenance activities. Project activities including marshalling yard development and use, the presence of material and equipment and vegetation and infrastructure maintenance have the potential to contaminate surface-water quality through the release of deleterious substances (e.g., fuel spills, releases of other potentially toxic materials). The most common potential deleterious chemical substances entering watercourses from Project activities tend to be hydrocarbons and herbicides. In general, spilled hydrocarbons have the potential to affect freshwater organisms both directly (through physical and toxicological processes), and indirectly, (through habitat effects, nutrient-cycling disruptions, and alterations in community and trophic relationships). Direct biological effects to fish include damage to fish gill membranes, fish mortality, irregular behavior, and impaired reproduction from contact with spilled hydrocarbons while indirect effects include substantial decreases in invertebrate populations. Effects to fish habitat include the loss/alteration of riparian vegetation (resulting from post-spill macrophyte cutting and oil-induced effects on vegetation stands) and the loss/alteration of spawning habitat and food sources by sinking particulates clogging substrate interstitial spaces. The only watercourse is an ephemeral stream with very limited fisheries value. Implementation of a detailed spill response plan and a well-designed EnvPP will ensure minimal potential effects to aquatic resources through accidental releases to watercourses. Fuel and oil leakage or other debris from equipment staging may cause soil contamination, which can cause direct mortality of natural vegetation. If soil contaminants flow to wetlands in the area, there may be direct mortality of wetland plants.

Self-Check 5	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I Fill the black space

1. The accidents, malfunctions, and unplanned events that have been selected based on experience and professional judgment are? 8%
   a. _____
   b. _____
   c. _____
   d. _____

. Answer the following question!

Note: Satisfactory rating 4 and above Unsatisfactory below 4 points

points

You can refer at the end of this UC for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

LG #25 LO #3-Inspect and test configured instrumentation and control devices

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Inspecting configured device
- Ensuring final inspections with the manufacturer's instruction/ manual
- Checking instrumentation and control devices
- preparing or completing report

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Inspect configured device
- Ensure final inspections with the manufacturer's instruction/ manual
- Check instrumentation and control devices
- prepare or completing report

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information sheet 1 Inspect configured device

One of the cornerstones to achieving continuous improvement is a command of the quality inspection process. Criteria based inspection plans are created to meet specific regulatory requirements and workflows, depending upon where the product is in the manufacturing lifecycle. Online visibility and real-time tracking of incoming raw materials, parts, and subassemblies are critical to successful inspections. An effective quality management solution can manage all the information related to inspections, and thus deliver a unified view of inspection criteria and results to key company personnel.

A streamlined inspection process eliminates paper documents, standardizes quality, and increases efficiencies on the shop floor. A thorough understanding of the types of inspections that can be automated will help you develop a strategy for success.

- The most common and fully featured inspections are:
  - ✓ Source / On-site Supplier Inspection
  - ✓ Receiving Inspection
  - ✓ Shop Floor Inspection (In-Process)
  - ✓ Final Inspection
  - ✓ First Article Inspection
  - ✓ Returned Material Inspection
  - ✓ Stocked Re-Inspections
  - ✓ Field Inspections
  - ✓ Device inspection
- Source / On-site Supplier Inspection

Source inspections are completed at the supplier prior to shipment to your facility. Inspectors are provided detailed work instructions that can be written specifically for the part, the manufacturer or for a broader part type. Source inspections are the first step in the process that tests for defects and nonconformance, prior to next assembly and determination of production order quantity. These supplier inspections validate compliance with engineering drawings and test things like castings and forgings before production begins. Skill level validation and tool recording are managed at each step to ensure compliance and traceability of tool usage (in

case the tool is found to be out of tolerance). Source inspections can be performed by internal or external providers depending on your level of delegation.

- Receiving Inspection

A receiving inspection serves as a gate keeper prior to a product reaching your inventory. Received materials, components, or finished goods are inspected at a designated step in the product lifecycle. Inspection steps and criteria are authored, revised and approved at the part number, part group and commodity level. To help lower costs, skip lot processing and sampling can be completed at the part/operation level to reduce the number of required inspections for a good supplier. It is the responsibility of inspectors to ensure that the material received arrives as specified in the purchase order and is evaluated for any damage to avoid potential problems later in the production process.

- Shop Floor Inspection (In-Process)

Shop floor inspections seek to examine workflow on the shop floor with the goal of reducing cycle time and Work-in-Process (WIP), while increasing capacity. Resources are evaluated to ensure proper training. Shop floor environmental factors are taken into consideration and products are inspected directly on the shop floor. Shop floor inspections can be performed by both manufacturing and inspection personnel.

- Final Inspection

Final inspections take place when production is complete. The overall product is measured against engineering, customer requirements, and standards. Final inspections and device approvals play an integral role in the decision to move items to stock or shipment. An inspection report is run prior to final device approval to ensure there are no open items. A final inspection report will validate that all required operations are complete, all nonconformances have been resolved, and required traceability has been recorded.

- First Article Inspection

A first article inspection is an initial sampling of a manufactured product to ensure conformity. The product or part is tested to see that it is processed as intended and conforms to the design specifications. For companies in highly regulated industries, a first article inspection will test for compliance with industry regulations. Based on the result of the inspection, an inspector may be presented with additional instructions at receiving or within the manufacturing process.

- Returned Material Inspection

Materials that do not conform to specifications are returned to the manufacturer for rework or repair. Inspection of these materials is necessary before products may be returned to inventory. Returned material inspections link non-conformances with prepopulated data from the inspection for efficient and accurate processing and approval.

- Stocked Re-Inspections

Product quality can change over time so testing intervals are established. If a problem is found with the current stock, sometimes it is necessary to pull all stock from the storeroom and Work-in-process (WIP) to re-inspect for the same problem.

- Field Inspections

Inspections performed in the field have unique requirements. Standards specific to the organization are measured such as operational procedures, site safety, compliance, and product quality.

The successful completion of the quality inspection process relies on a technologically advanced solution that enables the automation of critical processes and ensures compliance objectives are met. Automated scheduling, routings, work instructions, and escalations significantly increase productivity. With an effective quality management system, quality data can be integrated with MES and ERP systems for a complete view of the inspection process. Statistical Process Control (SPC) capabilities can automate data collection in manufacturing or engineering operations.

Additional benefits of a quality management system with advanced inspection capabilities include the elimination of lost paperwork, validation of data entry against master records, and faster processing of inspection information. Inspections can be configured to conform to the standard procedures for each installation. An electronic history of past inspections with audit trail tracking improves accuracy.

Every inspection facilitated with a TIP*QA* Quality Management solution from TIP Technologies is carried out with the goal of simplifying the manufacturing process, improving accuracy, and exceeding regulatory and compliance requirements. With these objectives in mind, risk to the organization will be significantly reduced and overall quality will improve.

Self-Check 1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I Fill the black space

2. What is Stocked Re-Inspections? 3%
3. Write the most common and fully featured inspections? 5%

. Answer the following question!

Note: Satisfactory rating 4 and above Unsatisfactory below 4 points

points

You can refer at the end of this UC for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information sheet 2. Ensuring final inspections with the manufacturer's instruction/ manual

LOOP CHECKING PROCEDURE OF FF and Conventional Transmitter (Flow/Level/Pressure) For FF device commission FF segment prior to loop testing by measuring resistance and DC voltage of segment conductor if all devices are connected otherwise only resistance will be recorded and voltage will be measured after all devices are connected and compare the result with FF segment checkout forms.

- Check and verify the DCS configuration for applicable points. Reference drawings will be P&ID and ISS.
- Apply the pressure for all (Analog / Digital) smart transmitters by using test equipment (Hand Pump) for 0%, 25%, 50%, 75% and 100% simulation to check the transmitter response at DCS. This method shall be used for all smart transmitters.
- Verify the corresponding reading in the DCS / Integral indicator and at remote indicator if applicable.
- For non-smart transmitters case Hand Pump shall be used for simulation or when required (4-20mA) ma source to be used for simulation purpose instead of hand pump.
- Alarms function (in DCS) shall be checked by simulating / verifying the required signal using communicator or hand pump using latest P&ID.
- For displacement type LT Hydraulic pump will be used with hosepipe and transparent tube with liquid (water).
- Normally Transmitter loop test should be performed after completion of the impulse line works including pressure test. In some case loop test can be executed without impulse tubing being connected if piping is not completed.
- In case of impulse line not installed and tested then this exception item to be mentioned in the loop test exception log sheet prior to signing the loop folder.

LOOP CHECKING PROCEDURE FF and Conventional Control Valves Loops

- For FF device commission FF segment prior to loop testing by measuring resistance and DC voltage of segment conductor if all devices are connected otherwise only resistance will

be recorded and voltage will be measured after all devices are connected and compare the results with FF segment checkout form.

- Check and verify the DCS configuration for applicable points. Reference drawings are to be P&ID and ISS.
  - ✓ If any logic / interlocking are involved in applicable loop. Energize the solenoid valve by forcing the applicable ESD points on functional logic and same procedure to be carried out for DCS logic.
  - ✓ If instrument air supply is not available then, dry and clean air or nitrogen shall be used.
  - ✓ Apply the command from DCS for 0%, 25%, 50%, 75%, 100% and monitor the response of the valve from the field.
- Verify the corresponding valve position.
  - ✓ Verify the controller action.
  - ✓ Verify the control valve action on increase signal.
  - ✓ Verify the control valve action on air supply failure.
  - ✓ Verify the control valve max / min travel stopper setting if applicable.
  - ✓ Check the hand wheel manual operation / function if applicable. Auto/ manual calibration is applicable.
  - ✓ Normally control valve loop test should be performed after completion of the external air supply piping works. In some cases when required, loop test can be executed without the internal air supply piping.
  - ✓ In case of air piping is not installed and tested then this exception item to be mentioned in the loop test exception log sheet prior to signing the loop folder.
  - ✓ Loop will be installed only and signed after the clearance of the punch list.

LOOP CHECKING PROCEDURE On / Off Valves Loops

- Valve response time shall be recorded in loop record sheet.
  - ✓ Check and verify the DCS / ESD configuration for applicable points.
  - ✓ If any ESD logic / interlocking are involved in applicable loop to energized solenoid valve, should be prepared ESD points on functional logic and same procedure to be carried out for DCS logic.

- ✓ If instrument air supply is not available then connect nitrogen cylinder. In big size of valve cases, big volume of
  nitrogen will be required then in that case on/off valves function test will be executed upon air supply availability.
- ✓ Apply the command from DCS / field for open and close as applicable.
- ✓ Verifying the corresponding valves position in DCS and field.
- ✓ Verify the partial stroke function test of "ZV".
- ✓ Verify the valve action on air supply failure.
- ✓ Check the hand wheel / hand jack manual operation / function as applicable.
- ✓ Normally On/Off valve loop test should be performed after completion of the external air supply piping works. In some cases when required, loop test can be executed without air.
- ✓ In case of air piping is not installed and tested then this exception item to be mentioned in the loop test exception log sheet prior to signing the loop folder
- ✓ Loop will be initiated only and signed after the clearance of the punch list.

LOOP CHECKING PROCEDURE MOV's Loop

- ✓ Check and verify DCS configuration for applicable points.
- ✓ Valve response time shall be recorded in the loop record sheet against ISS.
- ✓ If any ESD logic / interlocking are involved in applicable loop, then first normal condition should be prepared by forcing. The applicable ESD points on ladder on logic and same procedure to be carried out for DCS logic.
- ✓ Check and verify the logic / remote switch function.
- ✓ Stroke the MOV from DCS and field on applicable commands such as open, close and stop.
- ✓ Verify the status of the MOV at DCS and field.
- ✓ Check the hand wheel manual operation and function if applicable.

LOOP CHECKING PROCEDURE Switches Loops (Flow, Level, Pressure, Temperature)

- ✓ Check and verify the DCS / ESD configuration for applicable points.
- ✓ Simulate the contact operation (Make / Break) at the switch terminal block and verify the status in the DCS / ESD. However, ESD switch case actual pressure simulation to be provided with hand pump.
- ✓ ESD hand switches, Start / Stop, Open / Close shall be checked by operating the switch mechanism.

LOOP CHECKING PROCEDURE Vibration Loops (with Proximitors)

- ✓ Check and verify the VMS / DCS configuration for applicable points.
- ✓ Connect a spare probe to extension cable of applicable proximitors.(If applicable)
- ✓ Insert the probe into the TK-3 wobulator (Bently Nevada) and connect the Multi meter leads at proximitors terminals for check gap voltages.(If applicable).
- ✓ Adjust the probe at approximately (-10Vdc) gap voltages and reset VMS rack.(If pplicable)
- ✓ Simulate the signal by wobulator 0%, 50% and 100% of the range and verify the corresponding reading at VMS / DCS.(If applicable)
- ✓ Verify the response of the high and high alarms at VMS / DCS as per P&ID.
- ✓ Normalize the connection of extension cables. (If applicable)
- ✓ Actual probe gap voltage shall be adjusted to -10Vdc and check the point shows normal in VMS / DCS after VMS rack reset.(If applicable)

Please check also: What is MCC? How Motor Control Centre Works?

LOOP CHECKING PROCEDURE MCC / SWR Loops

- ✓ Check the Power Transmitter linearity on each cubicle wherever applicable VSD commands i.e. AO/AI Shall be included, and the Testing requirements if no test position available.
- ✓ Check and verify the DCS configuration for applicable points.
- ✓ If ESD logic / interlocking are involved in applicable loop, by forcing the applicable ESD points on ladder logic, same procedure to be carried out for DCS logic.
- ✓ Remove the control power transformer primary and secondary fuses for applicable MCC/SWR units (check / confirm if MCC/SWR unit is on test position by electrical).

- ✓ Apply 120Vac power (external power from building outlet) on the secondary fuses load side to energize the control circuit.
- ✓ Apply the command from DCS / ESD Field for start, stop or trip as applicable.
- ✓ Verify the running / stop or trip status in DCS / Field / Sub Station as applicable.
- ✓ Check and verify the local / remote switch function if applicable.
- ✓ After completion of the applicable loop check, the fuses should be returned on the control transformer.

All the above mentioned steps can be carried out with removing the pad lock on the MCC/SWR unit breakers.

Removal of the pad lock on the breakers required permission from Electrical Mechanical section.

Self-Check 2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part II Fill the black space

1. List down at least five verify the corresponding valve position (5%)

_____,_____

_____,_____

_____,_____

_____,_____

2. Write steps loop checking procedure MOV's loop (5%)

_____,_____

_____,_____

_____,_____

_____,_____

. Answer the following question!

Note: Satisfactory rating 5 points Unsatisfactory below 5 points

You can refer at the end this UC for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Score = _____
Rating: _____

Information sheet 3. Checking instrumentation and control devices

Instrumentation is the science of automated measurement and control, or can be defined as the science that applies and develops techniques for measuring and controls of equipment and industrial processes. Process control has a broad concept and may be applied to any automated systems such as, a complex robot or to a common process control system as a pneumatic valve controlling the flow of water, oil or steam in a pipe.

A basic instrument consists of three elements:

- Sensor or Input Device
- Signal Processor
- Receiver or Output Device

To measure a quantity, usually is transmitted a signal representing the required quantity to an indicating or computing device where either human or automated action takes place. If the controlling action is automated, the computer sends a signal to a final controlling device which then influences the quantity being measured. The physical components commonly measured are:

- Temperature, Pressure, Speed, Flow, Force, Movement, Velocity and Acceleration, Stress and Strain, Level or Depth, Mass or Weight Density, Size or Volume, Acidity/Alkalinity.

Sensors may operate simple on/off switches to detect the following:

- Objects (proximity switch), empty or full (level switch), hot or cold (thermostat), pressure high or low (pressure switch).

Most modern analogue equipment works on the following standard signal ranges.

- The accepted industrial standard for electronic signals is a 4 to 20 mA current signal that represents the 0% to 100% process condition.
- The standard industrial range for pneumatic signals is 20 to 100 kPa (3 – 15 psig), which corresponds to a 0% to 100% process condition.

Note: The live zero (4 mA) is used to distinguish between 0% process (4 mA) and an interrupted or faulted signal loop (0 mA). The live zero (20 kPa) allows the control room personnel to distinguish between a valid process condition of 0% (or a 20 kpa(g) reading) and a disabled transmitter or interrupted pressure line (or a 0 kpa(g) reading), providing a coarse rationality verification.

Table 3.1 The main classification according to instrument function

INSTRUMENT	DESCRIPTION
Detector	Are devices that can detect changes in a variable process. May or may not be part of the transmitter
Transmitter	Instrument which has the function of converting signals from the detector or otherwise capable of being sent away to a receiver, usually located in the instrument panel
Indicator	An instrument that indicates the value of the measured quantity sent by a transmitter, detector, etc.
Recorder	Instrument that registers graphically instantaneous all values measured over time, these values are sent by the detector, transmitter, controller etc.
Converter	Instrument whose function is to receive the information in the form of a sign, change this form and send it as an output signal, proportional to the input.
Arithmetic Unit	Instrument that performs operations on input values signals according to a given expression, and provides an output resulting from the operation.

Integrator	Instrument that indicates the values obtained by integrating measurement over time.
Controller	Instrument compares the measured value with the desired and, based on the difference between them, emits a signal to fix for the variable manipulated in order that this difference is equal to zero.
Final Control Element	Device whose function is to modify the value of a variable to take the case back to the desired value.

Detectors: Its main function is to convert radiation energy into an electrical signal. Detectors are used to measure particle physics, nuclear engineering, cosmic radiation, calorimeters and other attributes such as momentum, spin, charge etc. of the particles. There are two basic mechanisms for converting this energy: excitation and ionization.

- Ionization: An electron is stripped from an atom and the electron and resulting ion are electrically charged. Example, 3He neutron detectors, Geiger Mueller, and other gas proportional detectors are examples of ionization detectors.
- Excitation: Electrons are excited to a higher energy level and when the vacant electron is filled, an electromagnetic radiation is emitted. Example, scintillation detectors such as NaI, BGO, CsI, Polyvinyl Toluene (PVT), plastic scintillator and the neutron sensitive glass fibers.

Table 3.2 The most common detectors types and application

Instrument	Detection Principle	Applications
Ion chamber (IC)	Ionization of air (or other gases).	Direct measurement of exposure or exposure rates, with minimal energy dependence.
Geiger-Mueller (GM) Proportional counter (PC)	Ionization of gas with multiplication of electrons.	Detection of individual events, i.e. alpha or beta particles & secondary electrons, for measuring activity (in samples or on surfaces) & detecting low intensities of ambient x or gamma radiation.
Solid state diodes	Ionization of semi-conductor.	Detection & energy measurement of photons or particles; primarily for laboratory use.
Solid state diodes	Ionization & excitation followed by light emission.	Detection of individual events;
-Solids		- NaI (Tl) - photons; energy spectrometry; - ZnS (Ag) - alpha particles; detection only
-Liquids		Detection of low-energy beta emitters mixed with the scintillation fluid.
Photographic film	Ionization of Ag Br.	Personal exposure monitoring.
Thermo-luminescent (TLD)	Excitation of crystal light release by heating.	Personal and environmental exposure monitoring.

Transmitters: Are devices which convert the reading from a primary sensor or transducer into a standard signal and transmits that signal to a monitor or controller. Field instruments or smart transmitters monitor process control variables, such as temperature, pressure, level and flow. There are three kinds of signals that are present in the process industry to transmit the reading of a process variable from the instrument to the centralized control system. These are:

- Pneumatic signals
- analog signals and
- digital signals

Pitot Tubes: Measure the local velocity due to the pressure difference between points 1 and 2 in the diagrams below. Unlike the other differential flow meters, the pitot tubes only detect fluid flow at one point rather than an overall calculation. The first diagram shows a simple pitot tube configuration while the second shows a compact pitot tube configuration.

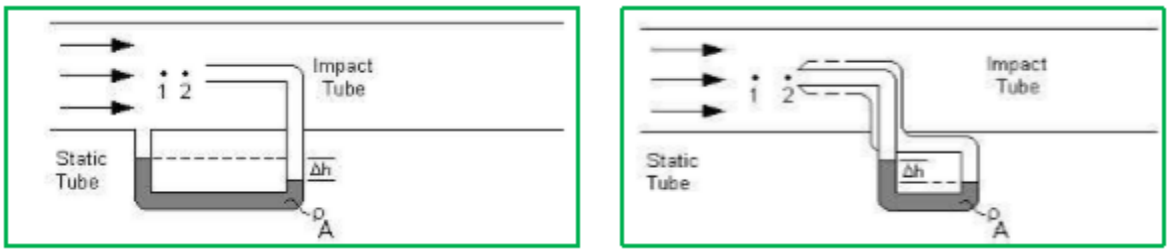


Figure 3.1

Process Control Switches: Process switches generate an on or off output based on a change in variable phenomenon, commonly used in the process control industry to monitor physical quantities such as flow, speed, temperature and pressure. Process switches can be characterized by switching technology used such as electro-mechanical or solid state, available in Normally Open (NO) or Normally Closed (NC) or both configurations.

A typical example is a pressure switch, when the pressure in a chamber has to be controlled with a certain value, 50 psi, as an example. The pressure switch controls the range of this temperature sending a high output when pressure is almost below 50 psi and a low output when pressure reaches almost above 50 psi. The range is defined by the process control of the chamber.

Digital Temperature Indicators: Are instruments with digital displays, built-in easy programmable, Windows-based software, and ideal for monitoring, testing and process control applications. Complete configuration of the instrument can be quickly performed from the front panel, including designating sensor input type, sampling rate, limit settings and resolution. Process and min/max, Values can also be selected for display from the front panel.

Load Cells: Are used in several types of measuring instruments, commonly used as weight-based level instruments to directly measuring the weight of a vessel or a support structure, through transducers used to convert a force into an electrical signal. This conversion is in two stages. Through a mechanical arrangement, the force being sensed deforms a strain gauge. The strain gauges measure the deformation (strain) as an electrical signal, changing the electrical resistance of the wire.

A load cell usually consists of four strain gauges called Wheatstone bridge configuration, with one strain gauge (quarter bridge), or two strain gauges (half bridge), are available. The electrical signal output is typically in the order of a few millivolts and requires amplification by an instrumentation amplifier before it can be used. The various types of load cells are; Hydraulic load cells, Pneumatic load cells and Strain-gauge load cells. Hydraulic load cells, Pneumatic

load cells and Strain-gauge load cells, Piezoelectric Load Cells, Vibrating Wire Load Cells, S-beam Load Cells, Capacitive Load Cells and Button Load Cells.

Digital Positioners: Replace, with many advantages, both the analog I/P and the P/P pneumatic positioners and provide accurate, repeatable signals, simplifying the control circuit and eliminating other components, with a positive feedback indication at the control room. The main difference is that digital positioners work with digital electronic signal conversions rather than analogic.

Digital positioners can also provide communication capabilities through either PROFIBUS-PA™, HART® communication protocols, FOUNDATION™ field bus networks, or even be operated through a Microsoft® Windows®-based HMI (Human Machine Interface) with simple PC software. When manual operations are preferred, simple configuration can also be accomplished using an interface with an intuitive menu, push buttons, and an LCD display. The main digital controllers are:

Figure 3.2

Limit Switches: Are electromechanical devices, adjusted individually for either alternating current or direct current with NC or NO contacts that consist of an actuator mechanically linked to control systems, signal lights, small solenoid valves, electric relays, or alarms, operated by the motion of a machine part or presence of an object. When an object contacts the actuator, the switch operates making or breaking an electrical connection for control of a machine, as safety interlocks, or to count objects passing a point.

Device Net/Control Net: Device Net and Control Net were originally developed by Rockwell Automation and actually are managed by the Open Device Vendor Association (ODVA) using the Common Industrial Protocol, called CIP, for upper protocol layers. Both Device Net/Control Net use a trunk line/drop-line topology with selectable communication rates, and are the world

leading systems for industrial automation, very popular network for time critical applications. The configuration process is based on electronic data sheets (EDS-Files) provided by the device manufacturers, and contain relevant communication parameters, both commonly described as:

- Device Net is a digital, multi-drop network, used in Ethernet I/P layer, serving as a communication network between industrial controllers offering a single point of connection for configuration by supporting both I/O and explicit messaging.
- Control Net offers good real-time capabilities, also used in Ethernet I/P layer, providing high speed deterministic transmission for time-critical I/O data and messaging data.

The ability to embed software commands into the memory of the device represents the real difference between digital and analog I/P segments. This allows automatic configuration and setup of the valve when equipped with a digital controller. The Fieldbus networks exchange data have two methods, Cyclic or Acyclic data:

- Cyclic data: Is information that is pre-configured to pass from one device to another at a known rate. Cyclic data is the sender and the receiver end of the message. Therefore if this cyclic data is not delivered with the proper timing, faults will occur on the network to be monitored for reliability assurance.
- Acyclic data: Are messages sent and received at any time as they are generated by the sender and generally have a lower priority than cyclic messages. The system incorporates a “request” and “response” communications scheme where the message sender waits to receive a response from the target before generating another message.

Self-Check 3	**Written test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Fill the table below

1. Described instrument function listed in below table? (Have 8 point)

INSTRUMENT	DESCRIPTION
Detector	
Transmitter	
Indicator	
Recorder	
Converter	
Arithmetic Unit	
Integrator	
Controller	
Final Control Element	

Answer the following question!

Note: Satisfactory rating 6 and above Unsatisfactory below 6 points

points

You can refer at the end of this UC for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information sheet 4 preparing or completing report

- **The report should have a structure**

There may be different types of the report, but one thing they have in common is that all of them require to be written following a particular structure**.** If possible, organize information into different sections so that your intended readers will be able to easily identify the most relevant parts that they want to read first. Alternatively, they can quickly go back to an earlier section, if they have to. Most types of reports contain common sections such as an abstract, or background of the project, which explains what the project is and its purpose, and a final summary of the entire project.

- **Ensure that the report is evidence-based and is supported by data**

A credible and extensive project report is underpinned by a significant amount of data, whether it is about the performance of the team or a comprehensive report about the project results**.** Using charts, tables, and graphs is a surefire way of making the report interesting and reliable for those who will read it. There is also an extensive selection of project management tools available offering different responsive reporting components to assist the project manager in compiling and presenting meaningful data.

- **Make it as objective as possible**

There is a clear distinction between facts and opinions**.** These should never be used together, especially if the report is dwelling on a failed project. The report becomes subjective if it reflects personal opinions of the writer. Make it objective by eliminating all parts which are not based on facts and real events. If it is really necessary to include a personal view or opinion, make sure to explicitly identify it as such. A separate section of the project report may be devoted to the writer's personal opinion to keep the rest of the report unbiased.

There are a number of ways project reporting helps an organization, a team, and even the project itself and here are some of them:

- **It tracks the progress of the project**

You should regularly check up on the amount and quality of work being accomplished and check it against the plan. It can ensure that the project is kept on track, and any problems, no matter how small they are, will be taken care of in order to prevent them from escalating into bigger ones.

- **It helps identify risks**

Risks are everywhere. Risk can make or break a project depending on how well the team was able to deal with it. Through regular project reports, these risks are monitored, and the team can identify ways to handle them.

- **It helps manage project cost**

Without regular updates on how the project is moving, project costs might get out of hand. Project reports make it possible to monitor expenses and manage the budget. It also promotes transparency with regards to the financial aspects of the project.

- **It gives stakeholders an insight on how the project is performing**

Project reports provide stakeholders a bird's eye view of its current state. It gives the team a clear understanding of their roles and the tasks that they are to accomplish. For the project manager, the reports provide them with updated relevant data. Lastly, project reports serve a basis for the decisions that have to be made at the top management level.

- **Project Report Template:**

Status Report

Project

Status: (Red Yellow Green)

Date: _____

Contact: _____

Prepared By: _____

Overall Status: Green

Explanation: _____

Key Accomplishments

List key tasks and milestones achieved in this period, along with any key changes

ID #	Key Issues	Action Plan	Status
			Open

Critical Milestones	Health	Due Date	Comment/Status
	G		
	G		
	G		
	G		
	G		
	G		
	G		
	G		

Tired of working with reports manually? Prosperforms.com is a modern solution to share regular reports and gather insights automatically.

Prosperforms.com collects data regularly with scheduled auto reminders. Run powerful reports with export and print features.

Project Name	
Project Director	
Estimated completion date	

1. Current status

2. Critical issues and decisions required

Description	
Suggested course of action	
Decisions required	

3. Current finances

Estimated total cost	
Initial cost estimate	
Total spend to date	

Planned spend to date	
Forecast spend	

Comment:

-

Review history — log of previous reports by date

• Date	•
• Report	•

Tired of working with reports manually? Prosperforms.com is a modern solution to share regular reports and gather insights automatically.

Prosperforms.com collects data regularly with scheduled auto reminders. Run powerful reports with export and print features.

Project status report

PROJECT SUMMARY

Report Date	Project Name	Prepared By
[Select Date]	[Project]	

STATUS SUMMARY

PROJECT OVERVIEW

Task	% Done	Due Date	Driver	Notes

BUDGET OVERVIEW

Category	Spent	% of Total	On Track?	Notes

RISK AND ISSUE HISTORY

Issue	Assigned To	Date

CONCLUSIONS/RECOMMENDATIONS

Tired of working with reports manually? Prosperforms.com is a modern solution to share regular reports and gather insights automatically.

Prosperforms.com collects data regularly with scheduled auto reminders. Run powerful reports with export and print features.

Self-Check 4	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I Fill the black space

i. How we can tracks the progress of the project? 3%

ii. Write to ensure that the report is evidence-based and is supported by data? 3%

. Answer the following question!

Note: Satisfactory rating 4 and above Unsatisfactory below 4 points

points

You can refer at the end of this UC for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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We wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this TTLM.

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This TTLM developed on December 2020 at Bishoftu Management Institute Center.

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11. https://www.safetyandhealthmagazine.com/articles/10994-reporting-near-misses
12.

Answer key

LG #23 LO #1- Plan and prepare for configuration

Self-Check 4	**Answer sheet**

1. An INTEGRATOR
2. SIGNAL FILTER
3. Modems
4. Buffer

Self-Check 5	Answer sheet

1.

a. The provision of independent assurance that the organization's preventative and corrective O&M strategy is in alignment with accepted industry good practice

b. Demonstrating due diligence for the operations and maintenance of installed SIS

c. Professionalism

d. Establishing an efficient, systematic and repeatable safety management system (procedures, techniques, tools, etc.) to maintain functional safety performance

e. Traceability and supporting documentary evidence covering the required O&M preventative, corrective, operational, inspection, change management and proof testing of the SIS

Self-Check 6	Written Test

1. Device Net

2. Control Net

Self-Check 7	Answer sheet

1.

a. Wide range sink and source operation (3.2 A, 110 V, 60 W)
b. Precise pulse generation (down to 100 µs width with 1 µs resolution)
c. Battery simulator version available

2.

d. Dual sink and source operation: 7 V and 3.2 A or 18 V and 1.2 A
e. Precise pulse generation (down to 100 µsec width with 0.1 µsec res.)
f. 50 V version available, 50 V and 0.6 A or 20 V and 1.2 A

LG #24 LO #2-Configure instrumentation and control devices

Self-check 1	**Answer sheet**

1. Permeability, Abrasion, Resistance, Burn resistance, Insulation, Cut resistance, Ability to be cleaned, Size, Comfort.

2.

a. Designers, manufacturers or suppliers of PPE can give advice on the specifications and appropriate use of their products.
b. Hazardous chemical safety data sheets
c. Risk assessments
d. Safe work procedures (safe work methods statements/job safety analysis).

Self-Check 2	**Answer sheet**

1.

b. Instrument root valves
c. Control relays
d. Manual switches
e. Equipment rating or capacity
f. Primary instrument tubing and valves
g. Pressure temperature and flow data
h. Elbow, tees and similar standard fittings
i. Extensive explanatory note

Self-Check 3	**Answer sheet**

1.

a. Fault detection: detection of the occurrence of faults in the functional units of the process, which leads to undesired or intolerable behavior of the whole system;
b. Fault isolation: localization (classification) of different faults; and
c. Fault analysis or identification: determination of the type, magnitude end cause of the fault.

2. fault detection

Self-Check 4	**Answer sheet**

1. Alarm 2. Relays 3. Recorders, data loggers

Self-Check 5	**Answer sheet**

1.

a. Worker accident
b. Fire
c. Hazardous materials spill
d. Vehicle accident

LG #25 LO #3-Inspect and test configured instrumentation and control devices

Self-Check 1	**Answer sheet**

1. Product quality can change over time so testing intervals are established. If a problem is found with the current stock, sometimes it is necessary to pull all stock from the storeroom and Work-in-process (WIP) to re-inspect for the same problem.
2.
    a. Source / On-site Supplier Inspection
    b. Receiving Inspection
    c. Shop Floor Inspection (In-Process)
    d. Final Inspection
    e. First Article Inspection
    f. Returned Material Inspection
    g. Stocked Re-Inspections
    h. Field Inspections
    i. Device inspection

Self-Check 2	**Written Test**

1.
    a. Verify the controller action.
    b. Verify the control valve action on increase signal.
    c. Verify the control valve action on air supply failure.
    d. Verify the control valve max / min travel stopper setting if applicable.
    e. Check the hand wheel manual operation / function if applicable. Auto/ manual calibration is applicable.
    f. Normally control valve loop test should be performed after completion of the external air supply piping works. In some cases when required, loop test can be executed without the internal air supply piping.

g. In case of air piping is not installed and tested then this exception item to be mentioned in the loop test exception log sheet prior to signing the loop folder.

h. Loop will be installed only and signed after the clearance of the punch list.

2.

b. Check and verify DCS configuration for applicable points.

c. Valve response time shall be recorded in the loop record sheet against ISS.

d. If any ESD logic / interlocking are involved in applicable loop, then first normal condition should be prepared by forcing. The applicable ESD points on ladder on logic and same procedure to be carried out for DCS logic.

e. Check and verify the logic / remote switch function.

f. Stroke the MOV from DCS and field on applicable commands such as open, close and stop.

g. Verify the status of the MOV at DCS and field.

h. Check the hand wheel manual operation and function if applicable.

Self-Check 3	**Answer sheet**

1. Described instrument function listed in below table? (Have 8 point)

INSTRUMENT	DESCRIPTION
Detector	Are devices that can detect changes in a variable process. May or may not be part of the transmitter
Transmitter	Instrument which has the function of converting signals from the detector or otherwise capable of being sent away to a receiver, usually located in the instrument panel
Indicator	An instrument that indicates the value of the measured quantity sent by a transmitter, detector, etc.
Recorder	Instrument that registers graphically instantaneous all values measured over

	time, these values are sent by the detector, transmitter, controller etc.
Converter	Instrument whose function is to receive the information in the form of a sign, change this form and send it as an output signal, proportional to the input.
Arithmetic Unit	Instrument that performs operations on input values signals according to a given expression, and provides an output resulting from the operation.
Integrator	Instrument that indicates the values obtained by integrating measurement over time.
Controller	Instrument compares the measured value with the desired and, based on the difference between them, emits a signal to fix for the variable manipulated in order that this difference is equal to zero.
Final Control Element	Device whose function is to modify the value of a variable to take the case back to the desired value.

Self-Check 4	**Answer sheet**

2. You should regularly check up on the amount and quality of work being accomplished and check it against the plan. It can ensure that the project is kept on track, and any problems, no matter how small they are, will be taken care of in order to prevent them from escalating into bigger ones.
3. A credible and extensive project report is underpinned by a significant amount of data, whether it is about the performance of the team or a comprehensive report about the project results**.** Using charts, tables, and graphs is a surefire way of making the report interesting and reliable for those who will read it. There is also an extensive selection of project management tools available offering different responsive reporting components to assist the project manager in compiling and presenting meaningful data.